Attitudes of Grades Ten and Twelve Students towards Science in Bhutan

Sangay Zangmo

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Education in Education for Sustainable Development

Prince of Songkla University

2016

Thesis Title56T Attitudes of Grades Ten and Twelve Students towards Science in Bhutan

Author Miss Sangay Zangmo

Major Program Education for Sustainable Development

Major Advisor

……………………………………………..
(Assoc. Prof. Dr. Chidchanok Churngchow)

Co-advisors

……………………………………………..
(Assoc. Prof. Dr. Theeraphong Kaenin)

……………………………………………
(Dr. Nattinee Mophan)

Examining Committee

…………………………….....Chairperson
(Asst. Prof. Dr. Nathavit Portjanatanti)

. ………………………………………...
(Assoc. Prof. Dr. Chidchanok Churngchow)

……………………………………………
(Assoc. Prof. Dr. Theeraphong Kaenin)

…………………………………………….
(Dr. Nattinee Mophan)

. ………………………………………...
(Asst. Prof. Dr. Konvika Kongkul)

The Graduate School, Prince of Songkla University, has approved this thesis as partial fulfillment of the requirements for the Master of Education Degree in Education for Sustainable Development.

…………………………………………
(Assoc. Prof. Dr.aTeerapol Srichan)
Dean of Graduate School

This is to certify that the work here submitted is the result of the candidate's own investigations. Due acknowledgement has been made of any assistance received.

……………………………………Signature

(Assoc. Prof. Dr. Chidchanok Churngchow)

Major Advisor

……………………………………Signature

(Ms. Sangay Zangmo)

Candidate

I hereby certify that this work has not been accepted in substance for any other degree, and is not being currently submitted in candidature for any degree.

……………………………… Signature

(Ms. Sangay Zangmo)

Candidate

ชื่อวิทยานิพนธ์ เจตคติต่อวิทยาศาสตร์ของนักเรียนเกรดสิบและสิบสองนักเรียนในประเทศภูฏาน

ผู้เขียน Miss Sangay Zangmo

สาขาวิชา การศึกษาเพื่อการพัฒนาที่ยั่งยืน

ปีการศึกษา 2558

บทคัดย่อ

การวิจัยเรื่องนี้ดำเนินการ โดยใช้การวิจัยผสมวิธี โดยใช้การออกแบบประเภทต่อเนื่องเชิงอธิบายเพื่อศึกษาอิทธิพลของเพศเชื้อชาติเกรดและการมีส่วนร่วมของบิดามารดาหรือผู้ปกครองที่มีต่อวิทยาศาสตร์ของนักเรียนในประเทศภูฏาน กลุ่มตัวอย่างเป็นนักเรียนจำนวน 383 คนซึ่งได้มาจากการสุ่มหลายขั้นตอนแบบเป็นสัดส่วนเพื่อตอบแบบสอบถาม โดยแบบสอบถามในด้านเจตคติต่อวิทยาศาสตร์และการมีส่วนร่วมของบิดามารดาหรือผู้ปกครองมีค่าสัมประสิทธิ์ความเที่ยง โดยวิธีของครอนบัคเท่ากับ .92 และ.81ตามลำดับ การวิเคราะห์ข้อมูลใช้การทดสอบค่า t แบบเป็นอิสระต่อกัน สหสัมพันธ์แบบเพียร์สันและการวิเคราะห์ความแปรปรวนแบบทางเดียว สำหรับผู้ให้ข้อมูลสำคัญในการสัมภาษณ์ประกอบด้วยนักเรียน 13 คนและครูวิทยาศาสตร์จำนวน 15 คน โดยการเลือกแบบเจาะจงเพื่อต้องการคำอธิบายของข้อค้นพบที่ได้จากแบบสอบถาม

ผลการวิจัยในภาพรวมพบว่า ผลการวิจัยเชิงคุณภาพสอดคล้องกับผลการวิจัยเชิงปริมาณ โดยระดับเจตคติต่อวิทยาศาสตร์โดยรวมของนักเรียนอยู่ในระดับสูงและการมีส่วนร่วมในภาพรวมของบิดามารดาหรือผู้ปกครองต่อวิทยาศาสตร์อยู่ในระดับปานกลาง สำหรับเพศไม่มีอิทธิพลต่อเจตคติต่อวิทยาศาสตร์ในขณะที่นักเรียนเกรดสิบสองมีระดับเจตคติต่อวิทยาศาสตร์สูงกว่านักเรียนเกรดสิบอย่างมีนัยสำคัญ ในขณะเดียวกันการมีส่วนร่วมของผู้ปกครองมีความสัมพันธ์ทางบวกกับเจตคติต่อวิทยาศาสตร์ แต่เชื้อชาติไม่มีอิทธิพลต่อเจตคติต่อวิทยาศาสตร์ของนักเรียนแต่อย่างใด ผลการวิจัยแสดงให้เห็นว่า ระดับเจตคติต่อวิทยาศาสตร์ของนักเรียนได้รับอิทธิพลจากการมีส่วนร่วมของบิดามารดาหรือ

ผู้ปกครองโดยตรงและไม่จำเป็นที่ผู้ปกครองต้องมีระดับการศึกษาสูงในการเสริมสร้างเจตคติต่อวิทยาศาสตร์ของนักเรียนแต่ประการใด

ข้อเสนอแนะของการวิจัยคือครูและโรงเรียนควรส่งเสริมให้ผู้ปกครองมีส่วนร่วมอย่างแข็งขันในกิจกรรมทางวิทยาศาสตร์ที่บ้านและการเรียนรู้ทางวิทยาศาสตร์ของนักเรียนถึงแม้ว่าจะมีอุปสรรคอยู่บ้างก็ตาม

Thesis Title Attitudes of Grades Ten and Twelve Students towards Science in Bhutan

Author Miss Sangay Zangmo

Major Program Education for Sustainable Development

Academic Year 2015

ABSTRACT

This research conducted using mixed methods explanatory sequential design to examine the effects of gender, ethnicity, grade and the parents or guardians' involvement in science on students' attitudes towards science. The sample consisting of 383 students, selected by proportional stratified random sampling, completed the questionnaire. The coefficient of reliability based on Cronbach alpha for attitudes towards science and the parents or guardians' involvement in science scales was .92 and .81 respectively. The data were analyzed using an independent *t*-test, one-way ANOVA and Pearson's correlation. Key informants for interview consisted of 13 students and 15 science teachers, selected by purposeful sampling. The interview was conducted to seek the explanations to the results obtained from questionnaire.

The overall results showed that qualitative findings supported the quantitative results. The findings indicated that the students' overall attitude towards science was at a high positive level and the overall parents or guardians' involvement in science was at moderate level. The gender had no significant effect on students' attitudes towards science while Grade 12 science students had significantly more favourable attitude towards science than those of Grade 10 students. Meanwhile, the correlation

between the parents or guardians' involvement in science and the students' attitudes towards science was positive, and the ethnicity had no influence on the students' attitudes towards science. Results also showed that students' levels of attitudes towards science are directly affected by involved parents and it is not necessary for the parents' level of education to be high in order for the parents to motivate or support their children's attitudes towards science. It is recommended that teachers and schools should encourage parents to be actively involved in their children's science activities at home and to support their children's science learning despite there being significant barriers to parental involvement.

ACKNOWLEDGEMENT

It would not have been possible for me to complete this thesis and my master's study without the help of many individuals. First and foremost I would like to thank my advisor, Associate Professor Dr. Chidchanok Churngchow, co-advisor, Associate Professor Dr. Theeraphong Kaenin and thesis committee member Dr. Nattinee Mophan for the time they have taken to advise, guide and support me in my thesis. It was a pleasure being the advisee of such wonderful people. I thank you all for your tireless effort.

