

*AUTHENTIC AND RELEVANT SCIENCE EDUCATION AT TRAIN LINE SCHOOL THROUGH
THE USE OF SCIENCE TECHNOLOGY AND SOCIETY (STS) EDUCATION?*

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Abstract

The students of Train Line School perceive science as irrelevant to their daily lives and perform below the level of proficiency on Science Tests. This is of serious concern as the students display a high level of level of technological innovation and are often involved in several activities that involve the application of scientific principles. The students of the Experimental Group were engaged in a three-month course of STS education that focused on the relevance Science, through purposeful infusion of SST content into the science curriculum. Data was gathered using surveys to assess students' perception of the relevance of science prior to and after the intervention. Students were given a Post-Test to assess if the Intervention had any impact on their learning of scientific facts and concepts and consequently their performance on science tests. Results of the study showed that students exposed to STS education had an improved perception of the relevance of science and had scored higher on the post test than students who were not exposed to STS education.

Chapter One:

Introduction to the Study

TITLE: - *AUTHENTIC AND RELEVANT SCIENCE EDUCATION AT TRAIN LINE SCHOOL THROUGH THE USE OF SCIENCE TECHNOLOGY AND SOCIETY (STS) EDUCATION?*

Background to the Study

Global trends have pointed to an overall low achievement in Science by primary school pupils. These trends have been seen across the United States of America as cited in the Science and Engineering Indicators 2004 Report which reports that “most students perform below levels considered proficient or advanced” (National Science Board, 2004). The trends are also reflected in the Trends in International Mathematics and Science Study (TIMSS) report of 2009, which indicates overall decreases in science test scores between 1995 and 2007 for 50% of the countries surveyed.

Science as defined in the Ministry of Education Primary Science Curriculum document (2006) “is a distinctive form of creative human activity which involves one way of seeing, exploring and understanding reality” the heart of which “is the desire to explore and understand the world”. This belief is underpinned by the epistemology of the Primary Science Curriculum, which is designed to enhance the problem solving and critical thinking skills of learners through an explicitly stated constructivist approach to teaching that fosters lifelong learning through the learners’ construction of their own knowledge. The value of such an approach to cognitive development is that learners gain understanding of how the world operates and of the beneficial application of science in

society. Furthermore, such an approach promotes self-fulfilment and fosters personal and national development.

The trend of underperformance in science education is not uncommon to our local context. This is evident in from the National Test results for Science in 2008 and 2009, which saw more than 50% of students writing the exam performing below the level of proficiency. This underperformance in Science is also marked at Train Line School. Results for the Standard Two level showed 72% and 76% of students performing below the level of proficiency for 2008 and 2009 respectively. At the Standard Four level 79% of students performed below the level of proficiency in 2008, whereas in 2009 81% of students failed to meet the required standard.

Research has suggested many reasons students underperform in science. These reasons include motivation, ethnicity, socioeconomic status, pedagogy, teachers' competence and relevance. Information gathered from a pre assessment survey of students who are underperforming in science revealed that irrelevance of subject matter was the main reason students had disaffection for the subject. This perception of science can have serious implications for their learning science as "the validity of much scientific knowledge depends on its successful worldly use and potential utility" (Ziman, 1994). Consequently, if students are to successfully construct scientific knowledge, the content being taught must extend beyond the acquisition of knowledge for knowledge sake, to include the relevance and applicability of knowledge to everyday life.

Science is a significant part of modern life and it is important that students understand its relevance in their daily lives. According John Ziman in Aikenhead (1994), teaching Science via STS Education allows students to see the relevance of the subject,

through the natural extension of valid science towards its technological and other practical applications. In addition to content relevance, STS Education gives students the opportunity to integrate Science with other curriculum areas so that it is not seen as an isolated subject. Thus the students experience the relevance of the science they are learning in a holistic and meaningful ways.

The students of Train Line School possess rich “Category 1” cultural knowledge (George, 1986) that bears much scientific merit as they follow conventional science principles. As part of their daily routine of work and play, the students of Train Line School are often engaged in activities and in the creation of technological innovations are based on sound scientific principles. Yet they do not see the relevance and applicability of the science they are learning in school to their everyday lives. This perception of the irrelevance and non-applicability of school science is mirrored in the students’ performance in the National Tests, where they continue to score poorly on the items that require them to apply scientific knowledge. STS extends the learning of science beyond the learning of scientific facts to include real life application of the content. Thus it promotes the meaningful and authentic learning of science as a discipline.

Statement of Problem

Despite the rich cultural knowledge of the students of Train Line School and despite the level of technological innovation displayed by them, students of Train Line School do not find science relevant to their daily lives and continue to perform below the level of proficiency on Science Tests. Science, Technology and Society is one of the fundamental components of the Nature of Science which is essential for promoting

students' understanding of the intricate nature of natural phenomena; as well as for developing scientific literacy. However, this feature of science education, which is a key of the Secondary School Science Curriculum, is not included in the Primary Science Curriculum of Trinidad and Tobago. Science Technology and Society (STS) education extends science beyond the acquisition of knowledge to include the relevance and applicability of knowledge to everyday life. A relevance-based approach to teaching science through Science Technology and Society education may improve students' perception of the relevance and applicability of science as well as students' performance on Science tests.

Aim of Study

Does teaching science through the use of everyday contexts help students to better understand scientific ideas and concepts?

Does teaching science in context improve students' attitudes to science?

“Science is one of the essential features of any society. It has profound effects on people's lives, especially through its application for practical purposes” (Primary Science Syllabus, 2006). The aims of this study are to investigate what impact, if any, a relevance based approach to teaching primary science through STS would have on students' perception of the relevance of science and students learning of scientific concepts and ideas.

Significance of Study

Science, Technology and Society (STS) is one of the fundamental components of the Nature of Science which is essential for promoting students' understanding of the intricate nature of natural phenomena; as well as for developing scientific literacy. However, this feature of science education, which is a key of the Secondary School Science Curriculum, is not included in the Primary Science Curriculum of Trinidad and Tobago.

Several studies have been conducted on the use of STS as a method for teaching science. However, there is limited information about its use in the Caribbean; and no information has been found on its use in the primary school system of Trinidad and Tobago. This study will provide new knowledge on the use of STS as a method of teaching and learning primary science. The results of the study will also provide data that will assist in the development of a plan for authentic and relevant science education at train line school.

Research Question

- a) What impact will using an STS relevance based approach to science teaching have on students' performance on science tests?
- b) How will an STS approach to science teaching influence students' perception of the relevance of science?
- c) What relationship if any, exists between the students' perception of the relevance of science and students' performance on science tests?

Research Hypotheses.**Comparing Teaching Strategies**

μ_1 . mean test scores in group 1 (control group taught by traditional method)

μ_2 . mean test scores in group 2 (experimental group taught by STS method)

Null Hypothesis.

There is no difference in the mean test scores of students taught by traditional and STS methods.

H_0 : mean test score of group taught by traditional method = mean test scores of group taught by STS method.

$$H_0: \mu_1 = \mu_2$$

Alternative Hypothesis.

An STS Approach to science teaching improves students' test scores.

H_1 : mean test scores of group taught by STS method > mean test scores of group taught by traditional method.

$$H_1: \mu_2 > \mu_1$$

Comparing Perception of Relevance

μ_a -mean of the perception of relevance scores in control group taught by traditional method

μ_b -mean of the perception of relevance scores in experimental group taught by STS method

Null Hypothesis.

An STS approach to teaching science has no effect on students' perception of the relevance of science.

H_0 : mean of the perception of relevance score of group taught by traditional method = mean of the perception of relevance scores of group taught by STS method.

$$H_0: \mu_a = \mu_b$$

Alternative Hypothesis.

An STS Approach to science teaching improves students' of the perception of relevance of science.

H_1 : mean of the perception of relevance scores of group taught by STS method > mean of the perception of relevance scores of group taught by traditional method.

$$H_1: \mu_b > \mu_a$$

Determining the Existence of a Correlation

Null Hypothesis.

No relationship exists between students' perception of the relevance of science and students' performance on science tests.

H_0 : Coefficient of the correlation = 0

Alternative Hypothesis.

Students' perception of the relevance of science influences their performance on science tests.

H_1 : Coefficient of the correlation \neq 0

Operational Definitions.

- **STS Education (1)** – An outlook on science education that emphasizes the teaching of scientific and technological developments in their cultural, economic, social and political contexts where students are encouraged to engage in issues that pertain to the impact of science on everyday life and make responsible decisions about how to address such issues (Aikenhead, 1994).
- **STS Education (2)** – A method of doing science that uses real world "issues" to interest students in learning science and the connections between science, technology, and society.
- **Relevance** – Having usability and applicability in daily life.

- **Perception** – The subjects’ opinions, feelings and attitudes
- **Traditional Teaching Methods** – Lecture, Note-taking and Diagramming

Time Line

PHASE	CONTENT	DURATION
Preparatory	<ul style="list-style-type: none"> ➤ Conceptualization of the Study ➤ Data collection for pre-assessment ➤ Literature Review 	September 2011 October 2011 – November, 2011 September, 2011 – May, 2012
Introductory	<ul style="list-style-type: none"> ➤ Unit planning ➤ Project planning for integration/ Teacher Training 	January, 2012 – February, 2012
Intervention	<ul style="list-style-type: none"> ➤ Expansion of Science Education ➤ Implementation of planned units through Project-based learning ➤ Data collection 	February, 2012 – April, 2012
Evaluation	<ul style="list-style-type: none"> ➤ Data analysis ➤ Interpretation and Evaluation of findings 	April, 2012
Completion	<ul style="list-style-type: none"> ➤ Final Write Up ➤ Submission 	May, 2012 June, 2012

Chapter Two

Literature Review

Despite the rich cultural knowledge of the students of Train Line School and despite the level of technological innovation displayed by them, students of Train Line School do not find science relevant to their daily lives and continue to perform below the level of proficiency on Science Tests. This study seeks to investigate if a relevance based approach to teaching science through STS education has any impact on students' perception of the relevance of science; and on student's performance on science tests for a group of Standard Four primary school students.

This literature review aims to inform the study on existing research in the field of STS education, highlighting specifically how STS education influences the kinds of learning experiences students have in the science classroom that fosters meaningful and authentic science learning. The literature review also establishes a theoretical framework for conducting the study. Information for this review of the literature was sourced from books, a wide variety of education and science journals; and from reports sanctioned by various international government bodies.

Introduction

The National Science Teachers Association, (2010) in its position papers on STS education States:

From health to climate change and from bioethics to energy, a myriad of personal and societal issues requires citizens to make informed decisions based on science and technology. These issues provide a rich and motivating context in which students can learn the principles and practices of science and technology... In addition,

science and technology are central to our well-being and success as individuals, as members of society, and as members of the global community. Therefore, NSTA advocates that K–16 science and technology instruction be provided within the context of personal and societal issues (p.2).

Scientific and technological literacy not only involves knowledge and understanding of the value of scientific and technological concepts, processes, and outcomes, but also requires that the individual is “able to use and apply science and technology in our personal and social lives with emphasis being placed on training students for autonomous and responsible decision making in the real world of the student where science and technology are components” (Zeidler 2003). Furthermore, the National Science Teachers Association (NSTA) in its position statement on Elementary School Science, outlines several facets of early experiences in science that are considered important for students to develop problem-solving skills that both empower and equip them with the necessary skills knowledge and competencies to participate in today’s dynamically advancing scientific and technological world. The positions highlighted express the need for students to have quality interactions in learning science in which the elementary science program provides “opportunities for students to develop understandings and skills necessary to function productively as problem-solvers in a scientific and technological world”, supported by a learning environment that fosters the development of “positive attitudes towards self and society, as well as science”(National Science Teachers Association, 2004). STS provides a setting and the requisite experiences for students to develop these basic ideas, skills and attitudes for students to function productively in society as it focuses on the importance of human experiences and personal involvement for authentic and meaningful learning to occur.

