

UNIVERSITY OF EDUCATION, WINNEBA

**PRE-SERVICE BIOLOGY TEACHERS' KNOWLEDGE, CULTURAL
BELIEFS AND ATTITUDES TOWARDS PERSONS WITH GENETIC-
RELATED CONDITIONS**



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RELATED CONDITIONS**



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**A thesis in the Department of Science Education,
Faculty of Science Education, submitted to the School of
Graduate Studies in partial fulfilment of
the requirements for the award of the degree of
Master of philosophy
(Science Education)
in the University of Education, Winneba**

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DECLARATION

STUDENT'S DECLARATION

I, Rose Perfect Antwi, declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE:

DATE:



SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of thesis/dissertation/project as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: Dr. Ernest I. D. N. Ngman-wara

SIGNATURE:

DATE:

DEDICATION

To my parents, Mr. Antwi Kingsley Boateng and Mrs Jessie Gagakumah and the entire Antwi family and also to my best friend Gideon Nunoo.



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I am very grateful to the Almighty God for granting me the strength to carry out this research work.

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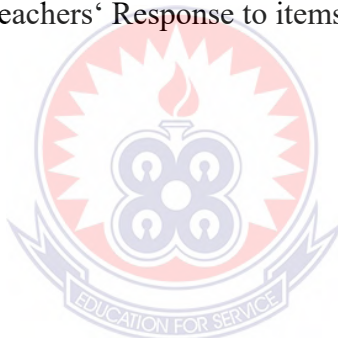
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ABSTRACT

Despite the increasing scientific knowledge, cultural beliefs and attitudes of pre-service biology teachers towards persons with genetic conditions still seems to be negative and the stigmatisation attached to it is worrisome. It was therefore the purpose of this study to explore pre-service biology teachers' knowledge, beliefs and attitudes towards persons with genetic-related conditions in the Central Region of Ghana. A descriptive survey design was employed in this study. An intact sampling technique was used to sample 162 final year pre-service biology teachers from OLA and Fosu Colleges of Education who participated in the study. A five-point Likert Scale item questionnaire was used to elicit information from pre-service biology teachers to answer the research questions. The data was processed using SPSS version 20. The influence of pre-service biology teachers' knowledge on their attitude towards persons with genetic-related conditions was determined through correlational analysis. The study found out that the final year pre-service biology teachers had moderate knowledge on genetic-related conditions, positive cultural beliefs and positive attitudes towards persons with GRCs. Correlational analysis of their knowledge against their attitude showed that their knowledge had a little influence on their attitude. The study recommended that further studies should involve all pre-service biology teachers



CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter entails the entire framework of the study. The chapter contains the background to the study, statement of the problem, purpose of the study, research objectives, research questions, significance of the study, limitation and delimitations of the study, and operational definition of key terms.

1.1 Background to the Study

In Ghana, Pre-service biology teachers pass through secondary education where they were taught the concept of genetics and evolution before entering College of Education. They should be able to use the knowledge gained to review their beliefs on certain genetic-related problems in the society such as albinism, sickle cell anaemia and haemophilia. They should be able to educate the students on the causes of these problems and how to handle them. In so doing the teacher would be helping in demystifying these problems in the society. This is because there are various genetic inherited problems that have different meanings in diverse cultural certain in Ghana.

The incidence of sickle cell disease in sub-Saharan Africa is one of the highest in the world (Prabhakar, 2009). Loew (2005) said that a widespread misconception is that persons must only come from Africa to be at risk. This is not true. Loew continued by saying that sickle cell anaemia and related diseases are found in the Middle East, India, Southeast Asia, China and the Philippines and not only Africans.

Most individuals suffering from sickle cell anaemia in rural areas in Africa pay a fatal price in early years of their lives because they are unable to look for care (Prabhakar, 2009). They fail to seek proper health care because there is the misconception that

sickle-cell disease is associated with evil spirits. It is said that evil spirits (witches) suck the blood of the patients and this even discourages parents from spending money on such diseases (Prabhakar, 2009). They resort rather to consultation of spiritualists for answers. Products of Senior High School (S.H. S) in Ghana should be able to understand how sickle cell anaemia is inherited because they are expected to learn genetics as part of the topics in the integrated science and elective biology course.

According to Mesaki (2008), albinos are deserted, killed or used for ritual sacrifice in many African societies such as Zimbabwe. He went on to say that albino children born to Maasai women were denied breast feeding and had to pass through harsh conditions. The famous Malian singer, Salif Keita, an albino, and his mother were expelled by his father because the father could not comprehend how black man could have white skin, Mesaki continued. Some parents refused to send their albino children to school due to the stigma attached to them. Again, some societies accuse parents with albino's children as having invoked God's punishment (Zimbabwe Albino Association, 2003). These beliefs are not different in Ghana. Albinos are believed to possess evil powers and incarnation of offspring of river gods. Some have it that albino organs have mystical powers that can make a person marvelously rich within a short time (Magobe, 2008). Recent revelation by Sheikh Salawati Imam Rashid, a one-time Imam in the Ghana Armed Forces, that some politicians in Ghana used albinos and children for rituals in the quest for powers (Gomoda, 2009; Daily Guide, 2009). This shows that the rights of albinos are abused without the needed attention being paid to them. The stigmatisation and the abuse can best be stopped through education of Ghanaian children or students in the Senior High Schools so that they too can disseminate what they acquire to the larger society.

According to Abbey, Alhassan, Ameyebor, Essiah, Fometu and Wiredu (2001), the inability of couples to have children is one of the major problems in many societies in Ghana. For example, it is alleged that a male who dies without being able to give birth is punished by inserting pepper into his anus. In most situations it is the husbands who blame their wives for frequent miscarriages and lack of pregnancy. Some men end up breaking their marriages. One of the causes of this problem may be the incompatibility of the blood of the foetus and mother due to the Rhesus factor (Abbey, Alhassan, Ameyebor, Essiah, Fometu & Wiredu, 2001).

Sex preferences in many societies in Ghana puts pressure on parents. Some husbands accuse their wives of not giving them children with preferred sex and this creates tension in the family. Many husbands become unfaithful to their wives by taking concubines with the hope of getting their preferred sex in their children (Abbey et al., 2001). Some of the negative effects of this include contracting sexually transmitted diseases, enmity between in-laws and broken homes. The inclusion of genetics in integrated science curriculum of senior high school is to help students know how sex of a child can be determined. This will enable them to dispel some of the unscientific beliefs common in their society that the woman determines the sex of the children.

In certain societies in Ghana, twins are seen to possess some evil powers which can be used to cause trouble in the family (Ladzekpo, 2003). People are therefore careful when dealing with twins. Some rituals are performed for twins and they are not allowed to eat certain foods and meat such as meat from rats. Beliefs about twins are common in other African countries such as Nigeria (Leroy, Olaleye-Oruene, Koeppe-Schomerus & Bryan, 2002).

Individuals with Down syndrome are viewed as strange people. Many societies in Ghana consider it as a disgrace to give birth to a child with this genetic disorder. Literature reviewed shows that, in England, some of the pregnancies which were diagnosed of Down syndrome were terminated (Morris & Alberman, 2009). If such killings go on in such developed countries, then the situation in Africa and for that matter Ghana can be horrible. Children with Down syndrome are stigmatised most of the time and discriminated against. Mentally retarded people are called “idiots”, “imbecile” and “moron” (Carr, 2009). They are believed to have come from river gods and are also stigmatised and at times abandoned.

Albinos are found in all societies in the world. There is the lack of knowledge on albinism. This has resulted in the insecurity caused by negative attitudes towards albinos. Recently, people with albinism have grown to be vulnerable to attacks and unwarranted killings from persons who believe that their body parts and limbs of people with albinism can be superstitiously used to generate income.

One can appreciate why we should be concerned with the effect of the above-mentioned beliefs on pre-service biology teachers who have had education on genetic disorders. It is therefore on this basis that the researcher deemed it necessary to undertake this study.

1.2 Statement of the Problem

Teachers' misunderstanding of subject matter may affect students understanding of what they are taught. Students would not be able to use what they learn to solve problems in the society if they do not understand the concept they are taught. Teachers who do not understand the concept of the subject may find it difficult in assembling appropriate teaching and learning materials and using them effectively to

achieve the objective of the lesson. Teachers' understandings of the central concepts of the subject they teach enable them to ensure that their students get deeper understanding of the central ideas and issues in the subject (Kennedy, 1997). She continues to say that students' understanding of concept in the subject matter helps them in seeing how these ideas relate to and can be put into use in real world situation.

It has been recognised that the cultural background of the students plays a role in preventing improvement in students' performance in schools (Avalos, 2005). The teacher has to identify the cultural beliefs of himself or herself and also his/her students in order to present his or her lesson in such a way that there would be conceptual change in the students concerning the topic or the lesson. The science teachers cannot bring about conceptual change in students if they do not understand the concept being introduced to them. Pre-service biology teachers' understanding of the concepts they will teach in future is therefore of great importance in realizing the national goals for science education.

Chattopadhyay (2005) observed that some undergraduate students lack understanding of genetic information related to cells and transmission of genetic information during reproduction. Shaw, Horne, Zhang and Boughman (2008) citing Lewis, Leach and Wood-Robenson (2000) and Lewis and Kattmann (2004) in separate studies showed that students fail to understand the genetics taught in the classroom, and this misunderstanding leads to their inability to use basic knowledge on genetics in their daily life situations. If pre-service biology teachers who are being equipped with scientific knowledge to teach the children have poor knowledge, beliefs and attitude, then how can the children know the right concept to change the stigmatisation and

other bad practices that the victims of genetic-related conditions encounter? To the best of my knowledge not much, if any, investigation has been conducted on this topic in Ghana in this area of science. It is therefore on this premise that the researcher deemed it necessary to investigate pre-service biology teachers' knowledge, beliefs, and attitudes towards persons with genetic-related conditions.

1.3 Purpose of the Study

The purpose of this study was to explore the knowledge, cultural beliefs, and attitudes of Preservice biology teachers towards persons genetic-related conditions in the Central Region of Ghana.

1.4 Objectives of the Study

The main objective of this study was to explore the knowledge, cultural beliefs and attitude of Pre-service biology teachers towards genetic-related conditions in the Central Region of Ghana. Specifically, this study sought to:

1. Determine pre-service biology teachers' knowledge about genetic-related conditions.
2. Examine pre-service biology teachers' cultural beliefs about genetic-related conditions.
3. Ascertain pre-service biology teacher's attitudes towards persons with genetic-related conditions.
4. Explore the influence of pre-service biology teachers' knowledge of genetic-related conditions on their attitudes towards persons with genetic-related conditions.

1.5 Research Questions

The following research questions guided the study:

1. What knowledge do pre-service biology teachers have about genetic-related conditions?
2. What cultural beliefs do pre-service biology teachers hold about genetic-related conditions?
3. What are the attitudes of pre-service biology teachers towards persons with genetic-related conditions?
4. To what extent does pre-service biology teachers' knowledge influence their attitudes towards genetic-related conditions?

1.6 Significance of the Study

The inculcation of genetics education in the curriculum of Junior High School and Senior High School (SHS) is supposed to have a positive impact especially in promoting scientific literacy to enable pupils and students appreciate persons with genetic-related conditions. The study will serve as an eye opener and will provide relevant information to pre-service teacher, teachers and other stakeholders. This will enable preservice biology teachers to be well equipped with the knowledge of genetic-related conditions. The scientific literacy knowledge gained by the pre-service biology teachers will in turn change their beliefs which can also influence their attitude towards persons with genetic-related conditions.

Moreover, when pre-service biology teachers are well equipped with scientific knowledge about genetic-related conditions, they will be able to translate the knowledge gained to the students and pupils alike. This will also help alleviate the many misconceptions and stigmatizations that surround persons with genetic-related

diseases. When children or students are equipped with the right scientific knowledge about genetic-related conditions, they will be able to educate their parents and relatives who hold cultural and superstitious beliefs about genetic-related conditions.

Knowledge on genetic-related conditions can also help put a stop to some bad socio-cultural practices that are carried out on victims of genetic related conditions, example the use of albinos for sacrifice.

The outcome of the research will be useful to Colleges of Education as to how they could handle the concepts of heredity to fully equip pre-service biology teachers with the needed understanding of the concept of inheritance for their own perusal and their future students.

1.7 Limitations

The sample for this study was selected from only two Colleges of Education in Central Region of Ghana and as such, findings could not be generalized to all Pre-service biology teachers in Ghana. Some respondents felt reluctant to participate and also respond to the questionnaire due to varying reasons. The pre-service biology teachers stated that they don't have enough time to respond to the questionnaires, others stated that they were preparing for their final year examination and as such they wouldn't want to spend their time on any other matter aside their pending exams. Therefore, the necessary explanation of the essence of the study was provided to respondents before the administration of the instrument.

1.8 Delimitations

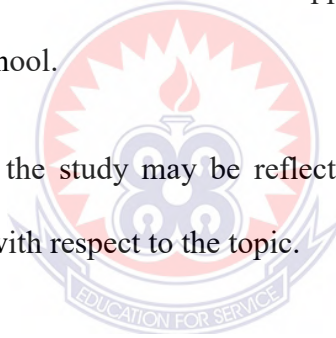
This study was confined to only pre-service biology teachers in the Central Region of Ghana. This is because it was not possible to engage all pre-service biology teachers

in the country since it required extended time frame, financial and supervisory roles which wouldn't have permitted the researcher to accomplish the task within the specified time frame.

Also, the study was delimited to specific related conditions such as Albinism, Down syndrome, Sickle cell anemia, Hemophilia and Parkinson's Disease, Huntington's Disease, Muscular Dystrophy, Colour Blindness, Tay-Sach's Disease and Cystic Fibrosis.

However, though pre-service biology teachers come from different parts of the country they share similar experiences, also, same Integrated Science curriculum was used by science teachers to teach them from upper primary through Junior High School to Senior High School.

Therefore, the results of the study may be reflective of what pertains among pre-service biology teachers with respect to the topic.



1.9 Abbreviations

SHS- Senior High School

PSBT- Pre-Service Biology Teachers GRC- Genetic-related condition

PD – Parkinson's disease

1.10 Definition of Terms

Knowledge of genetic-related conditions refers to an individual's ability to understand and appreciate the basic principles underlying the causes of genetic disorders and how such conditions and disorders can be prevented or managed.

Cultural beliefs in this study refers to a set of behavioural pattern related to thoughts,

manners and actions, which is a group of people have about genetic-related conditions in a society and therefore passed on to succeeding generations.

Attitude refers to a feeling or opinion people hold about persons with genetic-related conditions that is caused by one's knowledge, culture or exposure.

1.11 Organization of the Study

This study was organised into five chapters. Chapter one introduces the entire study by presenting the framework of the study. In chapter two, relevant literatures were reviewed to give readers more in-depth knowledge about the subject matter under discussion. Chapter three consists of the various approaches the researcher employed in carrying out the study. Chapter four presents and analyzes the data obtained from the study and discusses the results obtained. Finally, chapter five climaxed the entire study by summarizing, presenting the key findings, drawing conclusions, making recommendations and suggestions for future research.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

As part of this study, the researcher deemed it necessary to review relevant literature that will give readers an in-depth knowledge on the subject been studied. The researcher reviewed literature on the following sub-headings, scientific literacy, pre-service biology teachers' knowledge on genetic-related conditions, culture beliefs of pre-service biology teachers, causes of genetic-related conditions, causes of genetic-related conditions, common genetic-related conditions, and misconceptions about genetic-related conditions, influence of pre-service biology teachers' knowledge on their attitude and conceptual framework.

2.1 Scientific Knowledge and Literacy

The literature presents various definitions of scientific literacy. Scientific literacy has become a globally well-known educational catchphrase, fashionable word, and modern educational goal (Laugksch, 2000). Miller (1983) says there has been an increasing appreciation of the importance of increasing the percentage of populace who are sufficiently scientifically literate to take part in the resolution of public document disputes over cases involving science and technology (Laherty, 2000).

Brewer (2008) said fostering scientific literacy empowers students to:

- Understand the basic concept in the media and civil policy
- Improve inquiry and critical thinking skills
- Make connections about our interaction with the natural world

Notwithstanding the attention that scientific literacy has gained over the years, it is frequently seen as been controversial (Jenkins, cited in Laugksch, 2000). Scientific

literacy assumes to include simple and desirable qualities but under closer examination it becomes greatly more complex and often subtle, which has undoubtedly added to its controversial nature (Laugksch, 2000). Examination of the broad literature on scientific literacy suggests that there are a number of different factors that can influence interpretations of scientific literacy. These factors include ~~the~~ number of diverse interest groups that are concerned with scientific literacy, different conceptual definitions of the term, the relative or absolute nature of scientific literacy as a concept, different purposes for advocating scientific literacy, and different ways of measuring it” (Laugksch, 2000, p.74). Each one of the factors is made up of different positions, and it has been put forward that association of different facets of each of the five individual factors forms an ordered arrangement of varying interpretations and perceptions of scientific literacy (Laugksch, 2000). These diverse explanations lead scientific literacy to come into view as ~~an~~ ill-defined and disperse—and thus controversial—concept” (Laugksch, 2000, p. 74).