By the same token, I would like to offer my sincere thanks to Assistant Professor Dr.Nathavit Portjanatanti, the former dean of the Faculty of Education (2011-2015), Dr. Alisara Chomchuen, lecturer at the Department of Education, Faculty of Education and Dr. Nattinee Mophan, my thesis committee member for their guide and assistance in the validation of the instrument for my study. I also wish to thank all the *Ajarns* and the office staff at the Prince of Songkla University, under the Faculty of Education who in their own way supported and helped me in my endeavours. I am thankful to my classmates and all the other international friends for being a source of strength to each other.

My sincere thanks and gratitude to the Higher Education Research Promotion and Thailand's Education Hub for the Southern Region of ASEAN Countries (TEH-AC) Project Office of the Higher Education Commission for providing the scholarship.

Back at home, I am much obliged to the officials at the Department of School Education; Thimphu *Thromde* Education office and Thimphu *Dzongkhag* Education office and the host schools for their willingness and corporation in the collection of my data.

Last but not least, my heartfelt thanks and gratitude to my mother and family for their unwavering moral support and encouragement in all my endeavours.

Sangay Zangmo

CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1

Introduction

This chapter provides the general context for the study and sets out to give a brief background of Bhutan, about its education system, structure of the formal education system, science education in Bhutan and finally the details of students' participation in science education at various grade levels in schools.

1.1 About Bhutan

Bhutan, also referred to as "*Druk Yul*" (meaning the "Land of Thunder Dragon" in the national language *Dzongkha*[1]) is a small landlocked country in the Southern Asia nestled in the eastern Himalayas between the extensive borders of the two most populated countries, China and India. It has a rich culture that has remained intact because of its self-imposed isolation from the rest of the world until five decades ago.

The nation's territory totals an approximate 38,394 square kilometers and is divided into 20 *dzongkhags* (districts). These 20 districts are then divided into 205 *gewogs* (village blocks) and further into numerous *thromdes* (municipalities) for effective administration. Thimphu is the capital of Bhutan. Geographical landscape of the country is a complex knot of mountains, hills, spurs and valleys with altitudes ranging between 200 meters to above 7500 meters above sea level in south to north respectively. The climatic conditions are varied at different altitudes and are affected by monsoons like

[1] Language of fort

most of Asia. Temperatures vary greatly between day and night and at different altitudes. Most settlements are confined to deep, low valleys and gentle slopes.

The total population of the country is 757,042[2] of which 393,324 (52%) are males and 363,718 (48%) are females according to the population and housing census. Buddhism is the main religion of the country. Many diverse dialects are spoken in the country besides *Dzongkha* and English. English is both the medium of instruction in schools and an administrative language.

The modernization process in Bhutan began with the introduction of its first five year plan in 1961 and Bhutan aspires to be a country where development is holistic, inclusive and sustainable. This aspiration comes from its unique development philosophy of Gross National Happiness (GNH) - a term coined by the fourth king of Bhutan, Jigme Singye Wangchuck in 1972- which measures prosperity by taking into consideration the citizens' well being and not the Gross Domestic Product (GDP). According to this philosophy true development can happen when material, emotional and spiritual well being occurs side by side to complement and reinforce each other. The concept of Gross National Happiness consists of four pillars- Equitable and equal socio-economic development; Conservation and promotion of a vibrant culture; Environmental sustainability; and Good governance. These four pillars are further elaborated in nine domains. In accordance with these nine domains, 38 sub-indexes, 72 indicators and 151 variables are used to define and analyze the happiness of the Bhutanese people.

[2] Projected population by the Population and Housing census (PHBC), Bhutan.

Bhutan has existed as an independent nation with no background of colonial rule by any powers throughout its history. In March 2008, Bhutan became a democratic constitutional monarchy after 100 years of monarchy under the farsighted leadership of the Wangchuck dynasty and became the world's youngest democracy.

Figure 1: Mini-Map of Bhutan

Source: http://www.tribes.co.uk/map-of-bhutan

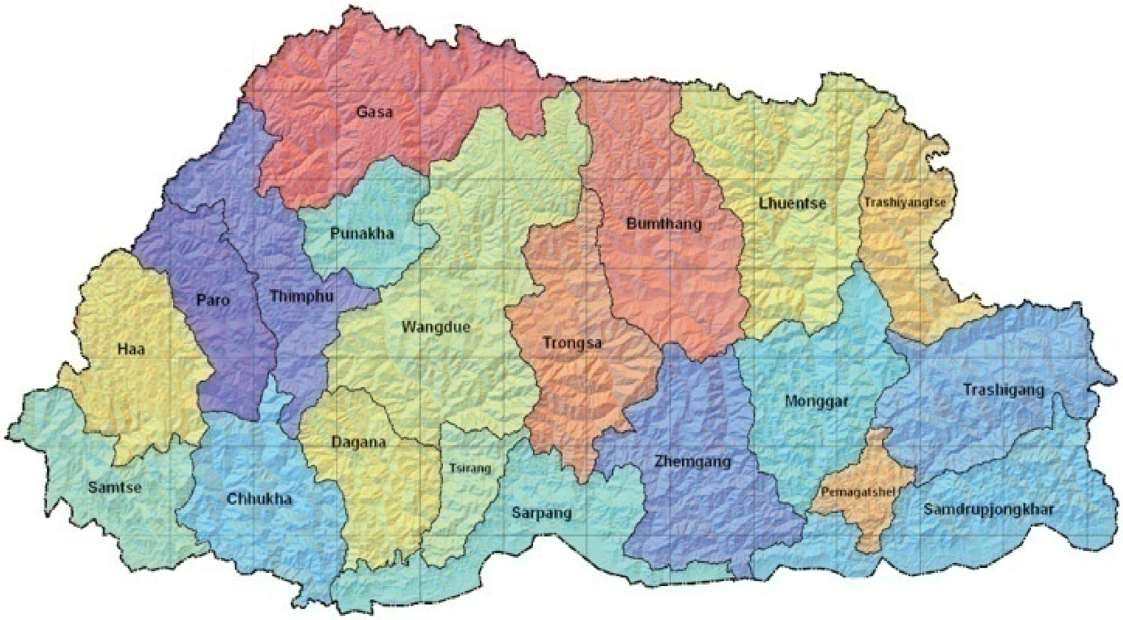

Figure 2: Map of Bhutan

Source: http://www.vidiani.com/detailed-administrative-and-relief-map-of-bhutan/

1.2 Education System in Bhutan

The only formal education that was available to Bhutanese students before the advent of modern education in Bhutan in 1950s was mainly monastic and literacy was confined to monasteries. Then, with the arrival of modern education system in 1950s there was a paradigm shift in the field of education. When the modern education first began, the first secular school was opened with the curriculum and the medium of instruction (*Hindi* –formal language of India) borrowed from India. However in 1960s, English was made the language of instruction to enable the small and isolated Bhutan to communicate with the world around it and also due to limited learning material in *Dzongkha*.

The modern education, since its arrival in 1950s has developed consistently and has made tremendous development in the education system with the inception of the first five year plan in 1961. Bhutan now has three major systems of education namely monastic education; formal, institution-based education; and non-formal and continuing education (Figure 3). Though the monastic education is the oldest system of education, the largest today is the formal, institution based education with 551 schools all over Bhutan. Formal schools throughout the country follow the curriculums designed by the Department of Curriculum Research and Development (DCRD). Admissions into the formal school begin at the age of six, in the monastic school at any age and in the non-formal centers for all ages as it is available to provide basic literacy to those who have missed formal schooling.

Bhutan, today envisages a system of wholesome education (all round development of children) that pays attention to extracurricular activities (for physical, intellectual, emotional and spiritual development) besides developing knowledge and qualities that will enable children to prosper in the school world and also in the world of work later (Royal Education Council, REC, 2012).

