UNIVERSITY OF EDUCATION, WINNEBA

ANALYSIS OF SENIOR HIGH SCHOOL STUDENTS' STATISTICAL LITERACY, ATTITUDES TOWARDS STATISTICS AND THEIR RELATIONSHIP

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DECLARATION

STUDENTS' DECLARATION

I, Charles Darko Bram, 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 Dissertation as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: DR. SYLVESTER ALI FRIMPONG

SIGNATURE: ……………………………………………

DATE: ……………………………………………………

DEDICATION

This dissertation is dedicated to my heavenly father Jehovah God for strengthening and guiding me through the period I pursued this programme. The work is also dedicated to my dear wife Mrs. Brightlene Essandor my brother Mr. George Ofosu Bram, my sister Mrs. Beatrice Amoabea and my dear friend Eric Amankwa.

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LIST OF ABBREVIATIONS

ATSQ: Attitudes towards Statistics Questionnaire

ANOVA: Analysis of Variance

H_0: Null Hypothesis

H_a: Alternative Hypothesis

M: Mean

N: Number of Participants

NCTM: National Council of Teachers of Mathematics

SATS: Student Attitudes toward Statistics

SD: Standard Deviation

SE: Standard Error

SHS: Senior High School

SLT: Statistical Literacy Test

ABSTRACT

The purpose of this study was to analyze the statistical literacy of Senior High School students, attitude towards statistics and their relationship. The study was conducted in Kade Senior High Technical School in the Denkyembour District of the Eastern Region of Ghana. Descriptive Research that employs the Explanatory Sequential Mixed Methods Design was used. A statistical literacy test and attitude towards statistics questionnaire was used to collect data from 180 randomly selected respondents of final year students from Kade Senior High Technical School, in the Eastern Region of Ghana. A one sample T test, One way Analysis of variance and Pearson Product Moment correlation analysis was used to analyze the data. Data analysis revealed a low mean percentage test score (37%) and the low passing rate (38%) which indicated that the level of students' knowledge in statistics was low. Also an overall students responds to attitude towards statistics questionnaire revealed that, only 29% of 180 participants responded positively to the items in the questionnaire, this shows that generally students have negative attitude towards the teaching and learning of statistics. The study also found a positive relationship between students' attitude towards statistics and their performance in the statistical literacy test. The findings of this study revealed that final year SHS students had performed relatively low in statistical literacy. Mathematics teachers should have adequate knowledge in statistics so as to employ appropriate instructional methods to develop students' statistical literacy.

CHAPTER 1

INTRODUCTION

1.0 Overview

This chapter gives a background of the study, statement of the problem, purpose of the study, hypotheses guiding the study and significance of the study. The chapter concludes with the limitation and delimitation and organization of the study.

1.1 Background of the Study

Statistical literacy refers to the skill of comprehending, critically analyzing, and effectively communicating statistical information and messages (Gal, 2002). Statistical literacy is typically defined as the ability to analyze and evaluate statistical information in a critical manner (Koga, 2022). Statistical literacy, like reading, writing, and speaking, is a skill, statistical literacy requires two types of reading abilities: comprehension and interpretation (Schield, 1999). Statistical literacy includes essential skills that can be utilized to understand statistical information or research findings. These abilities encompass organizing data, generating and presenting tables, and handling diverse forms of data. (Callingham & Watson, 2017). Teachers are expected to have difficulties in implementing statistical literacy.

In order to enhance statistical literacy in the classroom, educators may necessitate practical concepts and interactive learning activities (Sharma, 2013). Statistical literacy is essential to educate students particularly students in primary to become parts of a today's society that is constantly bombarded with arguments based on statistical decisions (Aziz & Rosli, 2021). There have been demands to enhance the incorporation of statistical literacy into the mathematics curriculum due to the significance of statistics in everyday life and professional environments (Sharma, 2017). Several agents, such as educational institutions, statistics agencies, statistical associations, and the media, can help improve statistical literacy, the more these many agents work together to increase statistical literacy, the better the outcomes (Ferligoj, 2015).

We currently live in an open data era, with data providers such as national statistics offices, Eurostat, the OECD (Organisation for Economic Co-operation and Development), and the United Nations aiming to make their data available to the public (Kokotsaki et al., 2014). Technological and communication advancements have expanded the number of statistical information available through popular media (Sharma, 2013). Statistics are widely disseminated in the media, yet anyone without a background in statistics may transmit information and make decisions (Budgett & Pfannkuch, 2010). Reading and analysing statistical data needs more than just basic literacy, it needs statistical literacy (Chick & Pierce, 2013). Statistical literacy is necessary for productive citizens in the 4.0 industrial revolution era (Yuniawatika, 2018). In order to actively participate in society, individuals must possess the ability to critically evaluate statistical data.

To cultivate this skill, it is imperative to commence the enhancement of statistical literacy among young individuals at different educational levels (Gonda et al., 2022). If children are not exposed to different aspects of statistical literacy during their schooling experience, exposing statistics to the environment might be a worthless experience since pupils will not form ideas about the data's contents (Singer et al., 2015). Many research on statistical literacy have been undertaken between 1980 and 2023. both in elementary school, middle school, and college, such as (Carel & Juandi, 2023; Weiland & Sundrani, 2022; Towse et al., 2022; Büscher, 2022; Gómez-Blancarte et al., 2021; Valentini, 2016) and other research. It is important to understand analyze how the study description connects to statistical literacy in order to collect comprehensive information and proper data. As a result, this study was carried out as a Systematic Literature Review (SLR) with bibliometric analysis (Farman, 2021). A systematic literature review provides a concise overview of the existing body of research conducted on a specific topic (Ariati & Juandi, 2022). It is carried out in order to find, select, assess, and synthesize all trustworthy research data relevant to that topic (Cronin et al., 2013). Based on the social, intellectual, and conceptual structure of disciplines, bibliometric analysis examines the evolution of a study domain, encompassing subjects and authors (Donthu et al., 2020). SLR was carried out using bibliometric analysis, which is one of the most extensive and intelligent data study methods in the literature (Farman, 2021).

Although statistical literacy is acknowledged by many educational researchers, curriculum developers and teachers around the world (Brown et al, 2014), it is still a new area of research in the field of mathematics education (English & Watson, 2015). Over the past decade there has been an increasingly strong call for statistics and mathematics education to focus more on statistical literacy, reasoning, and thinking. One of the main arguments presented is that traditional approaches to teaching statistics focus on skills, procedures, and computations, which do not lead students to reason or think statistically (Ben-Zvi & Garfield,2005). As a results many research studies indicate that many people in mainstream society as well as students are not literate in statistics (Sharma, 2017). Statistical literacy is a competency thus the ability to comprehend text and the meaning and implications of the statistical information in it, in the context of the topic to which it pertains (Rumsey, 2002). It is also defined as "trans-numerative thinking" where people will be capable of making sense of and use a different representation of data to make sense of the situation among them (Chick et al., 2005). In a broader view, statistical literacy consists of statistical understanding required in modern democracies as well as peoples' dual role of statistical producer and consumer (Gould, 2017). The knowledge of how to use and communicate statistics is necessary for students to become able citizens of our society, capable of making informed decisions (ABS, 2012).

The understanding that, statistics is not just mathematics has given rise to a new conception of statistical literacy and to a new field of study which is called statistics education. This field of study has emerged as an important discipline –with its own conferences and journals– that supports the teaching and learning of statistics. Statistics education is an emerging field that grew out of two main disciplines –statistics and mathematics education– and it is currently establishing itself as a unique field of study (Ben-Zvi, Garfield, 2005). Statistics education research over the last decade has emphasized the need for reform in the teaching of statistics with a growing body of research in this area (Tishkovskaya & Gillian , 2012). For example, National Council of Teachers of Mathematics (NCTM, 1998) in the United States indicates developing critical thinking and judgment based on data as one of the fundamental goals of the mathematics curriculum. Subsequently, researchers and educators around the world have been trying to understand the challenges in teaching and learning statistics and to identify the changes that are needed in the training of future statisticians (Tishkovskaya & Gillian , 2012). Rumsey (2002) said statistics may not be a traditionally core skill in mathematics such as algebra or geometry but it should still be a key part of the mathematics curriculum. ABS (2012) agues that, athough much is said about the need for a statistically literate society, acceptable levels and methods for achieving this at the school level are rarely addressed. Certainly however, the term 'literate' suggest a minimal set of 'basic skills'. Further there are different levels of basic statistical skills across the education sector: primary school students for example would not be expected to have the same skills as secondary students and beginning secondary students would not be expected to have the same skills as those completing their secondary education. UNECE (2012) in their jounal ‘Making Data Meaningfull’ classified abilities included in the term statistical literacy into the following three main levels.

Firstly, Statistical numeracy thus Mathematical skills are the first requirement in order to understand statistics. Statistical numeracy requires a feel for numbers; an appreciation for levels of accuracy, making sense of estimates, awareness of the variety of interpretations of figures as well as a judicious understanding of widely used concepts such as averages and percentages. Moreover, there is a fundamental need to know about statistical approaches and methods. To express it in one sentence: a common sense approach to data is needed in order to support an argument. The ability to understand statistical concepts. Secondly, communicating statistics thus Statistical literacy is more than numeracy. It includes the ability to read and communicate the meaning of data. This quality makes people literate as opposed to just numerate. Wherever words (and pictures) are added to numbers and data in your communication, people need to be able to understand them correctly.

On the one hand, our users need to have the ability to understand text, tables and graphs with statistical content. But on the other hand, official statisticians still have to consider their users in the way they present statistics. Thirdly, Discovering the use of statistics for professional and personal decisions Statistical. The third stage of statistical literacy can be postulated as a short question: What can we do with the new information? Getting users to appreciate the value of statistics is perhaps the most difficult and fundamental step. Decision makers in Vocationales and politics may need support particularly at this stage. The general public is also important, as high-quality official statistics are an essential pillar of democratic societies. This is challenging, because statisticians often do not leave the field of statistics and to comment on or interpret the results. Statisticians therefore have to help data users to interpret and use the figures correctly, because the statisticians often have a better understanding of what the figures show and what they do not show.

Although statistics education remains in the shadows of mathematics in Ghana, the provisions in the curriculum contain adequate statistics content to achieve the above levels of statistical literacy. The Mathematics syllabus is an evidence of emphasis Ghana Education Service and the Ministry of Education place on developing statistically literate graduates in the country. These content areas if learnt well will develop a nation of critical thinkers and capable consumers of information that would ultimately benefit social progress - future government and business leaders. However, mathematics and statistics education face challenges at all levels of learning. It is a known fact from history that most student considers mathematics as difficult and unpleasant subject to learn despite it numerous advantages. (Enu, Osei , & Nkum , 2015) said it is unfortunate that students at all levels of the Ghanaian educational ladder still have problems learning mathematics. Mathematics educators find it more difficult to help students gain knowledge and succeed in mathematics and statistics. According to Ben-Zvi & Garfield (2005), some of these challenges are that, Students equate statistics with mathematics and expect the focus to be on numbers, computations, formulas, and one right answer. They are uncomfortable with the messiness of data, the different possible interpretations based on different assumptions, and the extensive use of writing and communication skills. (Ben-Zvi & Garfield, 2005).

Also many statistical ideas and rules are complex, difficult, and/or counterintuitive. It is difficult to motivate students to engage in the hard work of learning statistics. Many students also have difficulty with the underlying mathematics (such as fractions, decimals, algebraic formulas), and that interferes with learning the related statistical content. Graham (2006) suggests that the present location of statistics within mathematics teaching has…created a very technique-based topic, with little emphasis on context or problem solving (Graham, 2006, p221) because teachers teach students to solve statistical problems like they would solve mathematical problems. Similarly, Stuart (2005) argues that mathematical thinking has dominated statistical teaching in the classroom. Stuart (2005) believes that mathematical thinking emphasizes mathematical models, methods and procedures and that the application of these techniques takes on more importance than dealing with the initial problem or context. Stuart (2005) gives an example of the limitation of mathematical thinking with the particular example of probability and distributions.

He argues that traditional mathematical thinking assumes that probability theory is fundamental to statistics. However, Stuart (2005) believes that variation is the fundamental statistical concept and that probability theory is not essential in coming to an understanding of variation and elementary methods of statistical inference, rather probability serves as an excellent model for statistical variation. He describes how teachers often start with the mathematical model – probability – rather than addressing the statistical concept of variation. Stuart (2005) claims that teachers simplify the conceptually difficult probability theory to make it more palatable for students, removing the students even further from understanding the problem in the original context. Stuart (2005) does not deny the importance of mathematics and mathematical thinking in statistics but rather claims that it is not essential in coming to an understanding of elementary methods of statistical inference. In a similar vein, Schield (2005a) characterises the differences between mathematics and statistics in terms of methods of reasoning. Schield characterises mathematics, probability and statistics as examples of deductive thinking where an argument is either true or false. He then argues that statistical literacy is an example of inductive (and some deductive) thinking. An explanation of inductive reasoning is reasoning that judges an argument on a continuum and that the stronger the argument the greater the chance that its conclusions are accepted as true. Schield (2005) states that for students to be statistically literate students have to ask whether a claim could be true rather than if it is true. Schield has complicated the issue somewhat by differentiating between statistics (as mathematical models and processes) and statistical literacy (as statistical thinking and reasoning).

Another area of interest among researchers in statistics education is the assessment of non-cognitive factors related to students' performances in statistics. This includes attitudes towards statistics and statistics anxiety. Many past studies showcased a relationship between post-secondary students' statistical achievements and these two non-cognitive factors (Chiesi & Primi, 2010a; Lester, 2016). As more attention has been given to students' difficulties in learning statistics, evidence from previous studies has shown that students' attitudes towards statistics and statistics anxiety might influence students' statistical reasoning (Agus et al., 2015; Agus et al., 2016; Tempelaar et al., 2007; Wilson, 2006). Developing positive attitudes towards statistics and reducing statistics anxiety among students are two goals in statistical teaching (Baloglu, 2004; Liau et al., 2015).

Additionally, it has been noted that students have a positive relationship between statistical reasoning and attitudes towards statistics (Tempelaar, 2004; Olani et al., 2011; Chiesi & Primi, 2010b) and a negative relationship between statistical reasoning and statistics anxiety (Primi et al., 2018). These findings indicate that students with positive attitudes would have better statistical reasoning, while students with higher statistics anxiety tend to perform lower than expectations in statistical reasoning and vice versa. The literature also revealed the components measuring attitudes towards statistics and statistics anxiety were predictor variables for statistical reasoning (Agus et al., 2015; Tempelaar et al., 2007). Generally, attitude is expressed as a summation of emotions and feelings experienced over time in the context of learning a course (Zhang et al., 2012). In statistics education, attitude towards statistics is described as the intense feelings, which are relatively stable and result from the positive or negative experiences encountered while learning statistics over a period of time (Martins et al., 2011). Schau (2003) categorised students' attitudes towards statistics into six components: Cognitive Competence, Value, Difficulty, Affect, Effort, and Interest. Cognitive Competence refers to the attitudes about intellectual knowledge and skills when applied to statistics, while Value refers to the attitudes about the usefulness, relevance, and worth of statistics in personal and professional life.

Difficulty refers to the attitudes towards the difficulty of statistics as a subject, while Affect refers to the student's feelings towards statistics, whether the feelings are positive or negative. Effort refers to the amount of effort students spend on learning statistics and Interest refers to the students' level of individual interest in statistics.

Students with positive attitudes towards statistics should develop statistical thinking, use statistical knowledge to solve daily life problems, and have a desire to participate in more advanced statistical courses in the future. On the contrary, students with negative attitudes towards statistics may tend to display their anxiety towards statistics in the classroom (Mohamad Judi et al., 2011). Negative attitudes towards statistics influence student learning and adoption of statistical thinking, students' achievement in these courses, and the likelihood that students will apply their statistical knowledge outside of the classroom, including their professional lives (Gal, 2004). These students view these courses as overwhelming learning and survival tasks that cause a great deal of stress, this hinder statistical thinking and negatively influence the acquisition of knowledge and skills in statistics. In addition to these, Watson (2006) indicates that low motivated students about statistics or students holding procedural beliefs about statistics tend to perform less in statistical.

In this study, student's attitude towards a statistics subject was measured through responses given by students towards a set of statements or items in a specific attitude component. Magnitude of an attitude was measured through their level of agreement or disagreement on each item. A positive attitude is vital to encourage students to get interested in learning a certain subject. This study engages an SATS survey developed by Schau (2003) according to six attitude components which are affective, cognitive capability, value, difficulty, interest and effort. Affective is a component assessing student's expression towards statistics course. The item used to measure the expression are statements showing student's interest, not feeling threatened, not disappointed, fun and not stressed in solving a statistics problem and in following the course. The second component in assessing attitude is the cognitive capability, which is student's attitude towards the knowledge and intellectual skill in using the statistics knowledge. The items used to measure this attitude are statements showing students do not having difficulties in understanding the statistics concept based on their way of thinking, have the ability to learn statistics by making least errors in calculation and understand of the formula and statistics concept. Value is the third component in assessing student's attitude towards a statistics course. This component assesses attitude towards the usefulness, relevance and advantage of statistics for individuals and their professional life. The items used to assess this attitude are statements showing that statistics is useful, necessary and relevant in their studies, as well as in daily lives and career. The next component is difficulty, which assesses attitude towards the difficulties in understanding the subject.

This includes how easy it is to understand a formula, technical method, and the massive calculation involved in the subject. Other indicators of the component include easiness of the course, low requirement for discipline and least requisite in new way of thinking using statistics. Interest is a component assessing student's tendency towards the subject. Items used in assessing this attitude is whether or not the student is interested in talking about the related statistical information with other individuals, using statistics, understanding the statistical information and their interest in learning statistics. Student's effort is also among the components assessed. If the students showed that they have given tremendous effort, they are categorised as having a positive attitude towards statistics. This component is assessed with statements such as student's intention in completing all the assignments, studying hard and attending all lectures in the subject. Therefore, understanding students' attitudes and their relationship with learning and achievement in statistics is important to foster positive attitudes, better achievement, and a life-long embrace of statistical thinking.

1.2 Statement of the Problem

In a rapidly changing world where data is ubiquitous, there is a pressing need for Senior High School students to develop statistical literacy skills to effectively interpret and draw meaningful conclusions from the vast amounts of information available. However, many students in Kade SHTS lack the necessary understanding of basic statistical concepts and techniques, leading to widespread misinterpretation of data and misinformation. Armah & Aseidu-Addo (2014), long-established that most students do not exhibit basic statistical literacy at the end of their pre tertiary education, they found that even students who receive top grades in a class may not understand and remember basic ideas of statistics. This is unfortunate given that the fact that Ghana Education Service has 'Statistics' content in the mathematics syllabus that meet international standards from Basic level to Senior High school level. According to Armah & Aseidu-Addo (2014), there are few substantial research studies in Ghana on students' knowledge in basic statistical concepts. There is therefore the need to extensively measure students' knowledge and attitude towards the subject and to find out if there is any association between them.

1.3 Purpose of the Study

The purpose of this study was to analyze the statistical literacy of Kade Senior High Technical School students, moreover students attitude towards statistics and relationship between attitude and performance was explored.

1.4 Objectives

The specific objectives to the study are:

1. To find out the statistical literacy level of Senior High School Students in Kade SHTS.
2. To find out if there is a significant Mean difference in students' statistical literacy test scores with respect to programme of study.
3. To find out the attitude of SHS students towards the teaching and learning of statistics
4. To examine the relationship between students' performance in statistical literacy test and their attitudes towards statistics.

1.5 Research Questions

This study intends to investigate these four research questions;

1. What is the statistical literacy level of Kade Senior High Technical School students?
2. Is there a significant Mean difference in students' statistical literacy test scores with respect to programme of study?
3. What is the attitude of SHS students towards the teaching and learning of statistics?
4. What is the relationship between students' performance in SLT and their attitudes towards statistics?

1.6 Research Hypotheses

The following hypotheses were formulated to answer research questions 2 and 4 respectively.

H_{02}: There is no significant Mean difference in SHS students' statistical literacy scores with respect to Programme of study.

H_{04}: There is no relationship between SLT scores of SHS students and their attitudes towards statistics.

1.7 Significance of the Study

Though Some investigation has been made into the teaching of statistics in Ghana, however, the links between statistical literacy and attitude towards Statistics have not been fully explored in research in the country, hence the need to access students at the Senior High level on the basic statistical knowledge, and also access their attitude towards the subject and the relationship between students' attitudes and test scores. This study will not only contribute to the mathematics/statistics education literature but also provides teaching implications for teachers, curriculum developers, and educational policy makers. The results of this study will point out further research in the context of both mathematics and statistics curriculum development and teacher education.

1.8 Delimitations

This study was limited to Kade Senior High Technical School, in the Kwaebibirem District in the Eastern region of Ghana. The scope of the study covers statistics education in the senior high school. It was also limited to the final year students of Kade SHTS offering courses such as General Science, General Agriculture, General Arts, Home Economics, Technical and Business. The study also measures students' basic knowledge in statistics and their attitude towards the subject.

1.9 Limitation

Due to lack of resources, the study was limited to only Kade Senior High Technical School as a result the generalization of the results would be limited in this regard. Also due to financial and time constraints for carrying out the study, the researcher was compelled to undertake the study in only one senior high school. Due to the small sample size; the findings could not be generalized to a wider population.

1.10 The Organizational Plan of the Study

The study was organized into five chapters. Chapter 1 constituted Introduction. Literature review in chapter 2. Methodology in chapter 3, chapter 4 contain Results and Discussions. Chapter 5 contains summary of findings, conclusions and recommendations.

1.11 Definition of Terms

In this section words terms and phrases are clearly defined following their use in the study.

- ‘**Statistics** is concerned with scientific methods for collecting, organizing, summarizing, presenting and analyzing data as well as deriving valid conclusions and making reasonable decisions on the basis of this analysis. Statistics is concerned with the systematic collection of numerical data and its interpretation’ (Varalakshmi, Suseela, Sundaram, Ezhilarasi, & Indrani, 2005).
- **Statistical Literacy** is the ability to read, interpret and critically evaluate statistical information in diverse contexts, and the ability to communicate understandings and concerns regarding the conclusions (Rumsey, 2002).

- **Attitude towards Statistics** , According to Gal (2004), the emotions and feelings including positive and negative responses experienced by individuals during learning statistics constitute attitudes towards statistics

CHAPTER 2

LITERATURE REVIEW

2.0 Overview

This chapter is a review of the literature on statistics and statistics education and its place in the mathematics classroom.

2.1 Theoretical Framework

Gal (2004) proposes a statistical literacy model that involves both a knowledge and certain attitude or dispositional components that operate together. According to Gal there are five interrelated cognitive elements that must be used to exhibit the knowledge component of statistical literacy: mathematical knowledge, statistical knowledge, knowledge of the context, literacy skills, and critical questions. Furthermore, Gal states that critical evaluation of statistical information (after it has been understood and interpreted) depends on the ability to access critical questions and activate a critical stance. He adds that some of these elements are held in common with literacy and numeracy whereas others are unique to statistical literacy. Gal writes that the components and elements in the model should not be viewed as fixed and separate entities but as a context-dependent, dynamic set of knowledge and dispositions that together produce statistically literate behaviour.