What is STS?

NSTA defines STS as “the teaching and learning of science in the context of human experience. It emphasizes the importance of technology and science, noting that technology is understood better and accepted more readily as curriculum and course topics appropriate for all students even though it has not been a focus previously” (Yager, 1992). STS in school science emerged during the late 1970’s to early 1980’s. This development in science education was formed around an innovation for science education which addressed an interdisciplinary approach to teaching and learning science within a social context.

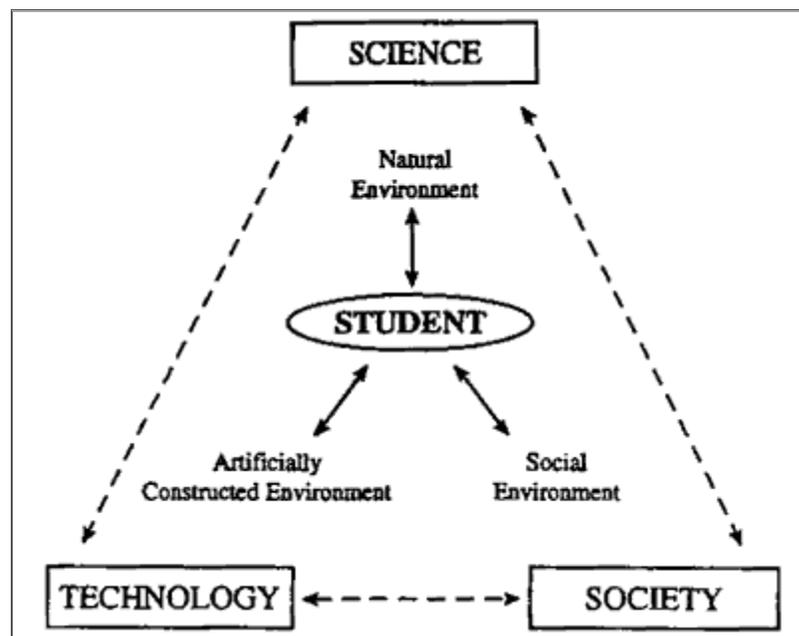


Figure 2.1- The essence of STS education

STS is a student centered approach to teaching science that helps “students make sense out of their social environment, their artificially constructed environment, and their natural environment” (Aikenhead, 1988; 1991). The fundamental goal of STS is to bridge the gap that exists between science and the ethical and social responsibility not addressed by traditional

science curricula. STS focuses on the application of scientific knowledge, technological expertise, social understanding, and humane compassion (Kranzberg, 1991, p. 238). It brings together the educational philosophies of Academic Rationalism and Social Reconstruction Relevance with an aim to producing citizens who are intellectually empowered to participate meaningfully in their society.

Why is there a need for STS Education?

“As future citizens, students must make decisions requiring an understanding of the interaction between science and technology and its interface with society”(Mansour, 2007). The goal of STS education is to enhance students understanding of the nature of these interactions as “science is no longer a separate subject from society but plays a vital role in the social-cultural context” (Ziman, 1980). Traditionally, science education focused on training students how to believe and think scientifically. “Science and technology education in schools has traditionally served an elite group of students”(Driver, Leach, Millar, & Scott, 1996), thus only a minority of science students developed a scientific worldview. STS education has the potential to negate the elitist ideals of traditional science and is therefore worthy of inclusion in the science curricula of schools.

The National Science Teacher Association (1990) postulates it is necessary to “have a citizenry that is prepared to understand and deal rationally with the issues and opportunities of a scientific and technological world”. This sentiment was reiterated by Creek (1992 p.64.) who stated that schools needed “to better prepare students to face the issues and challenges of the 21st century,” fundamental to which is “a tacit understanding of the nature of science and technology and their interactions with societal institutions, social mores and people.” These calls hints at the

need for our students to be more scientifically and technologically literate, if they are to participate meaningfully in society.

Aikenhead (2005) states “an STS approach to science education arises from a particular vision of school science promote practical utility, human values, and a connectedness with personal and societal issues, taught from a student-centered orientation”. This vision is reflective of a goal for science education for all that develops students’ capacities to function as responsible savvy citizens in a world increasingly affected by science and technology.

Aikenhead also reports that STS education is motivated by a major evidence-based ubiquitous failure of the traditional approach to teaching science where “school science content to have meaning for most students, especially outside of school” (p. 384). Thus if the goal of science for all is to be achieved students will need to understand the interactions between science technology and their society.

“Children at birth are natural scientists, engineers, and problem-solvers. They consider the world around them and try to make sense of it the best way they know how”(Murphy, 2011). However, according to Murphy, by the time students reach fourth grade, a third of them have lost an interest in science and by eighth grade, almost 50 percent have lost interest or deemed it irrelevant to their education and their lives. Egan (1996) in Aikenhead (2003) posits STS education can ignite interest in science as students will amass “knowledge that will ensure that their thinking conforms to what is real and true about the world” (p. 8).

The Ministry of Education (2006) in its Primary Science Syllabus states:

The rapid developments in the fields of science and technology impact on all students of Trinidad and Tobago. Being involved in a search for how the natural world operates and how scientific knowledge can be applied to the benefit of society, allows pupils to take control of their environment. It contributes to development at a personal as well as national level and promotes self-fulfillment.

(p. 3)

Science according to the M.O.E. is “one of the essential features of any society...It has profound effects on people’s lives and the environment, especially through its application for practical purposes”. This tenet of science as described by the M.O.E. relates directly to the goal of STS education which focuses on developing scientific capabilities in students. Becoming scientifically capable not only includes the acquisition of skills, knowledge; and the development of attitudes but also includes the cognitive and practical application of these resources in a variety of contexts. Thus STS should be an essential facet of primary science education.

Schools of Thought on STS Education

John Ziman in Aikenhead (1994) posits STS is a means of extending science, towards its real life applications. STS attempts to combine science and values education. It allows students to apply their knowledge and understanding of scientific ideas to familiar phenomenon. STS allows students to see the benefits of science and gives them a sense of ownership of science content. STS gives students a chance to enrich their experiences and fosters creativity and

imagination. Most importantly STS validates science by giving students a personal connection with what they are learning.

Chiappetta and Koballa (2002) expressed science as having a profound influence on society and rationalized, that because of this influence, science must be better understood. They also contented that this was true particularly for young people “who will experience a multitude of technological development in their lifetime.” According to Solomon (1993:15), in Alsop and Pedretti (2001), people need some STS education so that they can think, speak and act on those matters related to science that may affect this quality of living. Gabel (2003) defines STS as “an approach to teaching science that includes developing an appreciation of the interactive natures of science technology and society. She explained that STS involves the integration of science concepts with its technological applications and fosters awareness of the societal implications. This is further reiterated by Alsop and Pedretti (2001) who define STS as a multidisciplinary subject embedded with moral, ethical, political, philosophical, historical and economic perspectives which attempts to recognize and explore the connection between science and real life.

Ziman posits “to draw attention to the relevance of science, in detail to everyday life is to provide it with a clear social role which may be done through STS indication”. Also according to Ziman the trans-disciplinary approach of STS emphasizes its natural sciences and their associated technologies, presenting a more holistic picture of science education.

Fensham (1985) emphasizes that STS education focuses on the needs of all students and that science can be used in other contexts relevant to student learning. Ryder (2001) that most often, canonical science context is not directly useable in related everyday situations and that students in the STS science class can significantly improve their understanding of issues relevant

to both external and internal science and interactions among science, technology and society (p.23).

According to Chiappetta and Koballa (2002), STS facilitates students' construction of realistic concept of the relationship between science and the world at large. They also agreed with Yager (1995), that STS instructions makes science content more meaningful and relevant to students, as it is grounded in constructivism. They believe because STS stresses the application of knowledge students construct scientific understandings that are necessary for life beyond school.

Educational relevance always confronts political expediencies, (Aikenhead, 2004). The need to know science is defined by the lay public who is faced with a real life decision related to science and technology. Alsop and Pedretti (2001) also quote Aikenhead (1994:18) "STS is expected to fill a critical void in the science curriculum... on issues related to society and technology." As science is so culturally relevant to mankind, it is important that young people understand the big ideas of science "so that they can grasp and engage with their cultural heritage," (Millar and Osborne 1998:8). The Department for Education and Employment (1998) posits "Knowledge and Understanding of science helps pupils make sense of natural phenomena" and so students develop the ability to be in control of their environment that benefits society as a whole. "STS classes can see science stimulating enthusiasm and motivation; help students to concretize abstract science concepts, providing a "sense of wonder, marvel, awe, surprise, curiosity, confidence and pleasure. It excites students and inculcates in them, an interest in the natural world" (p.22).

Gabel (2003) however, noted that there is little evidence that students' knowledge of facts and concepts and principles improved because of STS instructions. However, she found that

there was a vast increase in students' ability to analyze data, test hypotheses and use their creativity, as well as their interest in science. She found that STS did in fact make science more relevant, meaningful and useful to students, the benefits of which supersedes the normal science curriculum. This she posits is so as STS education provide multiple opportunities and strategies to retrieve and apply the content" (NSTA, 2003, p. 8) by the use of problem based learning to introduce an authentic framework upon which to scaffold learning (Lawrence et al., 2001; Thomas, 2000).

There are many schools of thought on STS education and the label "STS" changes from country to country and over time. Today there are several STS type science curricula worldwide. These include "Science-Technology-Citizenship" (Kolstø,2001a; Solomon & Thomas, 1999), "Nature-Technology-Society" (Anderson, 2000), "Science for Public Understanding" (Eijkelhof & Kapteijn, 2000; Osborne et al., 2003), "Citizen Science" (Cross et al., 2000; Irwin, 1995; Jenkins, 1999), "Functional Scientific Literacy" (Ryder, 2001), "Public Awareness 2 of Science" (Solomon, 2003b), variations on "Science-Technology-Society-Environment" (Dori & Tal, 2000; Hart, 1989), and "Cross-Cultural School Science" (Aikenhead, 2000; Cajete, 1999). These STS types of science programs are often seen as vehicles for achieving such goals as "science for all" and "scientific literacy," and for improving the participation of marginalized students in school science.

Relevance and Student Learning

“Why are we learning this?”

“How am I going to use this in my life?”

“What’s the point of doing this?”

According to Ferlazzo (2011) relevance is an important concept to our students that helps them make those real-life connections to what they are doing in the classroom. Several curricular reform efforts have emphasized applying science to students’ lives as a means to making learning more meaningful. Hulleman & Harackiewicz (2009) hypothesize “making science courses personally relevant and meaningful may engage students in the learning process, enable them to identify with future science careers, foster the development of interest, and promote science-related academic choices and career paths” (p.1410)

“Relevance is a key component to intrinsically motivating student learning. It is a key factor in providing a learning context in which students construct their own understanding.” (Kember, Ho, & Hong, 2008). By establishing both personal and real-world relevance, students are provided with an important opportunity “to relate subject matter to the world around them and to assimilate it in accordance with their previously held assumptions and beliefs” (p. 260). Likewise, Wieman (2007) recommended that students be provided with intentional and explicit opportunities to discuss, “...why this topic is worth learning, how it operates in the real world, why it makes sense, and how it connects to things the student already knows.” By actively solving relevant problems...“relevance can bring theory to life, and provide the motivation necessary to inspire deep and sustained learning” (p.11).