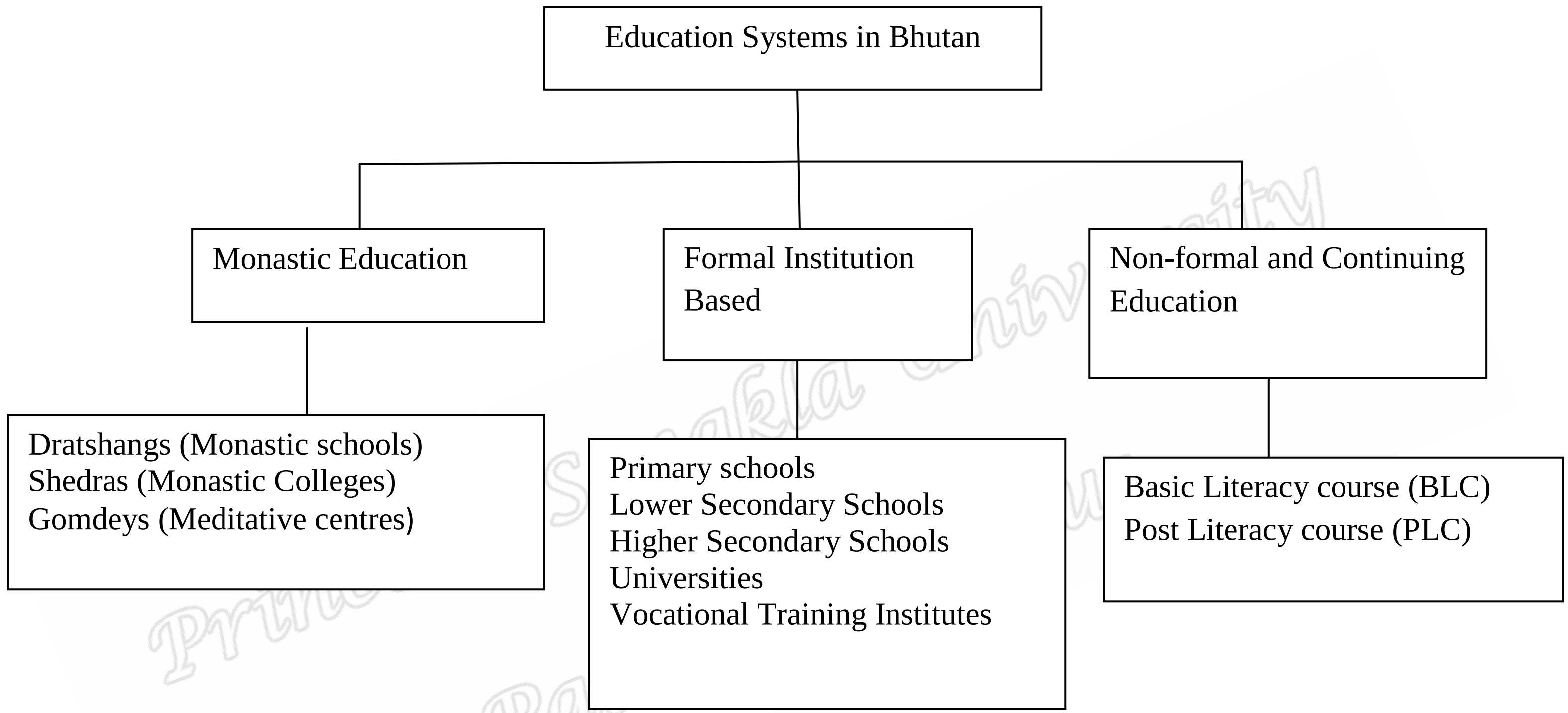

Figure 3: Three Major Systems of Education in Bhutan

Source: REC (2012) (adapted)

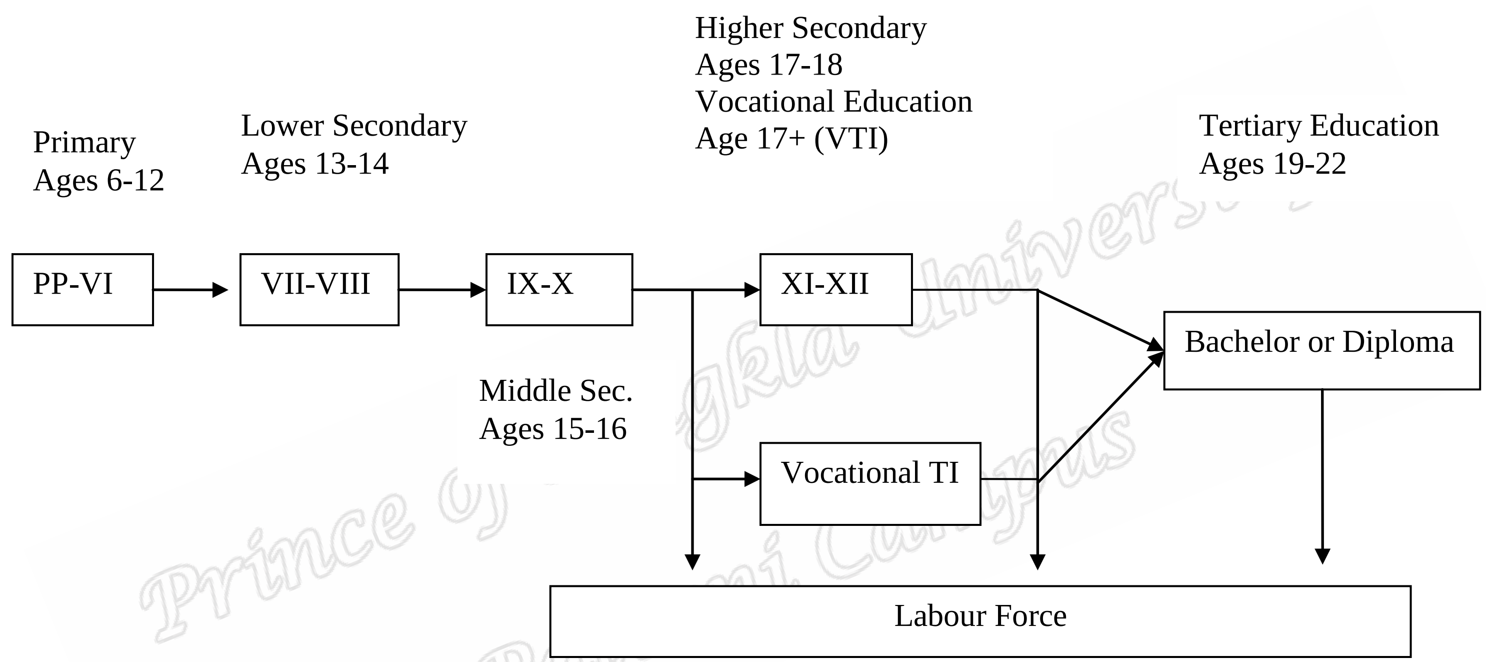

Figure 4: Formal Education Structure of Bhutan.

Source: REC (2012).

1.3 Structure of Formal Institution based Education System

The formal general educational structure (see figure 4) in Bhutan consists of seven years of primary education (PP-VI) unlike in most other South Asian countries, two years each of lower (VII-VIII), middle (IX-X) and higher secondary (XI-XII) schooling followed by a three to four years of degree program at various university colleges and institutes.

The free basic education compulsory for all comprises of eleven years of schooling from pre-primary to the end of middle secondary school. Access from one grade level to the next higher level is merit based and determined by school examinations and national board examinations (for Grade 10 and 12).

After the completion of Grade 10, based on the students' academic performance in the national board examination (Bhutan Certificate for Secondary Education, BCSE) the students choose to study in one stream from the three streams (Art, Commerce and Science) of study in government funded higher secondary education. The choices the students makes determines what profession they will pursue thereafter. Those who do not qualify for government funded higher secondary education in Grade 11 repeats or seek admission into vocational training institutes. Others, who can afford the fees join private schools within the country or go abroad.