Laugksch (2000) is among the researchers, who believe that for someone to be judged scientifically literate the one should be proficient in the serious discussion of science, which includes reading, writing and talking science. The South African Department of Education’s definition of scientific literacy encircles the most frequent international definitions including the advancement and use of acquired science process skills in a range of settings, the growth and use of scientific knowledge and understanding, and positive receptions of the relationships and responsibilities between science, society and the environment (Department of Education, 2002 cited in Webb et. al., 2009). Again, scientific literacy is the awareness and ability to grasp the meaning of scientific concept and processes needed for individual decision making, contribution to civic and cultural affairs, and economic productivity

(National Science Board, 1993). Also, scientific literacy is being able to read an article in a print media or listen to remarks on an electronic media and be able to comprehend what is being presented and also being able to question things without just accepting them (Brewer, 2008). Scientific literacy stands for what the citizens have to know about science (Durant, 1993 cited in Laugksch, 2000). In full, knowing an adequate amount of science to be able to assess the story that you are listening to in a fair and accurate way (Brewer, 2008). Individuals who are scientifically literate can inquire for, discover, or establish answers to questions about daily experiences (Laherty, 2000). Scientifically literate people have the ability to describe, explain, and predict natural phenomena (Laherty, 2000). It can be generalised from the above definition that scientific literacy is the ability of an individual scientific information, understand the concepts underlying that information and being able to apply that knowledge in everyday situation to better the life of individuals and the general public.

Jenkins cited in (Kuiper, 1998) is of the belief that science has been motivating and supporting economic development and students should be scientifically literate in order to make use of the benefit of science for their personal and society's benefit. One of the conference organisers, Miley, during an International Astronomical Union conference on communicating astronomy with the public, said development is based on three pillars which are culture, science and technology (Dorming, 2010).

There is no wonder African governments have been pledging to spend more on science and technology for the past 30 years. But poor public finances, combined with failing political will, have stopped them turning their promises into concrete action (Nordling, 2010). Most sub-Saharan African countries spend an average of just

0.3 percent of their GDP on science and technology-a far cry from the one percent promised in 1980. (The so- called Lagos Action Plan had no effect - in 2002) and again in 2005 (Nordling, 2010).

Socio-cultural studies jointly find that a person's indigenous and culturally acquired thinking and belief systems cannot just be displaced by western scientific rationality resulting in progress and it is also not necessarily pleasing for that to happen (Shumba, 1999). It is only science that can answer the problems of hunger, poverty, insanitation, illiteracy, superstition, deadening custom and tradition, vast resources running to waste and a wealthy country occupied by starving people (Midgley cited in Shumba, 1999). It is therefore only science and its rationality that is assumed to be good for all nations looking for growth and such country should grow away tradition and custom presumably the rationality on which they are found (Shumba, 1999). Shumba found that science and technology have frequently been linked to social and economic growth of several countries in the world including the under developed ones.

Various points of views about the nature world in science materials and literature on science education are more often than not offered from the angle of the scientific world view. The single rationality offered is that of science without creating a clear difference between it and traditional actions of viewing the world (Shumba, 1999). As a result, several students in developing nations have not accepted completely scientific explanation of the world. Based on such belief without proof, Swift (1992) said that the greater number of the evidence seems to be that traditional beliefs (and the rational attitude on which they are based) are a lasting constituent of local knowledge and though processes that the science and technology educator must work

with, in the developing countries (Shumba,1999).Based on incomplete information, Yakubu (1994) cited in Shumba (1999) said the scientific education offered in the developing nations has not been able to succeed in instilling the scientific spirit in the well-informed. That is, the indigenous rational understanding is so deeply rooted that is seems difficult to change.

Facts also exist to suggest that African students do not automatically make use of the knowledge they learn in science education in real-life (Shumba, 1999). It was detected that students go through the suffering of committing to memory what is essential to pass tests and examination yet they return to the protection of their traditional beliefs (Shumba, 1999). African students studied science in a manner which contradicted methods suggested in science curricula just because the message presented to them as science is so foreign to their ordinary situation and life (Shumba, 1999). As a result, science teaching has only produced in Africans learning facts, procedures and techniques, but yet not become saturated with the spirit of science, with the scientific approach of viewing nature, and with a scientific way of tackling new problems (Odhiambo, 1968 as cited in Shumba, 1999). Swift (1992) cited in (Shumba, 1999) said that Ghanaian undergraduates are persistent in traditional superstitious beliefs, the beliefs presented in a state of thought co-existence with Western science education, but developing more under stress. Shumba (1995) interviewed teachers who were admitted for a degree program in science and one biology teacher commented that he did not make out how science can hold up his belief, because he still has his beliefs (Shumba, 1999). To that teacher his beliefs are there and science is there too. Using the same sample of teachers, Shumba found that science teachers are purely traditionalist but kept a fairly traditional attitude with regards to aspects of traditional authority, religion, view of nature, and social change.

These researches do not suggest that citizens in developing countries cannot comprehend or welcome science and technology. Rather the idea is that the natural application of scientific spirit studied through Western system of education is lacking. Yakubu cited in Shumba, (1999). In this view, Yakubu (1994) conjectured that there appears to be something which inhibits the spontaneous application of scientific thoughts to problem situations. The inhabitation may likely be grounded in indigenous and cultural behavioural plan acquired before Western education was accepted (Shumba, 1999). The situation is not different in Ghana where pre-service biology teachers from different cultural backgrounds hold different attitudes and perceptions towards persons with genetic-related conditions.

2.2 Pre-Service Biology Teachers' Acquired Knowledge on Genetic-related Conditions

Pre-service biology teachers' knowledge can be acquired through their cultural backgrounds or exposure to scientific literacy through formal education. The pre-service biology teachers' scientific knowledge which they acquired from basic schools through secondary schools to Colleges of Education is elaborated in sub-section 2.2.1. Their cultural knowledge which they acquired from their exposure and interactions in the various communities has been explained in sub-section 2.2.2.

2.2.1 Pre-service Biology Teachers' Scientific Knowledge about GRCs

In their introduction to research into new prospective role for Biology teachers relevant to the year 2000 and beyond, El-Nemr and Tolymat (1999) said biology teachers need to be equipped adequately with conceptual knowledge to help students attain biological literacy.

George (2001) studied culture and science in developing world and emphasized that

teachers require help in understanding the conceptual knowledge of traditional practices and beliefs so as to be able to resolve the conflicts between the practices and beliefs and related science concepts. One of the topical areas in biology that may pose problems to students is genetics. Bowling, Wang, Myers, Dean, Markle, Moskalik and Huether (2008) have stated that major advances in genetics for some time now have considerably increased the effect of genetics and technologies on humanity. Genetic matters now play an important role in health and public policy (Kolsto, 2001) and those new ideas in this field continue to have significant implications for individual and society (Bowling et. al., 2008).

Notwithstanding this increased exposure to genetics, research on the understanding of the general public on genetics revealed a comparatively low understanding of genetics concepts (Bowling, et. al, 2008). Furthermore, Bowling, et. al., asserted that information on genetic-related areas provided informally through a variety of media is not always correct examples. Studies on students' knowledge of genetics also show low level of understanding of genetics (National Center for Education Statistics, cited in Bowling et. al., 2008).

Research conducted by Shaw, Horn, Zhang and Boughman (2008) revealed students' misconceptions of Genetics. Through the writing of essays by 12th grade students in America, which their teachers were asked to vet, it came out that most essays exhibited lots of misconception and misunderstanding. To them students reflected what they learned in the classroom, hence it showed misconception held and perpetuated by the teachers. Students in their study could not even differentiate between DNA, genes and chromosomes. Citing Lewis, Leach and Wood-Robinson (2000), Lewis and Kattmann (2004) said many different researches have shown that

students do not understand the genetics they are taught in their school. Misunderstanding by these students leads to their inability to put into use basic knowledge in everyday live situations. This could be due to the fact that the pre-service biology teachers were not taught genetics at all or they were poorly taught.

If students do not understand the concept they are taught, how can they know what is right or wrong? Students' knowledge on genetic-related conditions is likely to affect their attitude towards persons with genetic-related conditions.

Finley, Stewart and Yarroch (1982) showed that Mendelian genetics, mitosis and meiosis were among topics difficult and important for students to learn. However, Biology students do well in assessment in these concepts and they consider them important. If students are able to understand these basic genetic concepts, they will better understand genetic-related conditions and other genetic disorders.

Scientific knowledge in the field of medical genetics is growing fast. The completion of the Human Genome project in 2003 and the eventual identification of thousands of human genetic variants have heightened the expectations of health benefits (Khoury et. al., 2004). This rapidly accumulating knowledge will generate many possibilities for health care and is expected to improve the quality of life of individuals and families (Henneman et. al., 2004). DNA tests become more and more available; at the moment for hundreds of genetic-related conditions (Oosterwijk & Ausems, 2005). Until recently, scientific and public attention was mainly directed at monogenetic diseases, such as Huntington disease (Leschot & Willems, 2004). However, there is growing insight that genes also play a role in the development of more common diseases, such as asthma and diabetes. The development or the seriousness of a disease is then influenced by the environment in which the genetic components are

exposed; a person with a genetic defect will thus be more sensitive to certain environmental factors, e.g., nutritional factors (Leschot & Willems, 2004).

Several chronic diseases are already known to have a genetic component. Asthma, diabetes mellitus and cardiovascular diseases are highly prevalent examples of chronic diseases which development is attributable to both genetic and environmental factors are involved in the development of the disease. Diabetes mellitus is distinguished into two types, Insulin Dependent Diabetes Mellitus (type 1), in particular prevalent in children and young adults, and Non-Insulin Dependent Diabetes Mellitus (type 2), in particular prevalent in older adults and often accompanied by obesity. The genetic predisposition in the cause of diabetes mellitus still becomes clearer, especially regarding type 2 diabetes, while environmental factors, such as physical inactivity and adiposity mainly seem to play a role in the tempo of the disease's development (Illig et. al., 2005; Kavvoura & Ioannidis, 2005; Leschot & Brunner, 1998).

Regarding cardiovascular diseases, the most common cause of death in the developed world, it is now well established that both genetic and environmental factors influence the development of several cardiovascular disorders and their risk factors, such as hypertension, particular fatty acids and obesity (Hall, 2005; Iliadou & Snieder, 2004; Leschot & Willems, 2004).

Adequate knowledge of the genetic component of diseases, as well as personal attitudes towards DNA-testing, are major determinants of optimal utilization of results of genetic testing (Capelli et., al., 1999; Hietala et. al., 1995). Several population studies, e.g., in the Finnish and Dutch populations (Henneman, et. al., 2004; Jallinoja & Aro, 1999), generally show a lack of understanding of genes and

heredity among people. Because of the significance of genetic testing to chronically ill, to themselves as well as to their families and offspring, Morren and colleagues (in press) examined perceived knowledge in family relatives and their attitudes towards chronically ill patients. Their results showed low levels of perceived knowledge, especially in older and lower educated chronic patients.

Attitudes towards genetic testing, on the other hand, were found to be generally favorable, mostly in younger and higher educated patients. Higher levels of perceived knowledge were associated with more favorable attitudes. As the developments in genetic research are believed to be accompanied by due media attention, it was decided to follow the patients with asthma, diabetes mellitus type 2, and cardiovascular disease, who participated in the study of Morren et. al., (2013)

Similar situation is in Ghana where knowledge on genetic-related conditions influence people's attitude and perception to healthcare seeking behaviour.

Literacy, the ability to read and write is arguably the most valuable tool an individual has. Society's efforts to equip all citizens with literacy have paid off in terms of progress and improved quality of life (McCracken et. al., 2009). The rapid advancements in genetic science in the twenty-first century have brought about the need for a new kind of literacy—genetic literacy. This involves knowing the basic units of the genome and the rules through which they assemble into meaningful patterns as well as understanding the ways through which vast amounts of information can be generated from simple genomic elements. In the genomic era, understanding genetic information is becoming increasingly crucial for all aspects of our lives, including health (Dudlicek et. al., 2004) and education (Asbury & Plomin, 2013). There are at least five reasons why genetic literacy is crucial.

First, a wealth of findings leaves us with little doubt that practically all human traits are influenced by genes (Collins, 2010; Plomin et. al., 2016). Secondly, the cost and time taken to have DNA test of an individual are continuously reducing (Goyal et. al., 2017). Thirdly, many developed countries have already made genetic screening of newborns mandatory for the detection and early treatment/intervention for several genetic conditions (Pourfarzam & Zadhoush, 2013). In the future, this genotyping of a few genetic variants could be supplemented with whole-genome sequencing conducted soon after birth (Berg et. al., 2017).

Fourth, genetic discoveries continuously push the boundaries of our imagination: what seems impossible one day, quickly becomes a routine. Today, we can already edit the genome (Barrangou et. al., 2007) with gene-editing technologies advancing every day (Gaudelli et. al., 2017). Soon, gene editing may be used as a treatment for diseases, such as cancer (Cyranoski, 2016; Reardon, 2016) or sight loss (Heier et. al., 2017). Prediction of behavioural outcomes from DNA information is also becoming increasingly more precise (Selzam et. al., 2017).

Fifth, genetic advancements reveal fundamental and unique information on each human that has long-term consequences, not only for the individual, but also for family members (Dyer, 2015). Once sequenced, the genome of a person provides progressively more information, as new genetic discoveries are made. Therefore, although all sciences are important, genetic science is crucial as it touches all aspects of human existence.

A person's DNA sequence reveals information about the past, the present and the future; has implications for fundamental human rights, such as privacy (Lowrance & Collins, 2007); and provides an essential tool that can serve many purposes in

everyday life, including medicine (e.g., Archibald et. al., 2017; Rana et. al., 2017; Zhou et. al., 2017) and forensics (Roewer, 2013).

Universal genetic literacy will empower people to make informed decisions on the use of their genetic information. In addition, genetically literate societies will be better equipped to develop policies for ethical and fair distribution of benefits resulting from genetic science. Genetic literacy is not just about raising knowledge. It is also about enabling people to express informed opinions and engage in discussions and debates regarding applications of genetic knowledge. These include gene editing, prenatal screening, and preventative intervention based on probabilistic information.

The first step towards achieving universal genetic literacy is to evaluate people's genetic knowledge and attitudes towards genetics. Although there have been several studies looking at genetic literacy, these have focused on medical genetics, biology and evolution (Carver et. al., 2017), and mostly explored undergraduate populations (Bowling et. al., 2008; Carver et. al., 2017).

The results of these studies suggest that genetic knowledge is insufficient in the general population (Lanie et. al., 2004) and in non-science undergraduate students (Bowling et. al., 2008). For example, only 34% of 62 respondents, recruited through a random digit dialing method in the continental USA, knew that genes are stored in every cell of the body (Lanie et. al., 2004).

Previous research has identified that 85% of states in the USA had inadequate standards for genetics education (Dougherty et. al., 2011). Another qualitative study found limited genetic literacy in a rural Mexican-American population in relation to family risk of disease (Malen et. al., 2016). In contrast, one study (Schmidlen et. al.,

2016) concluded that their respondents had good genetic knowledge related to medicine.

Since the publication of On the Origin of Species by Means of Natural Selection (Darwin, 1859), there has been contention about the relationship between evolution, genetics and religion (Allum et. al., 2014; Curry, 2009). For example, Scientist believed humans to have originated from other primitive organisms but religion stands against the assertion. Religion believes humans were created by a supreme being (GOD).

Based on previous research (Shaw et. al., 2008), popular media outlets around the world continue to report genetic findings in binary and deterministic terms, often with misleading headlines—a damaging practice in an era of scrolling news (Condit et. al., 2001; O'Neill, 2015). People holding greater genetic knowledge may be less vulnerable to such misinformation.

Students' knowledge and understanding are often deeply rooted and instruction-resistant obstacles to the acquisition of scientific concepts and remain even after instruction. A large number of prior studies reported that primary and secondary school students have many conceptual problems concerning cell biology and genetics.

Learning and students' performance in educational settings can be affected by diverse factors. These could be as a result of the following - school environment (physical structure, instructional media, auxiliary spaces, etc), teachers (qualification, teaching experience, teaching style, attitude, sympathy, language skill), students (i.e., their ability, intelligence quotient, learning styles, attitude, need, and motivational styles, epistemological beliefs, etc.), as well as assessment methods, and sociocultural

factors (misconceptions, socio-economic status of parents/guardians). Misconception can be acquired by students prior to getting into school or it can be triggered at any stage of the formal education. Misconceptions refer to the concepts that have peculiar interpretations and meanings in students' perceptions that are not scientifically proven to be correct. Misconceptions have variously been referred to as naive beliefs, erroneous ideas, preconceptions and persistent pitfalls. However, prior to the formal education by learners at various levels, learners have brought incipient idea or concept about Biology. This initial idea brought in by students is sometimes contradictory and inappropriate to generally accepted idea or concept. These diverse concepts are often referred to as misconceptions or alternative concepts. They have their origin from learners' immediate environment, which are later taken to formal education starting at the primary level.

Science seems to be a difficult subject to understand and comprehend. Regardless of age, culture, and education background, individual person has his/her own perception of science. Genetics is one of the difficult concepts in Biology because of its broad and complex nature. Genetics is the study of heredity, the process of transmitting certain genes from parents to offspring. Offspring inherit their biological parents' genes that express specific traits, such as some physical characteristics, natural talents, and genetic disorders. The mechanisms are hard to understand because it is difficult to make the ideas tangible without the help of special instruments (Mbajiorgu, Ezechi & Idoko, 2006). The uses of the words, genes, DNA, chromosomes, are interchanged in trying to explain how traits are passed from one generation to the next (Lewis & Kattmann, 2004). Mendelian Inheritance refers to the process of transmitting traits from one generation to another. The inherited traits are determined by genes that are passed from parents to offspring. An offspring inherits

two sets of genes—one from each parent. A trait may not be observable, but its gene can be passed to the next generation. Students have an understanding on how genes play a role in transmitting traits, but this understanding is not aligned with the biological theory. Genes are passed down from parent as a whole and identically defines traits. Although this may be true based on observations, microscopically the mechanisms of genes and variations are more complex. Misconception is also affected by all levels of learners, starting from the primary school to the university learners. Nadelson (2009) and Cokadar (2012) stressed that misconception is also prevalent to the teachers. Sources of these misconceptions may be due to the lack of proper application and use of media that cannot illustrate the concepts studied. More so, misconception perhaps is affected by the process of the formation of knowledge in the minds of students. According to Osokoya and Etobro (2013), pre-service biology teachers had misconceptions about global warming, greenhouse effect and ozone layer depletion due to their various scientific beliefs.