Philosophical Underpinnings

The Ministry of Education's overall goal for science education, as stated in the Primary Science Syllabi (2006), "is to develop scientific capabilities in all young people from 5 – 18", with a "focus on science education for action as well as for personal enlightenment and satisfaction". In fostering this thrust, The Ministry of Education Science Syllabi, through its explicitly stated constructivist epistemology, call for teachers to engage students in authentic learning situation that involves collaborating and discussing ideas; finding possible solutions to everyday problems; integrating science and technology in society; and gaining higher-order thinking skills from pursuing the solutions. Such engagement would require teachers to develop lessons that incorporate new and innovative methods of teaching Science that mirror real world contexts and allows students to connect with other students and their environment as they construct their knowledge. Such interactions and learning possibilities can be nurtured through STS. This is so as STS education allows students to draw on their previous knowledge and build on them as they solve problems while making connections between the science they are learning in school and their daily lives in authentic learning situation.

Grounding the Literature in the Study

The students of Train Line School possess rich "Category 1 cultural knowledge" (George, 1986) that bears much scientific merit as they follow conventional science principles. They frequently engage in practices and activities that involve the technological application of scientific principles on a daily basis. Yet, they fail to see the relevance of their school science to their daily lives. The 'Literature' suggests that STS education goes beyond the acquisition of knowledge for knowledge sake and extend science to include its potential for practical application

and use. Thus STS education can help to make the learning experiences in the science class more authentic and relevant to students' lives.

STS education has been reported to have several benefits which have been used as a guide throughout the conducting of this study. The domains of STS education have been instrumental in guiding the implementation of The Intervention. As students perceived science as irrelevant to their lives, focus was placed on infusing aspects of the Application and Connections domains of STS (Technology) into the lessons during the implementation, for it is in these domains that students garner the experiences that allows them to see the relevance of their school science.

STS education has also guided the methods of data collection and analysis employed in the study. Research suggests that STS education improves students' understanding of scientific facts, bolsters higher order thinking skills and makes science meaningful to the learner. As such the study sought to test these research claims by collecting data via a Post-Test and Attitudinal Surveys. Data collected were analyzed and compared across groups to determine if the intervention STS education had any such impact on students' perceptions and academic performance with regards to science.

The Ministry of Education of Trinidad and Tobago Primary Science Syllabus embraces and explicitly stated constructivist approach to teaching and learning science. STS education is rooted in constructivism as it is geared at helping students make sense of their school science by drawing on their prior learning and integrating it with the natural, social and artificially constructed environments in which the students live work and operate. Thus STS education has a place in the primary science classroom.

Chapter Three

Methodology

The Intervention

During the study period, the members of the experimental group engaged in a course of STS Education for one school term (approximately three months). This method of intervention - STS Education - intended to show the relevance Science, through the modification traditional didactic methods of teaching and learning science. This was done by shifting the focus of the science class from the passivity of note taking to active involvement in the learning process via STS. Teachers of the classes participating in the study were trained in the teaching of Science through STS for delivery of the curriculum in their classes. The teachers collaborated with the researcher in the planning of the units and were supervised by the researcher during the implementation phase over the period of study.

As part of the intervention process, Science sessions were videotaped as documented proof of students' interactions and participation in lessons. Both students and teachers were required to keep reflective journals of their experiences in the Science class during the study period. At the end of the period, students shared their reflections on the study and engaged in a re-evaluation of their perceptions of the relevance of science in their lives.

Finally, students were tested on content covered during the study period. The results of this post-test was analyzed together with other data collected to determine whether the trends verify a relationship between students' perception of the relevance of Science Education and their performance on Science tests as evident by their scores.

STS Teaching Model

For the purpose of this study, the Yager-McCormack Domains of STS model was adapted for use in this study. The model contains several domains. However, for the sake of this research project only the six basic domains of the model were used as the study involved primary school students.

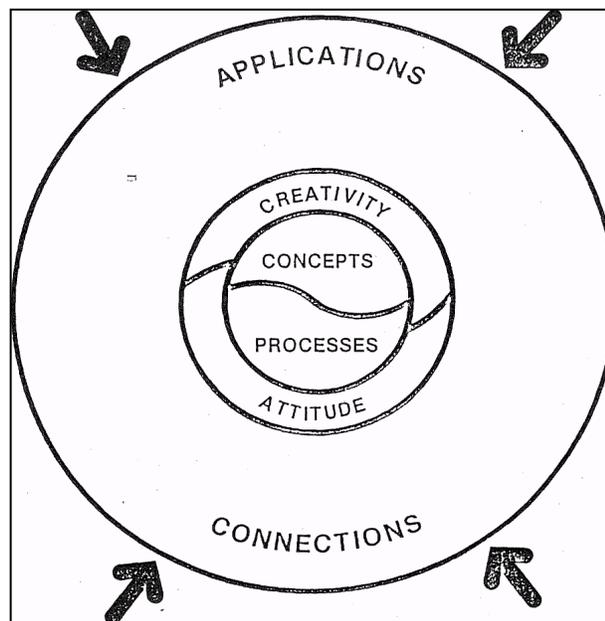


Figure 1 Yager-McCormack Domains of STS

Concept Domain.

In this domain, the goal of Science is to classify observable natural phenomena into manageable units for study, and to provide reasonable explanations for observed biological and physical relationships that are associated with these phenomena. The Concept Domain includes: facts, concepts, laws (principles), and existing hypotheses and theories being used by scientists. In the primary science the concept domain is categorized into six strands: Living Things, Ecosystems, Structures and Mechanism, Matter and Material, Earth and Space, Energy.

Process Domain.

Scientists use certain processes (skills) in the conduct of their work. Having a working knowledge of these processes of how scientists think and work is an integral element of learning science as they facilitate authentic learning of the units set out in the concept domain. Some processes of science are: observing and describing, classifying and organizing, measuring and charting, communicating and understanding communication with others, predicting and inferring, hypothesizing, hypothesis testing, identifying and controlling variables, interpreting data, and constructing instruments, simple devices, and physical models.

Creativity Domain.

At Train Line School, teachers view their science programs as “something to be done to students to help them learn a given body of information” (Yager, 1992). Very little focus is given in the classroom to the development of students' imagination and creative thinking which is contrary to the position of the Ministry of Education that states “Science education allows students to develop creativity both individually and collaboratively” (MOE, 2001). The range of abilities to be developed by the student in this domain include: visualizing - producing mental images, combining objects and ideas in new ways, offering explanations for objects and events encountered, questioning, producing alternate or unusual uses for objects, solving problems and puzzles, designing devices and machines, producing unusual ideas, and devising tests for explanations created.

Attitudinal Domain.

Human feelings, values, and decision-making skills are also important in science teaching and learning and must be addressed in the classroom. Yet classroom practices at Train Line Schools do not reflect teaching in the affective domain that will foster students' development of these qualities. The attitudinal domain is aimed at: developing positive attitudes toward science in general, science in school, and science teachers; developing positive attitudes toward oneself (an "I can do it" attitude); exploring human emotions; developing sensitivity to, and respect for, the feelings of other people; expressing personal feelings in a constructive way; making decisions about personal values; and making decisions about social and environmental issues.

Applications and Connections Domain.

Science and technology should not be divorced from each other as they both support the development and enhancement of each other. "Students at Train Line Schools need to become sensitized to those experiences they encounter which reflect ideas they have learned in school science" (Yager, 1992). For, it is through this type of interaction they are able to make connections and to see the applicability and relevance of what they are learning. Some dimensions of this domain include: seeing instances of scientific concepts in everyday life experiences; applying learned science concepts and skills to everyday technological problems; understanding scientific and technological principles involved in household technological devices; using scientific processes in solving problems that occur in everyday life; understanding and evaluating mass media reports of scientific developments; making decisions related to personal health, nutrition, and life style based on knowledge of scientific concepts .

STS Instructions.

STS education proceeds from the application/connections domain as the starting point for Science instruction. According to Yager and McCormack (1992), this method is student centered and can prove to be useful to students, as they engage in applying concepts and processes and making connections to real world problems. The applications/connections domain can be considered an appropriate starting point for Science instruction as it focuses on providing authentic, relevant and meaningful experience with science for students.

Rather than teaching from the assumption that students should be able to reach the applications/connections domain after experiences with organized knowledge and some processes, STS begin with applications, real issues, relevant questions, ideas that provide linkages and connections for students. By so doing STS Education fosters development of "higher-order thinking skills". Such a starting point also situates science in the real world contexts as opposed to that in which science is something people do in science classes or laboratories. Science thus becomes meaningful, relevant and authentic as students are able to connect school science to other curricula areas and to life in general.

Research Design

Subjects

Train Line Schools are two small schools in the Victoria Education District. The schools have a total collective population of three hundred and ninety-eight students most of who reside in the numerous squatting communities that comprise the school's catchment. At the time of the study there were four (4) Standard Four that are preparing to write the National Tests in June, 2012. This study involved two of the Standard Four classes with 9 and 21 students respectively, who have expressed disaffection for Science Education. Their Science experience had been limited to note-taking and diagramming. As a result, they considered science to be boring and loaded with "too much notes to learn".

The students, who are between the ages of 10 and 12 years old, all live within the squatting communities of the schools' catchment area, and all hail from low socio-economic, single parent families headed by young mothers. The students exhibit high rates of absenteeism. Many have serious behavioural problems with three of them requiring the services of the Ministry of Education's Student Support Services. Additionally, these children did not possess all the equipment that is necessary for school. The academic performance of some falls way below the required level for the Standard. However, these students excel at sports, athletics and practical hands on activities. It should be noted that these particular students have very high reading abilities, despite their lack of reading materials in the home.

The students' experience with technology is limited to the time they spend in the computer laboratory at school as none of their homes have computers. Their free time is spent mainly catching crabs in the nearby mangroves, bathing in the sea near their homes or playing

football, cricket and other outdoor seasonal games with friends in the neighbourhood. The students in the class have good interpersonal relationships with each other and work well in groups. They seem to be unmotivated to attend school and some of the students are unconcerned about poor test scores and grades. As far as Science Education is concerned, students seem to be uninterested in learning science. They expressed views that Science is irrelevant to their lives and saw no value in doing the subject. In fact, Science was ranked as the least important school subject by twenty two of the thirty-one families surveyed.

It is noteworthy that the teachers at Train Line Schools collaborate to plan for curriculum implementation. As such the students are exposed to the same curricular content as teachers follow the same scheme of work throughout the various levels. The schools do not engaged in streaming and as a result both groups are comparable in that they are both of mixed abilities and show a similar distribution of science scores. As the science test scores for the previous term indicated, the students perform poorly in science despite having above average reading abilities. They also perform fairly well in other subject areas.

Design and Procedure

This investigation employed a quasi- experimental design as random assignment to groups was not feasible in this situation. It should be noted however that the four Standard Four classes have been shown to be comparable in terms of the range of students' abilities found within the classes. The four groups of students were taught the same content as is outlined by the standardized scheme of work that had been collaboratively planned by the teachers of the classes. The experimental group was taught Science using the STS model of science education while the control group was taught using the methods that their teacher would usually employ in their science classes over the period of one school term. The effects of the independent variable i.e. the STS teaching strategy on the dependent variable i.e. students' performance/achievement as evidenced by the students' scores on the post test was investigated.