According to Gal (2004), statistical literacy focuses on aspects necessary to establish an awareness of data and critical thinking that must take place in order to consume data. It also focuses on the dispositional aspects of statistical literacy, a form of enquiry and action that an individual engages in as a result of processing the information. He also examines how these knowledge bases can interact with a person's dispositions, beliefs and attitudes towards data and statistics in general. For Gal, the dispositions or associated attitudes and beliefs motivate citizens to be critical thinkers with statistics. The dispositional elements of statistical literacy skills recognise that students should adopt a critical attitude to information at all times and become professional noticers. He questions the tacit assumption that students who learn to process data can transfer these skills to interpreting and critically evaluating statistical information. Gal points out that when a true level of statistical literacy has been reached, it allows the individual to take the knowledge bases and critical-thinking skills that have been accumulated and apply them on their own to the statistical information they encounter in everyday life and workplace. Moreover, Gal (2004) adds that anyone who lacks these skills is functionally illiterate as a productive worker, an informed consumer or a responsible citizen. Shaughnessy (2007) writes that although there are some overlaps between Gal's model of statistical literacy and is focused on different constructs—what adults need to be able to do in reading contexts versus statistical activity.

According to Gal (2004), reading contexts emerge when people are at home and watching television or reading newspapers or shopping or participating in community activities. Batanero (2002) suggests that while Gal's model can be useful at a macro-level of analysis for understanding what statistical literacy involves and to help policy makers to take decisions about the big ideas that should be taught at different curriculum levels, we need specific micro-level models that can be used to analyze statistical concepts. Another framework was built upon statistics education literature as well as interviews with statisticians and undergraduate students. The researchers have identified four dimensions: an investigative cycle, types of thinking, an interrogative cycle and dispositions. The investigative cycle or PPDAC cycle (problem, plan, data, analysis and conclusion) describes the process of statistical investigation. Wild and Pfannkuch's second dimension states that there are five fundamental types of statistical thinking: recognition of the need for data transnumeration (or using different representations of data to give better understanding), understanding variation, using statistical models and integrating the statistical with the contextual (Wild & Pfannkuch,1999).The interrogative cycles (generate, seek, interpret, criticize and judge) describe the thinking process that statisticians use when dealing with the problem and the data.

Finally, Wildand Pfannkuch describe the dispositions that statisticians require for statistical problem-solving. Wild and Pfannkuch's dimensions are non-hierarchical and non-linear, however, the investigative cycle and the interrogative cycle are sequential. Wild and Pfannkuch's(1999) dispositions components are skepticism, imagination, curiosity, awareness, openness, propensity to seek deeper meaning, being logical, being engaged and persevering. Under skepticism, Wild and Pfannkuch see the need to adopt a critical eye'. Although some of the statisticians that Wild and Pfannkuch researched believed that the dispositions could not be taught, Wild and Pfannkuch describe how the investigative cycle and the interrogative cycle, for example, can be used as thinking tools prompting students to address certain issues. While the Watson and Callingham (2003) and Sharma et al.'s(2011) frameworks come out of the work of statistics educators working in classrooms with students, the Wild and Pfannkuch (1999) framework comes from the researchers researching from the statistician's viewpoint and looking at what statisticians believe they do. Wild and Pfannkuch do not attempt to describe the progression or development in statistical literacy or the development of statistical concepts in students but rather outline what statisticians actually do. The focus is on describing a much wider framework for statistical thinking. This was clearly not the intention of the researchers. Wild and Pfannkuch do not see statistical thinking or statistical literacy as separate entities but rather that there is holistic thinking informed by statistical elements'. Reading (2002) suggests' profile for statistical understanding based on the SOLO taxonomy across five areas of statistics: data collection; data tabulation and representation; data reduction; probability; and interpretation and inference. Jones et al. (2000) developed a framework for characterizing children's statistical thinking.

The framework provides a coherent picture of young children's thinking and their cognitive knowledge. The frame-work has four levels of thinking across four key constructs. The GAISE framework (Franklin et al.,2007) identifies three levels of statistical development (levels A, B and C) that students from K to 12 progress through in order to develop statistical understanding. Grade ranges for these levels are not specified; however, ideally levels A, B and C would correspond with elementary (Grades K-5/Ages 5–11), middle (Grades 6–8/Ages 12–14) and high school (Grades 9–12/Ages 15–18). These frameworks do not specifically mention statistical literacy, although they are similar to the hierarchical framework of Watson and Callingham (2003)

2.2 Conceptual Framework

The study adopted the statistical literacy model by Gal (2004) which talks about Statistical Literacy comprises of both knowledge and certain attitude or dispositional components that operate together. And Watson cited in Yulco (2012) who develops a three-tiered statistical literacy framework for addressing the cognitive characteristics of statistical literacy.

2.1.1 Gal's Model of Statistical Literacy

Gal's (2004) model of statistical literacy consists of knowledge and dispositional elements presented in Table 2.1.

Table 2.1: Model of Statistical Literacy

Knowledge elements	**Dispositional elements**
Literacy skills	Beliefs and Attitudes
Mathematical knowledge	Critical stance
Statistical knowledge	
Context knowledge	
Critical Questions	

Statistical Literacy

Understanding or interpreting statistics necessitated not only knowledge of statistics but also other knowledge types as mentioned in Table 2.1. It is proposed that each knowledge base is contributed for statistical literacy of individuals (Gal, 2004) and these are described below in detail. Since most of the statistical messages are represented through oral or written text form, activation of specific literacy skills such as understanding or making inference is required in order to deal with those messages. Additionally, awareness of certain statistical terminology such as random, average, and representativeness is counted as literacy skills as a component of knowledge elements. "Knowing why data are needed and how it is produced, familiarity with basic terms and ideas related to descriptive statistics and graphical and tabular displays, understanding basic notions of probability and knowing how statistical conclusions or inferences are reached" (Gal, 2004) constitutes the statistical knowledge element for statistical literacy. For example, knowledge of big ideas in statistics, such as variation, is fundamental for understanding data sets or distributions. Additionally, knowledge of how data is represented in graphical form is one of the basics of statistical knowledge element since graphical or tabular displays are the most frequent forms of statistics that are confronted in daily life.

Although extra emphasis on mathematical computations while doing statistics is not good for the development statistical ideas and concepts, certain mathematical knowledge such as calculating mean and percent or proportional reasoning is required in order to understand the statistical ideas in the context of statistical literacy. Therefore, mathematical knowledge constitutes a knowledge element for the statistical literacy. Certain context or world knowledge is important in order to make sense of data. While looking for sources of variation and error, context knowledge is the main source for such a familiarity, and therefore an important knowledge element. Sources of statistical messages in the media are not always objective and are usually biased. Therefore, a critical evaluation is needed for those messages. Gal (2004) lists some "worry questions" such as whether sample size is large enough, whether a given graph is properly drawn, or does it alter certain tendencies in the data, whether any unintended variable explains the findings other than the variables included in statistical information. Hence, in order to evaluate objectivity or credibility of statistical reports, asking critical questions is crucial. Each of the knowledge elements might seem separate; however, statistically literate individuals use these elements interdependently in a dynamic relationship (Gal, 2004). For example, while dealing with statistical reports in the newspapers, one should have literacy skills together with context knowledge to grasp the meaning.

Also, statistical and mathematical knowledge is needed to understand how data are produced and why they are presented in a certain way. For critical evaluation of those messages, asking critical questions is required.

Critical evaluation of statistical reports has been emphasized in many definitions; therefore, statistical literacy involves a specific type of action, not just knowing terminology and passive interpretation of them (Gal, 2004). In order to activate the knowledge elements, certain dispositions such as a critical stance and attitudes and beliefs are required. Gal (2004) refers them in his model as “dispositional elements” of statistical literacy. Statistically literate persons should have a questioning attitude toward quantitative messages through asking “worry questions.” This questioning attitude is a part of critical stance and it is an essential part of statistical literacy since those messages could be misleading, biased, or one-sided. In order to have a critical stance toward data and have motivation for taking action, certain beliefs and attitudes are required (Gal, 2004). For the purpose of defining them, Gal (2004) utilizes McLeod’s (1992) conceptualization of affective domain in mathematics education in which attitude is described as an affective construct related to positive and negative responses about statistics while belief is considered as a cognitive construct related to opinions or ideas.

2.1.2 Watson's hierarchical Model of Statistical Literacy

Watson cited in Yulco (2012) develops a three-tiered statistical literacy framework for addressing the cognitive characteristics of statistical literacy. The level of complexity of each tier is consistent with learning models in developmental psychology such as the (Structure of Observed Learning Outcomes) model. These tiers are the foci of this study and they are described below in detail.

The first tier of this framework is basic understanding of terminology. The skills in this tier include the understanding the terminology of statistics without considering the context (Watson, 2006). This terminology includes specific concepts in the curriculum such as sampling, average, graphing, random, and variation. This tier also involves calculation of measures of central tendency or measure of spread without any reference to the social issues in the daily lives of students.

The second tier of the framework, which is contextualization of terminology including statistical language and concepts, requires students to read reports of statistics and interpret them, rather than only performing the statistical computations (Watson, 2006).

The third level of statistical literacy in this tier involves embedding the statistics terminology in the context of wider social discussions such as a comprehension of risk in situations where decision making is needed or drawing conclusions and inferences from graphs and charts. Questioning of statistical claims is the third tier of this framework. Students confidently challenge the statistical claims in the media in the third tier. The skills in this tier include constant questioning attitude towards statistical conclusions without proper statistical foundation. The important thing for statistical literacy in this tier is that students develop intelligent questions for data and related claims instead of believing everything they read in the media (Watson, 2006). This framework is mainly meeting with cognitive part of statistical literacy and affective issues are not directly indicated.

In addition to this model of statistical literacy, Watson (2006) described six components which contribute to statistical literacy. These components include mathematical/statistical skills, context, task motivation, task format, literacy skills, and knowledge concerning variation. The relationships among these components are presented in figure 2.1

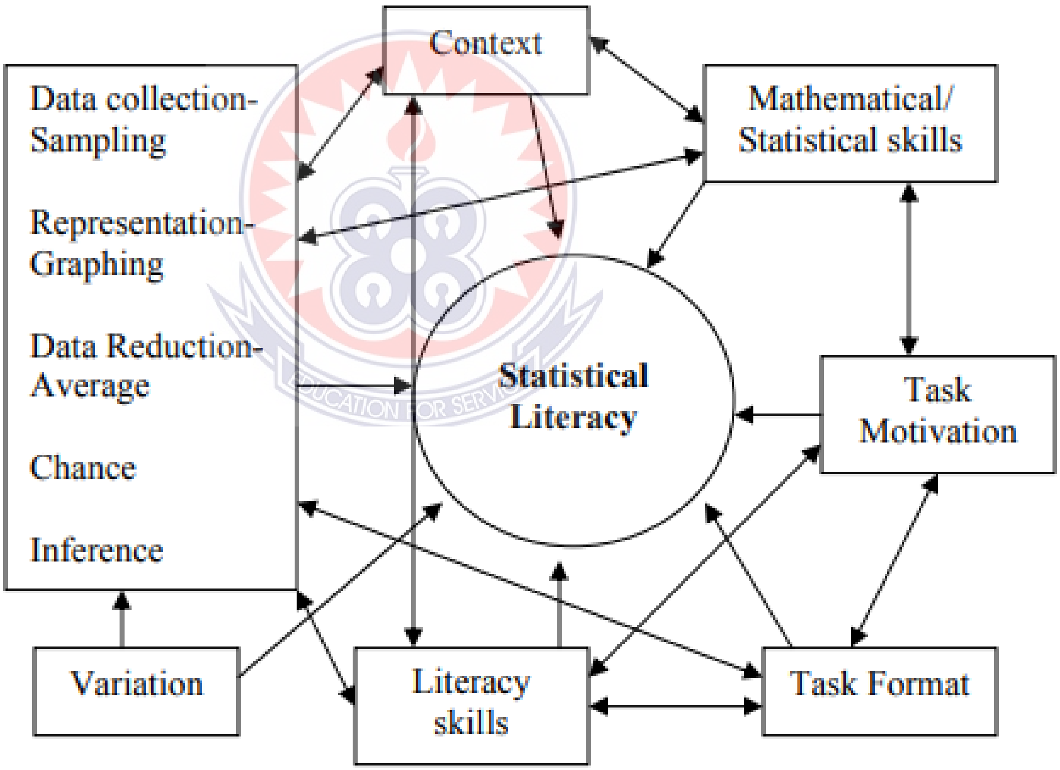


Figure 2.1: Links among the Components of Statistical Literacy (Watson, 2006)

The mathematical/statistical skills needed for statistical literacy include understanding and calculating averages and performing basic probability calculations including probabilities involving compound independent events. Variation is another component of statistical literacy and understanding the effect of variation on data collection, data reduction, chance, and inference are also important (Watson, 2006). Watson (2006) also believed that context plays a role in statistical literacy. According to Watson (2006), three levels of context exist, each with increasing complexity. The first level of context involves examples typically seen in an introductory statistics class such as tossing a die or reading tables with “mathematical, isolated contexts” (Watson, 2006, p. 249). The second level of context relates to more personal contexts such as school issues or experiences, and the third level of context concerns potentially unfamiliar media-based contexts. Watson (2006) believed that not until the context is understood can critical questioning occur. This assertion was based on several research studies described in Watson (2006) including one study in which students were asked to graph information from various contexts. The results indicated that graphical displays from contexts which were of interest and familiar to students were more advanced than those from unfamiliar or interesting contexts.

Additional components of statistical literacy include task format and motivation. Task formats are grouped into two types, open-ended questions and multiple choice questions. Watson (2006) preferred multiple-choice questions to assess statistical literacy because these types of questions permit students to “show recognition rather than creation of an appropriate answer” (Watson, 2006, p. 251). Task motivation refers to students’ dispositions toward the statistical literacy task. Gal (2004) refers to these dispositions in his model as “critical stance” and “beliefs and attitudes.” Other dispositions needed for statistical literacy include skepticism, curiosity, imagination, logic, and persistence (Wild & Pfannkuch, 1999) For any task format, general literacy skills are another important component of statistical literacy. Four strategies needed for general literacy as described by Luke and Freebody (1997) are discussed in Watson (2006) with respect to statistical literacy. The first strategy involves the "code breaking" aspect of literacy. In terms of statistical literacy, this strategy pertains to understanding and interpreting graphs. The second strategy pertains to context-based understanding which is related to understanding different interpretations of averages. The emphasis of the third strategy concerns understanding how information is used which parallels understanding concepts such as "samples" (Watson, 2006).

The fourth strategy involves "reading between the lines" and focuses on understanding the underlying meaning of text as well as what inferences can be made. This strategy focuses on questioning statistical claims (Watson, 2006). Since the research for this dissertation focuses on challenges students made concerning statistical claims encountered in everyday life, articles from the media were used in this research to assess what questions students asked concerning these claims. Therefore, research involving media articles in assessing statistical literacy is described in the following section.

2.2 Research studies on Statistical Literacy

Yolcu (2014) examined the role of gender and grade level on middle school students' statistical literacy. The study was conducted in the spring semester of the 2012-2013 academic year with 598 middle-school students (grades 6–8) from three public schools in Turkey. The data were collected using the Statistical Literacy Test, developed based on Watson's (1997) statistical literacy framework. Two-way ANOVA results revealed no significant grade level differences although female students performed significantly better than male students. The spiral curriculum in middle school mathematics may explain the lack of differences between grades. The higher performance of female students may be related to the linguistic aspects of statistical literacy, in contrast to the situation in school mathematics. The instrument, The Statistical Literacy Assessment Scale (SLAS), was developed to assess statistical literacy of graduate students in a statistics course for education majors (Reston, 2005). SLAS is composed of 15 items and focuses on two dimensions: understanding statistical terminology and concepts associated with real-world contexts and understanding claims and arguments presented in the media. For evaluation of tables, response choices included "yes-no-cannot tell." One point was assigned to each correct answer. For open ended-questions concerning claims found in the media, student responses were evaluated based on a three-point rubric scale. A score of 2 was assigned to responses in which the reasoning was correct and justified based on statistical concepts. A score of 1 was given for reasoning that was partially correct. If no attempt to reason was observed, a score of 0 was given A concern with SLAS is that the context used in this instrument is specific to current events in the Philippines.

If SLAS were administered elsewhere, the unfamiliar context may affect students' abilities to respond. In addition, SLAS does not address the "questioning attitude" of statistical literacy and the challenges students make concerning media claims. One of the major researchers in the area of statistical literacy is Jane Watson. Over time, her approach to assessing statistical literacy has evolved. What follows is a description of the progression of her research on statistical literacy including the development of instruments to assess statistical literacy. Watson and Moritz (2000) conducted a longitudinal study to assess understanding of the concept of "samples" over three years involving students who were in grades 3, 6, and 9 at the beginning of the study. An 11-item media survey focused on questions concerning newspaper articles was administered to students. Responses were evaluated based on four levels of increasing understanding (pre-structural, unistructural, multistructural, and relational) as described in Watson and Moritz (2000). Results indicated that the development of understanding the concept of "sample" increased with grade following the unistructural to multistructural to relational structure. Overall, students' understanding of "sample" developed to higher levels over time. The percentage questioning claims based on biased samples increased significantly from 22% to 66%. Over time, it was observed that some students reverted to a lower level but it was hypothesized that this might be due to a lack of motivation from the students to demonstrate their understanding (Watson & Moritz, 2000). This finding was a motivation for accounting for "effort" in this dissertation. Contexts of media articles may have affected students' understanding of sample size (Watson & Moritz, 2000). For example, girls were more likely to give the incorrect interpretation for an item involving cars. Identification of potential sources of bias in sample selection may have been affected by real life contexts which Watson and Moritz (2000) believed may have been a distraction for students.

Even though media articles were used in the survey, the questions asked in the survey may have led students to challenge certain aspects of the article. Watson and Moritz (2000) suggested that future research focus on the effect context and questions asked may have on students' responses. Furthermore "assessment of student outcomes needs to distinguish between simple 'recognition' of the meaning of the concept and the level of structuring of that recognition when applied in social contexts" (Watson & Moritz, 2000, p. 130). To assess growth in understanding of statistical concepts, Watson and Moritz (2000) advocated the use of very open-ended questions followed by more directed questions. This result was the impetus for using open-ended questions from a variety of contexts in this research. Watson and Callingham (2003) conducted two large scale research projects involving over 3000 students in grades 3 through 9. Unlike Watson and Moritz (2000), Watson and Callingham (2003) used open-ended questions from media articles because they believed these would allow students to show their understanding at a higher level. Responses were evaluated and grouped into six levels of understanding. These levels included Level 1: Idiosyncratic, Level 2: Informal, Level 3: Inconsistent, Level 4: Consistent non-critical, Level 5: Critical and Level 6: Critical mathematical. Responses allocated to Levels 1 or 2 focused on a single element and indicated that students had difficulty understanding the contexts. For Levels 3 and 4, context was considered in the response. Responses for Levels 5 and 6 denoted more advanced reasoning and understanding of nuances of language and context. Students' responses were characterized into levels of statistical literacy.

The use of characterizing students' responses into levels of understanding was the basis of SLCR, the instrument developed and used in this research. Based on Rasch modeling techniques, results indicated that the construct of statistical literacy is a one-dimensional construct since "mathematical skills and understanding of contexts, as well as content from the school curriculum, were all aspects of the same construct" (Watson & Callingham, 2003, p. 19). The six levels of the statistical literacy construct as described in Watson and Callingham (2003) are related to the tiers of the hierarchical model from Watson (1997). For example, Tier 3 which involves questioning statistical claims can be found in Levels 5 and 6. Higher levels of statistical literacy were not always related to higher ability because students at the same ability level may respond differently to a particular question. Similar characteristics were found between the six levels of statistical literacy as described in Watson and Callingham (2003) and the three-tiered hierarchical model from Watson (1997) discussed earlier in this chapter.

Skills necessary in Tier 1 of the hierarchical model are comparable to the mathematical and statistical skills listed in Table 2.3. Tier 2 and Level 3 are similar as well as Tier 3 is similar to Levels 5 and 6. Since the sample only involved students from the Australian state of Tasmania, caution should be taken to make inferences to all students since factors such as culture, gender, instruction, and prior experiences may have affected responses. Watson and Callingham (2003) recommended incorporating more socially-based examples from the media in curricula to promote and enhance statistical thinking and reasoning within a variety of contexts. "Statistical literacy is incomplete without the opportunity to engage with genuine social contexts, particularly such as those found in the media items" (Watson & Callingham, 2003, p. 21).

Using a 4-point coding system, Watson and Kelly (2003) evaluated students' definitions and student-provided examples of "sample," "random," and "variation" before and after lessons on these topics. A code of 0 was assigned if the student's response did not indicate an understanding of the term. A code of 1 was given if the response included a "single idea," and a code of 2 was assigned if the student gave a straightforward explanation of the term. Responses with complete explanations and examples were given a code of 3. In comparing pre-test and post-test responses, an improvement in understanding "sample" was observed for grades 3, 5, and 7. At grade 7, improvement in understanding "random" and "variation" was observed. For 9th graders, improvement in understanding was only seen for "random." The study concluded that instruction over time can improve students' understandings of terms associated with statistical literacy Callingham and Watson (2005) developed the Statistical Literacy Scale, an instrument to assess statistical literacy. The instrument consisted of 50 items that focused on three subgroups of statistical concepts:

average/chance (AC), sample/inference (SI), and graphing/variation (GV). For the AC subgroup, items pertained to measurements of chance and average The Statistical Literacy Scale was administered to 673 students in the above mentioned grades from five schools in the Catholic system in the Australian state of Tasmania. Different grades were used to represent different abilities. Responses were coded as 0-1 or 0-5 based on the complexity of the response. Results of Callingham and Watson (2005) indicated that the Statistical Literacy Scale had high item (0.96) and case (0.87) reliabilities which suggested that the scale defines a single construct. The three subgroups were each strongly correlated with the overall scale. AC and GV were moderately correlated with a correlation coefficient of 0.68, while GV and SI were more strongly correlated with a correlation coefficient of 0.79. The lowest correlation (0.62) was seen between subgroups SI and AC. This correlation between GV and SI may have occurred since both subgroups are of a qualitative nature while AC consists of items that are quantitative in nature. This indicated that there may be "overlapping components of the statistical literacy construct" which "implies that there may be different developmental pathways for students with respect to different subgroups" (Callingham & Watson, 2005, p. 30).

Yulco (2012) investigated the statistical literacy of 8th grade students and their attitudes towards statistics. Moreover, the relationship between their statistical literacy and attitudes towards statistics was examined. The study was conducted in Yenimahalle district of Ankara in the Spring semester of 2011-2012 academic year. The sample of this study was obtained through cluster random sampling. Nine schools were randomly selected for the study. A total of 1074 eighth grade students in these schools participated. The scales used in the data collection were Statistical Literacy Test (SLT) adapted from Probability Attitudes Scale previously developed for Turkish students (Bulut, 1994) and Attitude towards Statistics Questionnaire (ATSQ) developed by the researcher based on Watson's (1997) three tier framework. The analysis of the mean scores of statistical literacy in terms of content domains revealed that although sample, graphs, and chance contents had closer mean scores to each other which was around moderate value; average, inference, and variation content domains had lower mean scores. A one-way within subjects ANOVA indicated that there were significant differences between Tier 1, Tier 2 and Tier 3 aspects of statistical literacy. The pairwise comparisons indicated that students performed lowest in third tier of statistical literacy where students were required to evaluate inappropriate statistical claims. Although, students performed slightly higher in the first tier where they showed their ability in understanding statistical terminology; their performance was the highest in the second tier which was interpreting statistical claims in context. Eighth grade students' attitudes towards statistics were positive with a mean score of 3.52 in five point scale.