Mustami (2016) reported that there are misconceptions in biology textbooks; thus, both teachers and students who use such textbooks will have misconceptions. Students' misconceptions are often deeply rooted, instruction-resistant obstacles to the acquisition of scientific concepts and remain even after instruction. According to Dikmenli (2010), misconceptions are part of a larger knowledge system that involves many interrelated concepts that students use to make sense of their experiences. Students hold misconceptions that were developed before and during their early school years. One of the topics in biological field which become the research materials among educators is the difficulty of the students to understand the concept of genetics as well as the misconceptions on the connected materials (Mustami, 2016). A large number of prior studies reported that primary and secondary school

students have many conceptual problems concerning cell biology and genetics (Flores et. al., 2003; Lewis & Wood-Robinson, 2000; Marbach-Ad & Stavy, 2000, cited in Dikmenli, 2010). However, there is dearth of literature on detailed research related to biology student teachers' misconceptions about cell. Dikmenli (2010) stressed that, prior studies have shown that students experience difficulties in learning concepts related to the cell division process. Cell division constitutes the basis for genetics, reproduction, growth, development, and molecular biology subjects in the biology curriculum. As a matter of fact, a majority of the students or teachers evaluated topics such as gene, DNA, chromosome, and cell division as difficult to learn topics (Oztas, Ozay & Oztas, 2003). Research on students' conceptual understandings often indicates that, even after being taught, students use misconceptions different from the scientific concepts (Lewis et. al., 2000; Yesilyurt & Kara, 2007).

Dikmenli (2010) adduced reasons for these misconceptions to include students' inability to differentiate between doubling (replication), pairing (synapsis), and separating (disjunction), as well as determining whether or not these processes occur in mitosis, meiosis, or both. Further misconceptions include a lack of understanding of basic terms confusing chromatids with chromosomes, or replicated chromosomes with un-replicated chromosomes. This is a concern for instructors because cell division processes are fundamental to the understanding of growth, development, reproduction, and genetics (Chinnici, Yue & Torres, 2004). Dikmenli (2010) reported that studies conducted on problem solving related to genetics revealed that students have some misconceptions regarding the stages of meiosis. However, accurate organisation of many concepts in cell biology perhaps is dependent on the degree of understanding of cell division. Kibuka-Sebitosi (2007) stressed that students possess

misconceptions and inadequate knowledge about the behaviour of chromosomes and transference of genetic material during cell division. It further suggested that such misconceptions lead to conceptual problems in genetics. Saka, Cerrah, Akdeniz and Ayas (2006) have shown that science student teachers have misconceptions, particularly regarding the concepts of gene and chromosome, in accordance with their findings obtained from written responses and drawings. Altunoglu and Seker (2015) emphasized that one of the most popular scientific and technological advances are related with genetics such as human genome project, genetically modified organism, cloning of organism, gene therapy and genetic background of various illness. In spite of the importance of these scientific and technological developments, there is dearth of public awareness of such progress. Thus, these advancements in genetics have caused serious concern to the society (Durrant & Legge, 2005). For instance, genetically modified organisms have risk related with health problem and environmental problem but such organism can provide benefits; these controversial opinions were expressed by experts (Durrant & Legge, 2005).

Altunoglu and Seker (2015) suggested that the society by such controversial topics needs basic knowledge to make meaningful decision which is the best one between lots of options. One paramount function of the teacher is the dissemination of information. Misconceptions that already exist in students' minds are considered as barriers in understanding biological sciences, which may have adverse effect on subsequent learning. When students' initial understanding is not carefully considered, they may fail to grasp new concepts and information presented in the classroom, or they may learn for the purpose of test but revert to their misconceptions outside classroom (Ozmen, 2004). Recent studies on students' conceptual understanding of fundamental concepts in life science have indicated that new concepts can hardly be

learned unless the existing misconception is corrected or students are made to bring conceptual change. However, before misconception can be corrected, they need to be identified. It is a well-known fact that students enter into biology classroom with a lot of misconceptions which are based on their beliefs and observations. The study therefore, was set out to investigate existing misconceptions that conflict with currently accepted scientific concepts in studying about genetics of pre-service biology teachers - undergraduates in their second and third year in the faculty of education.

The misconception that Down syndrome is a rare disorder is refuted by the fact that Down syndrome is not rare. About 1 in every 700 babies is born with Down syndrome. There is a misconception that most children with Down syndrome are born to older parents but the scientific and research findings had it that over 80% of babies with Down syndrome are born to women under the age of 35, and the average age of a mother of an infant with Down syndrome is 28 years.

Pertinent to the misconception held by many is that Down syndrome is treatable but there are many treatments available for the problems associated with Down syndrome but there is no cure for it. People with Down syndrome have severe mental retardation but the fact is that most of the persons with Down syndrome have mild to moderate mental retardation. They have IQ score of 30 to 60 though much differences exist. What is important than IQ is that they are capable of learning.

The misconception that individuals with Down syndrome die young is refuted by the fact that average life expectancy of an individual with Down syndrome is now 50 years of age.

Though knowledge is demonstrably relevant, it is clearly more than just a case of ‘ignorance breeds contempt’, and more recently scholars have focused on the social psychological context within which knowledge and information may lead to attitude change, reinforcement or formation. More sophisticated theories of science and technology attitudes draw on the notion of low-information rationality (Kahana, et. al., 2005) and motivated reasoning (Kahana, et. al., 2005).

Moreover, knowledge of concepts involved in epigenetics is becoming increasingly important for understanding modern medicine, such as personalised medicine, and direct-to-consumer genetic testing. The genetics education community calls for a greater emphasis on the teaching of genomics in the high school science curriculum, with less focus on transmission genetics and Mendelian inheritance (Reydon, 2012).

Despite this, evaluations of the U.S. State standards in genetics teaching show that, from a list of genetic literacy benchmarks, only evolution and the nature of genetic material are adequately covered in the U.S. high school genetics curriculum, while topics such as gene expression and regulation, and genetic variation, are not properly addressed (Dougherty, et. al., 2011).

2.2.2 Pre-service Biology Teachers’ Cultural Knowledge about GRCs

Culture is defined as the “totality of socially transmitted pattern of thoughts, values, meanings, and beliefs” (Purnell, 2005). Belief is the state of mind in which a person thinks something to be the case, with or without there being convincing reasons that something is the case with factual certainty (Wyer et. al., 2005)

According to Wyer, Jr and Albarracin (2005), Cultural Knowledge means that you know about some cultural characteristics, history, values, beliefs, and behaviors of another ethnic or cultural group. "Cultural awareness" is the next stage of understanding other groups -- being open to the idea of changing cultural attitudes. "Cultural sensitivity" is knowing that differences exist between cultures, but not assigning values to the differences (better or worse, right or wrong). Clashes on this point can easily occur, especially if a custom or belief in question goes against the idea of multiculturalism. Internal conflict (intrapersonal, interpersonal, and organisational) is likely to occur at times over this issue.

Thus, pre-service biology teachers must be creative, innovative and imaginative in using pedagogy that helps diverse learners in the learning process with the 21st century skills in spite of their cultural knowledge about genetic-related conditions. In fact: ~~teachers~~ trying to become more culturally responsive in their practice made efforts to build positive relationships with their students and create positive learning environments. Their action revealed an understanding about the need to balance social supports and academic press” (Keogh, 2013). The idea of Keogh states that teachers in higher education must be equipped with knowledge about different cultures of their learners and these will be used as the core values in teaching with harmonious essence of ecological climate among parents, teachers as well as school administrators and other stakeholders.

These mean that knowing the concepts of different cultures is an important aspect in the learning outcomes of diverse learners.

2.3 Cultural beliefs of Pre-service Biology teachers about Genetic-Related

Conditions

Culture, as stated by (Bodley, 2009), is the lifestyle of a people. The way of life of people starts from the day they are born till death. There are diverse cultures in the world with each having its peculiar characteristics. The culture of the people includes their beliefs, rules of acceptable behavior, language, rituals, art, technology, styles of dress, ways of producing and cooking food, religion, and political and economic systems (Bodley, 2009).

African traditional culture is associated with religion and according to Hiebert (1976), every religion has misconceptions or stories of apparent source and events and their importance to the world. Hiebert continued by saying that these stories do not have proof that support them and to him misconceptions are expressions in words occurring as an underlying reality, when all other things are ignored and are not things that have real existence and need be dealt with in real life. Ghana, however, has a mixture of different beliefs and these beliefs are from Christianity, Islam and traditional religions which still give reverence to ancestors. They have the belief of the involvement of ancestors in the life of their successors and also believe in the forces of good and evil that can be manipulated by direct access to the divinities through prayer and sacrifice (Bodley, 2009). Bodley added that they believe in the efficacy of charms and amulets to ward off evil. Finally, the vast area of African life has been invaded by both Islam and Christianity but they have not succeeded in completely displacing, the area of health and healing (Bodley, 2009). Most of these beliefs are not scientific yet are strongly observed by traditional leaders in many African countries. If more than half of the population strongly holds on to these beliefs which include cultural beliefs in inheritance, then student may face a

challenge in the learning of scientific facts may contradict their cultural beliefs.

According to Kuiper (1998), science cannot be said to be a culturally independent phenomenon. To him, science comes with a way of looking at the world and with certain values attributed to the kind of knowledge it deals with. The nature of science and non-science is that both aim to gain information and to improve understanding of their field of study. What makes the two different are based on the assumption and methods applied to collect and organise the information and how the assumption are tested (Enger & Ross, 2002). Assumptions and principles are challenged and tested by scientists to find out the cause-and-effect relationships. A non-scientist may not believe that this is important. In his 1992 J. B. Danquah Memorial lectures, Akyeampong (1993) said the method to the understanding of nature in primitive times was generally magical and based on spiritual principles. Akyeampong further said culture embraces science and the interaction between the two produces creative opportunities to obtain knowledge in all fields. He therefore said there is a need to integrate science and harmonize it into our culture through educational policies that promote such idea.

Science and traditional views of the earth and everything on it are based on different ways science and traditions see it. This is explained by Ogunnyi cited in Kuiper (1998, p. 5):

“Each conceptual model has its merits and demerits. Despite this, the scientific world view has been found to be more effective in predicting and controlling natural phenomenon than any other thought system and this is unconnected with the process of documentation, opinions, self-criticism and persistence”.

Kuiper made it clear that science has not been absolute and lived in an active relationship with appropriate attribute such as culture. Again, Dager and BouJaoude

(1997) stated that combination of beliefs about religious conviction (among other things) and not about science will strongly influence how learners assess proof of evolution theory by delimiting what counts as support and finally interfere with accepting theory.

Culture affects an individual's common belief system and serves as an explanatory model for disorders such as Autism Spectrum Disorder (Gobrial, 2018). In spite of contrasting interests with which Autism Spectrum Disorder has to contend, multiculturalists assessed pressures of Autism Spectrum Disorder differently, and these evaluations offer both negative and positive reviews (Gobrial, 2018).

On the negative side, culture belief makes people believe that Autism Spectrum Disorder is a stigma. A stigma is known as the manifestation of a diverse form (Goffman, 2009). The negative attitudes towards persons with genetic-related conditions are looked down upon and in most cases cast out of society. Stereotyping against those with genetic-related conditions often occurs because of the negative perception of Autism Spectrum Disorder. People with less experience and knowledge of Autism Spectrum Disorder often hold inaccurate beliefs about the disorder (John, et. al., 2018)

Research has shown some cultural groups believe the effects of higher beings or persons with supernatural powers can also cause birth defects. With regard to higher beings, researchers have shown that in some cultures, individuals may feel that a family is "given" a child with a disorder as a punishment from God for parental sin (Kenen, 1980).

The "evil eye," an eye or glance held capable of inflicting harm, is a force that gets much recognition in many cultures for being the determinant of bad fortune, including birth defects. Some researchers have found that some individuals in Middle Eastern, African American, European American, and Hispanic cultures may believe in the effects of an "evil eye". This changes the attitude of the pre-service teacher towards individuals with genetic conditions causing the pre-service teacher not to get close to people with genetic-related conditions. Beliefs are the strongest indicators of people's behavior.

Culturally-based health beliefs have existed since the time of Hippocrates and have been passed on through generations (Reiss & Ash, 1988). Some of these beliefs are valid, while others are based on inaccurate information and naivete about the human body and pregnancy (Reiss & Ash, 1988). Much research has been conducted in collecting these beliefs within various ethnic/racial groups; however, this research has mainly been devoted to simply listing the perceived causes of illness. There has been a lack of information in the literature comparing different groups, as well as determining if differences exist among women who are pregnant and women who have had a child with a birth defect.

Since culture shapes thinking, one can understand how culture can be deeply ingrained into beliefs. Every culture view life experiences differently; therefore, each ethnic or racial group has different beliefs and theories of causation of illness, whether they are factual or not (Fisher, 1992; Kleinman, Eisenberg, & Good, 1978). Birth defects can be perplexing and mystifying to those who do not understand their causes, and these individuals may create myths in order to explain the unexplainable.

Many of the non-medical causes of birth defects are attributed to maternal impressions, something the pregnant woman thinks or sees. For example, one belief holds a child born with microcephaly or anencephaly is the result of his/her mother looking at a monkey during the pregnancy (Kenen, 1980). However, the monkey is not the only animal implicated in causing birth defects; researchers have shown that some cultures believe that a cleft lip is caused by looking at or eating a rabbit, hence the name "hare lip" (Kenen, 1980). Researchers have reported that a common belief in many cultures is a child will be born with a birth defect if a pregnant woman takes pity on or mocks an affected individual (Kenen, 1980).

Information concerning birth defects and genetic disorders typically has been obtained by interviewing women from specific cultural groups, regardless if they were pregnant or not. To our knowledge, only one study has assessed the cultural beliefs of women after having a child with a disorder following genetic counseling (Kenen, 1980). The results of Kenen's study showed a strong belief in a genetic cause for the child's disorder; however, the degree of influence of the genetic counseling on a client's cultural belief system for causation of birth defects has not been comparatively studied.

Thus, a pilot study comparing pregnant women with no family history of a genetic disorder and non-pregnant women with an affected child was undertaken to analyse the current status of these beliefs as a cause of birth defects as well as comparing beliefs between cultural groups.

2.4 Causes of Genetic-related Conditions

Biology is the scientific study of living things (Laing, 1989). One of the branches of biology is physiology which deals with the study of the physical and chemical

processes that occur in living organisms during the performance of life functions. It is concerned with such basic activities as reproduction, growth, metabolism, excitation, and contraction as they are carried out within the fine structure, the cells, tissues, organs, and organ systems of the body (Root, 1999). Genetics is an aspect of physiology that deals with heredity and variation.

According to Abbey, et. al., (2001, p.335) heredity is defined as “the passing on of traits or characteristics of parents to their offspring”. Heredity is also defined as “the handing off character or traits of parents to their progeny (offspring)” (Entsua-Mensah, Boateng Ennimful, Deborah & Koomson, 2009; p.429). These traits concerned with heredity are carried in the nucleus of a living cell. These traits are passed onto the young ones by the fusion of the male and female sex cells (gametes). Inheritance is the passing on of genetically controlled characteristics from parents to offspring (Encarta Dictionary, 2009). Inheritance can therefore be said to be the passing on of characteristics from parent to child. Idea that something is passed on from parents to offspring has been in the mind of man from time immemorial.

Laing (1989) made it clear, when delivering University of Ghana Alumni lecture on May 20, 1986, that the origin of heredity is found in folklores, practices and proverbs originating from our ancestors in the dim past of all societies. He cited examples to support his point that the practice of keeping crop plant variety seeds from crops with desirable characteristics or stem cutting showed that they were keen observers and considered to lead the development of agriculture in various civilizations.

Inheritance among societies in Ghana is based on the line of an individual. Those in the royal family qualify to be enskined or enstooled. There is a belief in them that something passes from parents to the young ones that qualifies them to inherit these

parents when the parents die. Information on these are passed on to the young ones in the family. This means that students come to school with some previous knowledge about heredity. Understanding of genetics by students can only be achieved when previous knowledge is identified, discussed in class and scientific explanation used to bring students to understand this concept better.

According to Wood and Robinson (2012) it was the effort of Gregor Mendel (1822, 1884), an Austrian monk that formal genetic sprang life. Mendel proved that the inheritance of a pair of contrasted characteristics could be explained by certain hereditary factors now known as genes. Genes are transmitted in single dose through each of the two reproductive cells, egg and sperm. The male and female sex cells fuse to form a zygote leading to the development of a new individual. The offspring produced from the fusion of the two sex cells carried two pieces of biological traits that had been from the two parents (egg from mother and sperm from father).

A genetic-related condition (genetic disorder) is an anatomical or physiological abnormality that occurs when a harmful mutation gene is inherited from one's parents that increases the risk of the offspring of developing that particular condition.

There are several types of genetic-related conditions in the human population which are caused primarily by gene (point) mutation and chromosomal mutations. Some of these are in turn, caused by environment (mutagens) such as toxic chemicals, smoke, and ionizing radiation such as gamma rays, x-rays and ultraviolet rays from the sun.