Changes in students' perception of the relevance of science were monitored by use of a Likert scale before and after the treatment. This was important to ascertain whether the students who were exposed to STS perceived science as more relevant after having been exposed to the intervention.

Although the study may be deemed quasi-experimental in design due to lack of randomization, the two Standard Four class that was not part of the intervention served to increase the reliability as well as increase the statistical validity of data collected in the study by serving as a control group for the intervention. Also, the post test was pilot tested in the Standard Five classes who have already covered the content, to ensure that the test has content validity.

Sampling

The study employed convenient sampling— two standard four classes at the particular schools – that were chosen based on availability and the willingness of the teachers to participate in the study. Though the lack of randomization may result in some systemic bias, this method was appropriate as it limited the threat to validity that may have resulted from disrupting the ‘normal’ classroom environment by randomizing the groups. Other threats to validity that may have arisen include the threat of interference of prior treatment as the students were surveyed about their views on science prior to the intervention. However, the use of two groups serves to limit the effects of this threat to the validity of the study.

All the students in the sample hailed from the same socio-economic circumstances and have limited exposure to technology; as such, any generalizations made will be contextually specific. However, it was reasonable to suggest that because the students in the sample are very typical of the school population the findings will be useful for making curricular decisions about science teaching within the school.

Variables of the Study:

Controlled Variable

Subject Matter/ Content.

All participants involved in the study were Standard Four students in the primary school system of Trinidad and Tobago. The teachers of these students collaborate in the planning of schemes and units of work; as such the students are expected to cover the same science content during the term.

Manipulated Variable**Method of Teaching Science.**

The experimental group in the study was exposed to the intervention of doing science through STS Education. The control groups were taught using the traditional methods that their teachers currently use in the delivery of the science curriculum.

Responding Variable 1**Students Perception of Science Education.**

Exposure to STS Education may cause a change in students' perception of the relevance of the science they are learning.

Responding Variables 2**Science Test Scores.**

Exposure to STS Education may improve students' performance on science tests.

Data Collection

Data Collection Instruments

<i>RESEARCH QUESTION</i>	<i>DATA SOURCE / DATA COLLECTION INSTRUMENT</i>
What impact will using an STS relevance based approach to science teaching have on students' performance on science tests?	➤ Results of post-test for both the experimental and control groups
How will an STS approach to science teaching influence students' perception of the relevance of science?	<ul style="list-style-type: none"> ➤ Likert Scale measuring students' pre-intervention and post-intervention perceptions of science. ➤ Focus Group Interview (Pre-Intervention perception)
What relationship if any, exists between students' perception of the relevance of science education and students' performance on science tests?	<ul style="list-style-type: none"> ➤ Results of post-test for the experimental group ➤ Likert Scale measuring students' post-intervention perceptions of science.

Table 3.1: Summary of Data Collection

The post test was used to provide an indication of students' achievement in science over the course of the term. It included both select response and supply response type items which were aimed at assessing students' understanding of scientific fact, principles and concepts as

well as their use of higher order skills such as data analysis and making inferences. This format mirrors the usual examination format to which students is accustomed and so allows for comparison of test scores between the experimental and control groups. Further these findings were used to determine whether the STS intervention resulted in any significant improvement in students' higher order thinking skills. Graphs and charts were used to compare the performance on items testing knowledge against items testing higher order skills and thinking.

The Likert Scale that was used to collect the pre-intervention perceptions of students would be re-administered to pupils to garner the perceptions of Science. The results of the post-intervention survey was used to improve the validity of the findings as it was used to determine whether there was any improvement in students relevance of the perception of science after being exposed to STS intervention. This was necessary as relevance can be perceived differently by the teacher and by the students. If it was found that the students exposed to STS had an improved view of the relevance of science as relevant it would add credence to the interpretation of STS used by the teacher. Conversely if students continue to think that science is boring and irrelevant to their lives it would suggest that the interpretation of STS method used by the teacher did not resonate with the students in terms of adding relevance. It should be noted however that the use of the Likert scale introduced a threat as it is likely that students may have given responses that they think the teacher would have expected. Despite this, the instrument, though inexact served to add quality to the of the research findings by providing an indication of the students perception of the relevance of the science they are learning.

Ethical Considerations and Trustworthiness

Relevant permissions were obtained for conducting the study i.e. permission from the principal of the school as well as permission from student's parents for them to be interviewed. On condition of participation, it was requested by the school that students' confidentiality be maintained. As such, students participating in the study were assigned an identification number by which they were referred to in the data. The identification numbers are known only to the researcher, thereby preserving the anonymity.

The implementation of the unit exposed students of the experimental group to a new method of learning and doing Science. Whereas it was the intention of the researcher for all students of the Standard Four classes to be part of the intervention, one of the Standard Four teachers declined to be a part of the study as he is retiring in September 2012, and did not wish to have the 'hassle involved'. In responding to this situation it was agreed that the students of the non-experimental group should not be placed at any educational disadvantage that may arise from their non inclusion in the study. As such the only variance in the conduct of the study was the method by which the content was delivered. There was no deviation from the planned program of work in agreement with the schools' attempt standardization.

There was an element of Researcher's Bias to be considered as the researcher is impassioned about the topic being researched. However, all attempts were made to minimize this bias by cross-referencing journals/ interviews with items on the Likert scale as well as by using member-checking to ensure reliability of participants' responses. Data was reported as gathered. The school has guaranteed access to information gathered and information gleaned from the study will be used only for the intended purpose as stated. Participation in the study was voluntary and participants were given the option to withdraw from the study at anytime.

Conducting the Study

Conceptualization of the study began in September 2011 after conducting an analysis of the school's performance in the Science National Tests for the period 2008 to 2010. This analysis showed that more than 50% of the students who wrote the exams failed to meet the required standard performance for the level. This led to the researcher examining the students' performance on teacher made Science tests. These analyses revealed that more than 75% of the students failed to achieve a score of more than 60% in Science tests at all levels of the school. These findings spurred the researcher to find out from the students how they feel about learning science as well as what may be contributing to their underperformance in science. As such a survey of students' attitudes towards science adapted from Koballa and Glynn (2006) was administered to students of the Standard Four classes as they were required to sit the Science National Tests at the end of the academic year. The responses to the survey questions were analyzed following which a focus group interview was conducted with the students to gain a deeper understanding of how students felt about learning and doing science. The interview was transcribed and analyzed for emergent themes. Following the analysis of the interview, the researcher began consulting the Literature for guidelines on how the students may benefit from learning science through STS education. The proposal to conduct the research was brought to the principals and standard four of the two schools, who agreed to the initiative.

The introductory phase of conducting the research began in January, 2012 with the identification of topics to be taught that would be best suited to the use of STS education. The teachers and the researcher collaborated to identify the topics that have not yet been taught and may be addressed by the intervention. A suitable STS Education model that could be adapted for use with Primary School students was found and teachers were trained in the use of the teaching

model. Two teaching units on the topics Magnetism and Electricity were collaboratively planned for implementation by the teachers in the classes. The implementation of the units began in February 2012. The lessons were to be taught by the class teachers and observed by the researcher periodically. Both teachers and students required to keep a journal. The researcher kept field notes of observed lessons. Upon completion of the unit implementation all students of the Standard Four classes would be given the same test bases on the units taught. The survey of attitudes towards science learning was administered to students. The results of the surveys and post-test were statistically analyzed and the results are presented in the Data Analysis Chapter of the study.

When the study was first conceptualized in September, 2011, it was the researcher's intent that it would have been conducted with the four Standard Four classes of Train Line Schools so that the effectiveness of the intervention could be measured through analysis of the post test results for both boys and girls; and through cross gender comparison. However, two teachers – one from the Boys' school and one from the Girls' school were unwilling to participate which led to the intervention being carried out on two classes with the other two classes forming the control groups. The teacher of one of the classes in which the intervention was being implemented did not keep a journal of the entire intervention process. Examination of the students' journal for that class and informal interviews with the students revealed that students were not encouraged to keep journals and that the teacher had used the traditional notes and lecture methods in the delivery of some of the lessons. The students' results for this said class are not included in the analysis as there was deviation from the intervention procedure which may present threats to the validity and reliability of the study. The analyses presented in the following chapter are for one experimental group and one control group in one of the Train

Line Schools. It was not possible to conduct cross-gender comparisons of results as the sample on which the reporting is based are of the same gender. The results yielded are specific to the class that participated in the study and cannot be generalized to the other students of Train Line Schools.

Data Analysis Procedure

The data gathered from the post test was used to determine whether there was a statistically significant difference between the means of the experimental group and the control group. This was conducted using the non-parametric Independent Samples t-test and the Mann-Whitney U-test both done at a 5% significance level to test the null hypothesis. It was assumed that the groups are normally distributed and have equivalent variance.

The performance of the students on knowledge based items as compared to items demanding higher level thinking will be compared using graphs and tables to determine whether there is a difference in the way students performed in these areas.

The data gathered from the Likert Scale instrument was scored. Each positive item receives the score based on points ranging from 5 to 1 (Strongly Agree= 5, Agree= 4, Undecided=3, Disagree=2, Strongly Disagree= 1). The scoring for each negative item would be reversed from 1-5 (Strongly Agree= 1, Agree= 2, Undecided=3, Disagree =4, Strongly Disagree= 5). The scores for each student was tallied and used to determine whether there was any significant statistical difference between the means of the perception of relevance score of the experimental group and the control group. The analysis was conducted the non-parametric Independent Samples t-test and the Mann-Whitney U-test both done at a 5% significance level to test the null

hypothesis. It was assumed that the groups are normally distributed and have equivalent variance.

“Correlation is the relationship between two or more paired variables. The degree of relationship is measure and represented by the coefficient of correlation” (Best, 2005, p. 378). If there is positive correlation then as one variable increases so does the other. The study sought to investigate whether students’ perception of the relevance of science influenced their performance on science tests. A correlation analysis between the results of students’ science test scores and the Post-Intervention survey was conducted using the non-parametric Spearman’s Rho formula to determine whether a relationship exists between these two variables. The coefficient of correlation, between the perceptions of relevance and the scores from the post-tests for the experimental groups was used to determine if the students’ perception of the relevance of science had an effect on their test scores.

The analyses as represented in graphical and discussion formats from which conclusions were drawn and inferences made.

Research Hypotheses: Comparing Teaching Strategies

μ_1 . mean test scores in group 1 (control group taught by traditional method)

μ_2 . mean test scores in group 2 (experimental group taught by STS method)

Null Hypothesis.

There is no difference in the mean test scores of students taught by traditional and STS methods.

H_0 : mean test score of group taught by traditional method = mean test scores of group taught by STS method.

$$H_0: \mu_1 = \mu_2$$

Alternative Hypothesis.

An STS Approach to science teaching improves students' test scores.

H_1 : mean test scores of group taught by STS method > mean test scores of group taught by traditional method.

$$H_1: \mu_2 > \mu_1$$

Research Hypotheses: Comparing Perception of Relevance

μ_a . mean of the perception of relevance scores in control group taught by traditional method

μ_b . mean of the perception of relevance scores in experimental group taught by STS method

Null Hypothesis.

An STS approach to teaching science has no effect on students' perception of the relevance of science.

H_0 : mean of the perception of relevance score of group taught by traditional method = mean of the perception of relevance scores of group taught by STS method.

$$H_0: \mu_a = \mu_b$$

Alternative Hypothesis.