After the completion of high school (Grade 12), students that qualify the national examination (Bhutan Higher Secondary Education Certificate, BHSEC) receive government scholarships to continue their education at the tertiary level with Royal

Universities of Bhutan. The government also provides scholarships to a limited number of students who meet the requirements for pursuing higher and professional studies abroad. Those students who do not qualify enter the job market, or others who can afford, fund tertiary education both at home and abroad.

1.4 Science Education in Bhutan

Bhutan introduced science education with the inception of a modern western education which was a part of the modernization process commenced in the 1960s. Since its inception the science curriculum has undergone number of changes at different times in different ways without a proper plan (Childs, Tenzin, Johnson & Ramachandran, 2012). In mid 1980s, the Education Department started *Bhutanizing* of science curriculums or making it more innovative within a Bhutanese context as it was realized that the Bhutanese students were learning science that was alien from their everyday lives. Therefore, the New Approach to Primary Education (NAPE), an innovative curriculum which required teachers to adapt to a new set of materials and a new approach to teaching that was oriented towards child centered learning was launched. The NAPE sought to make the primary science curriculum in Grades 4-6 take more account of teaching and learning science based on Bhutan's natural and social environment. The primary science curriculum in Grades 4-6 stressed the development of investigative skills unlike the traditional rote learning.

In the year 1999 and 2000, the teaching of science through three distinctive science disciplines (Physics, Chemistry and Biology) in Grades 7 and 8 was replaced by a single integrated science "Science for Class VII: Learning Science through

Environment" and "Science for Class VIII: Learning Science through Environment" mainly to bring the curriculum in line with the primary sciences in Grades 4-6 and to provide more time and opportunities for hands on activities. Thus, the curriculum from Grades 4 to 8 became an integrated science curriculum with more account of local examples. For Grades 9-12, the science curriculum remained that of the three distinct single science curriculums borrowed from India where text books are procured externally. The science curriculum at this level prepares the students for university studies, training and employment. For preprimary till Grade 3, science is studied through an integrated Environmental Studies (EVS) course taught in Dzongkha. The science at this stage expects student to develop awareness, curiosity and finally appreciate their immediate living and non-living environment around them.

The government's 10th Five year plan (2008-2012) prioritized the reform of the science curriculum and in order to recognize and understand the issues and challenges presented by the number of revisions science curriculum had undergone, a detailed study of the science curriculum was conducted from a well-informed perspective including a needs assessment for science education from different stakeholders (teachers, head teachers students, lecturers, science professionals) perspective (Childs et al 2012).

The findings of this needs assessment revealed that the science curriculum as a whole in Bhutan was fragmented, lacking coherence and progression of ideas across grades. The first was from Grade 3 to 4 associated with the change in the language of instruction from *Dzongkha* to English. The second leap was from Grade 8 to 9, from an integrated science curriculum to the three single science curriculums. The integrated science curriculum lacked science content and was more biology focused. The third area of discontinuity occurred when students moved from Grade 10 to 11 which were also the inadequacies of the integrated science curriculum. The students never caught up from conceptual demand of integrated science in Grade 9 and 10, and then entered Grade 11 without a strong enough foundation in each science to make the transition smooth.

The science lessons observation from Grade 4 to 8, showed that students were motivated and engaged doing minds on activities but the conceptual underpinning of these activities was very light. And the lessons observation in Grades 9- 12 indicated more teacher-led lessons leading to rote learning from text books. Increase in conceptual demand in Grade 9 and beyond with a significant change in pedagogy caused some de-motivation in students. In addition, a number of challenges were associated with practical work. Theory and practical were taught separately and rarely integrated with theory in Grade 9 to 12. Most practical work was mainly used as a proof for theory. Moreover, there was a lack of practical work in Grade 9 to 12 due to the lack of time and content overload (practical classes sometimes took place after school due to the lack of time in the main timetable to teach practical simultaneously), lack of equipment, lack of expert technical support, lack of teacher expertise and with no practical exam in Grade 10.

Therefore, with the valid findings from the needs assessment of the science curriculum as described above, a major science curriculum reformation as part of the 10th five year plan took place. The Department of Curriculum Research and Development (DCRD) under the Ministry of Education, Paro; Bhutan prepared the text books aligned to the new ‘science curriculum framework for Classes 4 to 8’ which was introduced in 2012. The revised science curriculum is said to be a “spiral curriculum” which repeats the study of a subject at different grade levels, with higher level of difficulty and in greater depth at each higher grade (Gyelmo, 2013)**,** and is expected to build a better foundation in the subject. The revised science curriculum is already being implemented and starting 2014, Grade 7 students across the country are studying the revised science. The implementation of the revised curricula in Grade 8 will be automatic. For Grade 9 to 12, DCRD has invited publishers and author to customize textbooks available in the market.

1.5 Students’ participation in science education at various grade levels in schools

There is an enormous difference between countries in students’ participation rates in science and the amount of time spent to science education. According to Johnson et al., (2007) Bhutan devotes a similar numbers of hours to science education to that of Thailand and Japan but less time to that of Botswana, Chile and Kenya. Bhutan and Mexico has similar students’ participation rates in science but Bhutan falls far behind the participation rates of Malaysia, Korea and Japan. However in the paragraphs that follows, the figures of Bhutanese students’ participation in science education at various grade levels in schools is discussed.

Science education is in general compulsory in all the schools in Bhutan starting from pre- primary (PP) till the end of middle secondary (Grade 10) level. According to the Annual Education Statistics 2013, a total of 47,511 students were enrolled in 384 primary schools and there has been a decline in pre-primary enrollment growth with an average growth rate of (-) 3.2% since 2008. Low participation in science in primary level is only a problem where children are not in school or the decline in the number of over- age or under-age children out of school (i.e. it is an evidence of the progress in right age enrollment as shown in Table 1 and 2) and the decline in population growth rate.

Once in school, the chance of remaining in school is different for both boys and girls. Some drop out before they complete their eleven years of basic education (till Grade 10). For the past six years (2008-2013) the annual enrollment growth rate for lower and middle secondary level declined from 2010 onwards with an average annual increase of 4.8% (see Table 3). The numbers of girls enrolled in these levels are high compared to boys in the past six years.

The transition rate from primary to lower secondary education is 93% indicating that 93% of student enrolled in Grade 6 in 2012 are enrolled in Grade 7 in 2013. In a similar manner, 91.3 % of the lower secondary (Grade 8) students moved on to middle secondary level (Grade 9) as shown Table 4.

With the increased enrollment growth rate at the lower levels of education and also due to the raise in free basic education level to Grade 10, a significant rise in the total number of students' enrollment is seen at higher secondary level both in public and private higher secondary schools. The increase in number of Grades 11 and 12 students were from 10,157 in 2008 to 16,469 in 2013. The total number of students enrolled (as of 2013) in science stream is the lowest (4,947) compared to the enrollment in art (5,356) and commerce (6,166) streams (see Table 5). The total number of boys enrolled in all the streams was 8,454 while the total number of girls was 8,015. The number of girls' enrollment in art and commerce stream was higher than the number of boys but the number of girls' enrollment in science stream was less than the number of boys. If such trend continues in the enrollment in science stream, gender bias within society will be particularly significant in case of science and technology; and will be seen as male preserve (Ramadas, 2003).