2.5 Albinism in Humans

Albinism is a situation in human beings where there is a failure to produce skin pigment, melanin (Levine & Miller, 1994). An albino has a light skin, white hair and pink eye. An albino lives a normal life because albinism is not a disease. It is a genetic disorder inherited from parents. It is controlled by a recessive gene. The recessive gene controls albinism with the dominant genes or the normal allele controlling the normal individual without albinism. The father and the mother who are normal must have the recessive allele in them. This means that both parents must be carriers (heterozygous normal). Albino in the possible offspring will be 25% (1 in 4). The ratio will be 3 normal: 1 albino. They are sensitive to bright light and therefore appear slit-eyed.

However, there are a number of cultural beliefs on the occurrence of albinism in human population especially in Africa. Albinos are believed to be special and strange beings that possess certain spiritual powers. Albinos are used for rituals in many African countries nowadays. In Tanzania, the extent to which these innocent individuals (albinos) are being murdered is alarming. According to Dave-Odigie (2010), albinos in Tanzania are defenseless group of people who are under danger of extermination as they are being killed with impunity, based on the belief that the concoction made from their body parts can bring good luck, wealth and success. The authorities have banned and withdrawn the licenses of traditional witch doctors in this country, Dave-Odigie added. British broadcasting Co-operation repeated that the security service in Burundi has arrested some people with fresh body parts, of persons with albinism, in their possession (Ghana Association of Persons with Albinism, GAPAA, 2010). They said the witchdoctors had informed their clients that liquid medicines prepared from body parts of persons with albinism will bring them luck in

love, life and businesses. The traditional beliefs on albinism in other African countries are not different in Ghana.

According to Sackey (2010), Ghanaians have some of the unscientific beliefs about albinism. Some Ghanaians believe that albinism comes about as a result of premature birth. Others assume that albinos do not attend the call of nature on Fridays. A more interesting misconception is that albinos do not die but vanish. But in most parts of Africa, it is believed that the bodies of albinos are good for ritual purposes. The major reason for the killing of albinos sprang from the latter belief. A group of persons killed and cut off certain parts of a 10-year-old albino girl in Tanzania and sold these parts to witch doctors (Usman, 2008). It was reported that a 2-year-old albino boy was stolen from his mother with the aim of using him in a black magic ritual (Morningstarr, 2009). There is the belief that albinos possess some spiritual powers and are good for rituals. Fetish priests recommend these innocent souls for these rituals. This belief is unscientific and unethical which have to be stopped with all seriousness. Some believe that albinos are spiritual beings from river gods of the land.

Albinos are seen as strange people as it is believed that they can get vanished while standing in the sun and are not seen in the afternoons. Some people tease albinos whenever they see them. Some spiritualists recommend to their clients to bring albinos to be used for sacrifices before their heart desires can be granted by the gods. This stigmatization can be removed through science education.

It is pertinent to note that the long history of social discrimination against persons with albinism has impacted negatively on their right to found a family. The right to found a family is guaranteed under the United Nations General Assembly's Universal Declaration of Human Rights (UDHR). Although it may be contended that the state does

not have a direct obligation to choose partners for its citizens, a broad and generous interpretation of this right supports the argument that states have an obligation to sensitise the public in order to ensure a change in the negative attitude about people with albinism. It is contended that promoting the right to found a family on the part of the state in situations of discrimination such as this, enjoins the state to create an environment that is conducive for the right to found a family to be exercised. One way of doing this is by raising awareness and sensitising the public about albinism.

Albinos in Tanzania are a vulnerable group of people who are under the threat of extinction as they are being killed with impunity, based on the belief that the potion made from their body parts can bring good luck, wealth and success. This has sparked angry protests, condemnations and outcries by the citizens who perceive that the government's response to the threat against the lives of the albinos are inadequate as the number of trials and convictions have not been commensurate with the number of killings. The phenomenon is also attracting international attention as there is a public and international outcry against it. This means that efforts need to be intensified both locally and internationally to check the scourge.

There are various studies conducted with regard to albinism in Africa particularly in Tanzania. Lookingbill et al. (1995) conducted a study on the skin cancer for albinos in Tanzania. The results of the study suggested that due to the nature of their skins, albinos are susceptible to cancer. The hypo pigmented skin of people with albinism makes them vulnerable to sun induced skin lesions and cancers and people with albinism require life-long protection from exposure to ultraviolet light.

Goffman (1997) conducted a study on stigmatization of Albino people. To date, this study has remained influential on the topic of stigma in the social sciences context.

Goffman argues that societies create categorizations, where some personalities are considered to be normal within a category, the outcome can be referred to as social identity. Goffman differentiates among people who are dishonoured and people who are dishonourable. A dishonoured person is someone whose distinctions are obvious on the spot, while a person who is dishonourable possesses unwanted characteristics that are not instantly perceivable to those present. Goffman identifies three types of stigma namely abominations of the body, blemishes of individual character, and tribal stigma. He further argued that a person who is stigmatized is seen as a victim, inferior, and someone who is not quite human. He concludes that Albinos undergo stigmatization in societies hence being perceived as inferior and due to this act they run away from the tasks of those considered normal, hiding behind their stigma.

E Goffman, Selections from Stigma', in (ed.) Lennard J. Davis; *The Disability Studies Reader*

Kromberg, J.G.R., Zwane, E.M. and Jenkins, T. (1987), conducted a research on albinism focusing on the African history with regard to stories, myths and tales. The study found that attitudes tales and myths have developed and changed over time. The results also indicated that some stories and tales suggest that albinism is the product of a Negress-gorilla or Negress-water spirit mating. Some of the societies in Africa refer to people with Albinism as monkey. Other studies have revealed existence of myths about albinism that regard them as blessings as well as punishments, and skills in sorcery as well as healing.

Lund and Gaigher (2002) conducted a study on the health intervention programme for children with albinism at a special school in South Africa. The results of the study revealed that albinism is the result of witchcraft. The study also found similar myths that advocate that families with babies that have albinism are victims of witchcraft and that it is because of this that these babies are born with albinism. Lund and Gaigher (2002) concluded that the lack of knowledge about albinism can lead to many superstitions. Although the study focused on health interventions for children with albinism, it was concluded that the existence of poverty in the society combined with superstitions would magnify problems related to skin and eyesight for children in special schools. Kelly (2010) conducted a research on oppression through omission looking on the human rights for persons with albinism in Uganda focusing on employment opportunities. The research findings showed that persons with albinism face challenges of discrimination while looking for employment. The results of the study suggest that while it is possible for persons with albinism to complete schooling, the attempt to find employment presents additional challenges of discrimination²⁶. Studies have found that an albino can complete the initial stages of interview which are conducted through written approach. However albinos found it difficult to survive a face-to-face interview particularly due to their inferiority.

Nyirinkindi (2007) conducted a study on the Economic and Social rights as well as service delivery at the local government level in Uganda. The findings of these studies suggest that albinos are compelled to avoid various professions due to their medical condition. Such professions involve those which expose albinos to the sun or bright lights which impair their vision such as welding. Nyirinkindi²⁹ argues that because of this discrimination and limitations of professions due to albinism, Many albinos struggle to get employment.

2.5.1 Social stigmatisation and discrimination

Albinos continue to suffer from discrimination and insults from societies in their day to day lives. The stigma against albinos discredits their reputation. This affects them socially and because of societal construction about them, as being outcasts, they are considered undesirable and a disgrace to society, rather than being accepted. According to Virginia³⁶ there is negative stigma connected to albinism where albinos are associated with, and classified as a blemish, mark, stain. This has made society to look at albinos with suspicion and fear. Many societies consider albinos mysterious, evil and in fact, incapable of doing the things that other normal human being can do.

People with albinism also suffer socially and psychologically because of negative family and societal attitudes.³⁷ Societies have been using offensive names for persons with albinism which has resulted to the injustice and stereotypes leading communities to denounce them based on their conditions rather than appreciating their humanity. This has been commonly experienced in East Africa, Tanzania in particular where various derogatory names such as *Zeru Zeru* meaning ghost like creature and mzungu connoting white man are normally heard spoken by different people irrespective of age.

Further to this, the advent of divorces is on the increase in several societies in Tanzania. Women happened to be the most affected by divorce, with some being rejected by their husbands. The situation is even worse for women who give birth to children with albinism. They are rejected by both their husbands and families, for bringing objects of disgrace in this regard albino children in society.

The birth of albino children is based on the myths that albino children are conceived when women engage in sexual intercourse with men of other races or men who are

cursed and unclean and of being witches. In fact Some children with albinism are hidden from the public or forbidden from socialising with others because they treated as outcasts while the unfortunate ones are killed at an infant age.

The social discrimination of persons with albinism has been extended to the marriage affairs where albinos are denied the right to found a family. According to Virginia, people who are pigmented find it relatively easy to find partners while those with albinism are routinely forced to lead their lives single because no one wants them. Even their own families have been constantly refusing to sanction relationships. Male albinos struggle to get wives while female albinos struggle to get husbands.

2.6 Sickle - cell anaemia

Sickle - cell anaemia is a genetic disorder of the blood caused by a defective gene that causes abnormal form of haemoglobin of the red blood cells which transports oxygen in the human body. The allele controlling sickle - cell causes the product of abnormal haemoglobin, resulting in a distorted, sickle - celled red blood cells. Sickle - cell anaemia results in damage to organs in certain parts of the human body (Eckman, 2009).

It is the most common inherited disorder among people of African descent, which according to World Health Organisation (WHO) affects one out of 400 African-Americans (Reece et. al., 2015).

Reece, et. al. (2015) stated that Sickle-cell disease is caused by the substitution of a single amino-acid in the haemoglobin protein of red blood cells. In homozygous individuals, all the haemoglobin is of the sickle-cell (abnormal) variety. When the oxygen content of an affected individual's blood is low, the sickle-cell haemoglobin

aggregate into rods that deform the red cells into a sickle shape. Sickled-cells may clump and clog small blood vessels, often leading to other symptoms throughout the body, including physical weakness, pain, organ damage and even paralysis.

According to World Health Organisation, regular blood transfusions can ward off brain damage in children with sickle-cell disease and new drugs can help prevent or treat other associated problems, but there is no cure currently.

Although two sickle-cell alleles are necessary for an individual to manifest full-blown sickle-cell disease, the presence of one sickle-cell allele can affect the phenotype. Thus, at the organizational level, the normal allele is incompletely dominant to the allele is incompletely dominant to the sickle-cell allele (Waugh & Grant, 2013).

Sickle cell disease is an all ethnic condition with the maximum prevalence rate among those of African, Mediterranean, Middle Eastern, Indian, Caribbean, and Central and South American descent (Hoffman, 2007). Vasava, Srivastava, Chudasama and Godara (2009) asset the knowledge about sickle cell disease and to promote awareness through education of secondary and higher secondary school adolescents. Vasava et. al., (2009) identified that out of 881 students present during pre-test evaluation, only 407 students (46.2%) had heard about sickle cell disease. This showed that more than half of the subjects had no education on sickle cell disease. They recommended that individuals with sickle cell disease have to learn more about it to enable them have early detection of problem such as fever or chest pains and seek early treatment. Vasava et. al. further advised that though it is recommendable for school going aged children to do physical education, teachers have to allow sickle cell disease students to rest if they are tired and to drink fluids after the exercise. If teachers are to work with the suggestion from Vasava et. al.,

(2009), the pre-service biology teachers must be aware of this disease and learn about it to assist their future student in their schools who have sickle cell disease. Teachers, students, parents and the community as a whole need knowledge about sickle cell disease and to be in position to assist individuals with the disease. If pre-service biology teachers do not have enough understanding of sickle cell disease, then they would succumb to non-scientific tale they hear about this disease.

According to Maxwell, Streetly, and Bevan, (1999), persons with sickle cell disease are stigmatized as drug addicts. Before 1980, sickle cell disease was believed by Nigerians to have been caused by evil spirits, witches or demons (Uzoegwu & Onwurah, 2003). Uzoegwu and Onwurah added that the disease was described as “*–Oya Ota Obara*” (the illness that consumes blood), due to may be the fact that it causes frequent anaemia. In addition, they said since the disease was not curable, it was misconceived to be caused by witches and wizards or charms set by imaginary enemies. Many people stigmatise children with sickle cell anaemia as *Ogbanje* (Igbo) or *Abiku* (Yoruba) that is reincarnation of dead children.

2.7 Down syndrome

Down syndrome (DS) is one of the chromosomal abnormalities which commonly occur to human beings (Jain, Thomasma & Ragas, 2002). They stated that the perception remains that DS infants is still not openly accepted by the society and that this lack of acceptance creates many complex ethical challenges in treating such babies. Ghana is a common place to hear down syndrome sufferers being referred to as ‘*river children*’, and sufferers of cerebral palsy as ‘*vulture children*’ (The Disablement Foundation of Ghana, 2008). The foundation added that in Ghana those learning disabilities such as Down syndrome still segregated and isolated, while some

are looked up in garages and dark corners of peoples' homes. The Foundation ponder on this attitude in Ghana and made the statement: ~~one~~ one could be forgiven for wondering if it was abject stupidity, ignorance, lack of Godliness and education, or sheer wickedness that propel some of as Ghanaians to perceive learning disabilities as a curse from God, and thus subject the victims to such heinous treatment. With many people passing through the formal education in Ghana the Foundation has come to the realization that there is no change in belief about these disabled people when they said that it is easy to ascertain people's concepts, beliefs, ideology and views they have probably changed by extensive travels and education, and that the notion of learning disabilities being sub normal and witches, and all the non-complimentary stereotypes associated with them has since been banished. However, the opposite is unfortunately the truth for victims, their careers and family members, and they have been adversely affected obnoxious way society treats them.

Agbenyega (2003) said that much work is at present being done in many countries in order to find the most befitting placement for persons with disabilities, mainly in the areas of education, training, and employment. However, there has been evidence to suggest that these efforts have been continuously frustrated by the nature and type of labels societies place on individuals with disabilities. He added that the nature of the label depends on the perception, tradition, culture and beliefs of the different societies in Ghana.

Ghanaians believe that it is a blessing when couples bear children but there is no reason a family can tell the cause of why a child is born with physical impairment except to assign it to the visitation of the gods (Agbenyega, 2003). Persons with Down's syndrome are believed to be offspring given by the river gods and as result labeled 'Nsuoba', which means water children (Avoke, 1997). Agbenyega, said a rich family with such disabilities is labeled "sikaduro" (juju money).

2.8 Parkinson's Disease (PD)

Parkinson's disease (PD) is a progressive degenerative neurological disorder characterized by tremors, slow movements, stiffness in arms and legs and balance problems (Anderson, Anderson & Glanze, 1998). Next to Alzheimer's Disease it is the most common neurological disorder in Australia, estimates suggesting there are currently over 80,000 cases in this country with 4000 new diagnoses each year (Parkinson's Victoria Inc., 2005). PD is predominantly diagnosed in individuals over 50, however it is not unknown in younger cohorts, with up to 30% of Parkinson's disease sufferers diagnosed before the age of 50 (Parkinson's Victoria Inc., 2005). As the population of Australia ages, the prevalence of this disease is likely to increase. Several studies have shown that individuals with PD report a variety of symptoms that are adversely associated with their quality of life. These include psychological distress and depression, cognitive impairment, physical mobility problems, social isolation, emotional reactions, sexual problems and dysfunction, sleeping problems and fatigue (Schrag, Jahansahi, & Quinn, 2001; Schreurs, De Ridder, & Bensing, 2000). Some of these symptoms are directly related to the disease course, but some may be a consequence of negative reactions to symptoms, by the sufferer or by the community at large. For example, one of the most adverse effects of living with PD is reported to be its impact on an individual's social interactions (Schrag et. al., 2000;

Shreurs et. al., 2000). This may relate to common symptoms of Parkinson's such as masked facial expressions and speech problems, which make it harder for others to communicate and leave open the way for social misunderstanding (Lyons & Tickle-Degnen, 2003; Simons, Pasqualini, Reddy, & Wood, 2004). It could also relate to those with PD being more likely to withdraw from social contact because of embarrassment, perceived communication difficulties or other issues relating to their illness. Because of such problems, individuals living with PD may have a reduced social support network making them more susceptible to depression and reduced quality of life. While the effects relating to PD differ from person to person, over time the symptoms and severity of the disease become increasingly debilitating (Abudi, Bar-Tal, Ziv, & Fish, 1997).

However, this process can take many years, so those with PD may enjoy significant periods of time before symptoms become debilitating, especially if treatment regimens are initiated early. Thus, enhancement of quality of life, and the maintenance of positive mood, social contacts and work/leisure interests are particularly important. The focus of this study is on public attitudes to Parkinson's disease. Public attitudes to disease are important, because they shape the context in which the ill person and their families and careers must live. When diseases are negatively viewed by the public, there may be less sympathy or support available for the sufferers and their families, sufferers may be stigmatised, and attitudes may even influence the level of funding available for medical research (Keusch, Wilentz, & Kleinman, 2006).

Public sympathy for some diseases and not others appears to relate to a range of factors, including age of the ‘typical’ sufferer, mode of transmission, and physical and cognitive symptomatology. For example, children’s and young person’s diseases receive more public sympathy and relatively more research dollars than diseases characteristic of older persons (Clarke, 2005). Those suffering from so-called life style diseases, for example those related to smoking and obesity, may be viewed as responsible for their condition and therefore receive less sympathy than those with illnesses for which causes are unknown or apparently unrelated to life style (Keusch et. al., 2006; Mateu- Gelabert, Maslow, & Flom, 2005).

Conditions that lead to physical or cognitive disabilities which the public may consider unattractive, frightening, or related to mental retardation or mental illness, are often stigmatized (Hills & MacKenzie, 2002; Jenette, Funk, & Murdaugh, 2005).