An STS Approach to science teaching improves students' of the perception of relevance of science.

H_1 : mean of the perception of relevance scores of group taught by STS method > mean of the perception of relevance scores of group taught by traditional method.

$$H_1: \mu_b > \mu_a$$

Research Hypotheses: Determining the Existence of a Correlation

Null Hypothesis.

No relationship exists between students' perception of the relevance of science and students' performance on science tests.

H_0 : Coefficient of the correlation = 0

Alternative Hypothesis.

Students' perception of the relevance of science influences their performance on science tests.

H_1 : Coefficient of the correlation \neq 0

Delimitations

This study is limited to two single sex primary schools in the Victoria Education District and involves thirty-one Standard Four students in one core subject area.

Limitations of the study**Sampling.**

Subjects were chosen using convenience sampling. As such findings gathered from the sample cannot be generalized.

Extraneous Variables.

Other variables not considered by this study may influence students' performance on science tests, thus there are threats to validity.

Implementation.

The intervention requires a teacher skilled in the STS model in order for it to be effective. Teachers carrying out the intervention have no formal training in STS education and are being trained by the researcher to enact the planned units of work

Chapter Four

Data Analysis

Data for this study was gathered from a Survey of Student's Attitude towards Science, a Focus Group Interview with students and a Post Test based on the units of implementation (refer to Appendix I). A Post Test was administered after implementation of two units of study called 'the intervention'. Microsoft Excel software was used to organize 'Raw Data' collected during the study. The software was also used to calculate percentages and to generate the graphs contained in this study. Statistical Analysis of the data was done using the IBM SPSS statistical analysis software.

Qualitative Analysis of data gathered from Interviews was also done. The Qualitative Data was analyzed using elements of the "Grounded Theory" (Strauss & Corbin, 1990) method of data analysis. Interviews conducted for the purpose of this study were transcribed and transcriptions coded using line by line open coding for the purpose of creating categories for classifying data. Themes were generated from codes and transcriptions re-analyzed for selective coding of any unclassified data under the previously generated themes. Lincoln and Guba (1985) posit that member checking is the most crucial technique for establishing credibility of an account. Member checking was employed where necessary to help improve the accuracy, credibility, validity, and viability of the interpretation. Data collected from interviews were triangulated with survey results to ensure credibility and validity of findings.

Students' Performance on Science Tests

The Post-Test which was administered as part of the implementation of this study was developed as a collaborative effort by the researcher and the teachers of the classes involved in the study. Questions for the Post Test were sourced from samples contained in several Science Textbooks, Science National Tests, online sources, and items developed by the class teachers and researcher. The Post test was administered under standard examination conditions by the class teachers under the supervision of the researcher and the school's principal acting in the capacity of external. The test was scored by the class teachers and second marked by the researcher using a collaboratively developed standardized marking guided. This data gathered was subjected to a statistical test of means to determine whether any significant statistical difference, existed between the mean test scores of the Control group and the Experimental group involved in the study. The study employed purposive and convenient sampling processes; thus there was no randomization in the assigning of students to the control and experimental group. It could not therefore be assumed that both groups were of equivalent variance. Consequently, the data collected from the Post Test was subjected to a statistical analysis of means using the Independent Sample *t*-test (one-tailed) and Mann-Whitney U-test both done at a 0.05 (5%) Significance Level test to the null hypothesis. These Non-parametric statistical tests were considered useful for the statistical analysis as the study involved a small sample and parametric assumption could not be met for the group.

Research Question

What impact will using an STS relevance based approach to science teaching have on students' performance on science tests?

	STUDENTVALUES	N	Mean	Std. Deviation	Std. Error Mean
Posttest	Control	9	54.4444	19.57748	6.52583
	Experimental	9	79.7778	12.06004	4.02001

Table 1- Group Statistics from the Independent Samples t-test: Post-Test Results

A comparison of the Group Statistics (Table 4. 1) for Control and Experimental groups shows that there is a noteworthy difference between the arithmetic means of the Post-Test scores both groups. There is a 25.334 point difference between the means of the groups; with the mean for the Control being markedly lower than that of the Experimental group. Having established that there was a difference in the arithmetic means of the post test scores for the two groups, the data was subjected to a statistical test of means to determine if there was any significant statistical difference between the means.

	Levene's Test for Equality of Variances		t-test for Equality of Means							
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
								Lower	Upper	
Post-Test	Equal variances assumed	2.201	.157	-3.305	16	.004	-25.33333	7.66465	-41.58167	-9.08499
	Equal variances not assumed			-3.305	13.307	.006	-25.33333	7.66465	-41.85302	-8.81365

Table 2: Independent Sample t-test: Post-Test Results

The independent sample t-test (table4. 2) was used to determine if the two groups involved in the study could be assumed to have equal variance using Levene's test for equality of variances. Results of the Levene's test set the p-value or level of significance for the groups at 0.157. Since the p-value is not less than alpha ($\alpha=.05$), it could be assumed that both the Control and Experimental Groups in the study are of equal variance, when analyzing the data.

It should be noted that the SPSS software only performs a 2-tailed Independent t-test. As such the value realized in the "Sig. (2-tailed)" column is halved when performing the statistical analysis to determine the Significance value for a 1-tailed test. The Significance value (p) calculated for the means of the two groups is .004 which is approximated to 0.01. Since the p-value (0.01) is less than alpha ($\alpha=.05$) it could be deduced that there is a significant difference between the means test scores of the Experimental group and the Control group:

$$t(16) = -3.305; p < .05$$

STUDENTVALUES	Ranks			Test Statistics ^a	
	N	Mean Rank	Sum of Ranks	Posttest	
Control	9	6.11	55.00	Mann-Whitney U	10.000
Experimental	9	12.89	116.00	Z	-2.697
Total	18			Asymptomatic Significance (2-tailed)	.007
				Exact Significance [2*(1-tailed Sig.)]	.006 ^b
				<i>a. Grouping Variable: STUDENTVALUES</i>	
				<i>b. Not corrected for ties</i>	

Table 3 - Mann-Whitney U Test: Post- Test Results

The results of the Post-Test for the two groups were also analysed using the Mann-Whitney *U* test (see table 4.3) to determine the students' performance on the Post-test. The results yielded corroborated the findings of the t-test by which the results were previously

analysed. Students in the Experimental Group had an average rank of 12.89 while students in the Control group had an average rank of 6.11. The Mann-Whitney U test found that the students in the Experimental Group performed significantly better than the students in the Control Group. The z -score of -2.697 yielded on the test is less than the significant value of $.05$ at which the test was conducted.

$$z = -2.697; p < .05.$$

Post-Test Sectional Analysis

A sectional analysis of the Post Test data yielded that both groups of students performed almost homogeneously in the Multiple Choice section of the paper. However, the Experimental Group performed better than the Control Group on the Structured Questions; having a mean score that is 26% higher than that of the Control group as shown in figure 4.1

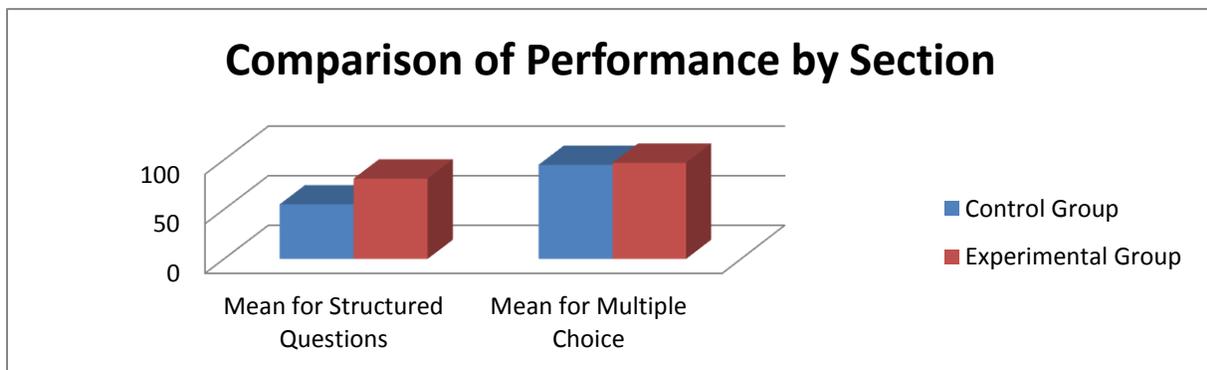


Figure 1 – Post-Test Analysis by Question Type

Further analysis of the Post-Test data showed that not only did the Experimental Group perform better than the control group on the Structured Questions, but also on the questions requiring the use of scientific Enquiry Skills, where the average of scores for the group was 36% higher than the average for the Control Group. Both groups had almost homogeneous scores on Knowledge/ Comprehension type questions.

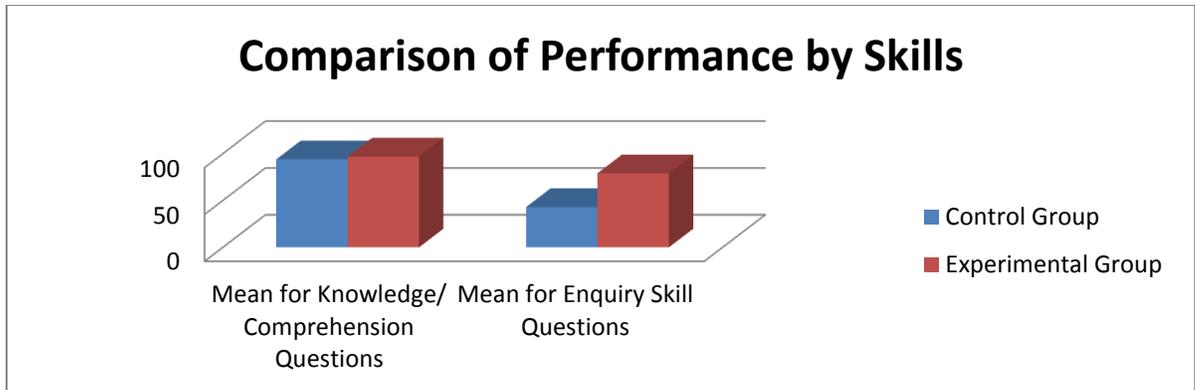


Figure 2 – Post-Test Analysis by Skills

Students' Perception of Science

A survey of students' attitude towards Science was administered to both the Control and Experimental Groups prior to and after the implementation of the intervention. The survey was adapted from the "Science Motivation Questionnaire" which was developed by Glynn & Koballa (2006). Data gathered from the pre intervention survey was used to determine how students felt about the science they were learning in school prior to the intervention. The purpose for administering the pre- intervention survey was to determine whether both groups of students had similar attitudes towards science going into the study. Results of the post intervention survey was compared to that of the pre-survey to determine if member's of the Experimental Group experienced any change in their perceptions of science after being exposed to the intervention. The post intervention survey was also administered to the Control Group. The post-intervention survey results of both groups were compared to for the purpose of finding out whether both groups of students still had the same perceptions of science at the end of the study period. An interview with a focus group comprising students of both classes was conducted at the end of the period as a means of gaining insights into what impact the intervention might have had on student's perceptions of science.

Research Question

How will an STS approach to science teaching influence students’ perception of the relevance of science?