The correlation analysis indicated that there were positive and significant relationship between students' attitudes towards statistics and statistical literacy scores. Watson and Moritz (2000) investigated the understanding of statistical concepts related to statistical literacy with middle school students in grades 3, 6 and 9. The research instrument was consisting of 11 items in relation to three tiered framework for statistical literacy. The results indicated that 15% of the students performed at a lower level, 48% performed at a higher level and 37% did not change their level compared to previous assessment. Performing at lower level might be related to motivation of students whereas performing higher level within four years indicated that understanding sample concept might develop gradually. Gal, Rothschild, and Wagner (1990) interviewed students of ages 8, 11, and 14 about their understanding of how means were computed and what they were useful for. They also gave the students nine pairs of distributions in graphic form and asked them to decide whether the groups were different or not. Only half of the 11- and 14-year-olds who knew how to compute the mean of a single group (and, also, to some extent, how to interpret it) went on to use means to compare two groups. Hancock, Kaput, and Goldsmith (1992) and, more recently, Watson and Moritz (1999) have reported similar findings. This difficulty is not limited to the use of means. Bright and Friel (1998) questioned 13-year-old students about a stem-and-leaf plot that showed the heights of 28 students who did not play basketball. They then showed them a stem-and-leaf plot that included these data along with the heights of 23 basketball players. Students had learned how to read this type of display and had no difficulty reading values from it.

Asked about the "typical height" in the single distribution of the non–basketball players, the students responded by specifying middle clumps (e.g., 150–160 cm), a reasonable group summary. Yet, shown the plot with both distributions, they could not generalize this method or find another way to determine How much taller are the basketball players than the students who did not play basketball. Aoyama and Stephens (2003) investigated the understanding of statistical concepts related to statistical literacy. The participants of this study were 55 students from grades 5 and 8 who answered the basic graph reading and Level F tasks. The results revealed that 95% of eighth grade students and likewise 82% of fifth grade students though could read the given data and graph but could not properly interpret the. The reason for this result was that students lacked sufficient experience with evaluating statistical information in graphs both in and out of school settings. Watson and Kelly (2008) investigated the literacy aspect of statistical literacy where they asked vocabulary of statistical literacy across grades. More explicitly, they wanted students who are in grades 3 and 5 (N = 359) to answer the definition of sample while students who are in grades 7 and 9 (N = 379) to answer additionally definitions of random and variation. There is a significant difference between grades on sample related tasks. Although they did not find significant difference between grades 7 and 9, there was a significant difference between grades 3 and 5 with a medium effect size and there was a significant difference between grades 5 and 7 with a small effect size.

Additionally, they did not find any significant difference between grades on random and variation related tasks. The researchers also investigated the effect of a specialized instruction related to chance and data with a smaller group of students. The change after instruction was evaluated with paired sample t-tests which indicated that there were significant differences in students grade 3, 5 and 7 from pre-test to post-test in sample related tasks. On the other hand, grade 7 students improved significantly on both for the terms random and variation whereas grade 9 students performed significantly better only on definition of random. Several studies could be found in the literature which examined statistical literacy in tertiary level since statistical literacy was also labeled as a goal for introductory statistics courses (Rumsey, 2002). One of the descriptive studies, apart from high school students, was the study of Schield (2006) in which he investigated the statistical literacy of college students, professional data analyst and college teachers (n=169) where survey instrument focused on informal statistics such as reading tables and graphs. In general, 44%, 65% and 81% of participants misread row table, pie chart and X-Y plots respectively. Among 49% of college students, 44% of data analysts and 28% of college teachers made error on average in this survey instrument. Moreover, the effect of introductory statistics course together with different teaching methods had been a concern for research in statistics education in tertiary level. However, the results of those studies regarding introductory statistics courses were conflictive rather than consistent. For example, students misunderstood confidence intervals which was a part of statistical literacy after introductory statistics course since these courses mainly focused on computation and memorization skills (McAlevey & Sullivan, 2010).

In addition, using media reports to promote statistical literacy for non-quantitative and quantitative majors made little difference in their understandings regarding statistical concepts in those reports based on the interviews conducted (Budgett & Pfannkuch, 2010) as opposed to studies conducted with middle school students (e.g. Merriman, 2006). Similarly, effect of stand-alone online introductory statistics course compared to traditional teaching methods on statistical literacy in the context of tertiary students was not found to be significant (Meyer & Thille, 2010). On the other hand, introductory statistics course, before research methods course, in social science undergraduate curriculum (Wade & Goodfellow, 2009), statistics course utilizing daily life examples (Martinez-Dowson, 2010) and exposure to instructional program (Wilson, 1994) made a significant difference in statistical literacy post test scores of tertiary students.

2.3 Research Related to Attitudes toward Statistics

Calma et al. (2022) investigated the knowledge and attitude towards Statistics and Probability of senior high school students, both public and private at the municipality of Magalang, Philippines. A 25-point multiple choice exam which was based on the Statistics and Probability curriculum of the Department of Education K to 12 program and a 20-item five-point Likert scale attitude questionnaire were administered to randomly selected 397 senior high school students from different strands. The study made use of descriptive-correlational and cross-sectional methods of research. Results showed that students all agree on all the positive attitude statements but mostly are undecided on the negative statements. The study also revealed that students have anxious feelings when they study Statistics and Probability. Students were found to perform unsatisfactorily in Statistics and Probability. Male and Lumbantoruan (2021) investigated students' perceptions and attitudes towards statistics. The writer collected the data through questionnaire to get the quantitative data. The result of the study showed that in terms of the students' perception towards statistics most of them have stated that they mostly agreed with all the statements dealing with perceptions. This can be seen from the first three statements that they could identify the distribution, measurement, and procedure of doing the statistics. The only thing they disagreed is on the ability to communicate the result of statistics and their perception regarding the easiness of the statistics.

In terms of the students' attitudes towards statistics, it is clear that the majority of the students showed their high feeling concerning the statistics. In terms of attitude on cognitive competence, most of them also agreed with the way of thinking to do statistics, understanding it, and requiring a great deal of discipline. Saidi and Siew (2022) investigated student's attitudes and anxiety towards statistics, 320 Tenth Grade science stream students from Malaysia were tested using the Statistical Reasoning Test Survey (SRTS), the Survey of Attitudes towards Statistics (SATS), and the Statistical Anxiety Scale (SAS), which assessed their statistical reasoning, attitude, and anxiety, respectively. Generally, the findings revealed the students held i) a quantitative level in statistical reasoning, ii) a positive attitude towards statistics, and iii) a moderate level of statistics anxiety. A positive relationship between attitudes towards statistics and statistical reasoning, and a negative relationship between statistics anxiety and statistical reasoning were also observed. Griffith et al. (2012) investigated Students' attitudes toward statistics using a mixed-methods approach including a discovery-oriented qualitative methodology among 684 undergraduate students across business, criminal justice, and psychology majors where at least one course in statistics was required. Students were asked about their attitudes toward statistics and the reasons for their attitudes. Five categories resulted for those with positive and negative attitudes and were separated on the basis of discipline. Approximately 63% of students indicated a positive attitude toward statistics. Business majors were most positive and were more likely to believe statistics would be used in their future career. Multiple methodological approaches have now provided data on the various domains of attitudes toward statistics and those implications are discussed. Several instruments were developed and utilized to assess attitudes towards statistics:

The Survey of Attitudes Toward Statistics (SATS) (Schau, C., 2003), the Attitudes Towards Statistics scale (ATS) (Wise, S.L., 1985) and the Statistics Attitude Survey (SAS) (Roberts, D.M. & Saxe, J.E. (1982). The SAS was developed by Roberts and Bilderback (1980) to improve the prediction of success in statistics courses beyond what was offered by general measures of affective reactions to mathematical domains. The instrument appears to have been designed as an "affective scale couched in statistical jargon" in line with the general item format and item phrasing employed by measures of math anxiety and attitudes towards mathematics (Fennema and Sherman 1976; Richardson and Suinn 1972). Roberts and Saxe (1982) suggest administering the SAS at the beginning and/or end of a statistics course. Students are given 33 statements regarding the perceived usefulness of statistics ("Statistics will be useful to me to test the superiority of one method over another"); personal competence in solving statistical problems ("I normally am able to solve statistics problems without too much difficulty"); beliefs about statistics ("I find statistics to be very logical and clear"); and affective responses to statistics ("The thought of taking another statistics course makes me feel sick"). Students respond using a 1-5 Likert-type scale ranging from Strongly Agree to Strongly Disagree. Roberts and Bilderback (1980) reported that the questionnaire is highly homogeneous (alphas in three samples all exceeded 0.93), and Roberts and Saxe (1982) corroborated that all items in the questionnaire load high on a single general factor. The ATS was developed by Wise (1985) in an attempt to improve on perceived limitations of the SAS, mainly that many of the SAS items seemed to Wise to measure prior achievement in or exposure to statistics, rather than attitudes. (For example, one SAS item states, "I make a lot of errors when I calculate statistics problems.") The ATS scale is composed of two subscales: a 9-item Course subscale, measuring attitudes towards the course in which students are enrolled, and a 20-item Field subscale, measuring attitudes towards the use of statistics in their fields of study.

As with the SAS, the students respond to each of the items using a five-point Likert scale, ranging from Strongly Disagree to Strongly Agree. Wise reported a correlation of 0.33 between the two sub-scales. He argued that since the ATS focuses on attitudes rather than students' previous experience with statistics, it is more appropriate than the SAS as a measure of changes in students' attitudes from the beginning to the conclusion of a statistics course. A few other instruments relating to statistics anxiety have been developed but have not been widely tested or evaluated, and their quality is yet to be established. A 24-item instrument, Students' Attitude Toward Statistics (STATS) has been developed by Sutarso (1992), and a small-scale pilot study indicates that this instrument does not particularly differ from the SAS and ATS. Another instrument, the Coping Strategies Inventory for Statistics (CSIS) has been designed by Jarrell and Burry (1989). It appears to have no particular relevance to statistics, as all of its items evaluate general test-taking skills and coping strategies. The word "statistics" is never mentioned in any of the CSIS items and is only used in the title of the instrument. The findings reported by Roberts and Reese (1987) regarding the similarity of the SAS and ATS scales (a reported correlation of 0.88 between the two scales), their homogeneity in terms of both high internal consistency (alpha coefficients exceeding 0.90), and their simple factorial structure (a single general factor, though Wise [1985] earlier reported two factors), do not sit well with the diverse content of the items.

Mvududu (2003) described attitudes towards statistics through constructivist learning environment which included personal relevance, student negation, critical voice, and uncertainty dimensions which revealed a positive relationship between these variables and attitudes. Another study conducted to investigate the predictors of attitudes toward statistics with 88 and 140 graduate students from educational departments (Aksu & Bikos, 2002). The significant predictor of statistics attitudes was departmental affiliation whereas previous experience in statistics and gender difference were not significant. Furthermore, Diri (2007) conducted a study which described the attitudes toward statistics lesson of 135 college students in a vocational school with a scale consisting of six different components. For the components of anxiety and importance, students reported positive attitudes whereas for the components of interest and confidence they reported negative attitudes. Also, for the components profession and enjoyment, students were not sure whether they agreed with positive or negative attitude statements. These studies indicated that predictors of attitudes towards statistics might be constructivist learning environment.

2.4 Research Related to Relationship between Attitudes toward Statistics and Statistical Literacy Scores

Calma et al. (2022b) investigated the knowledge and attitude towards Statistics and Probability of senior high school students, A 25-point multiple choice exam which was based on the Statistics and Probability curriculum of the Department of Education K to 12 program and a 20item five-point Likert scale attitude questionnaire were administered to randomly selected 397 senior high school students from different strands. The study made use of descriptive-correlational and cross-sectional methods of research. Results showed that students all agree on all the positive attitude statements but mostly are undecided on the negative statements. The study also revealed that students have anxious feelings when they study Statistics and Probability. Students were found to perform unsatisfactorily in Statistics and Probability. the study revealed that there is a low but positive and significant relationship between the knowledge and attitude of students towards Statistics and Probability. The study recommends the development and conduct of learning interventions to improve the students' knowledge and lessen their anxiety in learning statistics and probability. Repedro and Diego (2021) used descriptive-correlational research determined the attitudes toward statistics in the components of affect, cognitive competence, value, difficulty, interest and effort, and statistical literacy of 200 public senior high school students selected through stratified random sampling. The SATS-36© developed by Schau et al. (2003) was used to determine attitudes, while a researcher-made questionnaire was utilized to measure statistical literacy. Using descriptive statistics and inferential analysis, student's attitudes toward the subject were established positively in value, interest, and effort components. In contrast, a negative attitude was exhibited in the components of affect, cognitive competence, and difficulty. Students' statistical literacy was found to be low in all areas and as a whole

Student's performance in statistics was clearly shown to be related to their attitudes towards the course (Blitzstein, 2013; Newton & Veresova & Mala, 2016). Papanastasiou (2000) and Michelli (2013) also found a positive relationship between Statistics achievement and students' attitudes towards statistics. Concerning gender, Michelli (2013) mentioned that males had a more positive attitude towards math compared to females, but both genders scored approximately the same on the achievement test. Finally, extroversion was the only trait to have a significant relationship with achievement, showing that more extroverted students scored higher on the test. These findings indicate that educators should be aware of students' attitudes and seek to improve them to positively influence students' academic achievement. Moreover, the study of Blitzstein, (2013) shows a positive significant correlation between students' attitude towards learning and achievement motivation ($r = 0.53$, $p < .001$), and between students' attitude and academic achievement ($r = 0.16$, $p < .001$). However, a negative and low correlation ($r = -.038$, $p > .05$) was observed between students' achievement motivation and their academic achievement.

In another study conducted with middle school student, Yingkang and Yoong (2007) investigated attitudes towards statistical graphs with respect to gender and grade level. The questionnaire they used consisted of five subscales which were enjoyment, confidence, usefulness, learning preferences and critical views. The descriptive results revealed that their attitudes with respect to enjoyment, confidence, and usefulness were neutral to positive. In addition, students preferred traditional methods of statistics teaching which included clear explanation and practice and they were unlikely to have a questioning or critical attitude towards statistical graphs. As students' grade level increased, their attitudes became more positive whereas there were no gender differences. A research which investigated the possible relationship between statistical literacy and affective domain could be found in Carmichael's (2010) study where he conducted a study with 204 students in order to examine the possible relationship between interest in statistical literacy and self-efficacy in statistical literacy and students' statistical literacy. In order to analyze data, structural equation modeling techniques were utilized and the results revealed that interest had weak and insignificant relationship (r=.14) with statistical literacy while self-efficacy had an effect on both (r=.24) interest and (r=.16) statistical literacy achievement scores which indicated that students' competency values strongly predicted both of these constructs. Acording to Aseidu-Addo(2014), In Ghana, no substantial research has been conducted on students attitude and knowledge in basic statistical concepts. The available one is the results of Ghanaian junior high school two students" performance on the Trends in International Mathematics and Science Study (TIMSS). This is a series of studies undertaken once every four years by the International Association for the Evaluation of Educational Achievement (IEA). In this international study four main content areas, Number, Algebra, Geometry and Data and Chance are assessed under three main cognitive domains: Knowing, Applying and reasoning. Participating for the first time in 2003, Ghana"s overall performance in mathematics was poor, and this placed Ghana at the 45th position out of forty six participating countries on the overall mathematics achievement results table. Ghanaian Students" performance over the years has always been abysmal.

2.5 Statistical Literacy Construct

The statistical literacy construct from Watson and Callingham (2003) builds on previous work by Watson (1997) where she uses the Structure of the Observed Learning Outcome (SOLO) taxonomy of Biggs and Collis cited in Yulco (2012) from developmental psychology to categorize statistical literacy into a three-tier hierarchy with increasing sophistication: a basic understanding of statistical terminology; an understanding of statistical language and concepts when they are embedded in the context of wider social discussion; and a questioning attitude to contradict claims made without proper statistical foundation. Watson and Callingham (2003) have developed the three-tiered view into their statsistical literacy construct. The model is a six-level hierarchy that represents increasingly sophisticated thinking starting from idiosyncratic to critical mathematical. At the Idiosyncratic (Level 1) and Informal (Level 2) levels, students are only merely interacting with the language and meanings of statistical terms. For the Inconsistent (Level 3) and Consistent Non-critical (Level 4) levels of the construct, students are beginning to engage with the context and uncover the statistics embedded in the context. In the last two levels of the progression Critical (Level 5) and Critical Mathematical (Level 6), students are able to be critical and challenge claims made in statistical reports and data.

Watson and Callingham (2003) believe that traditional textbook questions could fulfil the requirements of levels 1 and 2 but that the same types of questions were unlikely to fulfil the need of ‘providing motivating contexts to challenge students’ critical thinking’ and that teachers would have to seek out contexts such as media reports to motivate and engage students. A real strength of the Watson and Callingham (2003) model is that the researchers have validated their statistical literacy scale with responses from a large number of Australian students. This has enabled them to attempt to determine how and when instruction for statistical literacy could take place and how instruction can be scaffolded to help students progress. Both Gal (2004), with his attitudes and beliefs, and Watson and Callingham (2003) describe a need for similar dispositions in their models. There are some obvious differences between Gal's (2004) approach and that taken by Watson and Callingham (2003). Gal presents a full definition of statistical literacy along with the necessary components that are needed. However, Watson and Callingham differentiate between hierarchical levels of statistical literacy. The different approaches can be explained by the contexts of their studies into adults and students, respectively. The essence of both Gal's and Watson and Callingham's descriptions are very similar. Both emphasized the need for statistical knowledge and skills, the ability to communicate ideas, the centrality of context and the need to be critical Sharma et al. (2011) developed sequences of activities through a research and development process called design research (Cobb & McClain, 2004). The collaborative study involved cycles of three phases: a preparation and a design phase, teaching experiment phase and a retrospective analysis phase. In this study, teaching experiments were conducted in two year-9 classrooms.

The emphasis on critical thinking and contextual understanding, however, can present challenges for teaching and assessment (Garfield and Ben-Zvi, 2009; Shaughnessy, 2007; Watson, 2006). To assist teachers, a framework must be identified that will provide information about the cognitive skills, including critical thinking in socially based curriculum approaches. I believe that such a framework is likely to be dynamic in nature and can be viewed as a developmental sequence. This means that prior knowledge and experiences will influence current understanding and lead to the development of more complex statistical literacy constructs. Existing classroom schemes of work tend to focus more on generating data rather than on interpreting or evaluating other studies or reports. The focus is on students going through the statistical inquiry cycle. School textbooks may also play a central role in statistics classroom to help students develop statistical skills and techniques. Students are expected to be able to work through the exercises by themselves with the teacher available to help them. In light of changed curriculum expectations and extended social expectations for statistical literacy, teachers across the different learning areas will have increased expectations placed on them in terms of appreciating statistical literacy and how to develop it (English and Watson, 2016a; Franklin et al., 2007). English (2013) claims that statistical literacy requires a long time to develop and must begin in the earlier years of schooling. It is likely that professional development for teachers will be needed (Pierce and Chick, 2013) if they are to assist their students to achieve the highest levels of statistical literacy before they leave formal schooling.

Multiple assessment frameworks have been established, and assessment studies have been conducted in order to assess the SL skills of high school students (e.g., Aoyama and Stephens, 2003; Callingham and Watson, 2017; Mooney, 2002; Mullis et al., 2012; Pfannkuch, 2005; Yolcu, 2014). Several studies, for instance, have investigated the level of SL attained by students in the same grade (e.g., Mullis et al., 2012; Pfannkuch, 2005), while some others provide the levels achieved by students from different grade levels (e.g., Aoyama and Stephens, 2003; Callingham and Watson, 2017; Yolcu, 2014). Of those involving students from different grades, Aoyama and Stephens (2003) conducted a study with years 5 and 8 students and claimed that the improvement across years 5 and 8 is unlikely to be attributed to formal statistical education due to the lack of statistical treatment between the two grades; instead, it might be attributed to cognitive development in general including students' experiences with data-based information in and out of class. Callingham and Watson (2017) conducted a longitudinal study of children in years 5 to 10 and discovered that there was very limited growth from years 5 to 6 and years 9 to 10; however, there was growth (although minor) throughout the transition from primary to secondary school (years 6 to 7). Finally, Yolcu (2014) found no significant grade level differences across years 6 to 8, and this lack of differences between grades might be caused by the spiral curriculum in middle school mathematics. All those studies were conducted in developed countries and did not involve students from the final year of schooling. The present cross-sectional study was conducted to investigate the critical responses exhibited by Indonesian year 9 and year 12 students. The year 9 and year 12 students were chosen as they represent Indonesian students participating in the PISA test and final year of schooling, respectively. Moreover, the present study also intended to understand whether the Indonesian students' SL is influenced by their gender. Although many studies have been conducted to investigate school students' SL, few studies were conducted on the effect of gender on the students' SL. Moreover, some studies on gender differences focused on the students' interest in or attitudes towards statistics (e.g., Carmichael and Hay, 2009; Chiesi and Primi, 2015) rather than on the students' SL levels.

Few studies have investigated the effect of gender on the students' SL levels. For instance, Watson and Moritz (2000) conducted a study in Australia with students in years 3–11, while Yolcu (2014) conducted a study in Turkey for students in years 6–8. In addition, both PISA 2003 and 2012 provided a broader picture of gender differences on the uncertainty and data subscale (OECD, 2004, 2014). The PISA reports covered the students' levels for the uncertainty and data subscale among the participating countries based on gender. Those studies or reports enabled further investigation of the trends that occurred over a decade as elaborated below.

2.6 Summary of Literature Review

The review of literature indicated that statistical literacy was a new area of research in mathematics education and there was a concern for researching statistical literacy within the scope of school mathematics (Shaughnessy, 2007; Watson and Callingham, 2003) since the ultimate goal of statistics instruction was labeled as statistical literacy (Ben-Zvi and Garfield, 2004). Since statistical literacy had entered into the literature relatively new, there was no common definition for this construct. However, in this study statistical literacy defined as understanding, interpreting, and evaluating statistical claims together with attitudes where a combined framework was constructed. In this framework, cognitive aspect of statistical literacy was conceptualized through Watson's (1997) three tiered framework while dispositional aspect was attitudes towards statistics taking Gal's (2004) model into account. The tiers included understanding, interpreting, and critical evaluation of statistical claims. Understanding terminology which was referred by the first tier could be counted as the literacy skill as stated by Gal (2004) and Watson (2006). In addition, three tiers were associated with diverse contexts since all of the frameworks took context into consideration. In the light of this combined framework, statistical literacy of students were examined through these three tiers and attitudes towards statistics. The research considering middle school students investigated different aspects of statistical literacy in terms of grade level and results of these researches revealed that statistical literacy was developed as grade level increased (e.g. Aoyama and Stephens, 2003; Watson and Kelly, 2008). In addition, there were a few remarkable intervention studies where the effect of project work (Merriman, 2006) and critical thinking skills (Doyle, 2008) improved conceptions and understanding regarding statistical literacy. There existed a considerable research in the context of university students; however, results of those studies were not consistent as stated in previous sections.

Attitudes towards statistics were considered very important to investigate since they had role in the teaching and learning process during class time, in the statistical behavior out of the class, and enrollment in further statistics related courses (Gal, Ginsburg and Schau, 1997). Despite of its importance, there were several definitions of attitudes towards statistics in the literature. For the purpose of this study, attitudes towards statistics could be described as the emotions and feelings experienced by individuals during learning statistics which addressed general attitudes toward statistics. The review of literature related to attitudes towards statistics revealed that there were a considerable number of studies in tertiary education context while research in precollege context was limited in number. Though explanatory studies conducted with middle school students indicated that students' attitudes differentiate between neutral and positive (e.g. Calderia and Mouriño, 2010), relationship between statistical literacy and effects of various interventions still remained ambiguous either suggesting weak relationships (e.g. Carmichael, 2010) or stayed in the same position after a teaching method (e.g. Yılmaz, 2006). It was possible to see this inconsistency in the tertiary education literature considering attitudes towards statistics as mentioned.