Disease stigma can be overt, as in the case of shunning of lepers, or in more modern times, the fear and denial associated with HIV/AIDS, particularly in Africa but relatively recently also in the western world. More subtle are the negative attitudes associated with some diseases which, while they are ‘accepted’ in enlightened societies, are somehow not entirely ‘acceptable’. A mark of such negative attitudes can be that those with the disease feel marginalized, and there may be attempts to keep the illness hidden from all but closest relatives. One example is epilepsy, which in most cases is a short lived and self-limiting condition (Jacoby, 1994), and which even in chronic cases, can usually be well controlled by drugs (Keusch et. al., 2006). Nevertheless, Keusch et. al., report that in the Netherlands where this condition has been successfully treated for many years, as recently as 1996 a woman was whipped

and placed in isolation because it was believed that her seizures resulted from magic. Some aspects of Parkinson's disease may be stigmatising because they are associated with other more negatively viewed conditions. For example, movement disorder can appear as drunkenness, while speech and communication difficulties may be mistakenly associated with mental retardation.

The association with ageing can in itself be a cause for stigma (Kahana et. al., 2005). As indicated previously, not all PD individuals are elderly, symptoms do not necessarily appear until the disease is well underway, and if diagnosis is early enough many symptoms can be controlled for years. But if there are negative public attitudes to the disease, and stereotypes associated with it that relate it to loss of bodily and cognitive control and rapid deterioration, these stereotypes will also affect those who are diagnosed. They may trigger depression and social withdrawal, both in sufferers and carriers. They may delay the seeking of treatment (and thus helpful early intervention) among those with symptoms (Keusch et. al., 2006; Link & Phelan, 2006).

There are few studies about public attitudes to PD and none in Australia. Greater understanding of popular beliefs about this disease will enable more informed public education campaigns about the nature of Parkinson's. Information on beliefs and attitudes will have the potential to assist in the development of interventions that are aimed to improve lifestyle and coping strategies of those living with the illness. In turn, through such campaigns and interventions it may be possible to reduce perceived stigma associated with Parkinson's disease and provide more support for sufferers and carriers.

2.9 Huntington's Disease

According to Waugh and Grant (2013) Huntington's disease is a genetic condition caused by a dominant allele that leads to the progressive deterioration of brain cells. Perhaps 1 in 24,000 individuals develops the disorder worldwide. Because the allele is dominant, every individual that carries the allele expresses the disorder. Nevertheless, the disorder persists in human population because its symptoms usually do not develop until the affected individuals are more than 30 years old, and by that time, most of those individuals have already had children.

Consequently, the allele is often transmitted before the lethal condition develops. A person who is heterozygous for Huntington's disease has a 50% chance of passing the disease to his or her children, even though the other parent does not have the disorder. In contrast, the carrier of a recessive disorder such as cystic fibrosis has 50% chance of passing the allele to offspring and must mate with another carrier risk bearing a child with the disease (Waugh. & Grant, 2013).

Huntington's disease is associated with deficient production of the neurotransmitter gamma aminobutyric acid (GABA). Extrapyrmidal changes cause chorea, rapid uncoordinated jerking movements of the limbs and involuntary twitching of the facial muscles. As the disease progresses, cortical atrophy causes personality changes and dementia (Waugh. & Grant, 2013).

2.10 Haemophilia

According to Raven and Johnson (2002) when a blood vessel ruptures, the blood in the immediate area of the rupture forms a solid gel called a clot. The clot forms as a result of the polymerization of protein fibres circulating in the blood. A dozen proteins are involved in this process, and all must function properly for a blood clot to form. A mutation causing any of these proteins to lose their activity leads to haemophilia, a hereditary condition in which the blood is slow to clot or does not clot at all.

Hemophilias are recessive disorders, expressed only when an individual does not possess any copy of the normal allele and so cannot produce one or two of the proteins necessary for clotting. It has been established that most of the genes that encode the blood-clotting proteins are on autosomes (chromosomes with numbers ranging between 1 and 22), but two, designated as factor VIII and IX are on the X - chromosome and for that matter, are sex-linked. Any male who inherits a mutant allele of either of the two genes will develop haemophilia because his other sex chromosome is a Y- chromosome that lacks any alleles of those genes (Raven & Johnson, 2002).

2.11 Muscular Dystrophy

Scanlon and Sanders (2018) stated that muscular dystrophy is a group of genetic diseases in which muscle tissue is replaced by fibrous connective tissue or fat. Neither of these tissues is capable of contraction, and the result is progressive loss of muscle function. The most common form is Duchenne's muscular dystrophy, in which the loss of muscle function not only affect skeletal muscles, but also cardiac muscles. Death usually occurs before the age of 20 due to heart failure. At present, it has no

cure. Duchenne's Muscular Dystrophy (DMD) is a sex-linked (X-linked) trait, which means that the gene for it is on the X chromosome and is recessive. The female sex chromosomes are XX. If one X chromosome has a gene for DMD and the other X chromosome as a dominant gene for normal muscle function, the woman will not have DMD but will be a carrier who may pass the defective gene to her children. The male sex chromosomes on the other hand are XY and the Y has no gene at all for muscle function. In this case, if the X chromosome has a defective gene for DMD, the male will have the disease. This explains why DMD is more common in males than in females.

Scientists have been able to locate the muscular dystrophy gene on the X chromosome and its protein product has been named as dystrophin. Treatments for DMD that are being investigated include: the injection of normal muscle cells or stem cells into affected muscles and the use of viruses to insert normal genes for dystrophin into affected muscle cells (Scanlon & Sanders, 2007).

2.12 Colour Blindness

According to Scanlon and Sanders (2018) colour blindness is a genetic disorder in which one of the three sets of cones is lacking or non-functional. Total colour blindness, the inability to see any colour at all is very rare. The most common form of colour blindness is Red-Green Colour Blindness, which is the inability to distinguish between red and green colours. If either the red cones or green cones are non-functional, the person will still see most colours, but will not have the contrast that the non-working set of cones would provide. So red and green colours will look somewhat similar, without the definite differences most of us see.

This is a sex-linked trait. The recessive gene is on the X chromosome. Just as any other recessive X-linked trait, a woman who is homozygous recessive for the trait will be colour blind. However, a heterozygous woman will be a carrier but may pass the gene for colour blindness to her children. A man with one recessive gene on the X chromosome will be colour blind since there is no corresponding gene on the Y (Scanlon & Sanders, 2018).

2.13 Tay-Sach's Disease

Raven and Johnson (2002) indicated that it is an incurable heredity disorder in which the nervous system deteriorates. Affected children appear normal at birth and usually do not develop symptoms until about the eight month, when signs of mental deterioration appear. The children are blind without a year after birth, and they rarely live past five years of age. Because the disease is caused by recessive allele, most of the people who carry the defective allele do not themselves develop symptoms of the disease.

The Tay-Sach's allele produces the disease by encoding a non-functional form of the enzyme hexosaminidase A. This enzyme breaks down gangliosides; a class of lipids occurring within the lysosomes of brain cells. As a result, the lysosomes fill with gangliosides, swell and burst, releasing oxidative enzymes that kill the cells. There is no cure for this disorder (Raven & Johnson, 2002).

2.14 Cystic Fibrosis

It is one of the most common lethal genetic diseases in the world, which according to Epidemiologist strikes one out of every 2,500 people of European descent.

The normal allele for this gene codes for a membrane protein that functions in the transport of chloride ions between certain cells and extracellular fluid (Reece et. al., 2015). These chloride transport channels are defective or absent in the plasma membranes of children who inherited two recessive alleles for cystic fibrosis. The result is an abnormally high concentration of extracellular chloride which causes the mucus that coats certain cells to become thicker and stickier than normal. The mucus builds up in the pancreas, lungs digestive tracts and other organs leading to multiple (Pleiotropic) effects including poor absorption of nutrients from the small intestines, chronic bronchitis, and recurrent bacterial infections. If left untreated, most children with cystic fibrosis die before their 5th birth day. However, daily doses of antibiotics to prevent infections, genetic pounding on the chest to clear mucus from clogged airways and other preventive treatment can prolong life (Reece et. al., 2015).

According to Raven and Johnson (2002) the mutant or defective gene which causes cystic fibrosis is known as cf gene that can be passed down from parent to offspring. The defective gene cf was isolated in 1987 by the Physiologist Paul Quinton. Its position on the human chromosome 7 was identified in 1989.

Furthermore, the chloride ion protein channels which are defective are destroyed by proteasomes leading to alteration in the composition of the tissue fluid around the cells. This change inactivates defensin, a natural antibiotic produced by lung tissue. In the absence of defensin, a bacterium called *Pseudomonas aeruginosa* stimulates

the lung cells to produce copious thick mucus which serves as an ideal growth environment for bacteria (Scanlon & Sanders, 2018).

2.15 Phenylketonuria (PKU)

Sadava (2014) showed that in 1934, the urine of two mentally retarded young siblings was found to contain phenylpyruvic acid, an unusual by-product of metabolism of the amino acid phenylalanine. It was not until two decades later, however, that the complex clinical phenotype of the disease that afflicted these children was traced back to its molecular phenotype. Scientists discovered that Phenylketonuria resulted from an abnormality in a single enzyme phenylalanine hydroxylase. This enzyme normally catalyses the conversion of dietary phenylalanine to tyrosine but it was not active in Phenylketonuria patients' livers. Lack of this conversion led to excess phenylalanine in the blood and explained the accumulation of phenylpyruvic acid. Later, scientists compared the amino acid sequences of phenylalanine hydroxylase in normal people with those individuals who had Phenylketonuria. In many cases, after examining the 451 amino acid polypeptide chain, persons without PKU had arginine at position 408 while those with PKU had tryptophan.

In high quantities, phenylpyruvic acid is toxic to the central nervous system, and if untreated, results in brain damage and mental retardation within a few months. Also because there is low levels of tyrosine, which is needed to make melanin, depigmentation occurs and affected children who are fair skinned and blonde (Sadava, 2014).

2.16 Some Rare Genetic-Related Conditions

According to Lines, et. al. (2012) rare genetic-related conditions are lifelong illness that may have a genetic component and impact fewer than 200,000 individuals in the United States.

In current clinical practice, genetic testing is confirmatory and takes place after a clinical syndrome has been identified through discussion with the patient or parents. In a typical case, the suspected gene will be amplified and sequenced through Sanger sequencing (Raffan & Semple, 2011). The result is a confidential statement about the mutation in the region sequenced. However, when suspected and common causes have to be eliminated first, it can lead to a lengthy diagnostic process for patients with rare genetic-diseases.

Glazov, et. al., (2012) explained that Mendilian diseases which part of some of the rare genetic conditions are usually described as mutations in a single gene which is inherited in accordance with Mendel's Laws. Some modern sequencing techniques are proving to be an effective approach for identification of rare genetic disorders (Calvo et. al., 2012). Some examples of rare genetic disorders include AA amyloidosis, adrenoleukodystrophy, Ehler's-Danlos syndrome, Mitochondrial diseases etc.

2.17 Complex Genetic-related Conditions

The vast majority of genetic diseases are complex genetic-related conditions. Some examples include Alzheimer's disease, Scleroderma, autoimmune disease among others (Hardy, 2012). There are complete databases that catalog genome-wide association studies on these diseases. For the most part, these complex diseases are caused by a combination of genetic, environmental, and lifestyle factors (Tennessen et. al., 2012).

Calvo, et. al., (2012) stated that Mitochondrial genetic-related conditions is caused by abnormal functioning of mitochondria. To date, more than 20 different molecular defects have been described in patients with mitochondrial diseases. These abnormalities may be the result of spontaneous or inherited mutations in the mitochondrial DNA or in nuclear genes that code for mitochondrial components. He and his colleagues reported in their book title –Epigenetics, epidemiology and mitochondrial DNA diseases- that mitochondrial DNA encodes only 13 proteins of the respiratory chain, while most of the estimated 1,500 mitochondrial proteins are nuclear-encoded. They also indicated that mitochondrial deficiencies often affect multiple tissues leading to multiple-system diseases that present with many phenotypic features. These characteristics make these diseases difficult to diagnose because of the multitude of candidate genes and highly variable nature of the clinical presentation.

2.18 Influence of Pre-service Biology teachers' Knowledge on their Attitude towards Persons with Genetic-Related Conditions

An attitude refers to a set of emotions, beliefs, and behaviors toward a particular object, person, thing, or event. Attitudes are often the result of experience or

upbringing, and they can have a powerful influence over behaviour. With much knowledge acquired by teachers in their field of study, their attitude towards people with genetic conditions is less negative and don't see them as being cursed by the gods but rather a genetic mutation made contributed to how such people with genetic conditions are.

Community attitudes are important determinants of the acceptance and support people with Down syndrome receive and of the opportunities that are available to them within their communities. Misconceptions about the behaviour, personalities and developmental potential of people with disabilities are likely to create negative attitudes and subsequent reactions such as discomfort, rejection or pity (Wang, Wu & Huang, 2007). The attitude of teachers towards people with genetic conditions will be determined by where the person is coming from, the cultural background and beliefs. In a different cultural background, it is believed that genetic disorders are seen as punishment, a person from such cultural background will not associate himself or herself much but a person with a wide knowledge about genetic conditions, he or she sees it to be a genetic mutation not punishment from any deity which will bring positive attitude towards people with genetic conditions.

Research conducted by Wang, Wu and Huang (2007) in schools in two provinces of South Africa reported biology students' understanding of the concepts of genetics and inheritance. Initial findings of this research showed lack of understanding of the methods and processes involved in genetics and inheritance by students. The result indicated students mistaken views resulting from a misunderstanding of the nature of genetic information in cells. There was a disagreement between traditional beliefs and scientific views on inheritance. Both the teachers and students made it known that the

teaching and learning of genetics was difficult.

According to USDA, (2007), societies consist of heterogeneous population made of different ages, cultures and ethnicities, with a more homogeneous population based on family, similar ethnicities and fewer cultural influences. As persons from multiple social groups interact, it would be expected that their thoughts, attitudes, values, behaviors, and (in most cases) language would be influenced (Saka, Cerrah, Akdeniz, & Ayas (2006)).

Saka, Cerrah, Akdeniz and Ayas (2006) said –Acculturation comprehends those phenomena which results when groups of individuals having different cultures come into continuous first-hand contact, with subsequent changes in the original cultural pattern of either or both groups”

It can be deduced from their result that the understanding of pre-service biology teachers from different localities would be different.

Research conducted by Saka, Cerrah, Akdeniz and Ayas (2006) revealed that significant differences existed in understanding among the age groups for the concepts of gene and DNA and none of the age groups displayed sound understanding. They found that in spite of the age levels, students in all groups possessed alternative ideas about the concepts they investigated.

Scientific literacy, from literature, is very important tool for continuous growth and development for a nation like ours. The need for scientific literacy is therefore unchallengeable and has to be promoted by all. However, the acceleration of scientific literacy may face an obstacle as scientific facts about nature and its occurrences have to come to meet cultural beliefs about some of these occurrences.

This may be overcome if pre-service science teachers who are going to be the future facilitators of science education in the country are fully equipped with the needed tools including better understanding of biological concepts and for that matter heredity. This study would seek to unravel pre-service science teacher cultural beliefs and their understanding of the causes of some of the genetically inherited traits.

2.19 Conceptual Framework

The conceptual framework for the study is presented in Fig. 1. The conceptual framework explains the relationship between the knowledge, cultural beliefs, and attitude of pre-service biology teachers towards persons with genetic-related conditions. The knowledge of pre-service biology teachers is borne from their cultural backgrounds and school knowledge.

The knowledge of the pre-service biology teachers affects their attitude toward persons with genetic-related conditions. The knowledge can affect the attitude positively or negatively. Knowledge that has scientific basis has positive attitude towards genetic-related conditions.

People's cultural beliefs affect their attitudes towards persons with genetic-related conditions in diverse ways, people from different cultural backgrounds have different attitudes towards persons with genetic-related conditions.

Fig. 1 depicts the relationship between the variables which is indicated by the arrows. The double-headed arrow between acquired knowledge of GRCS and attitudes towards GRC indicates that the pre-service biology teachers' knowledge on genetic-related conditions will influence their attitudes towards persons with GRCs. Likewise, the attitude of pre-service biology teachers will influence the knowledge they have

about GRCs.

The conceptual framework shows that attitude towards genetic-related conditions is affected by a person's knowledge and cultural beliefs. Knowledge affects attitude and one's cultural belief affects his or her attitude towards genetic-related conditions.