Table 1: Primary growth rate 2008-2013

Source: Ministry of Education (2013, p.2)

Year	**PP Enrolment**			**Growth**	
	Boys	**Girls**	**Total**	**#**	**%gr**
2013	6088	6345	12433	-1031	-7.7%
2012	6947	6517	13464	-1206	-8.2%
2011	7370	7300	14670	-1365	-8.5%
2010	8088	7947	16035	-215	-1.4%
2009	8145	8105	16250	1008	6.6%
2008	7612	7630	15242	-23	-0.2%
Average annual growth rate					**-3.2%**

Table 2: Primary enrolments by age 2012 & 2013

Source: Ministry of Education (2013, p. 3)

Class	Right age (in years)	Right age Enrolment		Overage enrolment		Underage enrolment	
		2012	**2013**	**2012**	**2013**	**2012**	**2013**
PP	6	52.0%	57.4%	41.0%	23.7%	8.0%	18.9%
I	7	43.0%	51.5%	46.0%	28.1%	12.0%	20.4%
II	8	36.0%	42.1%	50.0%	34.9%	14.0%	23.0%
III	9	31.0%	37.2%	57.0%	38.6%	12.0%	24.2%
IV	10	26.0%	31.6%	63.0%	48.8%	10.0%	19.6%
V	11	24.0%	27.6%	67.0%	54.4%	10.0%	18.1%
VI	12	22.0%	27.5%	69.0%	55.7%	9.0%	16.8%
Average		**33.4%**	**39.3%**	**56.1%**	**40.6%**	**10.7%**	**20.1%**

Table 3: Enrollment in class VII-X, 2008-2013

Source: Ministry of Education (2013, p. 5)

Year	**Enrolment in Class VII-X**			**Annual growth**	
	Boys	**Girls**	**Total**	**Growth**	**%**
2013	24833	26766	51599	771	1.5%
2012	24530	26298	50828	1994	4.1%
2011	23606	25228	48834	2112	4.5%
2010	22958	23764	46722	3227	7.1%
2009	21627	21978	43605	2750	6.7%
2008	20352	20502	40855	1944	5.0%
Average annual growth rate					4.8%

Table 4: Transition rates 2013

Source: Ministry of Education (2013. p.6)

Transition rate	**Male**	**Female**	**Total**	**GPI**
Primary to Lower Secondary	91.5%	94.5%	93.0%	1.03
Lower Secondary to Middle Secondary	90.7%	91.8%	91.3%	1.01
Middle Secondary to Higher Secondary	75.5%	73.0%	74.3%	0.96

Table 5: Enrolments in classes XI and XII by streams, gender and type of level

Source: Ministry of Education (2013, p. 6)

Type	Class XI						Class XII						Class XI & XII		
	Arts		Commerce		Science		Arts		Commerce		Science		All Streams		
	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Both
Public HSS	476	443	609	635	910	1326	393	373	644	613	780	1169	3812	4559	8371
Private HSS	1076	825	718	656	81	115	986	784	1167	1124	175	391	4203	3895	8098
Total	1552	1268	1327	1291	991	1441	1379	1157	1811	1737	955	1560	8015	8454	16469

1.6 Statement of the Problem

> In all the countries where progress has been strong in the areas we strive to develop, the strength of the education system has been in math and science.
>
> -Jigme Khesar Namgyal Wangchuck, Fifth king of Bhutan (REC, 2012; p.v)

Science knowledge and education are critical for a developing country's developmental process. Bhutan, like any other developing countries places great importance on its science education and has spent a considerable amount of money on science education, judged by its investments in the various revisions of the science curriculum, as well as its investments into science laboratories, science equipments and in-service training for teachers and laboratory assistants. This is because science is recognized as an indispensable feature of a modern society that plays an integral part in people's lives, both now and in the future. Yet, most science is learned in abstracts and Bhutanese people have thought of science as a difficult subject to teach and learn (Rinchen, 2003). Bhutanese people especially the students in general have found science to be difficult in a number of ways (for example, some students finds the numerical problems hard in physics while some find the chemical equations, chemical formulas in chemistry difficult to understand and recall, and still some find biological terms in biology difficult to say and remember. Others say that the time, work load or the level of critical thought required is intense) which is unfortunate because the beliefs or opinions of students may indicate an unfavourable attitudes towards science which can influence students' performances in ways that reinforce lower achievement (Papanastasiou & Papanastasiou, 2002).

Students' attitudes towards science can serve both as an outcome and as a factor (Akcay, Yager, Iskander & Turgut, 2010). As an outcome, it is believed to be the result of science learning in school. Science in Bhutanese schools is taught in various ways at different grade levels,- as environmental science (EVS) at preprimary level through Grade 3, then an integrated common course for all students from Grades 4 through 8 and finally as three specialized subject discipline (physics, chemistry and biology) for Grades 9 through 12. The students' experiences of learning science in their science classes thus varies at different grade levels; with a change in teaching mode from student centered to teacher centered as students move from lower to middle secondary school and this has probably helped to shape students' attitudes towards science (Child et al., 2012, Movahedzadeh, 2011)

Attitudes as a factor can influence science learning. In fact attitudes are a leading factor in student learning (Perkins, Adams, Pollock, Finkelstein & Wieman, 2004) because an individual student with a favourable attitude towards science often looks forward to science classes and laboratory experiments. Moreover, there is growing evidence that individual students who possess favourable attitude towards science performs better academically in science (for example, Narmadha & Chamundeswari, 2013; Olasehinde & Olatoye, 2014; Tshering, 1995) as well as in other subjects because there is a relationship between learning about science and learning about other subjects (Narmadha & Chamundeswari, 2013). Science teaches students to think critically not only in science but in other subjects as well (Movahedzadeh, 2011). In addition, attitudes seem to explain why some students engage in science and others do not (Aydeniz &

Kotowski, 2014). Therefore, “the investigation of students’ attitudes towards studying science has been a substantive feature of the work of the science education research community for the past 30–40 years” (Osborne, Simon & Collins 2003, p. 1049) and anyone familiar with science education literature will be aware that students’ attitude towards science- along with many factors affecting it, ranging from students’ gender to the involvement of parents or guardians at home- are being researched so that proper interventions can be planned.

Research in this area in other countries has grown rapidly and many studies have been conducted elsewhere to study the attitudes of students towards science but there have been only two such studies in Bhutan (for example Tshering, 1995; Rinchen, 2003) as is evidenced by library search, internet search, word of mouth search and information unit search. Over the past decade, there have been no studies in Bhutan devoted to students’ attitudes towards science despite the fact that a huge gender gap in the number of boys and girls enrolling in science stream and tertiary science-related fields are reported every year in Bhutan’s Annual Education Statistics. According to Annual Education Statistics 2014, a total of 1,740 boys and only 1,144 girls enrolled in science stream in public and private higher secondary schools in the year 2014. Likewise, the number of males (m) far exceeds the number of female (f) students in the tertiary science related fields like engineering and technology (m = 1,250, f = 510), forestry and agriculture (m = 389, f = 149), medical technology (m = 71, f = 59), medicine (m = 40, f = 24), public health (m = 16, f = 9), science/mathematics (m = 342, f = 167) with the exceptions being nursing (m = 122, f = 145) and architecture and design (m = 7, f = 8).

Such inequality in gender participation in most of the science related fields has a negative impact in general for society. For example, “a predominantly male group of engineers tailored the first generation of automotive airbags to adult male bodies, resulting in avoidable deaths for women and children” (Margolis & Fisher, 2002. p. 3).

Moreover, since students’ attitudes measured at any instant often show the context in which they are measured, it is not appropriate to apply the findings on students’ attitude towards science from one time period to another or from one society to another (Barmby, Kind &Jones, 2008). Therefore, asking the Bhutanese student “How well they think they do in science?” is totally different from asking the corresponding students in other developed countries. And the findings of other countries may not hold true for Bhutan due to the differences in curriculum (for example, in the Third International Mathematics and Science Study ,TIMSS among some countries found significant performance differences by content area in test items devoted to include: earth science, life science, physics, chemistry and environmental issues and the nature of science) and the various revisions in science curriculum (in case of Bhutan); and also due to differences in culture, ethnicity (about who is capable of learning and doing science in a field), etc.