CHAPTER 3

METHODOLOGY

3.0 Overview

In this chapter the researcher discussed the methodological issues of this research study, the description of and justification for the quantitative data collection procedures selected for this research in such a setting. There is also description of the methodology in practice. There is an in-depth description of the participants involved, the context and structure of the research and a description of the practicalities of the data collection techniques used in this quantitative enquiry.

3.1 Research Design

The research design for the study was the Descriptive Research that employs the Explanatory Sequential Mixed Methods (a two-phase design where quantitative data is collected and analyzed first, then qualitative data is collected and analyzed based on the quantitative results. The qualitative data is used to explain the quantitative data). Michell (2013) indicated that it is economical to use survey because it makes it possible for many subjects to be studied at a particular point in time. Also, survey has the advantage of providing a lot of helpful information from the subjects of the study (Fraenkel and Wallen, 2000). According to Edmonds and Kennedy (2017) exploratory sequential technique as a progressive strategy that is used anytime that quantitative results are augmented by qualitative data. One of the distinct advantages of using an exploratory sequential approach is described by Edmonds and Kennedy as a method that comparatively provides more robust validity. Applying both quantitative and qualitaive approaches to single research works offers a more significant opportunity to establish more insight into the study subject, whilst a higher degree of validity and accuracy are achieved compared to applying a single approach (Yingkang and Young, 2007).

3.2 Population

The population of the study comprises all the Senior High schools students in the Kwaebibirem District in the Eastern Region of Ghana. Yet the accessible population of this study is defined as all the one thousand and eight (1008) final year students enrolled in Kade Senior High Technical School in the Kwaebibirem District in the Eastern Region of Ghana since it is not feasible to reach the entire population.

3.3 Sample

In total a sample of one hundred and eighty (180) students were selected for the study. Table 3.1 shows the composition of the sample that was choosing.

Table 3.1: Sample of respondents

Programme	Gender		TOTAL
	Boys	Girls	
General Sciences	30	30	60
General Programe in Arts	30	30	60
Vocational (Home Econs)	30	30	60
TOTAL	90	90	180

3.4 Sample Techniques

A two stage stratified sampling procedure was used to select respondents. The population was first divided into the three main program of study before a simple random sample taken from each groups. For the purpose of this study 'Equal

Allocation' was employed to ensures that all strata have equal subsample sizes appropriate for statistical analysis which require variables to have equal sample size.

3.5 Data Collection Instruments

The data for this study was collected through a Statistical Literacy Test (SLT) and Attitude Towards Statistics Questionnaire (ATSQ). Statistical Literacy Test (SLT) is a modification of the statistical literacy Test used by (Yolcu, 2012).The content areas are sampling, average, probability, variation, tables and graphs. The ATSQ was adapted and modified from the Survey of Attitudes toward Statistics (Shau, 2003) also used by (Ong and Masitah , 2014). The questionnaire have 20 items and a five-level Likert Scale (Strongly disagree, disagree, Neutral, Agree and strongly agree) was used.

3.6 Pilot Testing

The pilot study was conducted to ensuring the content validity of items. Twenty (20) students were tested to make sure items produce the required results. According to the responses of students, some adjustments were made with the intruments before it was administered to the randomly selected respondents.

3.7 Reliability

Internal consistency methods were utilized to examine reliability of the instrument. For the statistical analyses of the internal consistency, Cronbach's alpha coefficient was obtained through SPSS software. The reliability estimate for scores on Statistical Literacy Test was found as 0 .72 according the data gathered from pilot study. Following to the adjustments made on SLT, the reliability estimate increased to 0.75 which was obtained in the actual study. Since reliability coefficient of a scale should be at least 0.70 (Fraenkel and Wallen, 2006) to have a reliable instrument.

3.8 Validity

To ensure content validity of the Statistical Literacy Test, the test items was given to three SHS mathematics teachers who are experts in Statistics with the syllabus and content area used. to check whether each question is appropriate for SHS in terms of content and format. Necessary corrections were made before the items were used.

3.9 Data Collection Procedures

The data for the study was collected during the Second semester of 2022/2023 academic year. After obtaining permission the school Head and mathematics Head of Department. The sampled students were asked to sit in allocated classrooms and with the help of the mathematics teachers the Statistical Literacy Test was administered to the students. Before they started the researcher introduced the reason to conduct this study to the students and assured them their responses would be kept completely confidential and would only be used for the study. After the Test the attitude towards statistics questionnaire was administered to them.

3.10 Data Analysis

methods for summarizing and describing the data set such as central tendencies, variability and distribution employed to gain knowledge into the data. To answer the first hypothesis, the researcher used frequencies, means and percentages to determine the statistical literacy of the students. A one-way Analysis of Variance (ANOVA) was used to test if there is a significant mean difference in student's statistical literacy scores with respect to three main programme of study**.** Attitude towards statistics data was analyzed by the use of summations, percentages and means. For analysis purpose, students' responses to the five options Likert scale were further grouped into a Likert scale with three options (Disagree, Neutral and Agree). Pearson product moment correlation tool were used to measure the relationship between students attitude towards statistics and SLT scores.

CHAPTER 4

ANALYSIS OF DATA

4.0 Overview

This chapter consists of the data analyses that were conducted to answer the research questions of this study thus Analysis of Senior High School Students' Statistical Literacy, Attitudes Towards Statistics and Their Relationship**.** The findings are presented and discussed in relation to the research questions.

4.1 Descriptive Statistics

Methods for describing the data set was used to summarize its main characteristics and to maximize insight into the data set and to check assumptions for the testing of hypotheses and handling missing values.

Table 4.1: Descriptive statistics of SLT scores

Statistic	**Science**	**Vocational**	**Arts**	Total Sample
Count (N)	60	60	60	180
Mean	44.03	31.03	34.70	36.59
Variance	262.982	202.383	169.423	239.350
Std. Deviation	16.217	14.226	13.016	15.471
Minimum	13	6	6	6
Maximum	84	63	65	84
Range	71	59	57	78
Skewness	0.341	0.145	0.208	0.396
Kurtosis	-0.107	-0.694	-0.579	-0.047

Table 4.1 revealed that a total of 180 respondents participated in the test, 60 each from Science, Vocational and Arts programme respectively. The overall minimum score was 6% and the maximum score was 84%. The maximum score coming from the science class, whiles the lowest score coming from Arts and Vocational category. The overall mean was 36.56%, we can also notice that the data were less variable in the Arts category than the Vocational and science category respectively. The highest score 84% was recorded for Science category with Acts and Vocational recording 65% and 63% respectively. Also the lowest score was 6% for both Arts and Vocational category and 13% for the Science category. Skewness and kurtosis values were within -1.00 and +1.00. However, according to Kunnan (1998), these values could be regarded as in the acceptable range which placed -2.00 and +2.00; hence these values did not violate normality assumptions (Kunnan, 1998).

4.2 Senior High School Students Statistical Literacy

Research question one; what is the statistical literacy of Kade Senior High Technical School students. This question investigates the statistical literacy of the students. a statistical literacy test was used to test the literacy of 180 randomly selected students. The results is shown in table 4.2.

Table 4.2: Sample Statistics

	N	Min	Max	Mean	Std. Deviation	Std. Error Mean
SLT Scores	180	6	84	36.59	15.47	1.24

Table 4.3: Descriptive Statistics of SLT Scores in terms of Tiers

Levels	N	% Mean Score	SD
Tier 1	180	75	2.5
Tier 2	180	21	5.4
Tier 3	180	9	3.6

Table 4.2 showed that, the mean score of the statistical literacy test was (36.59%), a standard deviation of 15.47 indicated that there was quite a big variation in the student percentage scores. The highest score obtained was (84%) out of (100%) marks and the lowest score was (6%). None of the students got all the questions correct. If the pass mark was set at 40%, only 37.78% of the students passed the statistical Literacy test. The low mean percentage test score (36.59%) and the low passing rate (37.78%) according to Yulco (2012) proved that the level of students' knowledge in statistics was low.

Table 4.3 shows students' percentage mean scores based on Watson's three tiered statistical literacy model. Tier 1 had a higher score (Mean =75, SD = 2.5) compared to tier 2 (Mean =21, SD = 5.4) and tier three (Mean = 9, SD = 3.6). this shows that students of Kade SHTS showed strength in this tier which comprises understanding the terminology of statistics without considering the context according to Watson cited in (Yulco, 2012). This terminology includes specific concepts in the curriculum such as sampling, average, graphing, random, and variation. This tier also involves calculation of measures of central tendency or measure of spread without any reference to the social issues in the daily lives of students.

Students however performed poorly in the second and third tier which is contextualization of terminology including statistical language and concepts which requires students to read reports of statistics and interpret them, rather than only performing the statistical computations and the important aspect of statistical literacy which require students to develop intelligent questions for data and related claims instead of believing everything they read in the media Watson cited in (Yulco, 2012). This is consistent with Watson and Kelly (2008) who investigated students' understanding and related definitions of the terminology of statistical literacy across grades which indicated that the majority of students performed well either in the lowest level or one level higher which involved idiosyncratic responses and one single related idea respectively. At this point, Watson and Kelly's (2008) results supported the findings related to Tier 1.

4.3 SLT Content Area Analysis

The results of this study were also examined through content domains of statistical literacy which revealed that students performed differently in different contents. The content areas of the statistical literacy test were; sample, averages, graphs, chance and variation. The number of correct answers per item were collected in order to assist the researcher to determine which area students find it difficult to answer and which they find it easy.

4.3.1 Sample

The 'Sample' items were item number 3, 4 and 12 (see Appendix A), the items ask how students understand random selection, difference between sample and population and representativeness of a sample. Students' response showed that they understand the difference between sample and a population but have a problem with random selection and representativeness. 42% percent of the students got sample related questions correct. This result is consistent with previous research done by Watson and Moritz (2000) where they indicated that students, who could not give related statistical ideas for definition of sample, were able to question claims in the sampling context.

4.3.2 Central tendency

Central tendency items were item numbers 2, 8 and 11. Item 2 (see Appendix A) ask about students understanding of the use of the mean. Item 8 also require students to identify the median among a group of data. Item 11 involved calculation, students were ask to find the mean age of a grouped frequency distribution. 75% of all participants were able to identify the median mark among the set of data, however, their understanding of the use of the mean was pre-statistical. Also calculation of mean score from the group frequency was a problem for some of the respondents.

4.3.3 Graph

Graph item was question 5, the item require students to interpret 2 graphs showing the production of tomatoes and price of tomatoes over a year.

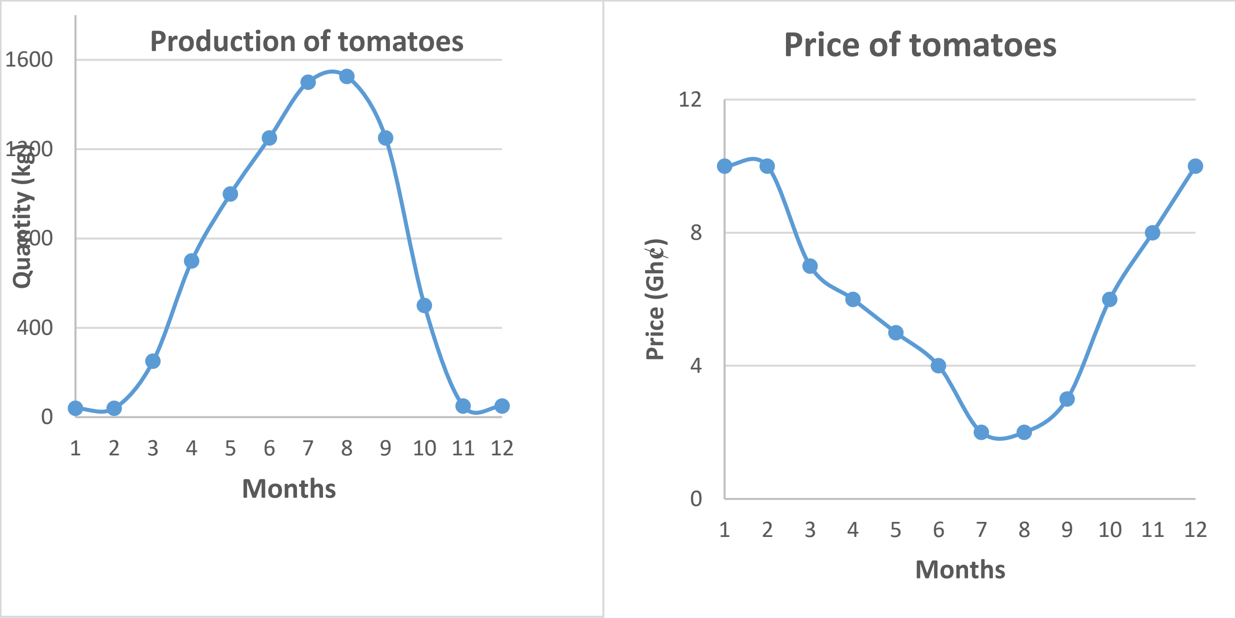


Figure 4.1: Monthly production and price of tomatoes

From figure 4.1, 70% of the students could not identify the relationship between the two graphs, though they could tell that, the graph rises and falls generally students responds to item 5 was pre-statistical.

4.3.4 Probability

Probability item was item 7 (see Appendix A), students were ask to find the probability of selecting an object from a set. Students responds to this item was also pre-statistical. This is consistent with (Yulco, 2012) who found that majority of participants did not performed well in items related to chance content though probability has been one of the oldest topics in Elementary Mathematics Curriculum and it is expected that teachers have the required knowledge and experience with understanding and application of these concepts.

4.3.5 Variance

Items on variance include item 9 (see Appendix A), students were ask to identify among these sets of data one which is more variable.

a. 10, 11, 12, 13, 14, 15

b. 13, 13, 13, 13, 13, 13

c. 11, 12, 12, 13, 13, 14

d. 10, 12.5, 12.5, 12.5, 12.5

The researcher noted that students might have misunderstood the word variable, they are used to standard deviation than variance. This accounted for the poor performance in that content area. 30% of respondents however did answered correctly.

Item 1 (see Appendix A) required respondents to write what they think statistics is. The researcher sampled 5 definitions common to all, these are;

- Statistics is a way of gathering data about a problem.
- Statistics is process of processing data.
- Statistics is the collection and management of data.
- Statistics deals with the collection, processing and presentation of data.
- Statistics is used to process data and present data.

The researcher noticed that students mentioned data in their definition of statistics, they also mention collecting, processing and presentation of data. These are obvious that students have ample knowledge about statistics. Although their definitions did not fully tell all what statistics is about, the researcher was happy about the responses.

4.4 Difference in SLT scores by program of study

Another research question of this study was to find out if there was a significant difference in mean scores of Science, Arts and Vocational programs in statistical literacy. Pallant (2007) stated that in order to compare differences between two or more conditions that had undertaken the same test items, one-way within subjects analysis of variance (or repeated measures ANOVA) should be used provided that the measures were in the same response scale. Therefore, in order to examine the difference between mean scores of programes in this study one-way within subjects analysis of variance was conducted. Prior to running the analysis, the statistical assumptions associated with one-way within subjects ANOVA were checked.

4.5 Assumptions

Lund and Lund (2012) argue that an assessment of the normality of data is a prerequisite for many statistical tests as normal data is an underlying assumption in parametric testing. According to them, there are two main methods of assessing normality - graphically and numerically. In this study the researcher opted for graphical method which can easily be seen and recognized. Graphical method was preferred because it represent numerical data in way one can see and understand. A box plot also called whiskey diagram was the preferred choice because it displays data base of the five number summary; the minimum, first quartile, median third quartile and maximum.

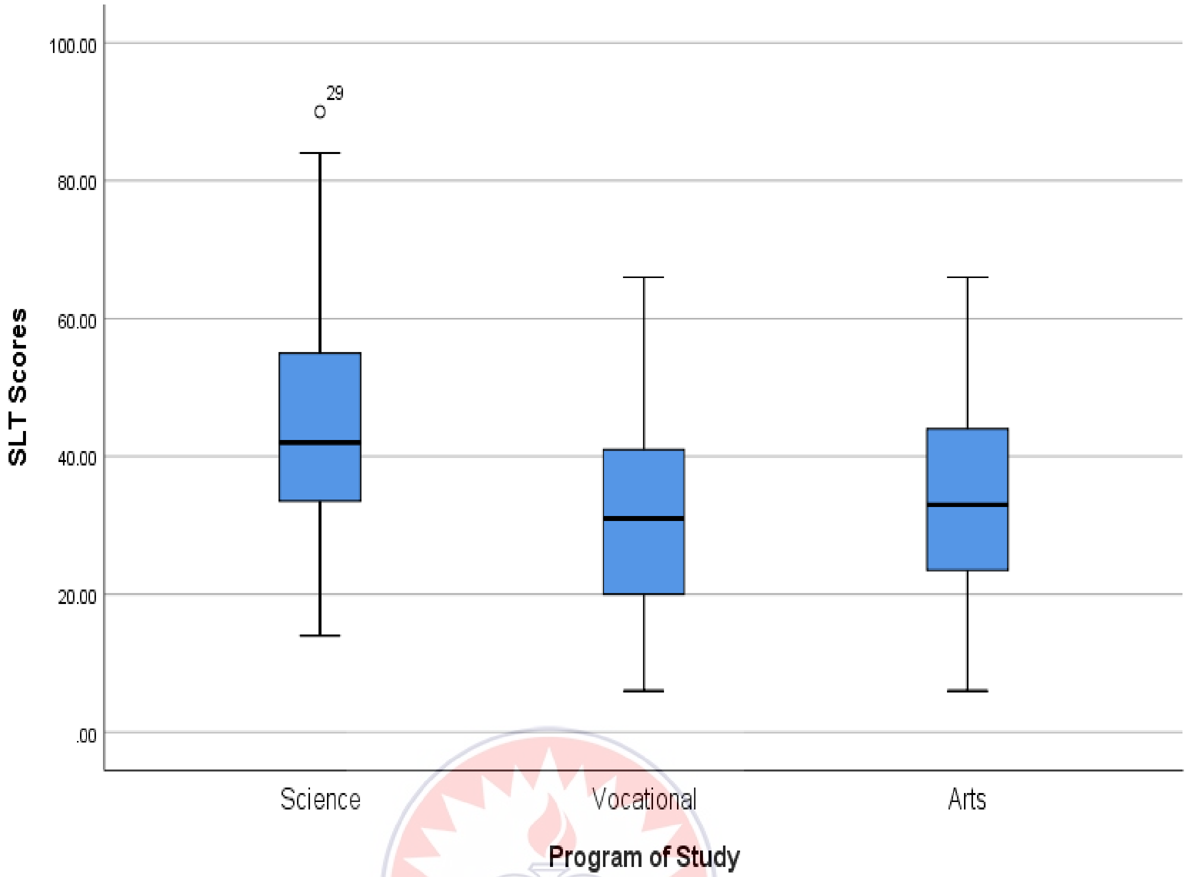


Figure 4.2: Box plot of SLT scores

Figure 4.2 show that the SLT scores of final year students is approximately normal, because the first quartile, median and the third quartile falls in the middle of the minimum and the maximum values. A numerical confirmation by using a Shapiro-Wilk normality test gave a P-values of 0.354, 0.184 and 0.270 for Science, Vocational and Arts programmes respectively. Level of measurement assumption was assured since the variable used for the ANOVA were statistical literacy scores of each program which were continuous variables.

A two stage stratified sampling method was utilized for this study which indicated that the respondents in this study were chosen randomly, hence, scores of individuals were obtained using a random sample of population. Measurement of respondents in one program of study was not influenced by others. That is, the measurements were independent from each other; therefore, there was no violation of this assumption.

4.6 Results of ANOVA

A one way analysis of variance (ANOVA) was used to find out if there was a difference in means among the three amin programs and also to determine if there exist any interaction effect.

Table 4.4: One way ANOVA output

ANOVA					
SLT Scores					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	5398.711	2	2699.4	10.786	0.00
Within Groups	44295.2	177	250.26		
Total	49693.91	179			

Table 4.5: Tukey HSD post hoc test

Dependent Variable: Scores

Tukey HSD

(I) Program		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Science	Voc.	9.33*	2.636	0.002	2.96	15.71
	Arts	13.00*	2.636	0.000	6.63	19.37
Voc.	Science	-9.33*	2.636	0.002	-15.71	-2.96
	Arts	3.67	2.636	0.498	-2.71	10.04
Arts	Science	-13.00*	2.636	0.000	-19.37	-6.63
	Voc.	-3.67	2.636	0.498	-10.04	2.71

A one-way ANOVA was performed to compare the effect of three different programmes on SLT scores. A one-way ANOVA revealed that there was a statistically significant difference in mean exam score between at least two groups (F(2, 117) = [10.7], p = 0.02). A Tukey HSD post hoc test for multiple comparisons indicated that the mean score for Science students (M = 44.03, SD = 16.217) was significantly different from Vocational (M=34.70, SD = 14.226) and Arts (M=31.03, SD = 13.016) at *$p < 0.001$. However the mean score of Vocational was not different Arts at *p= 0.348. As a results the null hypothesis which states that, there is no significant Mean difference in SHS students' statistical literacy scores with respect to Programme of study is rejected at 95% confidence level. Therefore we conclude that, there is a significant Mean difference in SHS students' statistical literacy scores with respect to programme of study. This is consistent with (Griffith et al., 2012) who's findings provided evidence that students performance in statistics differ with regard to program of study. They found that students doing Business courses performed better in statistics than those in the Arts courses.

4.7 Students' Attitudes towards Statistics

Responses of students' attitudes towards statistics was obtained through the administration of the ATSQ to the sample of 180 final year students of Kade Senior High Technical School. The questionnaire consisted of a total of 20 items which were five point Likert type items to be responded as Strongly Disagree, Neutral, Agree, and Strongly Agree. Assessment of students' responses to the attitude towards the statistics questionnaire was done by the use of summations, percentages and means was used. The mean score ranged from 1 (Minimum) to 5 (Maximum). A mean value of 3.0 is considered to be a neutral or undecided, below 3.0 indicates a poor/negative attitude towards statistics and a mean value above 3.0 indicates a positive attitude. Students' attitude was measured through responses given by students towards a set of statements or items relating to these four attitude component; Affective, Cognitive Capability, Value and Difficulty (Ayebo et al., 2019). The respondents exhibited their agreement and disagreement towards the items in each component.

The responses towards Affective component are summarized in tables 4.6.

Table 4.6: Analysis of ATSQ Affective component

No	**Affective Attitude Component**	**Mean**	SD
1	I like statistics	2.6	1.4
2	I don't feel intimidated when asked to solve a statistical problem	3.0	2.0
3	I don't feel stressed in my statistics class.	2.5	1.7
4	I enjoy taking statistics courses	2.1	2.5
5	I am not afraid of statistics.	3.1	2.8
	Average	**2.7**	2.1

Table 4.6 shows the mean score for each item under affective attitude component. Affective component assesses students' expression towards statistics course. The respondents exhibited their views towards the items in the component. Students' views in this attitude component was not positive (mean = 2.7, SD = 2.1). this is consistent with (Ashaari et al., 2011) who found students responds under this component to be negative. Responds to item one for instance which gathers students degree of like for statistics was not satisfactory (mean = 2.6, SD =1.4). however, students showed middling view on whether they feel intimidated when ask to solve a statistics question. Item three prove students stressed in statistics class Item four (mean = 2.1) confirms the fact that students are generally afraid of mathematics related subjects and they didn't really enjoy statistics lessons.