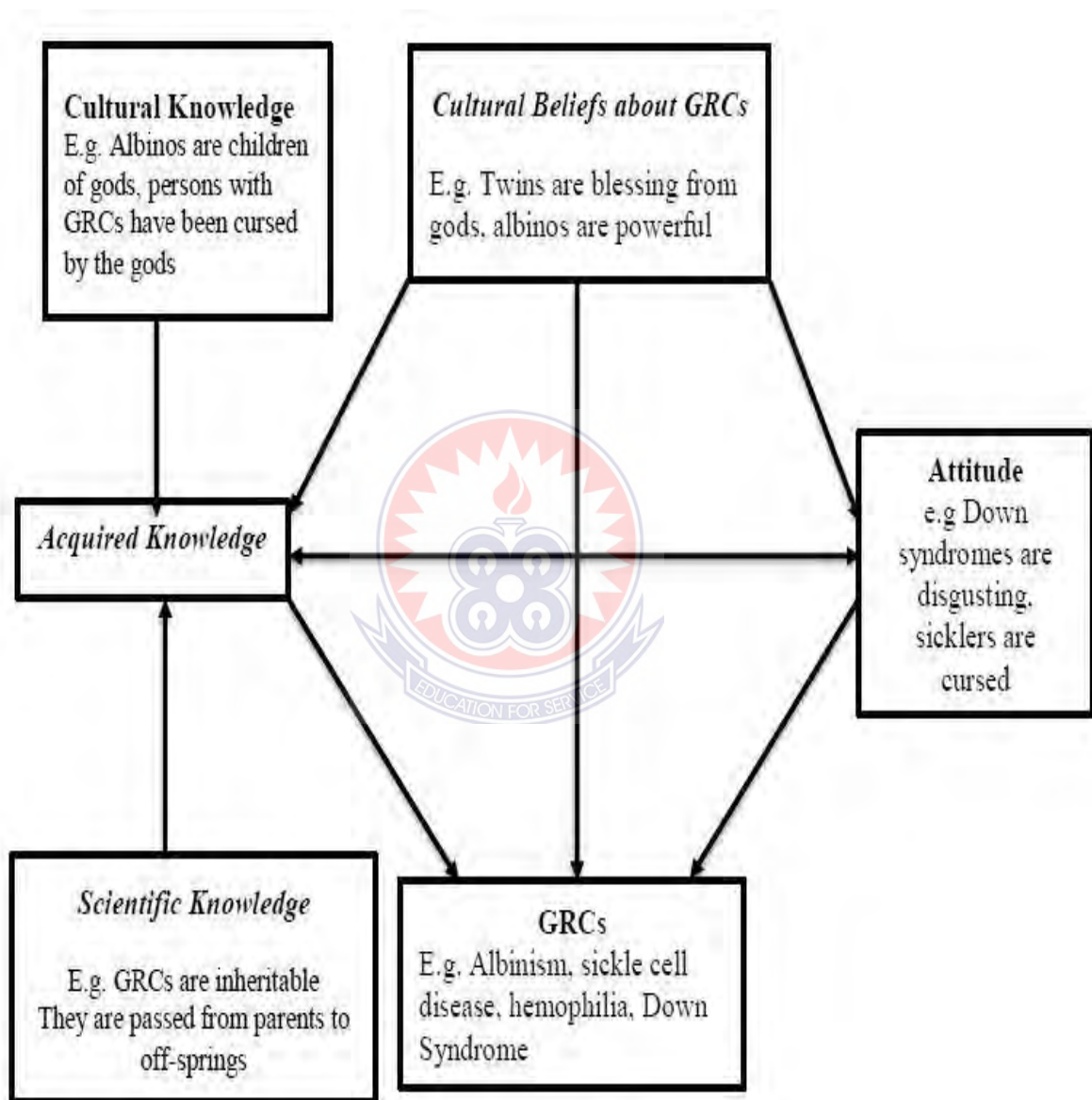


Fig. 1: Conceptual Framework

The concept attitude is dependent on numerous factors. From the conceptual framework, it can be seen that one's knowledge is dependent on multiple factors. The society or the environment one finds him/herself has impact on his/her knowledge. Culture, beliefs and level and type of education could all affect one's knowledge which can in turn affect the attitude.

The knowledge of an individual is affected by numerous factors including; formal education by learners at various levels. Learners have incipient ideas or concepts about Biology. For instance, in Senior High School, students are taught heredity in Integrated Science (Integrated Science Syllabus - Year 2, Unit 3 p. 31). Science students are taught concepts about heredity, variations, and evolutions (Biology Syllabus - Year 3, Unit 5, 6, and 7 – pp. 63, 64, and 65 respectively).

These initial ideas brought in by students are sometimes contradictory and inappropriate to generally accepted scientific ideas or concepts. These diverse ideas are often referred to as misconceptions or alternative concepts. They have their origin from the learners' immediate environment, which are later taken to formal education.

The arrow from the cultural knowledge and scientific knowledge indicates that pre-service biology teachers' cultural beliefs are likely to influence their acquisition of scientific knowledge on genetic-related conditions.

Pre-service biology teachers have encountered people in their communities with GRCs and had interactions with them and might have acquired some opinions about them. These opinions will influence their participation in classroom discussions on those conditions. This is likely to be in conflict with their cultural knowledge and scientific knowledge. The exposure to scientific knowledge may modify their cultural

beliefs about these conditions and may change or correct the misconceptions they have about these conditions. Therefore, the pre-service biology teachers' cultural beliefs and cultural knowledge about persons with such conditions will play a significant role in their acquisition of scientific knowledge about such conditions.



CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter of the study looks at the methodology and the various approaches the researcher employed in carrying out the study. It looks at the various mechanisms that were employed including the research design, sample and sampling technique, instrumentation, validity and reliability of the instrument, method of data analysis, ethical considerations.

3.1 Research Design

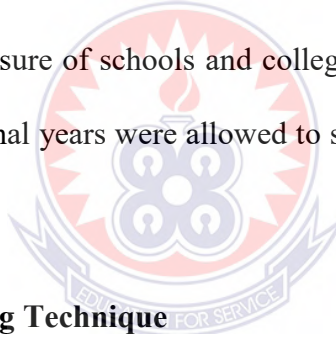
A descriptive survey research design was employed in this study. Descriptive survey is a type of research that aims at obtaining information about the present position of an organization, institution or a school (Cohen, Manion & Morrison, 2007). Information on variables of interest in the subjects were gathered and used to describe the knowledge, cultural beliefs and attitude of preservice biology teachers in the central region in relation to persons with genetic-related conditions. This design has the advantages of producing good amount of responses from a whole range of people, being less expensive, producing findings more quickly and is more likely to get the cooperation of respondents since data is collected at only one point in time. Also, this approach made it possible for the researcher to measure the reactions of many respondents to a limited set of questions, and therefore facilitated the comparison and statistical aggregation of the data (Cohen, Manion & Morrison, 2007). In addition, findings related to knowledge, beliefs and attitudes were noted to be reliable if data were drawn from a wider and representative sample which is a typical characteristic of a survey design and since this study sought to obtain large data on knowledge, beliefs and attitudes of pre-service biology teachers, the researcher found the survey

design appropriate for this study.

3.2 Population

Kusi (2012) defines a population as a group of individuals or people with the same characteristics the researcher is interested. Population may also be defined as a group of elements that are of interest to the study.

The population for this study was all final year pre-service biology teachers in the Central Region of Ghana. However, the accessible population was final year pre-service biology teachers in Fosu College of Education and OLA College of Education. The final year pre-service biology teachers were available to the researcher. This was because at the time of the study, the first and second years were not on campus due to closure of schools and colleges to curtail the spread of Covid-19 virus. However, the final years were allowed to stay on campus to write their final examinations.



3.3 Sample and Sampling Technique

According to Kusi (2012), a sample is a sub-group of the entire population under study. Sampling is the process of selecting a sample or a sub-group for a study. Alonge (2010) defines a sample as a subset of the population of interest. It is the chosen group of all the subjects of the population that the researcher wishes to know more about.

I used intact sampling technique to obtain a sample of 162 final year pre-service biology teachers from two Colleges of Education. This comprised of 65 and 97 final year preservice biology teachers from OLA College of Education and Fosu College of Education respectively.

Intact sampling is a type of non-probability sampling used to produce results that can be generalized only by making strong assumption about the samples. An intact group is an already existing group such as students in a particular class, students pursuing a particular programme or course, political group, cultural group, tribe, church groups among others. In this sampling technique, no selection procedure was applied but the entire group was used to represent the larger population that they were classified as part.

3.4 Instrumentation

I used questionnaire in obtaining data for this study (Appendix A). According to Worthen, White, Fan and Sudweeks (1999), the use of questionnaire is the best approach to elicit information about a person's feeling and beliefs that might not be accessible by any other means. According to Milne (1999) questionnaires are advantageous because responses are gathered in standardized way, making it more objective than interviews. Again, Milne said it is, usually, relatively quick to collect information using a questionnaire and information can be collected from a large portion of a group. Questionnaires are relatively simple to administer and easy to analyze. They can be used for sensitive topics which users may feel uncomfortable speaking to an interviewer about.

The construction and development of the questionnaire was guided by a guide to researchers for constructing questionnaires provided by Selltiz and her Associates (1976) and revised by Cohen, Manion and Morrison (2007).

The questionnaire used in this study included both close-ended and open-ended questions. The closed ended questions provided the advantage of generating frequencies of responses that are easy to code and analyze statistically (Oppenheim

cited in Cohen et al., 2007). The questionnaire consisted of 27 items distributed between two parts, A and B. Part A had five items which elicited information on background characteristics of the pre-service biology teachers who participated in the study. The background characteristics included age, sex, religious affiliation, programme pursued at high school and programme of study at the college. Part B had 22 items on five-point

Likert Scale type. Each item consisted of a statement followed by five weighted options namely Strongly agree (SA=1), Agree (A=2), Undecided (UN=3), Disagree (D=4) and Strongly disagree (SD=5)

3.5 Validity of the Instrument

Cook and Campbell (1979) defined validity as the most excellent available approximation to the truth or falseness of a given conclusion, suggestion or inference (Colosi, 1997). Validity of the instrument refers to the degree to which the instrument would measure what the research was supposed to measure. More simply, it is the accuracy of the measurement.

To ensure content validity of the instruments, the questionnaire was developed in line with the research objectives. The questionnaire was given to colleagues of the researcher to review and to comment on its face validity. The questionnaire was then given to the supervisor for assessment and corrections were necessary. The researcher ensured that the words and instructions were clear. Modifications and rectifications were effected after receiving the supervisor's comments.

3.6 Reliability of the Instrument

The instrument was piloted in Komenda College of Education. This school was chosen for the pilot exercise because the students shared similar characteristics and experiences with the sample selected from the two Colleges of Education for the study. They pursued similar programmes with common curriculum materials. The comments of the respondents in this institution were considered and identified errors were rectified before the actual administration of the instrument to collect data for the study.

The data from the pilot test of the questionnaire was used to determine the Cronbach Alpha reliability Coefficient of the instrument. The data was inputted into SPSS version 20 and reliability function of the software was used to determine the reliability coefficient which was 0.89.

According to Frankel and Wallen (2003), the value of the reliability coefficient should be 0.7 or preferably higher. Therefore, the value of 0.89 indicated the questionnaire had a very high internal consistency.

3.7 Data Collection Procedure

The researcher took an Introductory Letter from the Head of Department of Science Education of University of Education, Winneba. The letter was used to obtain permission from the authorities of the two colleges to carry out the study in the colleges.

The researcher and the subject tutors scheduled the time when to administer the questionnaires. On the scheduled dates, the researcher together with the subject tutors administered the questionnaire to the pre-service biology teachers in groups while

observing the Covid-19 protocols. Respondents were given the opportunity to opt out if they did not want to be part of the study and they were also given the opportunity to ask the researcher to clarify issues concerning the study which were not clear to them. The completed questionnaires were collected on the same day at OLA College of Education while those administered in Fosu College of Education were collected a day after administration. It took an average of 20 minutes for respondents to complete the questionnaire.

3.8 Data Analysis

Data analysis is the process of making data gathered in a study simpler in order to make it understandable (Frankel & Wallen, 2003). The outcome of the analysis was used to answer the research questions.

The Statistical Package for the Social Sciences (SPSS) version 20 was used to process the data. The study variables were defined, coded and inputted into the software (SPSS). The responses for each item on the questionnaire were coded by assigning them with unique numbers. For instance, variable such as sex had two values (male and female). Male was assigned -1 and female -2 . For religious affiliation, the values were assigned 1, 2, 3 and 4 for Christianity, Islamic, Traditional and Other religions respectively.

The coded data was then inputted into the Statistical Package for the Social Sciences (SPSS) computer software version 20 for analysis. The descriptive function of the SPSS was used to organize the participants background data into frequency counts and converted into percentages. It was also used to organize participants' responses to the Likert-Type Scale items of the questionnaire into frequencies, percentages, mean scores and standard deviations. The results of the analysis were presented in tables

and used to describe the knowledge, cultural beliefs and attitude towards of the pre-service biology teachers towards persons with genetic-related conditions. In this study, a mean score of 3 indicated that the pre-service biology teachers were undecided on the statement, a mean score greater than 3 implied that the pre-service biology teachers disagreed to the statement. A mean score of less than 3 indicates that pre-service biology teachers agreed to the statement.

An overall mean score greater than 3.0 under the knowledge scale was an indication that pre-service biology teachers had adequate knowledge about genetic-related conditions. If the overall mean score was less than 3.0 under the knowledge scale, it was an indication that the pre-service biology teachers did not possess adequate knowledge about the genetic-related conditions. If pre-service biology teachers had adequate knowledge about genetic-related conditions, they were more likely to have positive attitude towards persons with those conditions. Likewise, if they did not have adequate knowledge about GRCs, they were more likely to show negative attitude towards persons with such conditions.

With regards to their cultural beliefs, all the statements under the cultural beliefs subscale were negatively worded item, therefore an overall mean score greater than 3.0 was an indication that pre-service biology teachers had positive cultural beliefs about the genetic-related conditions. On the other hand, if the overall mean score was less than 3.0, it was an indication that the pre-service biology teachers had negative cultural beliefs about genetic-related conditions. If pre-service biology teachers had positive cultural beliefs about genetic-related conditions, they were more likely to show positive attitude towards persons with those conditions. Negative cultural beliefs in turn may lead to negative attitude towards persons with GRCs.

Moreover, under the attitude sub-scale, all the statements under the attitude subscale were negatively worded, therefore an overall mean score greater than 3.0 indicated that the pre-service biology teachers had positive attitude towards persons with genetic-related conditions. If the overall mean score was less than 3.0 under the attitude scale, it was an indication that the pre-service biology teachers had negative attitudes towards persons with genetic-related conditions. If pre-service biology teachers had positive attitude towards persons with genetic-related conditions, they were more likely to show love and care for persons with those conditions in their future classrooms. Conversely, if they show negative attitudes towards persons with such conditions, they may likely show discriminatory attitude towards such persons in their future classrooms.

3.9 Ethical issues

Ethical issues which include voluntary participation, informed consent and confidentiality (Trochim, 2006) were considered during the construction of the questionnaire. These ethical issues are necessary and were considered lest the respondents might have reacted to some of the items if those items posed threat to them (Cohen, Manion and Morrison. 2007). The pre-service biology teachers were not coerced into participating in this research work and also the research participants were fully informed about the procedures and risks involved in participating in this study. Participants were only engaged in this study upon their own consent. Participants were assured that any information they provide would not be made available to anyone who was not directly involved in the study and again respondents remained anonymous throughout the study.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Overview

The goal of this research was to explore the knowledge, cultural beliefs and attitudes of Pre-service Biology teachers towards persons with genetic-related conditions. The chapter presents the results of the analysis of the data obtained from the field which includes the background characteristics of the respondents, pre-service biology teacher's knowledge and attitude towards persons with genetic-related conditions. They were presented in tables and figures as frequencies, mean scores and standard deviations. The results were presented according to the research questions they answered. Descriptive statistical analysis was used to process the results to provide the basis for findings, conclusion and recommendations.

4.1 Demographic characteristics of Respondents

The data on the demographic characteristics of the respondents are presented in Tables 1 to 3. The data on the sex of the respondents is presented in Table 1.

Table 1: Sex Distribution of Respondents

Variables (sex)	Frequency	Percentage (%)
Male	103	89.6
Female	12	10.4
Total	115	100

Source: Field Data, 2020

A total of 162 pre-service biology teachers participated in the study. Out of this number, majority of them (n=88, 54.3%) were males and the rest (n=74, 45.7%) were females. This indicated that the study was dominated by male respondents.

Age Distributions of the Respondents

The data on the age distribution of the respondents is shown in Fig. 2.

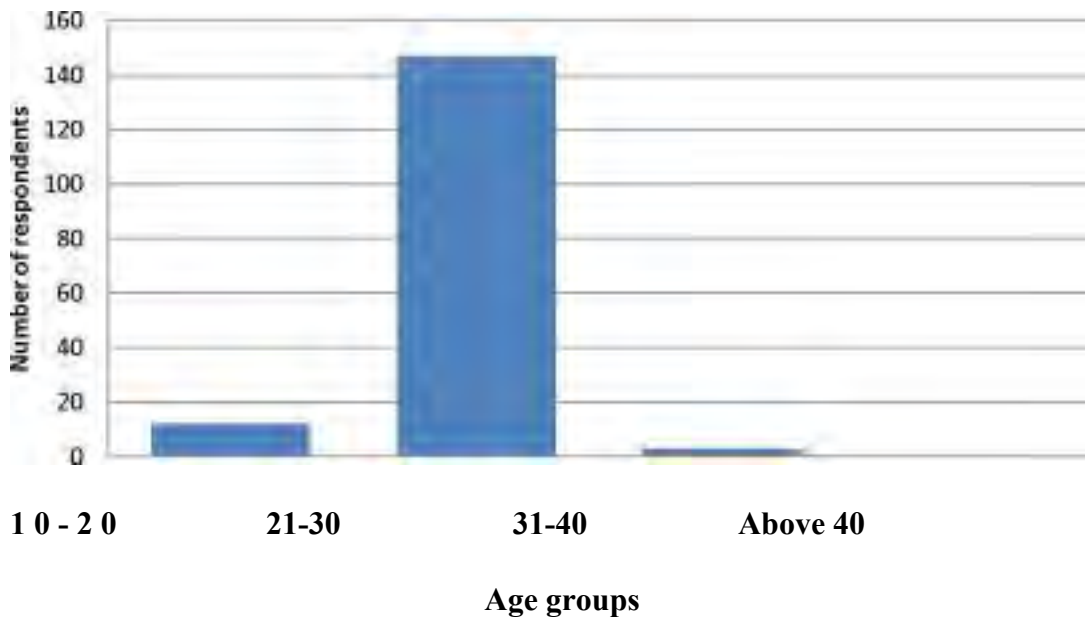


Fig. 2: Age Distribution of Respondents

A greater number of the respondents (n=147, 90.7%) were aged between 21 and 30 years, with only a few respondents (n=3, 1.9%) within the ages of 31 - 40 years. Quite a number of the respondents (n=12, 7.4%) were between 10 - 20 years. Figure 1 shows the age distribution of the respondents.