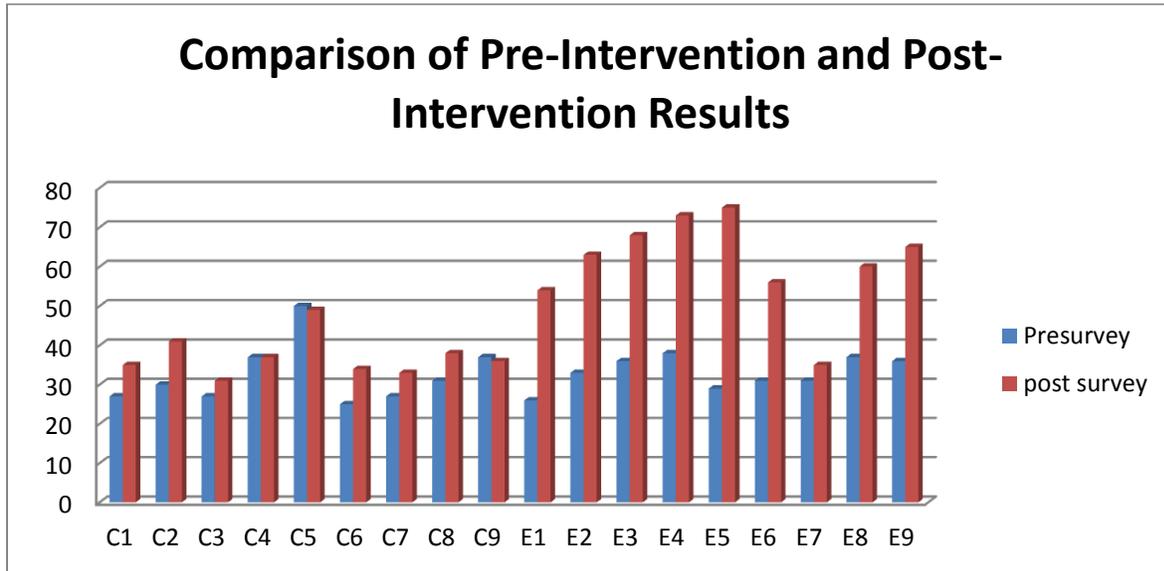


Figure 3 – Pre-Intervention and Post-Intervention Survey Results

A comparison of students’ Pre and Post-Intervention “Attitudes towards Science Survey” raw scores (Figure 4.3) shows that most students had higher scores in the Post-Intervention than in the Pre- Intervention Survey, which is indicative of an improved perception of the relevance of science education to the students. However, it should be noted that the Experimental Group, after being exposed to STS Education, had higher scores on the Post survey than students in the Control Group.

Group Statistics					
	STUDENTVALUES	N	Mean	Std. Deviation	Std. Error Mean
Post Intervention Survey	Control	9	37.1111	5.32552	1.77517
	Experimental	9	61.0000	12.04159	4.01386

Table 4 – Group Statistics: Post Intervention Survey

Despite the Experimental Group having higher scores than the Control Group on the Post- Intervention survey, it was necessary to determine if there was any significant statistical difference between the mean scores of both groups. The means of both the Control and Experimental groups were compared to establish if there was a significant difference between the mean scores on perception of relevance of science. As the study employed non-random sampling procedures the Experimental and Control groups could not be assumed to have equivalent variances. As such, Non-parametric tests were used in the analysis of the data. The Post- Intervention survey results of both groups were subjected to the Independent *t*-test (one-tailed) and the Mann-Whitney U test both tested at a 5% level of significance to the null hypothesis.

Comparing Post-Intervention Perceptions of Relevance of Science

Data gathered from the Post- Intervention Survey of both groups was analyzed using the Independent Samples t-Test to establish if there was a significant difference between the Control group and the Experimental groups (tables 4.5 and 4.6) with respect to the students' perception of the relevance of science.

Analysis of the group statistics (table 4.5) shows a distinct difference between the mean Post Intervention Survey scores of the Control group and that of the Experimental group. The groups differ by approximately twenty-four (24) points where the mean Post Intervention Survey score for the Experimental group is higher than that of the Control group.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Post-Intervention Survey	Equal Variances Assumed	3.019	.102	-5.443	16	.000	-23.88889	4.38889	-33.19292	-14.5846
	Equal Variances Not Assumed			-5.443	11.014	.000	-23.88889	4.38889	-33.54725	-14.2305

Table 5 - Independent Samples Test

Using Levene’s test for Equality of Variances, the Control and Experimental Groups were found to be of equal variance as the p-value calculated was found to be .102 which is greater than alpha ($\alpha=.05$). Therefore the data was analyzed using values for “Equal Variances Assumed”. The significant value for the two tail test of significance for the “Sig. (2-tailed)” is halved during analysis, to determine the Significance value for a 1-tailed test. The Significance value (p) is .000, which when approximated to .01 is less than alpha ($\alpha=.05$). Thus it may be concluded that there is a significant difference between the means of the Post-Intervention Survey scores of the Experimental group and the Control group.

$t(16)=-5.443: p<.05.$

STUDENTVALUES		Ranks			Test Statistics ^a	
		N	Mean Rank	Sum of Ranks	Post Intervention Survey	
Post Intervention Survey	Control	9	5.61	50.50	Mann-Whitney U	5.50
	Experimental	9	13.39	120.50	Z	-3.092
	Total	18			Asymptomatic Significance (2-tailed)	.002
					Exact Significance [2*(1-tailed Sig.)]	.001 ^b
					<i>a. Grouping Variable: STUDENTVALUES</i>	
					<i>b. Not corrected for ties</i>	

Table 6 - Mann-Whitney U Test: Post Intervention Survey

The Mann-Whitney U test was used to analyze the results of the Post- Intervention Survey (see table 7). A comparison of the results showed that if the Control Group had an average ranked score that was lower, than the average ranked score of the Experimental Group on the Post-Intervention Survey. Students in the Control Group had an average rank of 5.61 as compared to students in the Experimental Group who had an average rank of 13.39. The resultant difference in ranked scores was determined to be significant as the z score for the group was found to be less than alpha ($\alpha=.05$)

$z = -3.092, p < .05.$

Comparing Group Perceptions of Relevance for: Pre-Intervention versus Post-Intervention

Student ID# Control	Pre Intervention Survey	Post Intervention Survey		Student ID# Experiment	Pre Intervention Survey	Post Intervention Survey
	100	100			100	100
C1	27	35		E1	26	54
C2	30	41		E2	33	63
C3	27	31		E3	36	68
C4	37	37		E4	38	73
C5	50	49		E5	29	75
C6	25	34		E6	31	56
C7	27	33		E7	31	35
C8	31	38		E8	37	60
C9	37	36		E9	36	65
Mean	32.33	37.11		Mean	33	61

Table 7 – Comparison of Pre-Intervention and Post Intervention Survey Scores

Comparing Perceptions of Relevance

The Control Group.

The means of the Pre-Intervention and the Post-Intervention survey scores for the Control Group were compared using the Independent Samples t-test (one tailed) to determine if there was any significant change in the perception of relevance of science for this group. The analysis was necessary in order to determine if any extraneous variables, unaccounted for by the study that may have influenced the students' perceptions of the relevance of science, especially as the Control group was not exposed to the intervention of STS education.

Group Statistics					
Control Group Perceptions		N	Mean	Std. Deviation	Std. Error Mean
Survey Results	Pre-Intervention	9	32.3333	7.92149	2.64050
	Post-Intervention	9	37.1111	5.32552	1.77517

Table 8 - Group Statistics: Control Group Perceptions

Evaluation of the group statistics for the Control Group's perception of the relevance of science shows a marginal increase in the mean score after the implementation of the unit of work as shown in table 4.10 above. From this small mean increase it can be inferred that there was very little change in their perceptions of the relevance of science for the students of the Control Group.

		Independent Samples Test								
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Survey Results	Equal variances assumed	1.349	.262	-1.502	16	.153	-4.77778	3.18174	-11.52276	1.96721
	Equal variances not assumed			-1.502	14.005	.155	-4.77778	3.18174	-11.60170	2.04615

Table 9 – Independent Samples t-test: Control Group Perceptions

As this test compares results for the same group of students, it can be assumed that there is Equality of Variances according to the Levene's Test as the significant level calculated is .262 which is greater than alpha (alpha α = .05). The significant value given is for the two-tailed test, when halved to calculate the significance for the one-tailed test is equal to .0765 which is greater than alpha. It can therefore be concluded that there is significant statistical difference between the Control Group's Pre-Intervention and Post-Intervention survey scores. As the mean Post-Intervention score was higher than the mean Pre-Intervention score, it could be assumed that the students of the Control Group had an improved perception of the relevance of science after the implementation of the unit of work.

$$t(16) = -1.502: p < .05$$

Comparing Perceptions of Relevance

The Experimental Group.

A comparison of the means of the Pre-Intervention and the Post-Intervention survey scores of the Experimental Group was conducted using the Independent Samples t-test (one tailed) to determine if there was any significant change in the perception of relevance of science for this group. The analysis was necessary in order to determine what impact, if any exposure to the Intervention of STS education may have had on the students' perceptions of the relevance of science.

Experimental Group Perceptions		N	Mean	Std. Deviation	Std. Error Mean
Survey Results	Pre-Intervention	9	33.0000	4.06202	1.35401
	Post-Intervention	9	61.0000	12.04159	4.01386

Table 10 - Group Statistics: Experimental Group Perceptions

The group statistics for the Experimental Group records a marked increase in the students' mean score for the perceptions of the relevance of science after being exposed to the Intervention of STS education. The mean Post-Intervention score of 61 for the Experimental Group was 28 points higher than the mean Pre-Intervention score of 33.

	Levene's Test for Equality of Variances	t-test for Equality of Means								
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Survey Results	Equal variances assumed	3.969	.064	-6.610	16	.000	-28.00000	4.23609	-36.98011	-19.01989
	Equal variances not assumed			-6.610	9.797	.000	-28.00000	4.23609	-37.46511	-18.53489

Table 11 – Independent Samples t-test: Experimental Group Perceptions

The Levene's test for Equality of Variances (table 4.13) sets the Significance for the group at .062 which is higher than alpha ($\alpha=.05$) as such equal variances are assumed in the statistical analysis of the Pre-Intervention and Post-Intervention Survey means for the Experimental Group. The t-test for Equality of Means calculates the significance value for a two-tailed test at .000, which when halved and rounded up to .01 is less than alpha. Thus it can be concluded that there is a significant statistical difference between the mean scores of the Pre-Intervention and Post- Intervention survey results.

$$t(16) = -6.160; p < .05$$

Correlating Perception of the Relevance of Science and Performance on Science Tests

The 'Literature suggests that many factors contribute to students learning science as well as their performance on science tests. One such factor is their perception of the relevance of the science they are learning. Ziman, (1994) "the validity of much scientific knowledge depends on its successful worldly use and potential utility". In order to determine what correlation, if any, exist between the students' perception of relevance of science and their performance on science tests, the results of the Post-Intervention Survey and the Post-Test for both groups was statistically analyzed using the non-parametric Spearman's Rho 1-tailed test at a 0.05 level of significance.

Research Question

What relationship if any, exists between the students' perception of the relevance of science and students' performance on science tests?

A Bivariate Correlation analysis of the results Post Intervention Survey and the Post-Test was conducted to determine if any correlation between the students' perception of the relevance of science and their performance science tests. The analysis was done using a 1-tailed Spearman's rho correlation done at a .05 level of significance. The results yielded from this analysis (see table 4.14) shows a moderate direct correlation between the results of the Post-Intervention Survey and the results of the Post-Test as $\rho = 0.588$. The significant value for the test is set at 0.008 which is lower than alpha (alpha $\alpha = .05$). These results suggest that the correlation between the results of the Post-Intervention Survey and the results of the Post-Test is significant. Thus it may be assumed that as the students' perception of the relevance of science improved, their performance on science tests also increased or improved.