The responses towards Cognitive Capability component are summarized in tables 4.7.

Table 4.7: Analysis of ATSQ Cognitive component

No	**Cognitive Capability Attitude**	Mean	SD
6	I do not face problems in statistics because of my thinking style.	1.9	2.0
7	I know what is happening in statistics.	2.1	1.4
8	I do not make calculation errors very often in statistics.	2.8	2.0
9	I will understand statistics equations.	3.0	1.5
10	I can learn statistics	2.7	1.7
	Average	**2.5**	1.7

Cognitive component assesses attitude is the cognitive capability, which is students' attitude towards the knowledge and intellectual skill in using the statistics knowledge. Students' responses in this component was negative (mean = 2.5, SD = 1.7). Item number six shows that students face problems in solving statistics related problems (mean =1.9, SD=2.0). number seven shows that students don't know what is happening in statistics. Number eight also proved that students make calculation errors often in statistics, however students view on understanding statistical equations was middling. Item ten (10) show that students disagree to the fact that they can learn statistics, the mean response is (mean=2.7).

The responses towards Value component are summarized in tables 4.8.

Table 4.8: Analysis of ATSQ Value component

No	**Value Attitude**	Mean	SD
11	Statistics should be a required part of my study	2.0	1.5
12	I use statistics in my daily life.	2.7	1.4
13	I often make decisions based on statistics.	1.9	2.1
14	I will use statistics in my future career.	3.1	2.5
15	Statistics is relevant for my life	2.1	1.7
	Average	**2.4**	1.8

Value component as showed in table 4.8 assesses attitude towards the usefulness, relevance and advantage of statistics for individuals and their professional life. Students' responses to value items was negative (mean = 2.4, SD = 1.8). This is consistent with (Ashaari et al., 2011). Item eleven showed that students disagree to the fact that statistics should be a required part of their study. Students disagree to the fact that they use statistics in their everyday lives in item 12 (mean = 2.7). Item thirteen students responds disagree to the fact that they make decisions based on statistics. Students also showed a middling response to item 14 that they will use statistics in their future career also got (mean = 3.1) and in item fifteen students disagree to the fact that Statistics is relevant for my life (mean = 2.1, SD = 1.7)

Table 4.9: Analysis of ATSQ, Difficulty component

No	**Difficulty Attitude**	Mean	SD
16	Statistics formulae are easy to understand.	2.0	1.5
17	Statistics is not a difficult course.	1.2	1.1
18	Statistics can be quickly learned by most people.	1.8	2.5
19	Learning statistics does not require discipline.	3.0	2.3
20	Statistics does not involve too much calculation	2.1	2.0
	Average	**2.0**	1.9

Difficulty component assesses attitude towards the difficulties in understanding the subject. This includes how easy it is to understand a formula, technical method, and the massive calculation involved in the subject. Students responds to this category was negative (mean = 2.0, SD = 1.9. This is consistent with (Ashaari et al., 2011). Item sixteen shows that students disagree to the fact that Statistics formulae are easy to understand. They also disagree to the fact that statistics is not a difficult topic in item seventeen. students were found to show a moderate level of interest towards items 19 (mean = 3.0) and in item twenty students disagree that Statistics does not involve too much calculation (mean = 2.1, SD = 2.0).

Table 4.10. shows the mean score for each of the four attitude components namely; Affective, Cognitive Capability, value and difficulty.

Table 4.10: mean score for each component

Attitude Component	Mean	SD
Affective	2.7	2.1
Cognitive Capability	2.5	1.7
Value	2.4	1.8
Difficulty	2.0	1.9
Overall Average	**2.4**	1.9

Overall analysis shown in table 4.10 indicate that students had a negative attitude towards statistics (mean = 2.4, SD= 1.9) this is consistent with (Ashaari et al., 2011) who found the mean of students responds to attitude towards statistics to be 2. However, Yulco (2012) found the 8th grade students attitude towards statistics to be middling and Ayebo et al (2019) found that student's attitude towards statistics was positive with (mean = 4.58, SD = 1.27). students responds to items in all the four components namely; Affective, Cognitive capability, Value and Difficulty was all negative.

4.10 The Relationship between Students' Statistical Literacy and Their Attitudes towards Statistics

In order to examine the possible relationship between attitudes towards statistics and statistical literacy of SHS students, Pearson Product Moment correlation analysis was employed to test the relationship between students SLT scores and ATS data.

4.11 Assumptions

The assumptions to be assured before conducting analysis were level of measurement, related pairs, independence of observations, normality, linearity, and homoscedasticity (Pallant, 2007). The variables for correlational analysis were mean scores for attitudes towards statistics and mean scores for statistical literacy which were continuous variables. Hence, level of measurement assumption was assured. the measurements were independent from each other; therefore, there was no violation of this assumption. In correlational analysis, mean scores for each variables should be normally distributed (Pallant, 2007). In order to check normality of attitude towards statistics and statistical literacy scores, skewness and kurtosis values were examined.

Table 4.11: Skewness and Kurtosis Values of ATSQ and SLT

Mean Scores	N	Skewness	Kurtosis
ATS	180	-0.33	-0.11
SLT	180	0.22	-0.25

Table 4.11 indicated that skewness and kurtosis values for both variables were placed in the acceptable range. In addition, the sample sizes for each variable were quite large. Therefore, normality of distribution assumption was assured for Attitude Towards Statistics scores and Statistical Literacy Test scores.

Another assumption in correlational studies was linearity which referred that the relationship between variables should be linear (Pallant, 2007). In order to examine the linearity between variables scatterplot for Attitude Towards Statistics mean scores and Statistical Literacy Test mean scores.

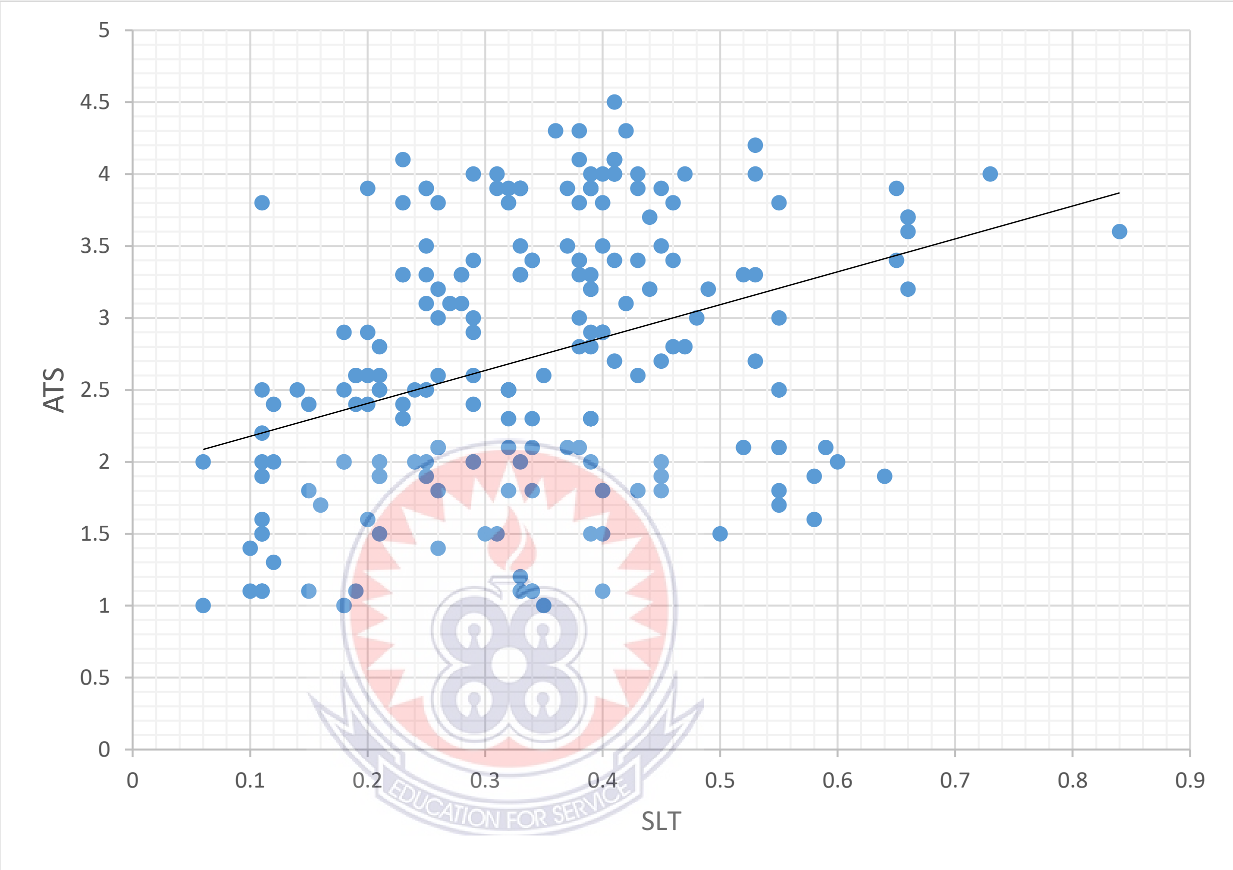


Figure 4.3: Scatterplot of ATSQ Mean Scores and SLT Mean Scores

From figure 4.3, there was a linear drawn in the scatterplot which indicated the linear relationship between these two variables. Hence, linearity assumption was ensured. The direction of this relationship was positive. Specifically, those who had higher mean scores on SLT had more positive attitude towards statistics. Regarding the slope of the line, it could be inferred that the relationship between Attitude Towards Statistics mean scores and Statistical Literacy Test mean scores were almost moderate.

4.12 Correlation Analysis

The relationship between attitudes towards statistics (as measured by the ATS) and statistical literacy (as measured by SLT) was investigated through the Pearson product-moment correlation coefficient. Table 4.9 shows the Pearson correlation analysis for the two variables.

Table 4.11: Pearson correlation output using SPSS

		SLT	ATS
SLT	Pearson Correlation	1	0.432**
	Sig. (2-tailed)		0.000
	N	180	180
ATS	Pearson Correlation	0.432**	1
	Sig. (2-tailed)	0.000	
	N	180	180

***. Correlation is significant at the 0.05 level (2-tailed).*

A Pearson product-moment correlation was run to determine the relationship between students' attitude towards statistics and their statistical literacy test scores. The data showed no violation of normality, linearity or homoscedasticity. There was a positive correlation between the two variables which was statistically significant ($r = 0.432$, $n = 180$, $p<0.001$).

Therefore, the null hypothesis is rejected at $\alpha = 0.05$ level and we conclude that there exist a positive relationship between students attitude towards statistics and their performance in statistical literacy test. This is in line with (Kakraba, Morkle, & Adu,

2011) who found that the correlation between students' perception of mathematics and their achievement in mathematics was found to 0.997. Which indicated a strong positive relationship between perception and achievement. Mathematics teachers are recommended and encouraged to teach statistics in such a way that will stimulate students' interests, and also assist the students to become more competent in statistics and achieve a much higher level of statistical literacy.

4.13 Discussion of Results

The purpose of this study was to analyze the statistical literacy of Senior High School students, attitude towards statistics and their relationship. Four research questions were used and the results are as follows.

4.14 SHS Students Statistical Literacy

The first research question was, what is the statistical literacy level of Kade SHTS students. The results of this study showed that, the mean score of the 180 selected students was 36.59% with a standard deviation of 15.47. The highest score obtained was (84%) out of (100%) marks and the lowest score was (6%). None of the students got all the questions correct. If the pass mark was set at 40%, only 37.78% of the students passed the statistical Literacy test. The low mean percentage test score (36.59%) and the low passing rate (37.78%). Also Analysis according to Watson's three tiered statistical literacy model showed that Tier 1 had a higher score (Mean =75, SD = 2.5) compared to tier 2 (Mean =21, SD = 5.4) and tier three (Mean = 9, SD = 3.6). this shows that students of Kade SHTS showed strength in this tier which comprises understanding the terminology of statistics without considering the context according to Watson cited in (Yulco,2012). This terminology includes specific concepts in the curriculum such as sampling, average, graphing, random, and variation. This tier also involves calculation of measures of central tendency or measure of spread without any reference to the social issues in the daily lives of students. the respondents of this study have performed relatively higher in the first tier of statistical literacy compared to other tiers which was in line with the previous research conducted with statistical literacy (Watson and Callingham, 2003).

Students' higher performance in the first tier of statistical literacy was an expected result due to the fact that majority of mathematics and statistics teachers teach definition of terms and how to do computations without relating it to real life situations or statistical concepts been contextualized around the ability of application or interpretation of statistics which refers Tier 2 in this study. Students however performed poorly in the second and third tier which is contextualization of terminology including statistical language and concepts, requires students to read reports of statistics and interpret them, rather than only performing the statistical computations and contextualization of terminology including statistical language and concepts which requires students to read reports of statistics and interpret them, rather than only performing the statistical computations and the important aspect of statistical literacy which require students to develop intelligent questions for data and related claims instead of believing everything they read in the media Watson cited in (Yulco,2012). This is consistent with Watson and Kelly (2008) who investigated students' understanding and related definitions of the terminology of statistical literacy across grades which indicated that the majority of students performed well either in the lowest level or one level higher which involved idiosyncratic responses and one single related idea respectively. At this point, Watson and Kelly's (2008) results supported the findings.

Teachers' knowledge and experience of taking critical positions towards data may have an influence on students' poor performance in the third tier of statistical literacy (Chick and Pierce, 2011; Watson, 2006). Since mathematics teachers' knowledge for teaching statistics has a strong influence on students' achievement, the low performance on statistical literacy of Kade SHTS students might be derived from the knowledge required for teaching statistics concepts. The relatively lower performance on third tier statistical literacy might also be originated from teachers' affect including beliefs and attitudes regarding both statistics and statistical literacy. Since teachers' beliefs do have an influence on the practices of teachers during teaching statistics (Pierce and Chick, 2011) and their attitudes towards statistics play an important role on development of statistical outcomes (Estrada, Batanero and Lancaster, 2011), it is crucial to remark that teachers' affect might have an influence on students' ability of evaluating statistical descriptions appear in everyday life or media often involve bias or lack of objectivity. The results of this study clarified that final year students of Kade SHTS statistical literacy is low this is consistent with Yulco (2012) who found that a low statistical literacy level with students in elementary school.

Although GES Mathematics syllabus at all levels contain data handlings for developing informed citizens who possess knowledge of statistical concepts to deal with existing statistical resources in society is vital, students who were taught by this curriculum performed poorly in statistical literacy. This result could be regarded as critical since statistical literacy does play an important role in society and building active and critical citizenship through informed contribution to the debates ranged from politics to environment.

The analysis of the mean scores of statistical literacy in terms of content areas (Sample, Graph, Central measures, spread and chance) revealed that there were variations between these content domains. Students performed better while implementing ideas of sample and evaluating statistical reports in sampling context. Although students have the ability to evaluate statistical claims related to sampling, they performed poorly in defining sample as a statistical terminology. This result is consistent with previous research done by Watson and Moritz (2000) where they indicated that students, who could not give related statistical ideas for definition of sample, were able to question claims in the sampling context. Hence, it could be inferred that the current curriculum contributes applying and evaluating ideas related to sampling more than it contributes to defining statistical terminology. Understanding average as "add them up and divide" algorithm was the most frequent response provided by students which is a consistent result with a research conducted with Turkish students where students have understood average as the arithmetic mean (Toluk-Uçar and Akdoğan, 2009). Also, most of them did not take median and mode into account as other ways of finding average of a given data set. In addition, only less than half of the participants were able to interpret average in context, which might be derived from students' procedural understanding of average concept. Similarly, their performance in evaluation of a statistical claim involving average as a representative value were poor as they could not recognize extreme values or explained this claim by providing evidence through arithmetic mean. In a relevant study which examined students' conceptions of average, it was found that students did not consider average as a representative value for the given data set (Mokros and Russell, 1995), which is similar to the findings for this study.

The lack of understanding average as a summarizing or representative value for students in this study might be related to the elementary mathematics curriculum. In Turkish curriculum average concept is represented through measures of central tendency which are mean, median and mode. Therefore, students might conceptualize average concepts through mean. Additionally, although average concept is instructed each year in line with the spiral nature of curriculum, students begin to learn average through arithmetic mean which may result in understanding average as "add them up and divide" algorithm. In addition, while teaching average concept, teachers may not focus on its characteristics of representative value of a data set; instead they may devote majority of instructional time for computational skills.

Another content domain of statistical literacy was graphs concept. The analysis of items related to graphs concept indicated that majority of participants performed better while interpreting graphical representations compared to their ability to evaluate misleading bar graphs in which only half of the students correctly explained their evaluations of statistical report. Aoyama and Stephens (2003) indicated that students did not have sufficient knowledge and experience for evaluating graphs whereas they correctly could read graphs which was not considered as critical. As seen, students performed relatively higher in the graphs concept than other content domains which might be derived from mathematics curriculum where the graph concept appears in the curriculum from Primary to SHTS. Therefore, students' capability of reading graphs was an expected result. However, although there is an objective considering critical evaluation of misleading graphs, half of the students failed to critically evaluate bar graphs in Statistical Literacy Test and they performed poorly in choosing appropriate graphical representations which was demanded by the first tier of statistical literacy. The reason for this result could be explained by findings in the Ghanaian context which indicated that teachers did not cover all of the objectives regarding graph concepts and caused errors and misconceptions about graphs.

Majority of participants performed well in items related to chance content; though they failed to ask questions for a statistical report in chance context. Chance or probability has been one of the oldest topics in Mathematics Curriculum and accordingly it is expected that teachers have the required knowledge and experience with understanding and application of these concepts. In addition, there are objectives regarding understanding randomness and interpreting chance in context in the national curriculum. However, since objectives regarding the critical evaluation of statistical claims in chance context do not exist in the curriculum and teachers may not allocate time for evaluation of chance related claims during instruction, students might perform poorly in third tier of chance content.

The different performances of students were also observed while they were doing inference based on statistics. Majority of students were able to make predictions based on data and explain their predictions, whereas most of them had failed to evaluate critically an inference without appropriate statistical foundation. This result is closely connected to the Mathematics Curriculum where there is an objective considering predictions based on data set while critical evaluation of inferences are not placed in the curriculum like in other content domains.

Similar to the other content domains, the performances of students in the second tier of variation are relatively higher than the first and third tier of statistical literacy, which could be attributed to objectives in the curriculum and statistics instruction in schools.

Almost one third of the students explained the meaning of variation through the measure of spread range, which was the easiest to calculate. Similar to the explanations of average, these responses might be originated from the procedural understanding of statistics and particularly the variation concept. Likewise, in the curriculum variation concept is represented through measures of spread which are standard deviation, range and interquartile range. Therefore, students might conceptualize variation concepts through range. Although majority of participants interpreted variation in context, their responses to items contextualized in the first and third tier addressed more variation where the data set consisted of the same numbers. This response might be regarded as a sign of possible misconception about variation concept of the students.

4.15 Difference in SLT scores by program of study

The second research question was, Is there a significant Mean difference in students' statistical literacy test scores with respect to programme of study? The results of this study showed that the mean score for Science students was 44.03%, Arts 34.7% and Vocational 34.7%. A one way ANOVA revealed that there was a significant mean difference in at least two groups with $p = 0.02$ this showed that students pursuing Science programmes performed better in statistical literacy test than students of Ats and Vocational programmes. This may be due to the fact that, science programmes involve a lot more mathematical approaches which exposes students' to everyday mathematics, as a result the mean score was higher. This is consistent with (Griffith et al., 2012) who's findings provided evidence that students performance in statistics differ with regard to program of study. They found that students doing Business courses performed better in statistics than those in the Arts courses.

4.16 Attitude Towards Statistics

The third research question was What is the attitude of SHS students towards the teaching and learning of statistics? Students attitudes towards statistics were measured through Attitude towards Statistics Questionnaire (ATSQ) and the descriptive analysis of this showed that 51% of the students responded negatively, 20% were neutral and 29% responded positively to the questionnaire indicating that SHS students had negative attitudes towards statistics while the mean value was close to neutral. Several studies have documented that the attitudes towards statistics ranged between negative to neutral in the context of pre-college students (e.g. Calderia and Mourino, 2010; Yingkang and Yoong, 2007).

However, Yuco (2012) found that Eighth grade students' attitudes towards statistics were positive with a mean score of 3.52 in five point scale. Negative attitude regarding statistics was mostly demonstrated in items under the affective and value components. As the affective component assesses the student's feeling towards the subject, the results have shown that the students feel quite intimidated, afraid and stressed in solving problems concerning statistics and in undergoing course. Value, on the other hand, assesses the significance of learning statistics course for the students. Students were found to be quite uncertain about the usage, relevance and advantages of statistics as well as their future professional life. They feel that this course is not relevant for their field of study, as well as for their future career, thus demonstrated some negative attitude towards the subject. This discovery is in line with the finding in previous researches by Kennedy and McCallister (2001) and Mills (2004).

To make this course enjoyable, not frustrating, less frightening and more effective for the students, attention from the academic staff on students' perspectives and attitude towards the experience in learning statistics is vital. Lecturers need to be aware of how students show changes in behaviours according to the learning experience and the effect from their achievement, efforts to improve their knowledge, and attempts in applying the knowledge and skills of statistics in their daily life. Future research should be carried out to produce a suitable approach for the academic staff to balance the student's attitude and perception towards this course. To encourage students to learn and use statistics, lecturers need to do their utmost to make teaching and learning more interesting and to relate the concept that they are teaching with student's daily life and field of study.

4.17 Association Between Attitude Towards Statistics and performance in Statistical Literacy Test

The forth research question was What is the relationship between students' performance in SLT and their attitudes towards statistics? The results considering the relationship between students' statistical literacy and their attitudes towards statistics revealed that there was a significant positive relationship between students' statistical literacy and their attitudes towards statistics. These findings are consistent and supported by other researches who found a direct relationship of attitude and performance of students in statistics (Chiesi and Primi, 2010; Dempster, 2009; Diri, 2007) . The findings of this study revealed that students with relatively higher attitudes towards statistics tended to perform higher on statistical literacy test. Yulco (2012), found a positive relationship between 8^{th} grade students attitude towards statistics and their performance in the literacy test. Therefore, in the present study, students' attitudes towards statistics do play a significant role on their statistical literacy. These findings are consistent and supported by other researches who found a direct relationship of attitude and academic performance of students (Amrai et al., 2011; Kazami, et al., 2013; Newton and Mwisukha, 2009; Veresova and Mala, 2016; Pajares and Miller, 1994). Also, the study of Amrai (2011) showed that the subscale effort had a significant relationship with academic achievement. This means that the more effort employed by the students in the course the higher their grade, thus, resulted to a better academic achievement toward the course. On the other hand, the results of the current study is contrary to the findings of Kinniard (2010), that there is no significant relationship on the attitude of the student to their academic achievement. Also, Li (2010) found out that effort failed to predict academic achievement.

Nevertheless, it is suggested that all educators should give much effort on the students' attitude towards the course as this would propel them to achieve higher in the learning process. The second assessment, Attitudes Toward Statistics (ATS) scale developed by Wise (1985) which had two subscales consisting of the attitude toward the field of statistics and the attitude toward the course. The ATS was created in an effort to improve on the SAS by focusing on items measuring attitudes, rather than student success. The most recent assessment instrument is the Survey of Attitudes Toward Statistics scale (SATS-28; Schau, 1992; Schau, Stevens, Dauphinee, and Del Vecchio, 1995) which initially reported four subscales consisting of affect, cognitive competence, value, and difficulty. The scale was later expanded to include two more dimensions of effort and interest (SATS-36; Schau, 2003). Both versions of the SATS have solid theoretical underpinnings as they are based on a number of popular theories including expectancy value, attribution, social cognition, and goal theories (e.g., Atkinson, 1957; Bandura, 1977; Weiner, 1979).