Therefore, the research on attitudes must be an ongoing field of investigation in which the researchers can explore the students’ attitude towards science in the current social and educational situation (Barmby et al., 2008). Therefore, the purpose of this study was to explore the attitudes of Grade 10 and 12 science stream students towards science in the context of contemporary science education in Bhutanese schools and to understand how gender, ethnicity, grade level and the parents or guardians' involvement in science at home with their children- affects Bhutanese students' attitude towards science. Moreover, by virtue of being a science educator, the researcher has taken up this study. The following research questions guided the study.

1.6.1 Research Questions

- What is the level of attitude toward science of Grade 10 and 12 science students studying in Public middle and higher secondary schools in Thimphu District of Bhutan towards science?
- How are the differences in attitudes towards science with regard to personal characteristics such as gender, ethnicity and grade?
- Is there a relationship between parents or guardians' involvement with their children in science at home and students' attitudes towards science?

1.6.2 Research Objectives

- To identify the level of attitude towards science of Grade 10 and 12 students in public middle and higher secondary schools in Thimphu district of Bhutan.
- To compare students' attitudes toward science with regard to their personal characteristics such as ethnicity, gender and grade.
- To find the relationship between parents or guardians' involvement with their children in science at home and students' attitudes towards science.

1.6.3 Research Hypothesis

- The students' attitudes towards science are different by their personal characteristics such as ethnicity, gender and grade.
- The students' attitudes towards science are affected by their parents or guardians' involvement in science at home.

1.6.4 Scope of study

The main purpose of this research is to explore the attitudes of Grade 10 and 12 science stream students towards science. There are nine public middle and two public higher secondary schools in the Thimphu district of Bhutan with a total of 2,071 Grades 10 and 12 science students. The sample size is 335 Grade 10 and 12 science students calculated from the total population by employing Yamane's sample size calculation formula.

The variables under study which develops the conceptual framework of the study are gender, grade level, ethnicity and the parents or guardians' involvement in science at home as the independent variables and 'attitude towards science' as the dependent variable which consists of the seven constructs namely; self–concept in science; keenness to learn science; enjoyment in learning science; disinterest; future participation in science; teacher interaction; and practical work in science.

1.6.5 Research contributions

1. The study will have served its purpose if it succeeds in providing important information about Bhutanese students' perceptions of science and their attitudes towards science in the context of contemporary science education in Bhutan.
2. Recommendations or suggestions which is well-supported by the school administrators, parents and students on how to improve students' attitudes towards science will be made in line with the factors (gender, grade, ethnicity and the parents' involvement in science at home) under study.

1.6.6 Operational definition of the terms

a) **Attitude towards science**- refers to students' favourable or unfavourable feelings about science based on his/her knowledge and belief about science; and their disposition to learn science. The students' attitude towards science in the present study is measured by a questionnaire comprising of the following seven attitude construct.

1. **Self concept in science** refers to one's own belief and ability to master school science.
2. **Keenness to learn science** refers to self-focusing, content and class focusing, planning about science learning.
3. **Enjoyment in science learning** refers to students' liking and feeling pleasure from learning science as well as conducting science related activities.

4. **Disinterest** refers to students' feeling boring, incompletion of home work and avoiding discussion.
5. **Future participation in science** refers to students' feelings or interest toward involving more with science in future.
6. **Teacher interaction** refers to students taking initiative in discussion and clarification with science teachers.
7. **Practical work in science** refers to students' favourable or unfavourable feelings toward science learning activities in practicals.

The three components of attitude (self-concept in science; practical work in science; and future participation in science) with its definitions are directly taken from the study of Kind et al., (2007) while the remaining four (keenness to learn science; enjoyment in science learning; disinterest; and teacher interaction) are adopted from Shah & Mahmood's (2011) study in Pakistani schools.

b) **Gender-** refers to the male and female students.

c) **Grade -** refers to the school class in which all the students are of similar age or ability. In the present study, the grade of students under study was Grade 10 and 12 science streams.

d) **Ethnicity**- category of people who identify with each other based on common ancestral, social, cultural or national experience. In this study, the ethnicities of students under study were the Sharchops, the Ngalops, the Lhotsam and others.

e) **Parents or guardians' involvement in science at home-** refers to the extent to which the parents or guardians and their child spent time together discussing school activities related to science and the help rendered by the parents or guardians in their children's school science work at home.

This definition is derived from a study (Desforges & Abouchaar, 2003) based on the things that the parents or guardians can generally do with their children relating to school science learning activities at home.

Chapter 2

Literature Review

There are two main issues that really interested the researcher as a science educator. The first was to understand the Bhutanese students' perception and their attitudes towards science and secondly, to determine how the factors like gender, grade, ethnicity and the parents or guardians' involvement in science at home influenced students' attitudes towards science. To compare the researcher's experiences and what is learned about these issues with other researchers, a literature review was undertaken to examine the numerous literatures written by many eminent school researchers, scientist and educationist on science education. The works of these elites were reviewed to identify the present knowledge and also with a view of making them a strong background for the very problem under study. This chapter is presented in the following details.

2.1 Conceptual framework

2.2 Background of Thimphu district

2.3 Attitude

2.4 Students' attitudes towards science

2.5 Factors influencing students' attitudes towards science.

2.1 Conceptual framework

An individual's attitude towards science is vague consisting of a large number of constructs that contributes in varying proportions to that attitude (Osborne et al. (2003). Therefore, the problems of dimensionality of attitude scales in most studies measuring attitude towards science have been solved by including the following range of components: “the perception of the science teacher; anxiety toward science; the value of science; self-esteem at science; motivation towards science; enjoyment of science; attitudes of peers and friends towards science; attitudes of parents towards science; the nature of the classroom environment; achievement in science; and fear of failure on course” (Osborne et al., 2003. p.1054) as the constructs of attitude. Similarly, the following set of statements of attitude construct- learning science in school; practical work in science; science outside of school; importance of science; self concept in science; future participation in science- has been developed by Kind et al. (2007). Likewise, in AtSL (Attitude toward Science Learning) scale developed by Shah and Mahmood (2011), the four statements namely keenness to learn science; enjoyment in science learning; disinterest; and teacher interaction- measured the attitude construct.

In the various sets of attitude constructs mentioned above which are used by the researchers once in their research, it is apparent that the several phrases or statements used contains more or less same elements or the similar construct. Therefore, in the present study, a part of conceptual framework which represents “attitude towards science” is developed by incorporating the attitude construct developed by Kind et al., (2007) and Shah & Mahmood, (2011); and as listed by Osborne et al., (2003) in order to direct the respondents’ position on some well defined continuum and to achieve the objectives of the study (Gardner, 1975 as cited by Osborne et al., 2003).

The dependent variable ‘attitude towards science’ and its constructs (self-concept in science; keenness to learn science; enjoyment in science learning; disinterest;

teacher interaction; practical work in science; and future participation in science) together with the independent variables-gender, grade, ethnicity: and the parents or guardians' involvement in science at home-forms the conceptual framework (see Figure 5) for the study. A thorough consideration of all these variables under study within the conceptual framework will display students' attitudes towards science.

1. **Gender**
2. **Grade**
3. **Ethnicity**
4. **Parents/ guardians' involvement in science.**

Attitude towards Science

1. **Self-concept in science**
2. **Keenness to learn science**
3. **Enjoyment in science learning**
4. **Disinterest**
5. **Future participation in science**
6. **Teacher interaction**
7. **Practical work in science**

Figure 5: Conceptual framework.

Figure 6: Map of Thimphu district

Source: http://www.druksakuratours.bt/wordpress/?p=309#more-309

2.2 Background of Thimphu district

Thimphu is the capital city of Bhutan, located in the western part of the country. It shares boundaries with Gasa and Punakha districts in the east, Chukha and Dagana district in the south, Paro district in west and Tibet (China) in the north. Thimphu has an area of about 2,067 sq. km with a current population of 122,153 according to the National statistics Bureau. Thimphu has one sub district and 8 blocks. As per the annual *dzongkhag* statistics 2010, there are a total of 41 schools (both public and private) including all levels of schools- 7 community primary schools, 6 primary schools, 9 lower secondary schools, 4 middle secondary schools and 2 higher secondary schools and 13 private schools. The total number of students studying at various school levels in Thimphu district as of 2013 as per the National Statistics Bureau is 25,072.