Correlations

			Post-Intervention Survey	Post-Test
Post-Intervention Survey	Correlation Coefficient		1.000	.558**
	Sig. (1-tailed)		.	.008
	N		18	18
Spearman's rho	Correlation Coefficient	Post-Test	.558**	1.000
	Sig. (1-tailed)		.008	.
	N		18	18
**. Correlation is significant at the 0.05 level (1-tailed).				

Table 12 – Spearman's rho correlation

Summary of Research Findings

This study was informed by three research questions that sought to investigate what impact, if any, a relevance based approach to teaching primary science through STS would have on students' perception of the relevance of science and students learning of scientific concepts and ideas. Data for this quasi- experimental study was gathered outlined in Table 4.15 below. Data gathered from the Post-Test, Pre-Intervention Survey and Post Intervention Survey was statistically analyzed and compared for both the Control and Experimental Groups. Inferences about students' perceptions and performance were made based on the results of the analysis.

<i>RESEARCH QUESTION</i>	<i>DATA SOURCE / DATA COLLECTION INSTRUMENT</i>
What impact will using an STS relevance based approach to science teaching have on students' performance on science tests?	➤ Results of post-test for both the experimental and control groups
How will an STS approach to science teaching influence students' perception of the relevance of science?	➤ Likert Scale measuring students' pre-intervention and post-intervention perceptions of science. ➤ Focus Group Interview (Pre-Intervention perception)
What relationship if any, exists between students' perception of the relevance of science education and students' performance on science tests?	➤ Results of post-test for the experimental group ➤ Likert Scale measuring students' post-intervention perceptions of science.

Table 13: Summary of Data Collection

Research Question1

What impact will using an STS relevance based approach to science teaching have on students' performance on science tests?

Research Hypotheses: Comparing Teaching Strategies

μ_1 . mean test scores in group 1 (control group taught by traditional method)

μ_2 . mean test scores in group 2 (experimental group taught by STS method)

Null Hypothesis.

There is no difference in the mean test scores of students taught by traditional and STS methods.

H_0 : mean test score of group taught by traditional method = mean test scores of group taught by STS method.

$$H_0: \mu_1 = \mu_2$$

Alternative Hypothesis.

An STS Approach to science teaching improves students' test scores.

H_1 : mean test scores of group taught by STS method > mean test scores of group taught by traditional method.

$$H_1: \mu_2 > \mu_1$$

Findings.

A comparison of the means scores of the Post-Test for both groups showed that the mean score of the Experimental group was higher than that of the Control group. The difference between the two means was found to be significant as the p-value for the test of means was

found to be less than the significant value for the test which was set at .05. Analysis of the students' performance found that the students who were exposed STS education performed better on questions that required higher thinking than students who were not exposed to STS education. It was also found that whereas students had homogenous performance scores on Multiple Choice Questions, students who were exposed to STS education performed better on the structured questions than those who were not. It may be therefore inferred from the analysis of the data that an STS approach to science teaching improves students' performance on science tests.

Decision: Reject the Null Hypothesis.

The Null Hypothesis for the comparison of teaching methods employed in the study proposed that there is no difference in the mean test scores of students taught by traditional and STS methods ($H_0: \mu_1 = \mu_2$). The Alternative Hypothesis suggests that an STS approach to science teaching improves students' test scores ($H_1: \mu_2 > \mu_1$). The p-value for the mean of the test scores is less than alpha ($\alpha=.05$). As such, the Null Hypothesis for the comparison of teaching methods is rejected. The decision to reject the Null Hypothesis is also supported by Hypothesis Test Summary for the Mann-Whitney U- test of mean test scores shown in table 4.4.

Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Posttest is the same across categories of STUDENTVALUES.	Independent-Samples Mann-Whitney U Test	.006 ¹	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.
¹Exact significance is displayed for this test.

Table 14 - Hypothesis Test Summary: Mann-Whitney U-test

Research Question 2

How will an STS approach to science teaching influence students' perceptions of the relevance of science?

Research Hypotheses: Comparing perception of relevance

μ_a . mean of the perception of relevance scores in control group taught by traditional method

μ_b . mean of the perception of relevance scores in experimental group taught by STS method

Null Hypothesis.

An STS approach to teaching science has no effect on students' perception of the relevance of science.

H_0 : mean of the perception of relevance score of group taught by traditional method = mean of the perception of relevance scores of group taught by STS method.

$$H_0: \mu_a = \mu_b$$

Alternative Hypothesis.

An STS Approach to science teaching improves students' of the perception of relevance of science.

H_1 : mean of the perception of relevance scores of group taught by STS method > mean of the perception of relevance scores of group taught by traditional method.

$$H_1: \mu_b > \mu_a$$

Findings.

A comparison of the Post- Intervention means for both groups showed that the mean score for students of the Experimental group was higher than that of students in the Control group by as much as 23%. Moreover the difference between the two means was found to be significant as the p-value for the mean of the Post Intervention Survey scores is less than 0.05.

Further comparisons revealed that students Experimental Group had overall higher scores in the Post-Intervention survey than students in the Control Group. At the end of the study period the students of the Control Group had a Post-Intervention mean increase of 4.78% over their Pre-Intervention mean score; as compared to the control group that recorded a Post-Intervention mean increase of 28% over their Pre-Intervention mean score.

Decision: Reject the Null Hypothesis.

The Null Hypothesis comparing the students' perceptions of the relevance of science after being exposed to STS education methods employed in the study proposed that an STS approach to teaching science has no effect on students' perception of the relevance of science. ($H_0: \mu_1 = \mu_2$). The Alternative Hypothesis suggests that an STS Approach to science teaching improves students' of the perception of relevance of science ($H_1: \mu_2 > \mu_1$). The p-value for the mean of the Post Intervention scores is less than alpha ($\alpha=.05$). As such, the Null Hypothesis for the comparison of teaching methods is rejected. The decision to reject the Null Hypothesis is also supported by Hypothesis Test Summary for the Mann-Whitney U- test of mean test scores shown in table 4.8.

Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Posttest survey is the same across categories of Student value.	Independent-Samples Mann-Whitney U Test	.000 ¹	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

¹Exact significance is displayed for this test.

Table 15 - Hypothesis Test Summary – Mann-Whitney U test

Research Question 3: What relationship if any, exists between the students' perception of the relevance of science and students' performance on science tests?

Research Hypotheses: Determining the Existence of a Correlation

Null Hypothesis.

No relationship exists between students' perception of the relevance of science and students' performance on science tests.

$$H_0: \rho = 0$$

Alternative Hypothesis.

Students' perception of the relevance of science influences their performance on science tests.

$$H_1: \rho \neq 0$$

Findings.

The correlation analysis of the results of the Post Intervention Survey and the Post-Test found that a moderate direct correlation exists between students' perception of the relevance of science and their performance on science tests. The correlation was also found to be statistically substantial as the significant value (1-tailed) calculated was calculated to be less than the .05 level of significance of the test to the null hypotheses.

Decision: Reject the Null Hypothesis.

The Null Hypothesis for determining the existence of a correlation between students' perception of the relevance of science proposed that No relationship exists between students'

perception of the relevance of science and students' performance on science tests ($H_0: \rho = 0$). The Alternative Hypothesis suggests that Students' perception of the relevance of science influences their performance on science tests ($H_1: \rho \neq 0$). The significant value for the Spearman's Rho (1-tailed test) statistical analysis is .008, which is less than alpha ($\alpha=.05$). As such, the Null Hypothesis for the determining the existence of a correlation between students' perception of the relevance of science and students' performance on science tests is rejected.

Chapter Five

Discussion, Conclusion and Recommendations

Discussion

Over the past two decades several reforms have taken place in the sphere of science which has induced new orientations in science education worldwide. One of the emerging approaches was Science-Technology-Society (STS). STS has been deemed a paradigm shift for the field of science education which has been termed the current megatrend in science education. *STS deals with real-world applications and issues of science and technology, and by taking a real-world approach to science in schools*(Kumar & Libidinsky, 2000, p. 18). According to Aikenhead (2005), STS instruction begins in the realm of society and focuses on “the application of scientific knowledge” (p. 7). Thus, STS education may help to make school science more authentic and relevant to students. This study sought to investigate the impact of a relevance-based approach to teaching primary science through STS on students’ perception of the relevance of science and students’ learning of scientific concepts and ideas.

A comparison of the means scores of the Post-Test for both groups involved in the study, showed students who were exposed to STS education had significantly higher test scores than students who were not. These findings are supported by Gabel (2003) who posits that STS education vastly increases in students’ ability to analyze data, test hypotheses and use their creativity. Further analysis of the Post test scores revealed these students performed better on questions that required higher thinking and on the structured question items than their peers who were not. The results of these analyses contradict claims made by Gable who noted “that there is little evidence that students’ knowledge of facts and concepts and principles improved because

of STS instructions” as the students of the Experimental Group performed significantly better and were able to correctly answer more questions on the Post-Test than students of the Control Group. However, they are supported by the findings of The Department for Education and Employment (1998) which states that “STS help students to concretize abstract science concepts”. The findings are also supported by the works of Ryder (2001) who notes “students in STS science class can significantly improve their understanding of external and internal science issues” (p.23).

Gömleksiz (2012) expresses the view that “students must be able to use what they learn in science classes” (p.212). The STS Intervention also had an effect on the students of the Experimental Group perception of the relevance of science. Data analysis shows statistically significant differences between the scores of the Pre-Intervention and Post-Intervention Science Attitude survey scores for the Experimental Group. Even the Control Group had a marginal increase in the Post- Intervention scores over the Pre-Intervention scores, difference between the scores deemed statistically insignificant which indicated that the traditional teaching method used with the Control Group had very little impact on the students’ perceptions of the relevance of science.

STS is a means of extending science, towards its real life applications... It allows students to apply their knowledge and understanding of scientific ideas to familiar phenomenon. STS allows students to see the benefits of science... STS validates science by giving students a personal connection with what they are learning. Aikenhead (1994)

Research by Aikenhead suggests that STS education makes school science authentic and relevant to students by allowing them to make connections between the school science and their

daily lives. Analysis of the Post-Intervention survey showed that students who were exposed to the Intervention of STS had an improved perception of the relevance of science which is in alliance with the findings of Aikenhead. The findings also supported by Ziman (1980) who posits “to draw attention to the relevance of science, in detail to everyday life is to provide it with a clear social role which may be done through STS indication”.

According to Solomon (1993:15), in Alsop and Pedretti (2001), “people need some STS education so that they can think, speak and act on those matters related to science that may affect this quality of living”. Fensham (1985) emphasizes that “STS education focuses on the needs of all students and that science can be used in other contexts relevant to student learning”. Chiappetta and Koballa (2002) states “STS facilitates students’ construction of realistic concept of the relationship between science and the world at large”. Yager (1995) agrees that STS instructions makes science content more meaningful and relevant to students, as it is grounded in constructivism. The works of Solomon, Fensham, Chiappetta and Koballa and Yager all support the findings of the study.

Analysis of the Pre-Intervention Attitude Survey, the Post Intervention Attitude Survey and the Post-Test showed that whereas there was no significant statistical difference between the mean Pre Intervention Survey scores of both groups involved in the study, the students of the Experimental Group had higher mean Post-Intervention and Post-Test scores after being exposed to the intervention of STS education. The results are indicative of a positive relationship between the students’ attitude towards science and the performance on the science test. This suggests that the intervention may have been responsible students increased perceptions of the relevance of science as well as for their improvement in test scores over the students of the Control Group.