All of the scales have made valuable contributions in providing a better understanding of students' attitudes toward statistics. The development and use of these inventories have mostly used quantitative methodologies Sophisticated models have been tested in an effort to explain the relationships between attitudes, skills, and performance (e.g., Harlow, Burkholder, and Morrow, 2002; Tempelaar, Van Der Loeff, and Gijselaers, 2007). Despite years of study on attitudes toward statistics, the domains of those attitudes are not yet fully understood and some of those domains may have changed over time because of the evolving modalities of course delivery. For example, the use of technology (e.g., statistical programs such as SPSS and SAS) may have been emphasized more over time, and hand calculations using formulas and tables to interpret significant findings may be used less frequently. Furthermore, some statistics classes are now offered online. These are just two factors that might be important in assessing student attitudes toward statistics because of the increasing reliance on technology in teaching the course.

Thus, perhaps some dimension of technology as related to a statistics course may be worth examining. Another approach to studying attitudes is to incorporate both qualitative and quantitative methodologies in the same design. A mixed-methods research design was used for this study in order to describe the attitudes from the perspective of the student using a qualitative approach along with a series of chi-square tests to examine relationships between attitudes and major.

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

The preceding chapter has presented the results of the of students test scores in basic statistics and their attitude towards statistics. This chapter highlights the main findings of the study and the overall study conclusions and implications of the study findings. It also provides concrete recommendations on what needs to be done based on the identified low performance of final year students of Kade SHTS, Kade in the Eastern Region.

5.1 Summary of Results

Based on descriptive and inferential analysis, it could be inferred that students in this study performed lower than average in statistical literacy. A low mean percentage test score (36.59%) and the low passing rate (37.78%) showed that the level of students' statistical literacy was below average. The analysis of the mean scores of statistical literacy in terms of Watson's three tier statistical literacy framework shows that students statistical literacy is at the first tier with (Mean =75, SD = 2.5). Which involves definition of terms and basic calculation and performed in poorly in the second and third terms.

The results of this study in terms of Programme of study indicated that students pursuing Science programmes performed better in statistical literacy test than students of Vocational and Arts programmes. This may be due to the fact that, science programmes involve a lot more mathematical approaches which exposes students' to everyday mathematics, as a result the mean score was higher. Also, students' attitudes towards statistics was generally low thus students in this study had negative attitudes towards statistics. This coincides with (Umar, Adamu, & Sadiq, 2014) who found that students' negative attitude toward mathematics, anxiety and fear is the main causes of poor performance in mathematics among public senior secondary school students. The correlation analysis indicated that there were positive and significant relationship between students' attitudes towards statistics and statistical literacy scores. This meant that higher levels of SHS students' attitudes towards statistics were associated with higher levels of their statistical literacy scores.

5.2 Conclusions

The findings of this study revealed that final year SHTS students of Kade SHTS had performed relatively low in statistical literacy. Based on Watson's three-tiered model students in this study showed strength in tier 1, the skills in this tier include the understanding the terminology of statistics without considering the context (Watson, 1997). This terminology includes specific concepts in the curriculum such as sampling, average, graphing, random, and variation. This tier also involves calculation of measures of central tendency or measure of spread without any reference to the social issues in the daily lives of students.

However students performed poorly in the second and third tier questions where they were required to critically evaluate statistical claims. This result is consistent with previous research conducted with middle school students on statistical literacy where majority of students were placed between informal and consistent-noncritical levels while very small percentage of students were in the critical and critical mathematical level (Watson and Callingham, 2003). As stated before, the objectives considering evaluation of statistical claims, which refers third tier, are limited in number in the

Mathematics Curriculum whereas objectives regarding understanding and interpreting statistics, which are first and second tier, respectively are relatively more. For example, there is only one objective targeting students' evaluation of statistical claims, messages, or representations in graphs concept. therefore, the school curriculum should aim at developing statistical literacy within statistics and probability content area in each level of education.

Furthermore, curriculum objectives should be modified in support for statistical literacy, therefore, curriculum makers or planners should identify and include objectives regarding critical evaluation and questioning of statistical claims to promote the development of statistical literacy within Basic and Senior High Schools. For instance, evaluation of arithmetic mean as a representative value or evaluation of a given sample in terms of generalization to a particular population should take place as objectives in the curriculum so that there would be the possibility of instruction those objectives.

Teachers' knowledge and experience of taking critical positions towards data may have an influence on students' poor performance in the third tier of statistical literacy (Chick and Pierce, 2011; Watson, 2006). Since mathematics teachers' knowledge for teaching statistics has a strong influence on students' achievement, the low performance on statistical literacy of students might be derived from the knowledge required for teaching statistics concepts. The relatively lower performance on third tier statistical literacy might also be originated from teachers' affect including beliefs and attitudes regarding both statistics and statistical literacy. Since teachers' beliefs do have an influence on the practices of teachers during teaching statistics (Pierce and Chick, 2011) and their attitudes towards statistics play an important role on development of statistical outcomes (Estrada, Batanero and Lancaster, 2011), it is crucial to remark that teachers' affect might have an influence on students' ability of evaluating statistical descriptions appear in everyday life or media often involve bias or lack of objectivity.

therefore, the school curriculum should aim at developing statistical literacy within statistics and probability content area in each level of education. Furthermore, curriculum objectives should be modified in support for statistical literacy, therefore, curriculum makers or planners should identify and include objectives regarding critical evaluation and questioning of statistical claims to promote the development of statistical literacy within Basic and Senior High Schools. For instance, evaluation of arithmetic mean as a representative value or evaluation of a given sample in terms of generalization to a particular population should take place as objectives in the curriculum so that there would be the possibility of instruction those objectives.

Since statistics is regarded as a methodological discipline distinct from mathematics (delMas cited in Yulco, 2012), teacher education programs should include courses related to specific teaching methods of statistics. The inclusion of such kind of courses would not only develop statistics instruction in terms of teachers' content and pedagogical content knowledge for teaching statistics, but also might have an influence on teachers' attitudes and beliefs about statistics and statistics teaching and learning. In other words, both in-service and pre-service teacher education should focus on development of statistical literacy and learning to teach statistical literacy within elementary schools.

The most notable finding regarding statistical literacy of SHTS students in terms of content domains was explanations of average and variation contents through measures of central tendency and spread. This indicated that students' conceptions were mainly procedural in these domains. In the Mathematics Curriculums, the meaning of these concepts should be clearly presented in addition to measures of central tendency and spread. Likewise, while teaching these subjects, the meaning of these subjects should be emphasized at first before introducing measurements. After students understand the meaning of statistical meaning of these concepts and reasoning behind them, the measures such as mean or standard deviation should be instructed. In addition, incorporating more contextual examples would probably provide students with a clear understanding of the meanings of these terms.

The results also indicate that students offering science courses performed better in statistical literacy than students offering Arts and vocational programmes, this could be attributed to the fact that, students pursuing science courses are exposed to more mathematical approaches than those in Vocational and Arts respectively. Teachers must be aware of this fact and concentrate more on the Arts students.

In this study, results considering final year SHS students' attitudes towards statistics revealed that their attitudes ranged between negative to neutral. To make this course enjoyable, not frustrating, less frightening and more effective for the students, attention from the academic staff on students' perspectives and attitude towards the experience in learning statistics is vital. teachers need to be aware of how students show changes in behaviours according to the learning experience and the effect from their achievement, efforts to improve their knowledge, and attempts in applying the knowledge and skills of statistics in their daily life. Since constructivist learning environments do play role on building positive orientations towards statistics (Cobb and Hodge, 2002), the classroom activities, regarding statistics concepts, should be arranged accordingly. In other words, classroom activities should not merely focus on procedural skills based on memorization; rather the focus of those activities should make students as doers of statistics. In addition, since technological tools such as statistics software (e.g. Dogan cited in Yulco, 2012) or video recordings had positive impact on attitudes towards statistics in the context of university students, these technological tools might be utilized in the instruction of statistics in SHS as well.

The results considering the relationship between students' statistical literacy and their attitudes towards statistics revealed that there was a significant positive relationship between students' statistical literacy and their attitudes towards statistics. Several perspectives could be found in the literature indicating that dispositional aspects of statistics instruction, such as attitudes and beliefs or task motivation, do play an important role in statistical literacy and these perspectives included dispositions into their statistical literacy models or frameworks (Gal 2004; Watson, 2006). Several studies have investigated the relationship between the attitudes towards statistics and statistical outcomes indicating a positive relationship (Chiesi and Primi, 2010; Dempster, 2009; Diri, 2007) which is in line with the current study conducted with SHTS students. The findings of this study revealed that students with relatively higher attitudes towards statistics tended to perform higher on statistical literacy test. Nonetheless, it is essential to emphasize that although there is a significant positive relationship between students' attitudes towards statistics and their statistical literacy, the relationship is strong. This result might be related to the nature of statistical knowledge needed for statistical literacy.

To be more precise, due to the fact that statistical literacy is regarded as a bridge between everyday life and statistical concepts (Watson, 2006), students might use informal statistical knowledge for their performance on statistical literacy depending on context. In addition, another study with undergraduate students revealed that weak or insignificant relationships between dimensions of attitudes towards statistics and statistical reasoning are derived from the nature of knowledge for statistical reasoning which was naïve knowledge when formal statistical knowledge had been forgotten by students (Tempelaar, Loeff, and Gijsealers, 2007). Furthermore, the items in the attitude questionnaire are stated through the word "statistics". These items might be confused students since they did not have a full understanding of what statistics was. Indeed, statistics in school mathematics might be instructed through statistical concepts such as sample or average without indicating these topics are within the scope of statistics and what statistics referred to as a concept. Therefore, in the present study, students' attitudes towards statistics built in mathematics classroom do play small but still significant role on their statistical literacy since students' performance of statistical literacy is both related to their informal knowledge of statistics and their image regarding statistics in their minds.

5.3 Recommendations

From the summary of the major findings of this study, it is recommended that:

- Professional development and training should be organized for teachers on how to effectively teach statistics and incorporate it into their lessons can be beneficial in improving statistical literacy in schools. This can help ensure that mathematics teachers feel confident and competent in teaching statistical concepts to their students. they would have adequate knowledge in statistics so as to employ appropriate instructional methods to develop students' statistical literacy.

- The mathematics curriculum of all levels of education should aim at developing statistical literacy within statistics and probability content area in each level of education. Data analysis and interpretation should be incorporated into the curriculum across different subjects, such as mathematics and science, and social studies. This could involve teaching students how to collect data, analyze it using statistical techniques, and draw conclusions based on the data.
- Use technology: teachers should incorporate statistical software, apps, and online tools into the classroom to make it easier for students to perform data analysis and visualization. This can help demystify statistics and make it more accessible to students. Also, educators must have an intervention or other enhancement methods to eliminate difficulties experienced by the students in statistics. Creating interactive graphs and tables through statistical software must also be introduced and demonstrated to the students for them to develop their statistical analysis towards the course and in order to eliminate negative attitudes towards the course
- Incorporate critical thinking: Teaches should teach students to critically evaluate statistical information presented in the media and in everyday life. This can help them develop a healthy skepticism and better understand how statistics can be manipulated or misrepresented.
- Hands-on activities: Engage students in hands-on, interactive activities that involve collecting and analyzing data. This could include conducting surveys, experiments, or simulations that require students to apply statistical principles in a practical way.
- Make connections to other subjects: teachers should show students how statistics are used in different disciplines, such as economics, psychology, and

environmental science. By making connections to other subjects, students can see the relevance and applicability of statistics in a variety of contexts.

- Mathematics teachers should pay more attention to helping students offering Arts related programmes, since most of them have problems in statistics.
- Teachers must also focus on development of positive attitudes towards statistics among students, knowing that positive attitude have positive association with performance.

5.4 Suggestions for further studies

The following are recommended for further research:

- The generalization of results were limited with accessible population, therefore, the same research might be replicated nationwide with broadened sample which is a representative of all Ghana Senior High School students. In addition, cross sectional surveys can be done where these constructs are examined with respect to grade level and gender with minor modifications in the instruments so that how statistical literacy and attitudes towards statistics alter with respect to those variables become clearer. In addition, cross sectional surveys can be done with respect to various SHS programmes and gender to reveal how statistical literacy and attitudes towards statistics change with respect to those variables become clearer.
- The changes in students' statistical literacy and attitudes towards statistics might also be investigated in a longitudinal study since same students may give a better idea about the changes in conceptions of statistical literacy and attitudes towards statistics. Findings of such longitudinal studies provide detailed information in relation to objectives in the mathematics curriculum.

- Though this research provided an examination of each content domain of statistical literacy, it is still limited with the instrument used. More research is necessary to be conducted on these specific contents such as sample or variation so that detailed examination of them would be possible. For example, typical errors and misconceptions might be investigated and statistics instruction in schools.
- Several intervention studies might be conducted to provide a cause-effect relationship with statistical literacy. The research considering effect of technological tools on both statistical literacy and attitudes towards statistics was scarce in the middle school context. The findings of experimental studies in the context of tertiary students might not always be informative for the middle school context. Therefore, investigating the effect of technological tools such as statistics software or calculators on statistical literacy and on attitudes towards statistics could provide a substantial contribution to the field of statistics education in the middle school context. Similarly, examining the effects of several teaching approaches on these constructs will provide wealthier information regarding how to develop statistical literacy and positive orientations toward statistics.
- Additionally, analysis of statistics instruction and teacher practices while teaching statistics in each level of education, would also be beneficial since there might be differences in the instruction of different contents in elementary mathematics in different level.
- Future research is required in the examination of student and teacher related variables in the context of statistical literacy through statistical modeling

approaches. so, it might be possible to understand which teacher and student related variables and to what extent these variables contribute to the statistical literacy of SHTS students.

- In addition to this, the affective domain that is related to statistical literacy is limited with this questionnaire. The reason for the small size of relationship between attitudes towards statistics and statistical literacy was explained that students might not have an idea of what statistics is in their minds. As a suggestion, more attitude instruments should be developed that have specific contextualization. That the relationship between statistical literacy and affective domain would become clearer.
- Examining the knowledge and attitudes towards statistics among different professional fields and how they impact decision-making processes.
- The instruments of this study should be modified to examine university students from non-quantitative majors or adults to examine their statistical literacy which is required for active and critical citizenship.
- Further qualitative research might be conducted for an in-depth examination of both statistical literacy and attitudes towards statistics through observations during statistics instruction and interviews. Therefore, it would be possible to understand how students evaluate statistical claims in a critical way and how their responses differ in relation to their attitudes towards statistics. Additionally, the two approaches including quantitative and qualitative methods might be utilized as a research design for the purpose of validation of students' responses.

- Developing and testing new assessment tools to measure statistical literacy accurately and reliably. And to investigate the effectiveness of different teaching methods and interventions in improving statistical literacy skills.
- Exploring the role of technology in enhancing statistical literacy, such as the use of data visualization tools and interactive learning platforms.

REFERENCES

Aksu, M. andBikos, L. (2002). Measuring and predicting graduate students' attitudes toward statistics. Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 23, 22-31

Akpınar, E, Eylem Yıldız, E., Tatar, N, and Ergin, O. (2009). Students' attitudes toward science and technology: an investigation of gender, grade level, and academic achievement. Elsevier Procedia Social and Behavioral Sciences, 2804–2808. Retrieved from http://www.sciencedirect.com

Australian Bureau of Statistics . (2012). *Statistical Literacy*. Retrieved on 26th June, 2016 from http://www.abs.gov.au/websitedb/download+Statistical_Literacy_Paper.pdf

Aoyama, K., and Stephens, M. (2003). Graph Interpretation Aspect of Statistical Literacy: A Japanese Perspective. Mathematics Education Reseacrh Journal , 15 (3), 207-225.

Amrai, K., Motlagh, S.E., Zalani, H.A and Parhon, H. (2011). The relationship between academic motivation and academic achievement students. Elsevier Procedia Social and Behavioral Sciences, 399-402. doi:10.1016/j.sbspro.2011.03.111. Retrieved from http://www.sciencedirect.com

Armah, G., and Asiedu-Addo, S. (2014). Ghanaian Students' Knowledge Of Averages After Senior High Education. *Researchjournali's Journal Of Mathematics*, 5–25. https//www.researchjournali.com%2Fpdf%2F1022.pdf&clen=444738&chunk=tru

Arthur, Y., Asiedu-Addo, S., and Assuah, C. (2017). Students' Perception and Its Impact on Ghanaian Students' Interest in Mathematics: Multivariate Statistical Analytical Approach. *Asian Research Journal of Mathematics*, *4*(2), 1–12. https://doi.org/10.9734/arjom/2017/33023

Ashaari, N. S., Judi, H. M., Mohamed, H., Tengku, & Wook, M. T. (2011). Student's Attitude towards Statistics Course. Procedia - Social and Behavioral Sciences, 18, 287–294. https://doi.org/10.1016/j.sbspro.2011.05.041

Ariati, C., & Juandi, D. (2022). Kemampuan Penalaran Matematis: Systematic Literature Review. LEMMA: Letters Of Mathematics Education, 8(2), 61–75.

Atkinson, J. W. (1957). Motivational determinants of risk-taking behaviors. Psychological Review, 64(6), 359–372.

Australian Bureau of Statistics . (2012). *Statistical Literacy*. Retrieved on 26th June, 2016 from http://www.abs.gov.au/websitedbs/CaSHome.nsf/home/downloadable+files.es /file/Statistical_Literacy_Paper.pdf

Awanta, E. (2009). Students' Views On Mathematics: A Survey Of Junior And Senior High Schools In The Ashanti And Brong Ahafo Regions. *Ghana Policy Journal*.

Awanta, E. (2000). Helping students overcome mathematics anxiety. *Journal of the Mathematics Association of Ghana*, 12, 58-63.

Ayebo, A., Bright, J., & Ballam, C. (2019, September 27). Examining the Factor Structure of the Survey of Attitudes Towards Statistics among Undergraduate Health Science Students. International Electronic Journal of Mathematics Education, 15(1). https://doi.org/10.29333/iejme/5942

Aziz, A. M., & Rosli, R. (2021). A systematic literature review on developing students' statistical literacy skills. Journal of Physics: Conference Series, 1806(1). https://doi.org/10.1088/1742-6596/1806/1/012102

Baloglu, M. (2004). Statistics anxiety and mathematics anxiety: Some interesting differences. Educational Research Quarterly, 27(3), 38–48. https://files.eric.ed.gov/fulltext/EJ792861.pdf

Baloglu, M., Deniz, M. E., & Kesici, Ş. (2011). A descriptive study of individual and cross-cultural differences in statistics anxiety. Learning and Individual Differences, 21(4), 387–391. https://doi.org/10.1016/j.lindif.2011.03.003

Bandura, A. (1977). Social learning theory. Englewood Cliffs, NJ: Prentice Hall.

Barbieri, G. A., and Giacché, P. (2006). The Worth Of Data: The Tale Of An Experience. *Istat (Statistics Italy), Italy* .

Budgett, S. andPfannkuch, M. (2010). Using media reports to promote statistical literacy for non quantitative majors. In C. Reading (Ed.), Data and context in statistics education: Towards an evidence-based society. Proceedings of the Eighth International Conference on Teaching Statistics (ICOTS8, July, 2010), Ljubljana, Slovenia.Voorburg, The Netherlands: International Statistical Institute. Retrieved from http://www.stat.auckland.ac.nz/~iase/publications/icots8/ICOTS8_7G1_BUDGETT.pd

Batanero, C. (2002). Discussion: The role of models in understanding and improving statistical literacy. International Statistical Review, 70, 37–40.

Barkatsas, T., Gialamas, V., andBechrakis, T. (2009).Investigating the factorial structure and the construct validity of the Survey of Attitudes Toward Statistics

(SATS): A European university study. *Paper presented at the European Conference on Educational Research,* Vienna, Austria

Begg, A., and Pfannkuch , M. (2004). *The School Statistics Curriculum.* Auckland: Auckland Uniservices Ltd of the University of Auckland.

Ben-zvi, D., and Garfield, J. (2004). Research on reasoning about Variability: A Forward. *Statistics Education Journal*, 1-3.

Ben-Zvi, D., & Garfield, J. (2005). *Statistical Literacy, Reasoning, And Thinking: Goals, Definitions, And Challenges.* USA. Retrieved from http://down.cenet.org.cn/upfile/28/2007727193622103.pdf

Biggs, J., & Collis, K. (1982). Evaluating the quality of learning: The SOLO taxonomy. New York, NY: Academic Press.

Birenbaum, M., &Eylath, S. (1994). Who is afraid of statistics? Correlates of statistics anxiety among students of educational sciences. *Educational Research, 36, 93-98.*

Blitzstein, J. (2013). What is the major difference between statistics and math major students? *Quora*, 1-2.

Bond, M. E., Perkins, S. N., & Ramirez, C. (2012). Students' Perceptions of Statistics: An Exploration. *Statistics Education Research Journal,*, 7.

Bright, G. W., & Friel, S. N. (1998). Helping students interpret data. In Lajoie, S. P. (Ed.), Reflections on statistics: Learning, teaching, and assessment in grades K–12 (pp. 63–88). Mahwah, NJ: Erlbaum.

Brown, J., David, I., Moltchanova, E., Seddon, H., & Harlow, J. (2014). Improving statistical literacy at university. In K. Makar, B. de Sousa, & R. Gould (Eds.), Proceedings of the Ninth International Conference on Teaching Statistics: Sustainability in Statistics Education. Voorburg, The Netherlands:

International Association for Statistical Education and the International Statistical Institute. [Online: iase-web.org/Conference_Proceedings.php?p=ICOTS_9_2014]

Budgett, S., & Pfannkuch, M. (2010). Assessing Students' Statistical Literacy. Assessment Methods in Statistical Education: An International Perspective, 103–121. https://doi.org/10.1002/9780470710470.ch9

Calma, J. D., Salvador, I. G. O., & Supan, A. M. (2022). Knowledge and Attitude towards Statistics and Probability of Senior High School Students. *ResearchGate*. https://www.researchgate.net/publication/363520940_Knowledge_and_Attitude_towards_Statistics_and_Probability_of_Senior_High_School_Students

Calderia, S. &Mouriño, H. (2010). Students' opinion on the subjects of statistics and probability in secondary schools of lisbon, Portugal. In C. Reading (Ed.), Data and context in statistics education: Towards an evidence-based society. Proceedings of the Eighth International Conference on Teaching Statistics (ICOTS8, July, 2010), Ljubljana, Slovenia. Voorburg, The Netherlands: International Statistical Institute. Retrieved from http://www.stat.auckland.ac.nz/~iase/publications/icots8/ICOTS8_C116_CALDEIRA.pdf

Callingham, R., & Watson, J. M. (2017). The development of statistical literacy at school. Statistics Education Research Journal, 16(1), 181–201. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85021048290&partnerID=40&md5=95b2b1f4b15f30f0b7af221263be69a1

Callingham, R.A. (1997). Teachers' multimodal functioning in relation to the concept of average. Mathematics Education Research Journal, 9(2), 205-224.

Carel, G., & Juandi, D. (2023). Student Statistical Literacy In Indonesia: Systematic Literature Review. Proceedings International Conference on Education of Suryakancana 2023, 535–543.