2.3 Attitude

Studies related to attitude show that the concept of attitude has under gone much evolution. Attitude has evolved from a physical concept- used in describing or marking the position of figures in space by the artist- to an evaluative concept (Shrigley, Koballa & Simpson, 1988, as cited in Angelis, 2003). And the researchers are still making attempts in defining both the construct and the means to evaluate it, as the attitude concept under investigation is always vague and consists of multiple subcomponents and attributes (Osborne et al, 2009).

The term ‘attitude’ meaning an internal state that will start an action was introduced into psychology in 1860s by Herbert Spencer and Alexander Bain (Cacioppo, Petty & Crites, 1994). Then for a few years (between late 1910 and early 1920s) a formative period for the study of attitudes in social psychology took place and by the end of 1920s, the attitude concept became an indispensable central concept in social psychology (Jones 1988, as cited in Brewster’s work, 2005). “Perhaps no single concept within the whole realm of social psychology occupies a more nearly central position than that of attitudes” (Murphy, Murphy & Newcomb, 1937, p.889 as cited in Collins and Ashmore, 1970)

According to psychologist, an attitude is a learned (from various sources like- personal experiences; social roles and norms; and by observation) tendency to judge or calculate the quality, importance, amount or value of things in a certain way. Such judgments or evaluation is positive, negative or at times mixed. Furthermore, the psychologist also suggests that there are three main components of attitude, i.e., affective or an emotional component, a cognitive component and a behavioral component. An emotional components concern about how the attitude object makes an individual feel. Experiencing negative emotions and physical reactions when confronted with the object, is said to be a negative attitude while a positive attitude is accompanied by positive affective reactions. For example, feeling excited when confronted with science experiments. The cognitive component is about an individual's evaluative thought and belief about the attitude object, for instance, the belief that science is a tough subject. And, the behavioral component is about how the attitude object influences an individual's behaviour when confronted with it. The behavioural response of an individual can be overt and as well as covert.

On the basis of visibility, the three components of attitude can be divided into two parts-one comprising of visible behavioral component and another with affective and cognitive components which are not directly visible and analyzable. From these three components, it is impossible to say which one is most important because it depends on the attitude object. Accessibility of affective and cognitive components varies with the attitude object. Many researchers have found that affective component is more accessible than cognitive component. This is because cognitive component of attitude requires deliberate thinking over the attitude objects' attributes and its cognitive judgments are more complex while affective judgments just come out from us.

In the attitude's history of evolution, several varying theoretical conceptualization of attitude took place at different points, but finally it was Louis Thurstone who stated that "attitude can be measured" (Thurstone, 1982 as cited in Cacioppo et al, 1994, p. 261). Thurstone's literary definition of attitude was, "The intensity of positive or negative affect for or against a psychological object. A psychological object is any symbol, person, phrase, slogan or idea toward which people can differ as regards positive or negative affect" (Thurstone, 1946,p.39 as cited in Collins and Ashmore 1970). Thus, Thurstone saw attitude as a feeling toward an attitude object that can be measured by the self report consisting of the constructed set of relevant belief statements. Each belief statement is evaluated with range from maximal positivity to maximal negativity. Since then, researchers assessing attitudes in their studies have constructed a range of belief statements under a set of attitude constructs.

2.4 Students' attitudes toward science

An attitude which is "the most distinctive and indispensable concept in contemporary American Social psychology" (Allport, 1968, p.59, as cited in Fishbein & Ajzen's work, 1975) is now a focus area of study for many science education researchers. Educational researchers in almost all the societies of the world have explored 'students' attitude towards science' (for example, Craker, 2006; Ebrahimitabass, Dehghani & Rezaei, 2012; Kipkorir, 2013; Mohammad, Khan& Ali, 2012; Osborne et al, 2003; Rinchen 2003; Sarjou et al, 2012; Weinburgh, 2000) and have come up with many informative results.

Educational researchers, while exploring students attitude towards science have been very clear from an individual perspective for the definition used for the phrase "attitude towards science" as the term "attitude" has been defined diversely across the literature of science education (Aiken & Aiken, 1969; Alrehaly, 2011; Aydeniz & Kotowski, 2014). As the term 'attitude' measures cognitive capabilities or affective behavioural dimension (Fishbein & Ajzen, 1975), the phrase 'attitude towards science' across the literature has also been defined to measure a single dimension (affective or cognitive) or the combination of the any two or three dimensions of attitudes. For instance, Morrell & Lederman (1998) defined attitude towards science from an affective perspective as "favourable or unfavourable feelings about science as a school subject" (p-77). Based on the affective- behavioural perspective, Lovelace & Brickman (2013) define attitude towards science as "their positive or negative feelings and dispositions to learn science" (p-606). Akcay, Yager, Iskander & Turgut (2010) has included affective-cognitive aspects when it is defined as "the feelings, beliefs and values held about an object that may be the endeavour of science, school science, the impact of science and technology on society; or scientist" (p-2). Thus, in the present study the definition used for attitude towards science refers to students' favourable or unfavourable feelings about science based on his/her knowledge and belief about science; and their disposition to learn science. This definition is based on all the three components of attitude; and is derived from the study of Kind et al. (2007) and Lovelace & Brickman (2013).

However, with the different definitions of attitude and its measures as mentioned above, there are some obstacles in obtaining the attitude of students towards science. The main obstacle is that, the different measures of attitude, focuses on different but limited sub construct of attitudes while the kind of attitude that students hold towards science consists of a large number of sub constructs all of which contribute in varying proportions towards an individual's attitude towards science (Osborne et al., 2003). In addition, the different measures of attitude measure the students' expressed preferences and feelings towards science at a particular instant because that particular behaviour at an instant may be influenced by the attitudes more strongly held than the ones that is under consideration (Brown 1976; Potter and Wetherall 1987 as cited in Osborne et al., 2003).

2.5 Factors influencing students' attitudes towards science

There are many factors that influence students' attitude towards science, but only a few significant factors that the researcher thought was related to Bhutanese students are discussed.

2.5.1 Gender

Gender is the learned social roles and responsibilities of men and women. These learned gender roles and expectations vary within societies and between cultures, and can change over time (UNESCO, 2003).

Gender related differences in experiences have been found in students at every age from kindergarten through secondary schools (Klawe, 2002). According to Clewel and Campbell (2002), in school, both the females and males have similar experiences, but more males reported fewer interest and experiences in the biological sciences while females expressed very less experience and interest in physical sciences.

Out of school, females expressed more experiences with biological science process (bread making, planting seeds, weaving and stitching) while males had more experiences with physical science equipments namely batteries, electric toys, fuses, microscopes and pulleys. Such differences in experiences with physical and life sciences were due to differential access, their choice and their own views which are the expression quite similar to the society's common views of what is relevant for girls and boys

With gender related differences in experiences and interest to science, males and females also have a different future jobs interest (Jones, Howe & Rua, 2000). Males are strongly interested in math, engineering and technology fields while females are interested in health related fields and education (Desy, Peterson & Brockman, 2011). Girls tend to have a negative attitude towards science at higher grades as most of the girls are confronted with unfriendly male classmates and teachers (Rinchen, 2003). Sadker and Sadker (1994, p.22 as cited by Papadimitriou, 2004) gives a clear picture description of what happens to most girls in the class:

> Each time a girl opens a book and reads a womanless history, she learns she is worthless. Each time the teacher passes over a girl elicit the ideas and opinions of boys, that girl is conditioned to be silent and to defer. As teachers use their expertise to question, praise, probe, clarify, and correct boys, they help these male students sharpen ideas, refine their thinking, gain a voice, and achieve more. When female students are offered the leftovers of teacher time and attention, morsels of amorphous feedback, they achieve less. (p.13)

Girls are aware of such gender disparity instructional strategy used by teachers as highlighted above, but apparently accepted such situation as the norm while teachers seemed to be unaware or simply accepted such behaviour as the norm (Greenfield, 1997).