Table 2: Religious Affiliations of Respondents

Variable (Religious Affiliation)	Frequency	Percentage (%)
Christianity	150	92.6
Islam	12	7.4
Traditional	0	0
Total	162	100

Source: Field Data, 2020

A significant proportion of the respondents (n=150, 92.6%) attested to be Christians and the remaining (n=12, 7.4%) affirmed to practice Islam. This result indicated that the participants belonged to only two different religions. In Ghana there are three major religious groups, these are Christianity, Islamic and African Traditional religion.

Table 3: Programmes Pre-service Biology Teachers Pursued at SHS

Variable (Programme Studied at SHS)	Frequency	Percentage (%)
General Science	97	59.9
Business	7	4.3
Agricultural Science	38	23.5
General Arts	10	6.2
Visual Art	1	0.6
Home Economics	9	5.6
Total	162	100

Source: Field Data, 2020

More than half of the pre-service biology teachers (n=97, 59.9%) offered General Science at SHS, while about a third of the respondents (n=38, 23.5%) offered Agricultural Science. Only one of the participants (0.6%) claimed to have offered

Visual Arts at SHS. The data suggests that about 83% of the pre-service biology teachers offered General Science and Agricultural Science. This was an indication that the pre-service biology teachers had some level of scientific literacy due to the programmes they offered at Senior High School.

4.1.2 Data Presentation and Analysis on Research Question 1

Research Question 1:

What knowledge do pre-service biology teachers have about genetic-related conditions?

Research question one was meant to assess the knowledge of pre-service biology teachers on genetic-related conditions. The pre-service teachers' knowledge about genetic-related conditions (PTKGRC) instrument was used to collect data from the participants to answer research question 1. Descriptive statistics was used to analyse respondents' scores on KPTGRC. In order to answer research question 1, item number 7 to 13 were pooled. The summary of the frequencies and percentages of responses were presented in Table 4. Sample questionnaire can be found at appendix A.

A high mean score for negatively worded item indicated that pre-service teachers possessed positive knowledge about genetic-related conditions. However, a low mean score for positive worded items indicated that pre-service teachers had positive knowledge on genetic-related conditions. The overall average mean scores and average standard deviations for all the items were determined. Table 4 presents the analysis of the results.

The mean scores ranged from 1.81 (SD=1.03) to 3.87 (SD=1.47). The overall mean score was 3.01 (SD=1.24). The overall average mean of 3.01 (SD=1.24) was an indication that the pre-service biology teachers had moderate knowledge about genetic-related conditions.

Item 7, 9 and 11 had mean scores less than 3.0. These items were positively worded items and as such their low mean score indicated that the pre-service teachers had positive knowledge about genetic-related diseases. The percentage frequencies of the respondents' scores to the items depicted a similar trend as the mean scores.

Table 4: Descriptive Statistics of Pre-service Biology Teachers' Response to items on their Knowledge About Genetic-related Conditions

S/N	Statement	MS	SD	A “%” “F”	UD “%” “F”	D “%” “F”
6.	Poor nutrition cause GRC	3.80	1.29	25.9(42)	4.9(8)	67.9(110)
7.	Down syndrome is a GRC	1.86	1.05	83.9(136)	4.3(7)	11.7(19)
8.	GRCs are contagious	3.81	1.33	22.2(36)	10.5(17)	67.3(109)
9.	All GRCs are inheritable	2.57	1.47	61.1(99)	6.2(10)	32.0(53)
10.	Albinism affect people who aren't resistant to the sun	3.87	1.21	17.2(28)	13.6(22)	69.1(112)
11.	Sickle cell carrier parents can give birth to carriers	1.81	1.14	81.5(132)	4.9(8)	13.6(22)
12.	Colour blindness is dominant in males than females	3.10	1.03	29.6(48)	33.3(54)	37.0(60)
13.	Most GRCs are environmentally Influenced	3.23	1.40	37.1(22)	13.6(22)	49.4(80)
Overall mean score / SD		3.01	1.24			

Source: Field Data, 2020

Majority of the pre-service biology teachers (n=110, 67.9%) disagreed that poor nutrition caused genetic-related diseases whilst a very few of them (n=42, 25.9%) strongly agreed to the fact that poor nutrition caused genetic-related diseases

A larger number of the respondents (n=136, 83.9%) agreed that Down syndrome is a genetic-related condition while a very few of them (n=19, 11.7%) disagreed that Down syndrome is a genetic-related condition.

Majority of the pre-service biology teachers (n=109, 67.3%) disagreed that all genetic-related conditions are contagious while a small number of them (n=36, 22.2%) agreed that all genetic-related conditions are contagious.

A significant number of the pre-service biology teachers who participated in the study (n=99, 61.1%) agreed to the fact that all genetic-related conditions are inherited whilst a small number of the participants (n=10, 6.2%) undecided as to whether all genetic-related diseases are inheritable.

A significant proportion (n=112, 69.1%) of the respondents disagreed that Albinism affect people who are not resistant to the sun with a small number of them (n=22, 17.2%) claiming that they agreed that Albinism affect people who are not resistant to the sun while 13.6% (n=22) of the participants had no idea or were undecided.

A greater number of the pre-service biology teachers who participated in the study (n=132, 81.5%) agreed to the fact that Sickle cell carrier parents can give birth to carriers with a small number (n=22, 13.6%) of them also disagreed to the fact that Sickle cell carrier parents can give birth to carriers.

Majority of the pre-service teachers (n=60, 37%) stated that they disagreed that

colour blindness is dominant in males than in females while a few of them (n=54, 33.3%) were undecided whether colour blindness is dominant in males than in females with small number of them (n=48, 29.6%) stating that they agree.

A significant number of the pre-service teachers (n=80, 49.4%) who participated in the study disagreed that most genetic related conditions are environmentally influenced. Quite a great number of the respondents (n=60, 37.1%) also agreed that genetic related conditions are environmentally influenced.

4.1.3 Data Presentation on Research Question 2

Research Question 2:

What cultural beliefs do pre-service biology teachers hold about genetic-related conditions?

Research question 2 sought to explore the cultural beliefs of pre-service biology teachers towards genetic-related disease. The cultural beliefs pre-service biology teachers hold about genetic-related conditions (CBPTGRC) instrument was used to collect data from the participants to answer research question 2. Item number 14 to 18 were pooled to answer research question 2. Descriptive statistics was used to organise respondents' scores on CBPTGRC with frequency counts which were converted into percentages. The average mean scores and the standard deviations for the various items were also determined. The results of the analysis are presented in Table 5. Sample questionnaire can be found at appendix A.

Table 5: Mean score, Standard Deviation, Frequency Counts, and Percentage Scores of Pre-service Biology Teachers' Response to items on Cultural Beliefs

S/N Statement	MS	SD	A	UD	D
			“%” “F”	“%” “F”	“%” “F”
14. People with GRCs are cursed by gods	4.41	0.87	3.1(5)	10.5(17)	86.5(140)
15. Twins are blessing from the gods	4.34	1.06	8.0(13)	5.6(9)	86.4(140)
16. Albinos are evil	4.63	0.79	3.7(6)	4.3(7)	91.9(149)
17. Albinos are used for ritual purposes	4.36	1.04	6.8(11)	6.8(11)	86.4(140)
18. Women are responsible for sickle cell	4.35	1.07	8.0(13)	99(16)	82.1(133)
Overall mean score / SD	4.42	0.97			

Source: Field Data, 2020

A mean score higher than 3.0 suggests that pre-service teachers' cultural beliefs towards persons with genetic-related conditions was positive, but a mean score that is less than 3.0 depicts that they had negative cultural beliefs towards persons with genetic related conditions.

The mean scores ranged from 4.34 (SD=1.06) to 4.63 (SD=0.79). The overall average mean score was 4.42 (SD=0.97). The overall average mean of 4.42 was an indication that the pre-service biology teachers had positive cultural beliefs about genetic-related conditions.

All the statements under the cultural beliefs sub-scale were negatively worded item, therefore an overall mean score greater than 3.0 was an indication that pre-service biology teachers had positive cultural beliefs about the genetic-related conditions. On

the other hand, if the overall mean score was less than 3.0, it was an indication that the pre-service biology teachers had negative cultural beliefs about genetic-related conditions.

The percentage frequencies of the respondents' scores to the items depicted a similar trend as the mean scores. Majority of the pre-service teachers (n=140, 86.5%) stated that they disagreed that people with genetic-related conditions are cursed by gods whilst only a few of the pre-service biology teachers (n=5, 3.1) agreed that people with genetic-related conditions are cursed by gods. A greater number of the pre-service teachers (n=140, 86.4%) disagreed that twins are blessing from the gods while only a small fraction (n=13, 8%) of the pre-service agreed with the statement.

A larger number of the pre-service biology teachers (n=149, 91.9%) disagreed that Albinos are evil while only few of them (n=6, 3.7%) agree to the fact that Albinos are evil. Majority of the participants (n=140, 86.4%) stated that they disagreed that Albinos are used for ritual purpose while a small number of them (n=11, 6.8%) agree that Albinos are used for ritual purpose.

A greater number of the pre-service biology teachers (n=133, 82.1%) who participated in the study stated that they disagree that women are responsible for sickle cell while a small number of them (n=13, 8%) agree to the fact that women are responsible for sickle cell.

4.1.4 Data Presentation on Research Question 3

Research Question 3:

What are the attitudes of pre-service biology teachers towards genetic-related conditions?

The research question was to explore the attitude of pre-service biology teachers towards genetic-related conditions. The pre-service biology teachers' attitude towards genetic-related conditions (PTAGRC) instrument was used to collect data from the participants to answer research question 3. Item number 19 to 27 were pooled to answer research question 3. Descriptive statistics was used to organise respondents' scores into frequencies, percentages, mean scores, and standard deviations on PTAGRC. The results of the analysis are presented in Table 6. Sample questionnaire can be found at appendix A.

All the statements under the attitude subscale were negatively worded, therefore an overall mean score greater than 3.0 indicated that the pre-service biology teachers had positive attitude towards persons with genetic-related conditions. If the overall mean score was less than 3.0 under the attitude scale, it was an indication that the pre-service biology teachers had negative attitudes towards persons with genetic-related conditions.

The mean scores ranged from 3.5 (SD=1.49) to 4.57 (SD=0.94) with an overall mean score of 4.34 (SD=1.03). The overall average mean (4.34) was an indication that the pre-service biology teachers had positive attitudes towards genetic-related conditions.

Majority of the pre-service biology teachers (n=150, 92.6%) disagreed that people with Down syndrome are cursed and useless while a quiet number of them (n=9, 5.5%) claiming that they agree that people with Down syndrome are cursed and

useless with only 1.9% (n=5) of the respondents attested that they have no decision on whether people with Down syndrome are cursed and useless.

Table 6: Mean score, Standard Deviation, Frequency Counts, and Percentage Scores of Pre-service Biology Teachers' Response to items on their attitude Towards Persons with GRCs

S/N Statement	MS	SD	A		UD		D	
			“%”	“F”	“%”	“F”	“%”	“F”
19. People with down syndrome are cursed & useless	4.57	0.94	5.5(9)		1.9(3)		92.6(150)	
20. Sicklers are not worthy to be taught	4.54	0.89	6.2(10)		3.1(5)		90.8(147)	
21. Down syndromes are idiots	4.44	1.05	8.0(13)		3.7(6)		88.2(143)	
22. Albinos do not deserve to be part of main classroom the main classroom	4.50	0.89	5.0(8)		4.9(8)		90.1(146)	
23. Down syndromes are not educable	4.43	1.02	7.5(12)		0.6(1)		92.0(149)	
24. Down syndrome can infest	4.44	0.97	6.8(11)		4.9(8)		87.6(142)	
25. I don't have a friend with colour	3.50	1.49	29.6(48)		16.0(26)		54.3(88)	
26. People with Down syndrome are disgusting	4.25	1.13	11.7(19)		5.6(9)		82.7(134)	
27. Better to segregate people with GRCs	4.39	0.93	4.3(7)		7.4(12)		88.2(143)	
Overall mean score / SD	4.34	1.03						

Source: Field Data, 2020

Most of the respondents (n=147, 90.8%) were of the opinion that sicklers are not worthy to be taught. Only a few of the pre-service biology teachers (n=10, 6.2%) stated that they agree that sicklers are not worthy to be taught.

Majority of the of the pre-service biology teachers (n=143, 88.2%) disagreed with the statement that down syndromes are idiots while a small number of them (n=13. 8%) also agreed that down syndromes are idiots. A significant number of the respondents (n=146, 90.1%) disagreed with the statement that Albinos do not deserve to be part of the main stream classroom while a small number of them (n=8, 5%) also confirmed that they agree that Albinos do not deserve to be part of main stream classroom. Majority of the respondents (n=149, 92%) were of the view that people with Down syndrome are not educable. Only a few of the pre-service biology teachers (n=12, 7.5%) stated that they agree to the fact that Down syndromes are not educable.

A larger proportion of the respondents (n=142, 87.6%) disagree that Down syndromes can infect others while a small number of them (n=11, 6.8%) also agree that Down syndromes can infect others with only 4.9% (n=8) claiming that they have no idea.

A little over half of the respondents (n=88, 54.3%) disagreed with the statement that they don't have friends with colour blindness while almost half of them agree they don't have a friend with colour blindness.

A greater number of the pre-service biology teachers (n=134, 82.7%) disagreed that Down syndromes are disgusting while only (n=19. 11.7%) agree that Down syndromes are disgusting.

Majority of the respondents (n=143, 88.2%) were of the view that they disagree to the fact that it is better to segregate people with genetic- related conditions while only a few of the pre-service biology teachers (n=7, 4.3%) stated that they agree to the fact that it is better to segregate people with genetic- related conditions.

4.1.5 Data Presentation on Research Question 4

Research Question 4:

To what extent does pre-service biology teachers' knowledge influence their attitudes towards genetic-related conditions?

The question sought to determine the extent to which pre-service biology teachers' knowledge influence their attitude towards persons with genetic-related conditions. The overall mean score for the participants' response on their knowledge about genetic-related conditions was 3.01 (SD=1.24). The overall mean score for pre-service biology teachers' response on the attitude scale was 4.34 (SD=1.03). The mean scores of the participants' responses on the IPTK-PTAGRC subscales for the variables, knowledge and attitude were used to establish any correlation between the variables. The Correlation Statistical function of Microsoft Excel 2010 version was used to determine/ establish the correlation between the variables. The results of the analysis are presented in Table 7.

The Pearson Correlation Coefficient (r) was found to be -0.08 which was an indication that preservice teachers' knowledge on genetic-related conditions had little influence on their attitude towards genetic-related condition.

Table 7: Results of Correlational analysis on the mean scores of Pre-service Biology Teachers' knowledge and attitude towards persons with genetic-related conditions

Variables	PBTK	PBTA
PBTK	1	-0.08
PBTA	-0.08	1

The results of the correlation analysis showed that pre-service biology teachers' knowledge on genetic-related conditions had a positive and statistically correlation ($r = -0.08$, $p < 0.05$) about knowledge on their attitudes with a small coefficient of determination ($r^2 = 0.0064$). That is, the pre-service biology teachers' knowledge on genetic-related conditions accounted for 0.64% on their attitude towards persons with genetic-related conditions. Nonetheless, it is an indication that pre-service biology teachers' attitude on genetic-related conditions might increase with improvement in their knowledge about genetic related conditions.

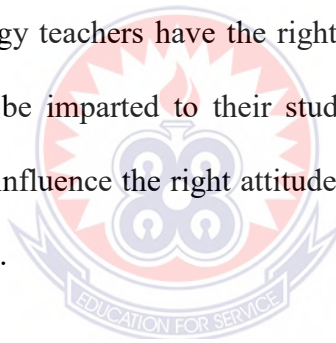
4.2 Discussion of Data on Pre-service Biology Teachers' Responses to Questionnaire

This section presents the discussions based on the findings of the study according to the research questions that guided the study. The discussion was based on the following themes; pre-service biology teachers' knowledge on genetic-related conditions, pre-service biology teachers' cultural beliefs about genetic-related conditions, pre-service biology teachers' attitude towards persons with genetic-related conditions, and the influence of pre-service biology teachers' knowledge on their attitudes towards persons with genetic-related conditions.

4.2.1 Pre-service Biology Teachers' Knowledge on persons with Genetic-related Conditions

The level of knowledge one has about genetic-related conditions is likely to affect his or her attitude towards persons with such conditions. Knowledge can also influence one's belief about the causes and behavioural pattern towards persons with genetic-related conditions.

The study revealed that pre-service biology teachers in the Central region of Ghana possessed relevant knowledge on genetic-related conditions. For instance, majority of the pre-service biology teachers (n=110, 67.9%) who participated in the study disagreed that poor nutrition caused genetic-related conditions. This finding depicted that the pre-service biology teachers have the right knowledge about genetic-related conditions which would be imparted to their students in the classroom. The right knowledge will possibly influence the right attitude of students towards persons with genetic-related conditions.



With the view of whether all the genetic-related diseases are contagious, a significant number of pre-service biology teachers (n=109, 67.3%) disagreed that all genetic-related conditions are contagious. This finding is a clear indication that the pre-service biology teachers have knowledge on genetic-related conditions.