Carmichael, C. S. (2010). The Development of Middle School Children's Interest in Statistical Literacy. Unpublished Doctoral Dissertation, University of Tasmania, Tasmania.

Chance, B. L. (2002). Experiences with Authentic Assessment Techniques in an Introductory Statistics Course . *Journal of Statistics Education Volume 10*.

Chick, H., Watson, J., & Pfannkuch, M. (2005). *Transnumerative thinking: finding and telling stories within data.* Wellington: New Zealand council for EDucation Research.

Chick, H., & Pierce, R. (2013). The Statistical Literacy Needed to Interpret School Assessment Data. Mathematics Teacher Education & Development, 15(2), 1–19. http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ1018712 &site =ehostlive%5Cnhttp://search.ebscohost.com/login.aspx?direct=true&db=ehh& AN=94988 608&site=ehost-live

Chiesi, F. &Primi, C.(2010). Cognitive and non-cognitive factors related to students' statistics achievement. Statistics Education Research Journal, 9(1), 6-26.

Cherney, I. D., & Cooney, R. R. (2005). Predicting student performance in a statistics course using the mathematics and statistics perception scale (MPSP). Transactions of the Nebraska Academy of Sciences and Affiliated Societies, 30, 1–8. Chew, P. K. H., & Dillon, D. B. (2014). Statistics anxiety update: Refining the construct and recommendations for a new research agenda.

Perspectives on Psychological Science, 9(2), 196– 208. https://doi.org/10.1177/1745691613518077

Carter, C. S., and Yackel, E. (1989), "A Constructivist Perspective on the Relationship Between Mathematical Beliefs and Emotional Acts," paper presented at the Annual Meeting of the American Educational Research Association, San Francisco (ERIC document ED309076).

Cobb, P., & Hodge, L. (2002).*Learning, identity, and statistical data analysis*: Proceedings of the Sixth International Conference on Teaching Statistics, Cape Town, South Africa. http://www.stat.auckland.ac.nz/~iase/publications/1/2e1_cobb.pdf

Cobb, P., & McClain, K. (2004). Principles of instructional design for supporting the development of students' statistical reasoning. In D. Ben-Zvi & J. B. Garfield (Eds.), The challenge of developing statistical literacy, reasoning, and thinking (pp. 375–395). Dordrecht: Kluwer.

CRDD. (2007). *Teaching Syllabus For Mathematics (Junior High School 1 – 3).* Accra, Ghana: Ministry of Education.

CRDD. (2010). *Teaching Syllabus For Core Mathematics (Senior High School).* Accra: Ghana Education Service.

Cronin, T., Sheppard, J., & de Wildt, G. (2013). Health-seeking behaviour for schistosomiasis: A systematic review of qualitative and quantitative literature. Pan African Medical Journal, 16, 1–9. https://doi.org/10.11604/pamj.2013.16.130.3078

Davidson, J. (2016, July 6). *What is Statistics?* Retrieved from Southern State Community College: http://www.sscc.edu/home/jdavidso/mathadvising/AboutStatistics.html

Dempster, M. (2009).The role of previous experience and attitudes toward statistics in statistics assessment outcomes among undergraduate psychology students.Journal of Statistics Education, 17(2). Retrieved from www.amstat.org/publications/jse/v17n2/dempsterpdf.html

Diri, F. Ü. (2007). İstatistik dersine yönelik tutumların araştırılması meslek yüksek okul örneği. Gazi University, Ankara.

Doyle, P. (2008). *Developing statistical literacy with students and teachers in the secondary mathematics classroom.* Waikato: The University of Waikato .

Donthu, N., Kumar, S., & Pattnaik, D. (2020). Forty-five years of Journal of Business Research: A bibliometric analysis. Journal of Business Research, 109(October 2019), 1– 14. https://doi.org/10.1016/j.jbusres.2019.10.039

Edmonds W.A., Kennedy T.D. Explanatory-Sequential Approach. In: Edmonds W.A., Kennedy T.D., editors. *An Applied Guide to Research Designs: Quantitative, Qualitative, and Mixed Methods.* SAGE Publications, Inc.; Thousand Oaks, CA, USA: 2017. pp. 196–200.

English, L. D. & Watson, J. M. (2015). Statistical literacy in the elementary school: Opportunities for problem posing. In F. Singer, N. Ellerton, & J. Cai (Eds.), Problem posing: From research to effective practice (pp. 241–256). Dordrecht: Springer.

English, L. (2013). Promoting statistical literacy through data modelling in the early school years. In E. J. Chernoff & B. S. Sriraman (Eds.), *Probabilistic thinking: Presenting plural perspectives* (pp. 441–457). New York, NY: Springer.

English, L., & Watson, J. (2016a). Making decisions with data: Are we environmentally friendly? Australian Primary Mathematics Curriculum, 21(2), 3–7.

English, L. D. & Watson, J. M. (2015). Statistical literacy in the elementary school: Opportunities for problem posing. In F. Singer, N. Ellerton, & J. Cai (Eds.), Problem posing: From research to effective practice (pp. 241–256). Dordrecht: Springer.

Enu, J., Osei , A., & Nkum , D. (2015). Factors Influencing Students' Mathematics Performance In Some Selected Colleges Of Education In Ghana. *International Journal of Education Learning and Development*, 5.

Evans, B. (2007). Student attitudes, conceptions and achievement in introductory undergraduate college statistics. The Mathematics Educator, 17(2), 24–30.

Everitt, B. S., & Skrondal, A. (2010). *The Cambridge Dictionary Of Statistics Fourth Edition.* New York: Cambridge University Press.

Fennema, E., and Sherman, J. A. (1976), "Fennema-Sherman Mathematics Attitudes Scales: Instruments Designed to Measure Attitudes Towards the Learning of Mathematics by Females and Males," *Journal for Research in Mathematics Education*, 7,

Farman. (2021). Students ' Mathematical Creative Thinking : A Systematic Literature Review with Bibliometric Analysis. Journal of Mathematics Education, 7(2), 47–58. https://doi.org/10.31327/jme.v7i2.1846

Ferligoj, A. (2015). How to improve statistical literacy? Metodoloski Zvezki, 12(1), 1–10. https://doi.org/10.51936/xcxb9472

Franklin, C., Kader, G., Mewborn, D., Moreno, J., Peck, R., Perry, M., & Schaeffer, R. (2007). Guidelines for assessment and instruction in statistics education. (GAISE) Report: A pre-K-12 curriculum framework. Alexandria, VA: American Statistical Association. Retrieved from http://www.amstat.org/ education/gaise/GAISEPreK

Fraenkel, J., & Wallen, N. (2006). How to Design and Evaluate Research in Education. New York: McGraw-Hill.

Feinberg, L. B., & Halperin, S. (1978). Affective and cognitive correlates of course performance in introductory statistics. Journal of Experimental Education, 46(4), 11–18.

François , K. & van Bendegem, J.P. 2010. Ethical-political aspects of statistical literacy. . In C. Reading (Ed.), Data and context in statistics education: Towards an evidence-based society. Proceedings of the Eighth International Conference on Teaching Statistics (ICOTS8, July, 2010), Ljubljana, Slovenia. Voorburg, The Netherlands: International Statistical Institute Retrieved from http://www.stat.auckland.ac.nz/~iase/publications/icots8/ICOTS8_C258_FRANCOIS.pdf

Gal, I. (2000). *Adult Numeracy Development: Theory, Research, Practice.* Cresskill, New Jersey: Hampton Press.

Gal, I. (2002). Adults' Statistical Literacy: Meanings,Components, Responsibilities . *International Statistical Review*, 1-5.

Gal, I., Ginsburg, L., & Schau, C. (1997). Monitoring Attitudes and Beliefs in Statistics Education. In I. Gal, & J. Garfield (Eds.), The assessment challenge in statistics education (pp. 37-51). Amsterdam: IOS Press.

Gal, I., Rothschild, K., & Wagner, D. A. (1990). Statistical concepts and statistical reasoning in school children: Convergence or divergence. Paper presented at the annual meeting of the American Educational Research Association, Boston, MA

Gal, I. (2004). Statistical Literacy: Meanings, Components, Responsibilities. In D. Ben-Zvi, & J. Garfield, The challenge of developing statistical literacy, reasoning and thinking (pp. 47-78). Dordrecht: Kluwer Academic Publishers.

Garfield, J., & Ben-Zvi, D. (2004). Research on statistical literacy, reasoning, and thinking: issues, challenges, and implications. In D. Ben-Zvi & J. Garfield (Eds.), *The challenge of developing statistical literacy, reasoning, and thinking* (pp. 397409). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Garfield, J., & Ben-Zvi, D. (2009). Helping students develop statistical reasoning: Implementing a statistical reasoning learning environment. *Teaching Statistics*, *31*(30), 72–77. doi: 10.1111/j.1467-9639.2009.00363.x

Garfield, J. B. (1994). Beyond Testing and Grading: Using Assessment To Improve Student Learning. *Journal of Statistics*, 2.

Garfield, J. B., & Iddo, G. (2000). Teaching and Assessing Statistical Reasoning. *NCTM Year Book*.

Graham, A. (2006). Developing thinking in statistics London: Paul Chapman Publishing.

Griffith, J. F., Adams, L. T., Gu, L. L., Hart, C. L., & Nichols-Whitehead, P. (2012). Students' Attitudes Toward Statistics Across The Disciplines: A Mixed-Methods Approach. *Statistics Education Research Journal*, *11*(2), 45–56. https://doi.org/10.52041/serj.v11i2.328

Gaur, A. S., & Gaur , S. (2009). *Statistical Methods for Practice and Research; A Guide to Data Analysis Using SPSS.* Auckland: SAGE Publications.

Gonda, D., Pavlovičová, G., Ďuriš, V., & Tirpáková, A. (2022). Implementation of Pedagogical Research into Statistical Courses to Develop Students' Statistical Literacy. Mathematics, 10(11). https://doi.org/10.3390/math10111793

Gould, R. (2017). Data literacy is statistical literacy. Statistics Education Research Journal, 16(1), 22- 25. https://iase-web.org/documents/SERJ/SERJ16(1)_Gould.pdf

Gómez-Blancarte, A. L., Chávez, R. R., & Aguilar, R. D. C. (2021). A Survey Of The Teaching Of Statistical Literacy, Reasoning And Thinking: Teachers' Classroom Practice In Mexican High School Education. Statistics Education Research Journal, 20(2). https://doi.org/10.52041/SERJ.V20I2.397

Head, B.W. (2008). Three Lenses of Evidence-Based Policy *The Australian Journal of Public Administration*, Vol 67, no. 1, pp1-11.

Hafiyusholeh, M., Budayasa, K., & Siswono, T. Y. E. (2018). Statistical Literacy: high school students in reading, interpreting and presenting data. *Journal of Physics. Conference Series*, *947*, 012036. https://doi.org/10.1088/1742-6596/947/1/012036

Hatch, G. & Shiu, C. (1998). Practitioner research and the construction of knowledge in mathematics education. In A. Sierpinska & J. Kilpatrick (Eds.) Mathematics education as a research domain: A search for identity – Book 2 Dordrecht, Netherlands: Kluwer Academic Publishers.

Hatten, R., Knapp, D. & Salonga, R. (2000). Action Research: Comparison with the Concepts of 'The Reflective Practitioner' and 'Quality Assurance'. Action Research E-Reports, 8. Availability: http://www.fhs.usyd.edu.au/arow/arer/008.htm [cited 28 August 2007]

Holms, P. (1986). *Statistics Course for All Students Age 11-16.* Sheffield: Center for Statistics Education.

Hancock, C., Kaput, J. J., & Goldsmith, L. T. (1992). Authentic inquiry with data: Critical barriers to classroom implementation. Educational Psychologist, 27(3), 337-36

Harvey, A. L., Plake, B. S., and Wise, S. L. (1985), "The Validity of Six Beliefs About Factors Related to Statistics Achievement," paper presented at the Annual Meeting of the American Educational Research Association, Chicago, IL

Helgeson, S. L. (1993), "Assessment of Science Teaching and Learning Outcomes," Monograph #6, National Center for Science Teaching and Learning, Ohio State University.

Hembree, R. (1990), "The Nature, Effects, and Relief of Mathematics Anxiety," Journal of Research in Mathematics Education, 21, 33-46.

Hunsley, J. (1987), "Cognitive Processes in Mathematics Anxiety and Test Anxiety: The Role of Appraisals, Internal Dialogue and Attributions," Journal of Educational Psychology, 79, 388-392.

Hilton, S. C., Christensen, H. B., Collins, B. J., Hadfield, K., Schaalje, B., and Tolley, D. (1999). A Randomized, Controlled Experiment to Assess Technological Innovations in the Classroom on Student Outcomes: An Overview of a Clinical Trial in Education. Proceedings of the 6th International Conference on the Teaching of Statistics. pp. 209-212.

Jones, G. A., Thornton, C., Langrall, C. W., Mooney, E. S., Perry, B., & Pratt, I. (2000). A framework for characterising children’s statisticl thinking. Mathematical Thinking and Learning, 2(1 and 2), 11–50.

Jarrell, M. G., and Burry, J. A. (1989), "Coping Strategies Inventory for Statistics," paper presented at the Annual Meeting of the Mid-South Educational Research Association, Little Rock, AK (ERIC document ED313446).

Irwin, K. & Woodward, J. (2005). A snapshot in the discourse used in Mathematics where students are mostly Pasifika (a case study in two classrooms) In Higgins J. et al (Eds.) foreword Holton D. Findings from the New Zealand Numeracy Development Project 2004. (pp. 66-73). Wellington: Ministry of Education.

Ivády, R. E. (2007). Implicit Learning and Second Language Acquisition. *Periodicals Of Implicit Cognition (2007) 1, 1-8.*, 1-5.

Kakraba, S., Morkle, C., & Adu, J. K. (2011). *The Relationship between Students Perception of Mathematics and thier Mathematics Achievement in Senior High Schools.* Cape Coast: UCC Press.

Kassim, N. L. A., Ismail, N. Z., Mahmud, Z., & Zainol, M. S. (2010). Measuring Students" Understanding of Statistical Concepts using Rasch Measurement. International Journal of Innovation, Management and Technology, 1(1), 13-19

Kazemi F., Shahmohammadi, A. & Sharei, M. (2013). The Survey on the relationship between the attitude and academic achievement of in-service mathematics teachers in introductory probability and statistics. World Applied Sciences Journal, 22 (7), 886-891, Retrieved from DOI: 10.5829/idosi.wasj.2013.22.07

Kennedy, R. L., & McCallister, C. J. (2001). Attitudes toward advanced and multivariate statistiks when using computers. (ERIC Document Reproduction Service No. ED 464 097).

Kensington-Miller, B. (2004). Professional development of mathematics teachers in low socio-economic secondary schools in New Zealand. In I. Putt, R.

Faragher, & M. McLean (Eds.), Mathematics education for the third millennium: Towards 2010 (Proceedings of the 27th annual conference of the Mathematics Education Research Group of Australasia), (pp. 320-327). Sydney: MERGA.

Kinniard, J. (2010). Does attitude impact academic achievement? Faculty of the College of Education, Ohio University. Unpublished Master's Thesis.

Koga, S. (2022). Characteristics of statistical literacy skills from the perspective of critical thinking. Teaching Statistics, 44(2), 59–67. https://doi.org/10.1111/test.12302

Kunnan, A. J. (1998). An introduction to structural equation modeling for language assessment research. Language Testing, 15(3), 295-332.

Kokotsaki, D., Menzies, V., & Wiggins, A. (2014). Durham Research Online Woodlands. Critical Studies on Security, 2(2), 210–222.

Koparan, T. (2015). The effect of project-based learning on students' statistical literacy. International Journal of Mathematical Education in Science and Technology, 46(5), 658–686.

Latu, V. (2005). Language factors that affect Mathematics teaching and learning of Pasifika students In P. Clarkson, A. Downton, D. Gronn, M. Horne, A. McDonough, R. Pierce, & A.Roche (Eds.), Building connections: Theory, research and practice. Proceedings of the 28th annual conference of the Mathematics Education Research Group of Australasia (pp. 274–281). Sydney: MERGA.

Langrall, C.W. (2010). Does context expertise make a difference when dealing with data? In C. Reading (Ed.), Data and context in statistics education: Towards an evidence-based society. Proceedings of the Eighth International

Conference on Teaching Statistics (ICOTS8, July, 2010), Ljubljana, Slovenia. Voorburg, The Netherlands: International Statistical Institute Retrieved from http://www.stat.auckland.ac.nz/~iase/publications/icots8/ICOTS8_2A2_LAN G RALL.pdf

Lester, D. (2016). Predicting success in psychological statistics courses. Psychological Reports, 118(3), 772–777. https://doi.org/10.1177/0033294116647687

Liau, A. K., Kiat, J. E., & Nie, Y. (2015). Investigating the pedagogical approaches related to changes in attitudes toward statistics in a quantitative methods course for psychology undergraduate students. The Asia-Pacific Education Researcher, 24(2), 319–27. http://dx.doi.org/10.1007/s40299- 014-0182-5

Li, J. (2005). Statistics Education for Junior High Schools in China. In Burrill, G., & Camden, M. (Eds.) *Curricular Development in Statistics Education: International Association for Statistical Education.* Voorburg, the Netherlands: International Statistical Institute.

Li, L.Y. (2010). Study of the attitude, selfefficacy, effort and academic achievement of city u students towards research methods and statistics. Discovery – SS Student E-Journal, 1, 154- 183.

Lund, A. & Lund, M. (2012). *Two-Way ANOVA using SPSS:* Lund Research Ltd. Retrieved on 7th January, 2012 on http://www.statistics.laerd.com/spss-tutorials/two-way-anova-using-spss-statistics.php

Male, H., & Lumbantoruan, J. H. (2021). Students' perceptions and attitudes towards statistics. *Advances in Social Science, Education and Humanities Research/Advances in Social Science, Education and Humanities Research*.

https://doi.org/10.2991/assehr.k.210615.095

Martinez-Dowson, R. (2010). The effects of a course on statistical literacy upon students' challenges to statistical claims made in the media. Unpublished Doctoral Dissertation, Clemson University, Clemson

Mata, M. D., Monteiro, V., & Peixoto, F. (2012). Attitudes towards Mathematics: Effects of Individual, Motivational, and Social Support Factors. *Child Development Research*.

Meaney, T. & Flett, K. (2006). Learning to read in mathematics classrooms: reading and the mathematics classroom. [online]. Australian Mathematics Teacher; 62(2) 10-16; 2006. Availability: [cited 21 Mar 07].

Meaney, T. & Irwin, K. (2003). Changing their answers? In 'Educational research, risks and dilemmas: NZARE/AARE Conference 2003 29 November - 3 December 2003, Auckland New Zealand'. Auckland: New Zealand Association for Research in Education.

Merriman, L. (2006). Using media reports to develop statistical literacy in year 10 students. Proceedings of the seventh international conference on teaching statistics. Voorburg, The Netherlands: International Statistical Institute. Retrieved from www.stat.auckland.ac.nz/~iase/publications/17/8A3_MERR.pdf

Meyer, O., &Thille, C. (2010).Developing statistical literacy across social, economic and geographical barriers using a "stand-alone" online course. Proceedings of the seventh international conference on teaching statistics. Voorburg, The Netherlands: International Statistical Institute. Retrieved from http://www.stat.auckland.ac.nz/~iase/publications/17/6C3_MEYE.pdf

Michelli, M.P. (2013). The relationship between attitudes and achievement in mathematics among fifth-grade students. Honors Theses. Paper 126

Moore, D. S. (1997). New Pedagogy and New Content: The Case of. *International Statistical Review*.

McAleyev, L. & Sullivan, C. (2010). Statistical literacy and sample survey results. International Journal of Mathematical Education in Science and Technology, 41(7), 911-920

McLeod, D. B. (1992), "Research on Affect in Mathematics Education: A Reconceptualization," in Handbook of Research on Mathematics Teaching and Learning, ed. D. A. Grouws, NY: Macmillan, pp. 575-596.

Mills, J. D. (2004). Students' attitudes toward statistics: Implications for the future. *College Student Journal*, 38(3), 349-361.

Mooney, E. S. (2002). A framework for characterizing middle school students' statistical thinking. Mathematical Thinking and Learning, 4(1), 23–63. https://doi.org/10.1207/S15327833MTL0401_2

Moreno, J. L. (2002). Toward a statistically literate citizenry: What statistics everyone should know. In Proceedings of the Sixth International Conference on Teaching Statistics. Voorburg, the Netherlands: International Statistical Institute. CD ROM.

Mullis, I. V., Martin, M. O., Foy, P., & Arora, A. (2012). TIMSS 2011 international results in mathematics: ERIC

Mvududu, N. (2003). A cross-cultural study of the connection between students' attitudes towards statistics and the use of constructivist strategies in the course. Journal of Statistics Education 11(3). Retrieved from http://www.amstat.org/ publications/jse/v11n3/mvududu.html

National Council of Teachers of Mathematics. (1998). Curriculum and Evaluation Standards. *Center for the Study of Mathematics Curriculum*.

National Council of Teachers of Mathematics. (2000). Principles and standards for school mathematics. Reston, VA: NCTM

Newton, M. A., & Mwisukha, A. (2009). The relationship between peer attitudes towards school selected peer group activities and academic achievement of secondary school students in Nairobi. Journal of Educational Research and Development, 4(1), 99-104.

Nolan, M. M., Tanya , B., & Kent, H. (2012). Surveys Assessing Students' Attitudes Toward Statistics: A Systematic Review Of Validity And Reliability. *Statistics Education Research Journal*.

Nolan, M. M., Tanya , B., & Kent, H. (2012). Surveys Assessing Students' Attitudes Toward Statistics: A Systematic Review Of Validity And Reliability. *Statistics Education Research Journal*.

OECD. (2004). Learning for tomorrow's world: First results from PISA 2003. OECD Publishing.

OECD. (2014). PISA 2012 Results: What students know and can do – Student performance in mathematics, reading and science (Volume I, Revised edition, February 2014), PISA, OECD Publishing. https://doi.org/10.1787/978926

Ohio Mathematical Planning Commitee. (2016). Adult Numeracy Themes. *Ohio Literacy resource Center*. Retrieved from http://literacy.kent.edu/Oasis/Resc/Educ/data.html

Ong, J. K., & Masitah , S. (2014). *Investigating Students' Competence Level In Secondary School Statistics.* Istanbul, Turkey : International Conference on Social Sciences and Humanities .

Onwuegbuzie, A. J. (2000). Academic procrastinators and perfectionistic tendencies among graduate students. Journal of Social Behavior and Personality, 15(5), 103.

Onwuegbuzie, A. J. (2004). Academic procrastination and statistics anxiety. Assessment & Evaluation in Higher Education, 29(1), 3-19. https://doi.org/10.1080/0260293042000160384

Ottaviani, M. G. & Luchini, S. R. (2005). Data and Predictions" Emerging as one of the Basic Themes in the Mathematical Curriculum of the First Cycle School Level in Italy. In Burrill, G., & Camden, M. (Eds.) Curricular Development in Statistics Education: International Association for Statistical Education 2004 Roundtable. Voorburg, the Netherlands: International Statistical Institute

Pallant, J. (2007). SPSS Survival Manual. New York: Open University Press. Retrieved on 17th May, 2016 from. http://www.mheducation.co.uk/openup/chapters/0335208908.pdf

Papanastasiou, C. (2000). Effects of attitudes and beliefs on mathematics achievement. Studies in Educational Evaluation, 26(1), 27–42. Available at: https://doi.org/10.1016/s0191-491x(00)00004-3.

Pajares, F., & Miller, M.D. (1994). Role of self-efficacy and self- concept beliefs in mathematical problem solving: A path analysis. Journal of Educational Psychology, 86, 193-203.