The correlation analysis of the results of the Post Intervention Survey and the Post-Test found that a moderate direct correlation exists between students' perception of the relevance of science and their performance on science tests. These findings are in alignment with research findings of Ferlazzo (2011), (Kember, Ho, & Hong, 2008) and Hulleman & Harackiewicz (2009) who identified relevance as a key factor to motivating student learning. Also important, is that the results of the study support theory put forth by Wieman (2007) who found that "relevance can bring theory to life, and provide the motivation necessary to inspire deep and sustained learning" (p.11).

Conclusion

The aim of this study was to investigate the impact of a relevance-based approach to teaching primary science through STS on students' perception of the relevance of science and students' learning of scientific concepts and ideas. From the findings of the study it may be concluded for the students of the Experimental Group that STS education impacted positively on students' perceptions of the relevance of science and on their performance on the science test. Furthermore, the findings suggest that there is a direct positive relationship between the two variables. Notwithstanding the findings as relates to students who were exposed to the Intervention, it is noteworthy that students of the Control group also recorded an increase in the Post-Intervention survey scores over the Pre-Intervention scores albeit a marginal increase. This finding is indicative of some extraneous factor not accounted for by the study may have accounted for the improvement in the perception of relevance scores attained by the students on the Post-Intervention survey.

Findings of this study are limited to a small sample of Standard Four male students from one primary school in one education district in Trinidad and Tobago. Consequently they are not typical of all students who have been exposed to STS education. Also, there are several domains of STS education. However, findings in this study are relative to only the Applications and Connections domains of STS; as such they are not an attestation to the overall effectiveness and impact of STS education on primary science education.

Recommendations

Science, Technology and Society (STS) is one of the fundamental components of the Nature of Science which is essential for promoting students' understanding of the intricate nature of natural phenomena; as well as for developing scientific literacy. However, this feature of science education, which is a key of the Secondary School Science Curriculum, is not included in the Primary Science Curriculum of Trinidad and Tobago. Several studies have been conducted on the use of STS as a method for teaching science. However, there is limited information about its use in the Caribbean; and no information has been found on its use in the primary school system of Trinidad and Tobago. The intent of this study is to provide new knowledge on the use of STS as a method of teaching and learning primary science that can serve to propel further research in the field. Additionally, the results of the study will also provide data that can be integrated into the development of a plan for authentic and relevant science education at Train Line School.

Findings of the study are limited and therefore specific to the sample with which the study has been conducted. Yet data gathered are evidence that STS education can impact on students' perception of the relevance of science and on their learning of scientific ideas and concepts. Therefore the use of STS education can be included as a teaching method for use in the science classroom at Train Line School. However, it is recommended that the method be piloted at the upper primary level of the school where the students are at a more advanced stage of cognitive development and are more likely to benefit from STS instructions. It is also recommended that students' achievement in science be monitored and tracked during the piloting of the progress so that comprehensive analysis of the effectiveness of the program and its impact on students' achievement in science may be determined.

The focus of this study was on using STS education as a means of providing more authentic and relevant school science experiences for students through the use of purposeful infusion of STS content into two science units. Results gathered gives credence to the success of the Intervention. It is therefore the recommendation of the researcher that students be exposed to a wider range of STS education that covers several STS domains during the piloting of STS in the school. It is also recommended that STS instructions be expanded beyond infusion to include STS content so that students may experience the full experience of STS education. Thus, findings made at the conclusion of the pilot phase may be a truer representative of effectiveness of the use of STS as a method of teaching primary science. The researcher also recommends that the piloting of STS education be extended to include other schools with different demographics, so that findings may be more typical of the results of the impact of use of STS education as a method of teaching primary science.

STS education has been proven to have vast benefits to students who engage in STS studies during higher levels of education which have not been explored in this study. These benefits may hold serious implications for the effective teaching and learning of primary science. However, the benefits of STS cannot be assumed for all levels of education. As the researcher has found no documented information with regards to STS education in the primary school system of Trinidad and Tobago, it is recommended that continued and more extensive research be done in this field to so that there may be documented evidence that speaks to the use of STS education as a means of teaching primary science in Trinidad and Tobago.

REFERENCE

- Aikenhead, G. (2004). Education, The Humanistic and Cultural Aspects of Science & Technology. *A plenary paper presented to the 11th International Organization for Science and Technology Education (IOSTE) Symposium*, (pp. 4-7). Lublin, Poland,. Retrieved January 30, 2011, from <http://www.usask.ca/education/people/aikenhead/ioste2004.pdf>
- Aikenhead, G. (2005). Research into STS Education. *Educación Química*, 16, 4-11. Retrieved March 1, 2012, from http://www.usask.ca/education/people/aikenhead/research_sts_ed.pdf
- Aikenhead, G., & Solomon, J. (1994). *STS Education: International Perspectives on Reform*. New York: Teacher's College Press.
- Alsop, H., & Hicks, K. (2001). *Teaching Science: A Handbook for Primary and Secondary School Teachers*. Virginia: Stylus Publishing Inc.
- Best, J., & Khan, J. (2009). *Research in Education* (10th ed.). New York: Pearson Education Inc.
- Boud, D., Keogh, R., & Walker, D. (1995). *Reflection: Turning Experience into Learning*. London: Kogan Page.
- Bybee, R. (1995). Science Curriculum Reform in the United States. In *Redesigning the Science Curriculum*. Washington, DC: National Academy of Sciences. Retrieved from The National Academy of Sciences.

Cheek, D. W. (1992). Evaluating Learning in STS Education. *Theory into Practice*, 33(1), 64-72.

Retrieved February 5, 2012, from

<http://www.jstor.org/discover/10.2307/1477056?uid=3739200&uid=2&uid=4&sid=56272687673>

Chiapetta, E. L., & Fillman, D. A. (1993). Do middle school life science textbooks provide a balance of scientific themes? *Journal of Science Teaching*, 30(7), 787-797.

Driver, R., Leach, J., Millar, R., & Scott, P. (1996). *Young people's images of science*.

Buckingham: Open University Press.

Fensham, P. (1992). Science and technology. In P. Jackson (Ed.), *Handbook of research on* (pp.

789-829.). New York: Macmillan Publishing Co. Retrieved 10 11, 2011, from

http://www.usask.ca/education/people/aikenhead/research_sts_ed.pdf

Ferlazzo, L. (2011, MAy 11). *Helping Stidents Motivate Themselves:Practical Answers To Classroom Challenges*. Sacramento: Eye on Education. Retrieved from Edublog.

Gabel, D. (2003). *Enhancing the Conceptual Understanding of Science in Educational Horizons*.

NewJersey: Pearson Educational Inc.

Glynn, M. S., Brickman, P., Armstrong, N., & Taasoobshirazi, G. (2011, August 28). Science

Motivation Questionnaire II:Validation With Science Majors and Nonscience Majors.

JOURNAL OF RESEARCH IN SCIENCE TEACHING, 48(10), 1159–1176.

Glynn, S. M., & Koballa, T. R. (2006). Motivation to Learn in College Science. In J. J. Mintzes,

& W. H. Leonard (Eds.), *Handbook of College Science Teaching* (pp. 25-32). Arlington,

VA: National Science Teachers Association Press.

- Halpin, D. (2009, October). National curriculum reform in China and England: Origins, character and comparison. *Frontiers of Education in China*, 258-269.
- Hulleman, C. S., & Harackiewicz, J. M. (2009, December 4). Promoting Interest and Performance in High School Science Classes. *Science*, 326, 1410-1412.
- Kember, D., Ho, A., & Hong, C. (2008). *Active Learning in Higher Education*, 9, 249-263.
- Koballa, E., & Chiapetta, T. (2002). *Science Instructions in Middle and Secondary Schools*, 5th Ed. J. Pearson. New Jersey, U.S.A.: Education Inc.
- Kumar, D. D., & Libidinsky, L. J. (2000). Analysis of Science Education Reform Resources On the World Wide Web. *American Secondary Education*, 8(4), 16-21. Retrieved January 19, 2012, from <http://www.jstor.org/stable/41064404>
- Lincoln, Y. S. (1985). *Naturalistic Inquiry*. Newbury Park, CA: Sage Publications.
- M.O.E. (2006). *Primary School Science Syllabus Standard Four and Five*. Port of Spain: GORTT, Curriculum Development Division.
- Mansour, N. (2007, December). Challenges to STS Education: Implications for Science Teacher Education. *Bulletin of Science Technology and Society*, 27(6), 482-497. Retrieved December 29, 2011, from <https://eric.exeter.ac.uk/repository/bitstream/handle/10036/47176/Challenges%20to%20STS%20Education.pdf?sequence=1>
- Mansour, N. (2009, August). Science-Technology-Society (STS): A New Paradigm in Science Education. *Bulletin of Science Technology*, 29(4), 287-297.

- Mc Comas, W. (1998). *Nature of Science in Science Education*. Boston: Kluwer Academic Publishers.
- McKinley, E. (2005). Locating the global: culture, language and science education for indigenous students . *International Journal of Science Education*, 227-241.
- Murphy, T. (2011). *STEM Education--It's Elementary*. St. Catherine University, National Center for STEM Elementary Education . St. Paul, Minn: St. Catherine University Press.
Retrieved May 21, 2012, from <http://www.usnews.com/news/articles/2011/08/29/stem-education--its-elementary>
- National Centre for Education Statistics. (2009). *Trends in International Mathematics and Science Study*. Washington : IES.
- National Science Foundation, Division of Science Resources Statistics. (2004). *Science and Engineering Indicators 2004*. Arlington, VA: National Science Board.
- National Science Teachers Association. (2004). *Science/Technology/Society: A New Effort for Providing Appropriate Science for All*. Arlington, VA: NSTA. Retrieved February 5, 2012, from <http://imet.csus.edu/imet6/dibble/showcase/NSTAPositionStatementSTS.pdf>
- National Science Teachers Association. (2010). *Teaching Science and Technology in the Context of Societal and Personal Issues*. Arlington, VA: NSTA .
- Park, D.-Y. (2006). *Curriculum Reform Movement in the US – Science Education*. Normal, IL: Illinois State University Press.
- Primary School Syllabus*. (March 2006). Port of Spain: Government Printery.

- TEACHING SCIENTIFIC LITERACY THROUGH A SCIENCE TECHNOLOGY AND SOCIETY COURSE: PROSPECTIVE ELEMENTARY SCIENCE TEACHERS'. (2004, October). *The Turkish Online Journal of Educational Technology*, 3(4), 58-61. Retrieved September 30, 2011, from <http://www.tojet.net/articles/v3i4/348.pdf>
- US Department of Education. (2011). *The Educator's Best Friend*. Retrieved May 1, 2012, from No Educator Left Behind: Purpose of Testing: http://www.educationworld.com/a_issues/NELB/NELB057.shtml
- Wieman, C. (2007). Why not try a scientific approach to science education. *Chsnge*, 9-15.
- Yager, R. E. (1992). The Status of Science-Technology-Society ReformEfforts Around the World. *ICASE YEARBOOK 1992*. (R. E. Yager, Ed.) Arlington, Virginia, United States of America: NSTA. Retrieved January 14, 2012, from http://www.icaseonline.net/robert_yager.pdf
- Ziman, J. (1980). *Teaching and learnig about science and technology*. Cambridge : Cambridge University Press.