George (2001) studied culture and science in developing world and emphasized that teachers require help in understanding the conceptual base of traditional practices and beliefs so as to be able to bring to the fore in science classroom. This he said as a result of the teachers being products of traditional communities which implies that their beliefs and Bowling, Wang, Myers, Dean, Markle, Moskalik and Huether (2008) reported that major advances in genetics for some time now have considerably

increased the effect of genetics and technologies on humanity. The findings from the study where a greater number of the pre-service biology teachers (n=132, 81.5%) agreed to the fact that Sickle cell carrier parents can give birth to carriers lends support to their report.

Lewis and Kattmann (2004) reported that different researches have shown that students do not understand the genetic knowledge they are taught in their school. Misunderstanding by these students leads to their inability to put into use basic knowledge in everyday live situations. Students come to school with different knowledge about genetic-related conditions due to the cultural backgrounds or traditions they were brought up with. The school is therefore entrusted with the responsibility of teaching the students to develop scientific literacy (knowledge) in order to ascertain whether their cultural beliefs have scientific basis.

This implies that if the students do not understand the concept they are taught in schools, they may end up with many misconceptions about genetic-related conditions. As students develop misconceptions about genetic-related conditions, they tend to possess poor knowledge about the condition. The pre-service biology teachers' poor knowledge about genetic-related conditions may results in negative attitudes towards people with such conditions.

The respondents were final year pre-service biology teachers who had majored in biology. These pre-service biology teachers had cultural knowledge about persons with genetic-related conditions since they might have interacted with such persons in their communities and their respective schools. They would have also gained some knowledge in topics on genetics from basic school level to college through secondary level of education.

It can therefore be said that the pre-service biology teachers had requisite knowledge on genetic-related conditions. Rightly so the study indicated that the pre-service biology teachers had some appreciable level of scientific knowledge. The levels of scientific knowledge intend may influence their attitude towards persons with genetic-related conditions.

The pre-service biology teachers demonstrated moderate knowledge on genetic-related conditions. The overall average mean score on pre-service biology teachers' knowledge on genetic-related conditions was 3.01 (SD=1.24). All the mean scores were less than 3.0.

4.2.2 Pre-service Biology Teachers' Cultural beliefs about Genetic-related Conditions

African traditional culture is associated with religion and according to Hiebert (1976), every religion has myths or stories of apparent source and events and their importance to the world.

Traditional Religions in Ghana believe in the involvement of ancestors in the life of the people. The cultural believes in the forces of good and evil that can be manipulated by direct access to the divinities through prayer and sacrifice (Bodley, 2009). Bodley added that they believed in the efficacy of charms and amulets to ward off evil.

If more than half of the population strongly holds these beliefs which includes beliefs about inheritance, then student from such backgrounds may face a challenge in the learning of scientific facts that conflict with their cultural beliefs. However, pre-service biology teachers' cultural beliefs acquired was to influence their ideas about

the genetic-related conditions incorporated in their communities.

This is because majority of the pre-service biology teachers (n=140, 86.5%) stated that they disagree that people with genetic-related conditions are cursed by gods. It was also revealed in the study that a greater number of the pre-service biology teachers (n=140, 86.4%) disagreed that twins are blessing from the gods. Cultural and religious beliefs make people think that twins are blessings from God.

There are a number of cultural beliefs on the occurrence of albinism in human population in Africa. Albinos are believed to be special and strange beings that possess certain spiritual powers. They are therefore used for rituals in many African countries such as Tanzania. According to Dave-Odigie (2010), albinos in Tanzania are a defenseless group of people who are under danger of extermination as they are being killed with impunity, based on the belief that the concoction made from their body parts can bring good luck, wealth and success.

British Broadcasting Co-operation reported that the security service in Burundi arrested some people with fresh body parts of Albinos (Ghana Association of Persons with Albinism, GAPA, 2010). However, majority of the participants of the study (n=140, 86.4%) disagreed with the statement that Albinos are used for ritual purpose (Item 17, Table 5).

Sickle cell disease can be inherited from both carrier parents, a carrier parents and a normal parent, and it can also be inherited from a sickler and a normal parents or carrier parents. This genetic inheritance disproves the fact that women are responsible for sickle cell disease. Finding from the study had it that a greater number of the pre-service biology teachers (n=133, 82.1%) who participated in the study stated that they

disagreed with the statement that women are responsible for sickle cell.

The pre-service biology teachers held positive cultural beliefs about genetic-related conditions. The overall average mean score for pre-service biology teachers' cultural beliefs was 4.42 (SD=0.97).

4.2.3 Pre-service Biology Teachers' Attitudes towards persons with Genetic-related Conditions.

Attitude is a concept that is concerned with an individual's way of thinking, acting and behavior. Attitudes are formed as a result of some learning experiences and exposures from people sometimes. Attitudes are sometime acquired by following the examples or imitating an elder, parents, teachers and other role models. For example, children learn to be gossips or talkers if their parents are such. Others show love and respect to others because they find themselves around people who show love and respect to others. This is a natural socialization principle in the society where younger generations learn from the older generations through interactions and observations. In the classroom, students model the teacher by imitating whatever he or she does. Therefore, the teacher's attitude towards persons with genetic-related conditions could have effects on the students since the teacher's attitude has direct influence on the attitude of the students. If teachers demonstrate positive attitude towards persons with genetic-related conditions in their future classrooms by showing them the love and care, other students or pupils might likely imitate and replicate such behaviours learnt from their teachers.

The study revealed positive attitude of pre-service biology teachers towards persons with genetic-related conditions. This can be associated with the knowledge they have gained from learning genetics from basic school level through second cycle schools to

the Colleges of Education. They have been exposed to scientific literacy which has enlightened them on issues about genetic-related conditions. This has also become possible because the knowledge they acquired from schools though conflicted with their cultural knowledge about genetic-related conditions, they would be able to better understand the fact surrounding such conditions and would therefore use the knowledge to educate others on such conditions.

Majority of the pre-service biology teachers (n=150, 92.6%) disagreed with the statement that people with Downs syndrome are cursed and are useless. This implies that the pre-service biology teachers are more likely to translate this attitude and behavior to their future classroom practices to emphasize the scientific basis for such conditions.

In similar vein, most of the respondents (n=147, 90.8%) were of the opinion that persons with sickle cell (disease) conditions are worthy to be taught. This assertion is a positive demonstration that pre-service biology teachers would accept and show love to persons who are victims of sickle cell conditions.

Again, majority of the respondents (n=146, 90.1%) attested that Albinos deserve to be part of the main classroom stream. This assertion is a positive indication of acceptance of albinos in the main classroom stream and that is a positive attitude being depicted by the pre-service biology teachers.

The pre-service biology teachers had positive attitudes towards persons with genetic-related conditions. The overall average mean score for the pre-service biology teachers' attitude towards persons with genetic-related conditions was 4.34 (SD=1.03).

4.2.4 Influence of Pre-service Biology Teachers' Knowledge on their Attitude towards Persons with genetic-related conditions

Attitude is influenced by many factors. Pertinent to these factors are knowledge one has about that subject matter. Perception which may sometimes be misconceptions is a factor that influences people's attitude about a particular subject matter or situation. In a like manner, pre-service biology teachers' attitude towards persons with genetic-related conditions may be affected by numerous factors such as the knowledge they possess about GRCs.

The study revealed a weak correlation between pre-service biology teachers' knowledge on genetic-related conditions and their attitude towards genetic-related conditions. The Pearson Correlation Coefficient was -0.08 ($p < 0.05$) which was an indication that pre-service biology teachers' knowledge on genetic-related conditions had small influence on their attitude towards genetic-related conditions.

Both the teachers and students made it known that the teaching and learning of genetics was difficult. In this study, pre-service biology teachers demonstrated to have requisite knowledge on GRCs. Though they come from different cultural backgrounds, the results of the correlation of their knowledge against their attitude showed that there was a weak correlation between their knowledge and their attitude.

In addition to the above, the findings of this study indicated that all the pre-service biology teachers had some level of knowledge with regards to genetic-related conditions. Their level of knowledge makes them understand GRCs because of some topics such as genetics and inheritance they learnt back in SHS science subject that impacts more knowledge on genetics. The pre-service biology teachers also have

cultural knowledge about genetic-related conditions that they acquired from their exposure and interactions in their communities and schools.

According to USDA, 2007, societies consist of heterogeneous population made of different ages, cultures and ethnicities, with a more homogeneous population based on family, similar ethnicities and fewer cultural influences. As persons from multiple social groups intersect, it would be expected that their thoughts, attitudes, values, behaviors, and (in most cases) language would be influenced (Redfield, Linton, & Herskovits, 1936 cited in Smokowski, Rose & Bacallao, 2008). Pre-service biology teachers in like manner come from different backgrounds with different cultural beliefs that tend to possess diverse ideology and portray different attitudes towards person with genetic-related conditions. Formal education has also increased in a great deal their scientific literacy which has contributed to the knowledge they already possessed from their cultural backgrounds.

Findings of the study had proven that pre-service biology teachers' knowledge influences their attitude towards persons with genetic related conditions. The knowledge they acquired from their cultural background and that of their schooling sum up to form the acquired knowledge which in turn modify their attitude towards persons with such conditions. The knowledge has demonstrated positive influence on their attitude towards persons with such conditions.

There was a weak correlation between pre-service biology teachers' knowledge and their attitude towards genetic-related conditions. The pre-service biology teachers' knowledge on genetic-related conditions had a positive statistically correlation ($r = -0.08$, $p < 0.05$) about knowledge on their attitudes with a small coefficient of determination ($r^2 = 0.0064$).

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter presents the summary of the entire work, major findings from the study, drawn conclusions and finally recommendations that were made.

5.1 Summary

The purpose of this study was to explore pre-service biology teachers' knowledge, beliefs and attitudes towards persons with genetic-related conditions in the Central Region of Ghana.

A descriptive survey design was employed in this study. A sample of 162 final year pre-service biology teachers from OLA and Fosu Colleges of Education participated in the study. An intact sampling technique was used to get the respondents for the study. Respondents were all final years. A questionnaire containing five-point Likert Scale items was used to elicit information from preservice teachers to answer the research questions.

The coded data was then inputted into the Statistical Package for the Social Sciences (SPSS) computer software version 20 for analysis. The descriptive function of the SPSS was used to organise the participants background data into frequency counts and converted into percentages. It was also used to organise participants' responses to the Likert-Type Scale items of the questionnaire into mean scores and standard deviations.

The influence of pre-service biology teachers' knowledge on their attitude towards persons with genetic-related conditions was determined through correlational

analysis.

5.2 Main Findings

The study found that;

1. The pre-service biology teachers demonstrated moderate knowledge on genetic-related conditions. The overall average mean score on pre-service biology teachers' knowledge on genetic-related conditions was 3.01 (SD=1.24). All the mean scores were less than 3.0.
2. The pre-service biology teachers held positive cultural beliefs about genetic-related conditions. The overall average mean score for pre-service biology teachers' cultural beliefs was 4.42 (SD=0.97).
3. The pre-service biology teachers had positive attitudes towards persons with genetic-related conditions. The overall average mean score for the pre-service biology teachers' attitudes towards genetic-related conditions was 4.34 (SD=1.03).
4. There was a weak correlation between pre-service biology teachers' knowledge and their attitude towards genetic-related conditions. The pre-service biology teachers' knowledge on genetic-related conditions had a positive statistically correlation ($r = -0.08$, $p < 0.05$) about knowledge on their attitudes with a small coefficient of determination ($r^2 = 0.0064$).

5.3 Conclusions

The purpose of this study was to explore pre-service biology teachers' knowledge, beliefs and attitudes towards persons with genetic-related conditions. The following conclusions were drawn from the study.

Pre-service biology teachers possessed moderate knowledge on the concept of genetic-related conditions. The acquired knowledge is a merge of cultural knowledge from their communities and scientific knowledge which they acquired through their formal education process, thus from basic school through high schools to Colleges of Education.

The final year pre-service biology teachers had positive cultural beliefs about persons with genetic-related conditions, therefore they are likely not to discriminate against persons with such conditions.

The pre-service teachers demonstrated positive attitudes towards persons with genetic-related conditions. This was influenced by the knowledge they had acquired from their backgrounds and scientific knowledge they acquired from basic schools through high schools to Colleges of Education.

The pre-service biology teachers' knowledge had a positive influence on their attitude towards persons with genetic-related conditions.

5.4 Recommendations

Based on the findings of the study the following recommendations were made;

1. The pre-service biology teachers demonstrated moderate knowledge on genetic-related conditions. It is therefore recommended that the Ministry of Education and the Ghana Education Service should intensify the science

curriculum of the Colleges of Education by adding more topics on genetics and its related subject matter to the curriculum content. This will improve the scientific knowledge or the scientific literacy of the pre-service biology teachers which will influence their cultural beliefs. Improved knowledge and positive cultural beliefs will also have a positive influence on their attitudes towards persons with genetic- related conditions.

2. On the aspect of cultural beliefs, though the study found out that the pre-service biology teachers had positive cultural beliefs about genetic-related conditions, they could not attain 100% positive cultural beliefs towards persons with GRCs which also implied that some of the pre-service biology teachers have negative cultural beliefs about the conditions. Therefore, it is recommended that topics that can address issues of misconceptions and myths people hold about genetic-related conditions should also be taught in order to change their negative perceptions about the conditions to contribute to their positive cultural beliefs about GRCs.

5.5 Suggestions for Future Research

The study was supposed to include all pre-service biology teachers but due to the upsurge of covid- 19 pandemic at the time of the study, only final year pre-service biology teachers were involved in the study. This was because at the time of the study, schools and colleges had closed down but the final year students were on campus to complete their final year examination. The results of the study showed that the final year pre-service biology teachers had moderate knowledge about GRCs. The knowledge in turn had a little influence on their attitude.

Further studies should therefore include all pre-service biology teachers thus, first years, second years and final year pre-service biology teachers so that future studies could be carried out to ascertain whether there will be an improvement in the knowledge, cultural beliefs and attitude of pre-service biology teachers after going through the science curriculum at the Colleges of Education.



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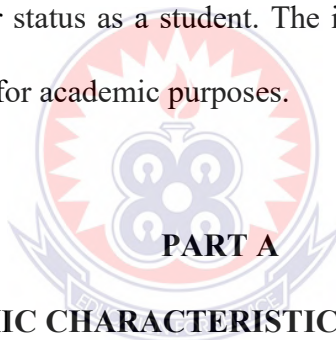
APPENDIXES

APPENDIX A

QUESTIONNAIRE

Dear Pre-service teacher,

Thank you for agreeing to take part in this study. The purpose of the study is to investigate the effects of your ideas on your attitude towards people with genetic related conditions. It is hoped that the information you provide will help address the challenges that will confront you in future as implementer of the integrated science curriculum and as you teach to dispel pupils' cultural beliefs and perceptions about people with genetic related conditions. Your responses on the items will not be used in any way to affect your status as a student. The information will be confidentially handled and will be used for academic purposes.



DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

This section requires you to provide information about yourself. Please tick appropriately in the box against the option that best applies to you.

1. Sex Male Female
2. Age in years 10 - 20 21 - 30 31 - 40 above 40
3. Marital status
Single Married Separated divorced Cohabiting Engaged other
4. Religious affiliation
Christianity Islamic Traditionalist Other

5. Programme studied at Senior High School

General Science [] Business [] Agricultural Science [] Visual Art []

General Art []

Home Economics []

Technical []

other

PART B

I am grateful for your agreement to participate in this study. Each item in this section consists of a statement followed by five options namely, Strongly Agree (SA), Agree (A), Undecided (UD), Disagree (Disagree), and Strongly Disagree (SD). Read each statement carefully and select the option that best represents your opinion about the statement and tick (V) in the box below the option you have selected. Do not write your name or index number.

KNOWLEDGE ABOUT GENETIC-RELATED CONDITIONS						
No.	ITEM	SA	A	DK	DA	SDA
6.	Genetic-related diseases are caused by poor nutrition					
7.	Down syndrome is a genetic related disease					
8.	Genetic related diseases are contagious					
9.	All genetic related diseases are inheritable					
10.	Albinism affects Blacks who are not resistant to the sun					
11.	Sickle cell carrier parents can give birth to a sickler					
12.	Colour blindness is dominant in males than in females					
13.	Most genetic related diseases are environmentally influenced					

CULTURAL BELIEFS ON GENETIC-RELATED CONDITIONS						
No.	ITEM	SA	A	DK	D	SDA
14.	Victims of GRC are cursed by the gods					
15.	Twins are blessings from the gods for ones good deeds					
16.	Albinos are evil because they possesse eveil powers					
17.	Albinos are used for ritual purposes because they					
18.	Women are responsible for sickle cell disease in children					
19.	Victims of Down Syndrome are cursed and useless					



PRE-SERVICE TEACHERS' ATTITUDE TOWARDS PEOPLE WITH GENETIC RELATED CONDITIONS						
No.	ITEM	SA	A	DK	DA	SDA
20.	Sicklers are not worthy to be taught because they may die					
21.	Victims of Down Syndrome are idiots and they cannot					
22.	Albinos do not deserve to be part of the main stream class,					
23.	People with genetic-related diseases are not educable and must not be enrolled in school					
24.	Down syndrome victims are not and will not be my friends because they can infest me or my unborn children with the					
25.	I don't have a friend who has an issue with colour blindness nor haemophilia					
26.	People with genetic-related diseases are disgusting especially victims of Down Syndrome					
27.	It is better to segregate people with genetic-related diseases from the general public					

Thank you for your time!

APPENDIX B

INTRODUCTORY LETTER

UNIVERSITY OF EDUCATION. WINNEBA