Pierce, R., & Chick, H. L. (2013). Workplace statistical literacy: Teachers interpreting box plots. Mathematics Education Research Journal, 25, 189–205.

Perney, J., and Ravid, R. (1991), "The Relationship Between Attitudes Towards Statistics, Math SelfConcept, Test Anxiety and Graduate Students'

Achievement in an Introductory Statistics Course," unpublished manuscript, National College of Education, Evanston, IL.

Perepiczka, M., Chandler, N., & Becerra, M. (2011). Relationship between graduate students' statistics selfefficacy, statistics anxiety, attitude toward statistics, and social support. https://doi.org/10.15241/mpa.1.2.99

Petocz, P., & Reid, A. (2005). Something strange and useless: Service students' conceptions of statistics, learning statistics and using statistics in their future profession. International Journal of Mathematical Education in Science and Technology, 36(7), 789-800. https://doi.org/10.1080/00207390500271503

Pfannkuch, M. (2006). Comparing Box Plot Distributions: A Teacher's Reasoning *Statistics Education Research Journal* 5 (2) 27- 46 November 2006

Pfannkuch, M. (2001). Assessment of school mathematics: teachers' perception and practices. *Mathematics Education Research Journal*; 13(3) 185-203; December 2001. Availability:

Pfannkuch, M & Horring, J. (2005). Developing Statistical Thinking in a Secondary School: A Collaborative Curriculum Development. In Burrill, G. & Camden, M. (Eds.) Curricular Development in Statistics Education: International Association for Statistical Education 2004 Roundtable. (pp 204-218) Voorburg, the Netherlands: International Statistical Institute

Reading, C. (2002). Profile for statistical understanding. Proceedings of the sixth international conference on teaching statistics, Cape Town, South Africa.

Repedro, R. E., Jr, & Diego, C. V. (2021). Attitudes toward Statistics and Statistical Literacy of Public Senior High School Students. *Philippine Social Science Journal (University of Negros Occidental-Recoletos- Online)/Philippine Social*

Science Journal (University of Negros Occidental-Recoletos-Print), *4*(3), 48–56. https://doi.org/10.52006/main.v4i3.399

Risqi, E. N., & Setianingsih, N. R. (2021). Statistical Literacy Of Secondary School Students In Solving Contextual Problems Taking Into Account The Initial Statistical Ability. *Pi : Mathematics Education Journal*, *4*(1), 43–54. https://doi.org/10.21067/pmej.v4i1.5285

Roberts, D. M., & Bilderback, E. W. (1980). Reliability and validity of a statistics attitude survey. Educational and Psychological Measurement, 40(1), 235–238.

Roberts, D.M. & Saxe, J.E. (1982). The validity of a statistics attitude survey. A follow-up study. Educational and Psychological Measurement, 42(3), 907- 912.

Roberts, D. M., and Bilderback, E. W. (1980), Reliability and Validity of a Statistics Attitude Survey, *Educational and Psychological Measurement*, 40, 235-238.

Reid, A., & Petocz , P. (2012). Students' Conceptions of Statistics: A Phenomenographic Study. *Journal of Statistics Education Volume 10, Number 2 (2002).*

Richardson, F. C., and Suinn, R. M. (1972), "The Mathematics Anxiety Rating Scale: Psychometric Data," *Journal of Counseling Psychology*, 19, 551–554.

Roberts, D. M., and Reese, C. M. (1987), "A Comparison of Two Scales Measuring Attitudes Towards Statistics," *Educational and Psychological Measurement*, 47, 759–764.

Rumsey, D. J. (2002). Statistical Literacy as a Goal for Introductory Statistics Courses. *Journal of Statistics Education Volume 10*, 1-5. Retrieved from www.amstat.org/publications/jse/v10n3/rumsey2.html

Roberts, D. M., and Bilderback, E. W. (1980), "Reliability and Validity of a Statistics Attitude Survey," Educational and Psychological Measurement, 40, 235-238.

Roberts, D. M., and Saxe, J. E. (1982), "Validity of Statistics Attitude Survey: A Follow-Up Study," Educational and Psychological Measurement, 42, 907-912.

Sahari, N., Hairulliza , M. J., Hazura , M., & Tengku , M. T. (2010). *Students' Attitude towards Statistics Course.* Malaysia : Elsevier Ltd.

Salleh, F. (1998). Form four students' attitudes towards mathematics and attitude-related factors. Universiti Brunei Darussalam, Brunei Darussalam.

Sanchez, J. (2007). International Statistical Literacy Project . *International Statistical Institute, 56th Session*, 1.

Saidi, S. S., & Siew, N. M. (2022). Assessing Secondary School Students' Statistical Reasoning, Attitude Towards Statistics, And Statistics Anxiety. Statistics Education Research Journal, 21(1), 6. https://doi.org/10.52041/serj.v21i1.67

Saidi, S. S., & Siew, N. M. (2019). Investigating the Validity and Reliability of Survey Attitude towards Statistics Instrument among Rural Secondary School Students. *International Journal of Educational Methodology*, *5*(4), 651–661. https://doi.org/10.12973/ijem.5.4.651

Setiawan, E. P., & Sukoco, H. (2021). Exploring First Year University Students' Statistical Literacy: A Case On Describing And Visualizing Data. *Journal on Mathematics Education*, *12*(3), 427–448. https://doi.org/10.22342/jme.12.3.13202.427-448

Schau, C. (1999). Survey of Attitudes Toward Statistics (SATS). Available online5 and 6. Retrieved from htt://www.evaluationand**statistics**.com/sitebuildercontent/sitebuilderfiles /**sats**28pre.pdf

Schau, C. (2003). *Students attitudes: The "other" Important outcome in statistics education. 2003 ASA Proceedings*: *Papers presented at the American Statistical*

Association Joints Statistical Meetings. Alexandria, VA: American Statistical Association, Section on Statistical Education, pp. 3673 - 3681.

Schau, C., Stevens, J., Dauphinee, T.L., & Ann, D.V. (1995). The development and validation of the survey of attitudes towards statistics. Educational and Psychological Measurement, 55(5), 868-875

Sharma, S. (2017). Definitions and models of statistical literacy: a literature review. Open Review of Educational Research, 4(1), 118-133. https://doi.org/10.1080/23265507.2017.1354313

Sharma, S. (2013). Developing statistical literacy with Year 9 students: A collaborative research project. Research in Mathematics Education, 15(2), 203–204. https://doi.org/10.1080/14794802.2013.797742

Schield, M. (1999). Statistical literacy: Thinking critically about statistics. Of Significance Journal. The Association of Public Data Users, 1(1). Retrieved from, http://www.statlit.org/pdf/1999SchieldAPDU.pdf

Schield, M. (2004). Statistical literacy curriculum design. In Burrill, G., & Camden, M. (Eds.). (2005). Curricular Development in Statistics Education: International Association for Statistical Education 2004 Roundtable. Voorburg, the Netherlands: International Statistical Institute. Retrieved from http://www.stat.auckland.ac.nz/~iase/publications/rt04/2.4_Schield.pdf

Schield, M. (2006). Statistical literacy survey results: Reading graphs and tables of rates and percentages. Conference of the International Association for Social Science Information Service and Technology, Retrieved from, www.StatLit.org/pdf/2006SchieldIASSIST.pdf

Sharma, S., Doyle, P., Viney, S., & Talakia, S. (2010). Towards Understanding Models For Statistical Literacy: A Literature Review. *Waikato Journal of Education 15*, 5.

Sharma, S., Doyle, P., Shandil, V., & Talakia'atu, S. (2011). Developing statistical literacy with year 9 students. Set: Research Information for Educational Research, 1, 43–60.

Shaughnessy, J. M. (2007). Research on statistics learning and reasoning. In F. K. Lester, Jr (Ed.), Second handbook of research on mathematics teaching and learning (pp. 957–1009). Reston: The National Council of Teachers of Mathematics.

Singer, F. M., Nerida F, E., & Cai, J. (2015). Mathematical problem posing: From research to effective practice. Mathematical Problem Posing: From Research to Effective Practice, 1– 569. https://doi.org/10.1007/978-1-4614-6258-3

Skovsmose, O. & Borba, M. (2004). Research methodology and critical mathematics education. In P Valero & R Zevenbergen (Eds.), Researching the socio-political dimensions of mathematics education: Issues of power in theory and methodology. (pp. 207-226). Dordrecht, the Netherlands: Kluwer Academic Publishers. Stein, M.K. (2001). Teaching and learning mathematics: How instruction can foster the knowing and understanding of number. In J. Brophy (Ed). Subject-specific instructional methods and activities. Advances in Research on Teaching. Vol. 8. New York: Elsevier.

Snell, L. (1999). Using chance media to promote statistical literacy. Paper presented at the 1999 Joint Statistical Meetings, Dallas, TX.

Schoenfeld, A. H. (1992), "Learning to Think Mathematically: Problem Solving, Metacognition, and Sense Making in Mathematics," in Handbook of Research on Mathematics Teaching and Learning, ed. D. A. Grouws, NY: Macmillan, pp. 334-370.

Steen, L. A. (1997). *Why Numbers Count: Quantitative Literacy for Tomorrow's America (Literacy Series.* New York: College Entrance Examination Board.

Stuart, M. (2005, July 3). *Mathematical Thinking versus Statistical Thinking; Redressing the Balance in Statistical Teaching*. Retrieved from Trinity College,Dublin: Retrieved from htt://www.scss.tcd.ie/disciplines/statistics/tech-reports/0507.pdf

Sutarso, T. (1992), "Some Variables in Relation to Students' Anxiety in Learning Statistics," paper presented at the Annual Meeting of the Mid-South Educational Research Association, Knoxville, TN (ERIC document ED-353334).

Tishkovskaya, S., & Gillian , A. L. (2012). Statistical Education in the 21st Century: a Review of Challenges,. *Journal of Statistics Education*, 4. Retrieved from http://www.amstat.org/publications/jse/v20n2/tishkovskaya.pdf

Tempelaar, D. (2004). Statistical reasoning assessment: An analysis of the SRA instrument. Proceedings of ARTIST Roundtable Conference on Assessment in Statistics, August 1–4, Appleton, WI. http://www.rossmanchance.com/artist/proceedings/tempelaar.pdf

Tempelaar, D. T., Gijselaers, W. H., van der Loeff, S. S., & Nijhuis, J. F. (2007). A structural equation model analyzing the relationship of student achievement motivations and personality factors in a range of academic subject-matter areas. Contemporary Educational Psychology, 32(1), 105-131. https://doi.org/10.1016/j.cedpsych.2006.10.004

Umar, T. S., Adamu, A., & Sadiq, A. (2014). The Causes of Poor Performance in Mathematics among Public Senior Secondary School Students in Azare Metropolis of Bauchi State, Nigeria. *IOSR Journal of Research & Method in Education*, 8.

UNECE. (2012). *Making Data Meaningful Part 4: A guide to improving statistical literacy*. Geneva: UNECE.

Utomo, D. P. (2021). An analysis of the statistical literacy of middle school students in solving TIMSS problems. *International Journal of Education in Mathematics, Science and Technology :*, *9*(2), 181–197. https://doi.org/10.46328/ijemst.1552

Utts, J. M. (1996). *Seeing Through Statistics.* Belmont, CA,: Duxbury Press.

Varalakshmi,V.,Suseela, N., Sundaram, G. G., Ezhilarasi, S., & Indrani, B. (2005). *Statistics Higher Secondary – First Year.* Tamilnadu.: Tamilnadu,Textbook Corporation.

Veresova, M. & Mala, D. (2016). Attitude toward school and learning and academic achievement of adolescents. The European Proceedings of Social and Behavioral Sciences (EPSBS). eISSN: 2357-1330. Retrieved from http://dx.doi.org/10.15405/epsbs.2016.11. 90

Vanhoof, S., Sotos, A. E. C., Onghena, P., Verschaffel, L. (2006).Attitudes toward statistics and their relationship with short- and long-term exam results. In A. Rossman& B. Chance (Eds.), Working cooperatively in statistics education: Proceedings of the Seventh International Conference on Teaching Statistics, Salvador, Brazil. Voorburg, TheNetherlands: International Statistical Institute. Retrieved from http://www.stat.auckland.ac.nz/~iase/publications/17/C133.pdf

Valentini, A. (2016). Promoting and assessing statistical literacy among university students. The case of tuscany. Electronic Journal of Applied Statistical Analysis, 9(4), 589–609. https://doi.org/10.1285/i20705948v9n4p589

Valentini, A., & Carbonara, M. (2016). Italian NSI for the school. A new project to promote statistical literacy in italian regions. Electronic Journal of Applied Statistical Analysis, 9(4), 716–735. https://doi.org/10.1285/i20705948v9n4p716

Wade, B. &Goodfellow, M. (2009). Confronting statistical literacy in the undergraduate social science curriculum.Sociological Viewpoints, 25, 75-90.

Wallman, K. K. (1993). Enhancing Statistical Literacy: Enriching Our Society. Journal of the American Statistical Association, 88 (421), 1-8.

Wang, D. Q., & Wu, B. N. (2010). *Compare students' attitudes to learn mathematics and statistics in China and Australia*. Proceedings of the Eighth International Conference on Teaching Statistics, Ljubljana, Slovenia. Voorburg, Netherlands: International Statistical Institute.

Watson, J. (1997). Assessing Statistical Thinking Using Media. In I. Gal, & J. Garfield (Eds.), The Assessment Challenge in Statistics Education (s. 107-122). Amsterdam: IOS Press.

Watson, J. (2006) Statistical Literacy at School: Growth and Goals, Mahwah, NJ: Lawrence Erlbaum Associates.

Watson, J. (2003). The time is perhaps at hand when it will be recognized. *The time is perhaps at hand when it will be recognized*.

Watson, J. M. & Callingham, R. (2003). Statistical literacy: A complex hierarchical construct. Statistics Education Research Journal, 2(2), 3–46.

Watson, J. & Kelly, B. A. (2008).The Vocabulary of Statistical Literacy. International Journal of Science and Mathematics Education, 6, 741-767

Watson, J. M., & Moritz, J. B. (1999). The beginning of statistical inference: Comparing two data sets. Educational Studies in Mathematics, 37, 145-16

Watson, J. M., & Moritz, J. B. (2000). Development of understanding of sampling for statistical literacy. Journal of mathematical Behavior, 19, 109-136.

Watson, J., & Callingham, R. (2020). COVID-19 and the need for statistical literacy. Australian Mathematics Education Journal, 2(2), 16–21.

Watson, J. M., & Moritz, J. B. (2000). Development of understanding of sampling for statistical literacy. The Journal of Mathematical Behavior, 19(1), 109–136. https://doi.org/10.1016/S0732-3123(00) 00039-0

Wilson, T. M. (2006). Statistical reasoning at the secondary tertiary interface. [Doctoral dissertation, Queensland University of Technology]. https://eprints.qut.edu.au/16358/3/Therese%20Wilson%20Thesis.pdf

Wilson, B. L. (1994). The development and evaluation of an instructional program in statistical literacy for use in post-secondary education, Unpublished Doctoral Dissertation, Illinois State University, Illinois.

Wikipedia. (2016, June 8). *Statistics Education*. Retrieved from Wikipedia Web site: en.wikipedia.org/wiki/Statistics_education

Wikipedia. (2016, July 26). *Statistics education*. Retrieved from Wikipedia: www.en.wikipedia.org/wiki/Statistics_education.

Wise, S. L. (1985). The development and validation of a scale measuring attitudes toward statistics. Educational and Psychological Measurement, 45(2), 401–405.

Wilkins, J. L. M., & Ma, X. (2003). Modelling change in student attitude toward and beliefs about mathematics. *The Journal of Educational Research*, 97(1), 52-63.

Wainer, H. (1992). Understanding graphs and tables. Educational Researcher, 21(1), 14-23

Weiner, B. (1979). A theory of motivation for some classroom experience. J. Educ. Psychol 71:3-25

Wild, C. J., & Pfannkuch, M. (1999). Statistical thinking in empirical enquiry (with discussion). International Statistical Review, 67(3), 223–248.

Ying Kang, W., & KhoonYoong, W. (2007).Exploring attitude toward statistical graphs among Singapore secondary school students. The Mathematics Educator, 10(1), 39-58.

Yılmaz, S. (2006). The effects of real data based and calculator supported statistics activities on 7th grade of students' statistics performance and attitude toward statistics. Unpublished Master Thesis, Middle East Technical University, Ankara.

Yolcu, A. (2012). *An Investigation Of Eighth Grade Students' Statistical Literacy, Attitudes Towards Statistics And Their Relationship.* Ankara: Metu Library.

Yolcu, A. (2014). Middle School Students' Statistical Literacy: Role Of Grade Level And Gender. *Statistics Education Research Journal*, *13*(2), 118–131. https://doi.org/10.52041/serj.v13i2.285

Yuniawatika, Y. (2018). Statistical Literacy and its Urgency for Students. 269(CoEMA), 170– 173. https://doi.org/10.2991/coema-18.2018.41

Zamalia, N. (2009). A discriminant analysis of perceived attitudes toward statistics and profile identification of statistics learners. *Proceedings of the 2nd WSEAS*

International Conference on Multivariate Analysis and its Application in Science and Engineering. 41-47. Received from http://www.wseas.us/e-library/conferences/2009/istanbul/ MAASE/MAASE04.pdf

APPENDICES

Appendix A: Statistical Literacy Test

SENIOR HIGH SCHOOL

STATISTICAL LITERACY TEST (SLT)

SEX………………… AGE…………

FORM/CLASS………………

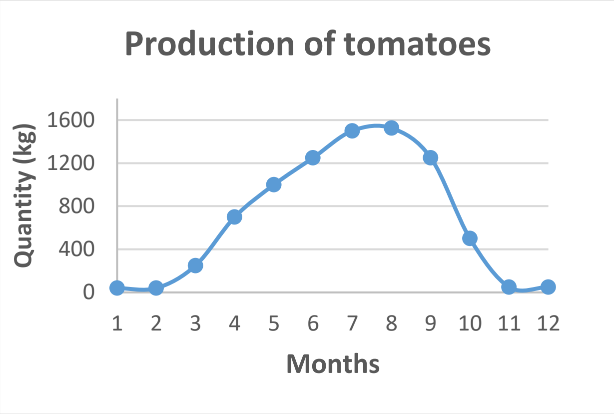
1. In your own words what is statistics?

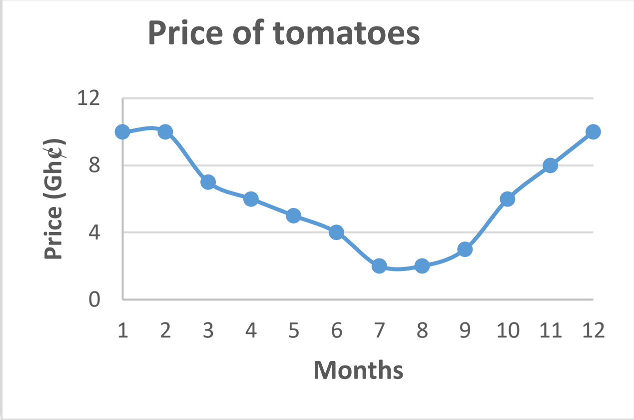
2. A teacher recorded all the marks students got in a science test, she found the **mean** score to be 45%. What does 45% mean stands for?

3. A mathematics teacher chose 3 students at **random** to represent the school in an inter - school quiz competition. What is the meaning of the word random?

4. How would you differentiate between a sample and a population?
5. A researcher who lives in a town consisting of 50 families has found the mean of children per family to be 2.2. Which one of the followings is absolutely true?
   a. Half of the families in this town has two children.
   b. There are more families with 3 children than families with 2 children.
   c. The mean of children per adult is 2.2.

d. There are 110 children in this town





6. Figure 1 and 2 represents the **monthly** production of tomatoes and price per kg respectively, which of these can be concluded from the two graphs?
    a. The price of tomatoes is high in 1st quarter and less in 3rd quarter of the year.
    b. The production of tomatoes is less in 3rd quarter with low price.
    c. Since production of tomatoes is less in 1st quarter, the price is high.
    d. Low prices of tomatoes in the first quarter as a results of low production of tomatoes.
7. There are 20 identical balls in a box. Twelve are blue and the rest are green. If one ball is taken at random from the box, what is the probability that the ball is green?

8. The scores of 10 students in an examination are given as follows: 45, 12, 75, 81, 54, 51, 24, 67, 19 and 39. What is the median of the scores?

9. Which of the data sets involve more variability? Provide your answer without calculation.

e. 10, 11, 12, 13, 14, 15

f. 13, 13, 13, 13, 13, 13

g. 11, 12, 12, 13, 13, 14

h. 10, 12.5, 12.5, 12.5, 12.5

10. A complete study of every unit or object in the population is known as…………………………..

11. Consider a data set of 26 children of ages 14 years and below. The frequency distribution of variable 'age' is tabulated as follows:

Age Group	**0-4**	**5-9**	**10-14**
Frequency	8	12	6
Cumulative Frequency	8	m	26

a. What is the mean Age b. What is the value for m

12. Ali is a member of library club in an elementary school and he wants to investigate the number of books at students' homes. Which one of the following might be a representative sample of the students from his school for this research?

a. 30 students chosen randomly from the library club

b. 30 students chosen randomly from the whole school

c. 30 students chosen randomly from Ali's class

d. 30 female students chosen randomly from the whole school

13. In a school of 940 pupils, the number of girls exceeds the number of boys by 150. How many girls are there in the school? A) 620 B) 545 C) 470 D) 395

A pie chart is to be drawn from the data in the table below. Use it to answer Questions 14 to 15.

Cassava	20%
Yam	17%
Plantain	28%
Maize	35%

14. What will be the angle of the sector for maize?

15. If cassava cost 50.00, what will be the cost of the items altogether?

Appendix B: Students Attitude towards Statistics Questionnaire

UNIVERSITY OF EDUCATION, WINNEBA

Department of Mathematics Education

Attitude towards Statistics Questionnaire

The purpose of this questionnaire is to gather data on students' attitude towards the teaching and learning of STATISTICS. Your thoughtful and truthful responses will be greatly appreciated. Please answer each question to the best of your knowledge. Your name is not required. Your responses will be kept completely confidential. Thank you for taking time to complete this questionnaire.

Background information

Gender: Female ☐ Male ☐

Age:…………………

Programme ………………………………………

Form/Class…………

Instructions

Please tick [√] in the appropriate box with headings (Strongly Disagree, Agree, Neutral, Agree, Strongly Agree) **One** which best describe your view of the questions provided below.

No	**ITEMS**	**Strongly Disagree**	**Disagree**	**Neither**	**Agree**	**Strongly Agree**
	PART I					
1	I like statistics					
2	I don't feel intimidated when asked to solve a statistical problem					
3	I don't feel stressed in my statistics class.					
4	I enjoy taking statistics courses					
5	I am not afraid of statistics.					
	PART II					
6	I do not face problems in statistics because of my thinking style.					
7	I know what is happening in statistics.					
8	I do not make calculation errors very often in statistics.					
9	I will understand statistics equations.					

10	I can learn statistics					

PART III

11	Statistics should be a required part of my study					
12	I use statistics in my daily life.					
13	I often make decisions based on statistics.					
14	I will use statistics in my future career.					
15	Statistics is relevant for my life					

PART IV

16	Statistics formulae are easy to understand.					
17	Statistics is not a difficult course.					
18	Statistics can be quickly learned by most people.					
19	Learning statistics does not require discipline.					
20	Statistics does not involve too much calculation					

Thank you for your cooperation.