Nonetheless, the findings in the literature about the classroom grades of girls in science in schools reveal that girls do better on classroom grades while boys lead on science and math achievement test. Therefore, girls believe that grading system is not fair and hard work does not lead to success (Mitchell & Hoff, 2006). Similarly, the Annual Status of Student learning (ASSL) 2011 of 33,256 students of Grade 4, 6 and 8 from 378 schools in Bhutan, in English, math and science showed that boys outperformed girls in math and science while girls performed better than boys in English and exhibited higher verbal ability (Deki, 2012). Likewise, in a study by Majere, Role & Makewa (2012) determining gender disparities in self concept, attitude and perception in physics and chemistry, the boys had better academic achievement in both physics and chemistry though both the genders had the same attitude towards physics and chemistry. Both the boys and girls had a comparable self concept in physics, but girls had a higher self concept in chemistry which did not influence their performance in chemistry. However, Kipkorir (2013) found no difference in performance between boys and girls in secondary schools in science, but there was a significant difference in mean score in science in single sex schools compared to mixed schools. Single sex schools performed significantly better than mixed schools. Therefore, it was suggested that the problem is not gender but the type of the school and the learning environment.

Weinburgh's (1995) meta-analysis of the literature from 1970 to 1991 examining gender differences in student attitude towards science and correlations between attitudes and achievement in science, revealed that boys exhibited more positive attitude towards all types of science than girls, but there a strong positive correlation between attitude and achievement in both biology and physics was noted for girls than for boys. However, Greenfield (1997) found no relation between gender and attitude towards science.

Though the findings about gender, their performances and achievement in science; and their attitude towards science vary among the studies, gender difference in participation in science related career exists in almost all the societies in world which has a negative impact in general in society. For instance, "if the engineering field is dominated by male gender, the products designed by engineers like computers, chairs, buildings, cars, wheelchairs, etc-the needs and design unique to women may be overlooked" (Hill, Corbett & Rose 2010. p. 3). Therefore, if there is a diverse work force with females entering into the field of science, the scientific and technological services, products and solutions will represent all users (Hill et al, 2010).

2.5.2 Grade

Our school lives are mostly spent in different classrooms at different grade. From preschool or kindergarten to twelfth grade, there are distinct changes in the curriculums and a major change in the classroom environment. With each grade at higher level or with age, children's attitudes towards specific subject declines. For instance, Butler (1999), Francis & Greer (1999), Greenfield (1997), Gibson & Chase (2002), Murphy & Beggs (2003), Neathery (1997) and Weinburgh (2000), observed a decline in positive attitudes towards science with each grade at higher level or with older students having more negative attitudes than the younger ones. The magnitude of the decline varied across grade levels and appeared to be more marked when children first entered school and as they moved into middle school and high school (Eccles, Midgley & Adler 1984). The decline in students' attitudes towards science across the grade levels is caused due to the student's perception of science as a relatively difficult subject because of growing abstractions and complexities of science lessons (Dunne & Rennie, 1990) and also due to the type of science courses taken by students in each grade (George, 2006).

With growing abstractions and complexities in science at the upper level of secondary schools, science is not taught as a way of investigation, but as a group of facts that needs to be memorized affecting the natural curiosity of the children negatively as they moved through the grades (Weinburgh, 2000). In addition, these science facts at higher grade levels are taught using the most prevailing contemporary practices such as students copying the teachers' notes (Ebenezer & Zoller, 1993) which do not give students much opportunity to enjoy science. Furthermore, with each grade the child grows and they are interested and engage themselves in many non-school activities resulting in low achievement in school work. However, Shah, Mahmood & Harrison (2013) has found that with increase in grade, students' attitudes towards science learning increases.

Students' attitudes towards science and grade levels has a negative correlation, i.e., as the student progresses through each grade at higher levels, the student experiences a change in a classroom environment coupled with the growing abstraction and complexities of science lessons together with the drastic changes in teaching methods which all contributes to the decline in students' attitude towards science. Thus, it is very important for the science educators and students in particular to be aware of all the changes that a student faces as they climb up the grade levels so that the students and the science educators can work together to improve students' attitudes towards science.

2.5.3 Ethnicity

The word "ethnicity" is the derivational of the Greek word *ethnos* meaning "nation" or people belonging to a distinctive culture. Ethnicity is a social construct to categorize human beings without any biological justifications and it is or has been a powerful social and cultural force in any society and in modernity at large (Atwater, Lance, Woodard & Johnson, 2013). Ferrante & Brown (1998, as cited in Atwater et al, 2013) refer ethnicity to a group of people who shares a common ancestry with distinctive and visible social traits, a national origin, and a place of birth.

In Bhutan, there are four broad and distinct ethnic groups. They are the Ngalops, the Sharchops, several aboriginal people and Lhotshams. The Ngalops (meaning the earliest risen or first converted) are living mostly in western and northern parts of Bhutan. They are the people of Tibetan ancestor who moved to Bhutan before the ninth century. Therefore, they are often cited as Bhote (People of Bhotia or Tibet) in foreign literature. The Sharchops (meaning easterner) comprise of most of the population of eastern Bhutan and is the biggest ethnic group that has been fitted into the Tibetan-Ngalop culture. They are considered to be the descendants of an Indo-Mongoloid people who have migrated from Assam or Burma during the past millennium. Other ethnic groups such as Mangdips, Kurtoeps, Khengpas and Bumthaps in the eastern and central valley; and the Layaps and Lunnaps in the north are also found within the above mentioned two ethnic groups.

Throughout Bhutan, in scattered villages several small aboriginal or indigenous tribal people including Drokpa, Lepcha, Doya, etc are found living. Culturally and linguistically, they are a part of the populations of West Bengal or Assam and have embraced the Hindu culture and beliefs. The Lhotshams (meaning southern Bhutanese) are people of Nepalese origin constituting a majority in southern Bhutan and are mostly Hindus.

According to the Race, Ethnicity and Education Special Interest Group in British Educational Research Association (BERA), “The terms ‘race’ and ‘ethnicity’ are acknowledged as problematic but are also commonly used” (paragraph 1) as a self-identification marker for an individual over which some have more freedom than others in claiming their ethnic identity (Atwater et al, 2013). The process of developing one’s own ethnic identity is heightened as an individual experiences increased exposure to different ethnicities (Booth, Curran, Frey, Gerard, Collet & Bartimole, 2014).

In schools, ethnic disparity is seen in all the important areas- in the areas of enrollment, graduation rates, academic achievements and duration of study (Fnu, 2011). Garrison (2013) agrees with Fnu (2011) and further adds that ethnic disparities are also found in colleges at every key transition point-college enrollment, choice of major, college graduation, graduate school enrollment and doctoral degrees. Students' ethnicity may influence their learning attitudes towards specific course choice, their preparedness to enroll and their achievement in certain academic areas (Fnu, 2011). For instance, the TIMSS (Trends in International Mathematics and Science Study) results of US students' performance in 2007 and previous years differed across ethnicities (Alrehaly, 2011).

Catsambis (1995) and Neathery (1997) also supports Fnu (2011) and explains that ethnicity has the power to influence students' attitudes toward science, their career interest and achievements in science, but Neathery's (1997) finding showed that ethnicity and attitudes towards science are not correlated.

In a study by Gonzales, Blanton & Williams (2002), both ethnicity-based and gender-based stereotype threat influenced the performance of undergraduate students. The ethnicity sensitized individuals to negative stereotypes about their gender but their gender did not qualify the ethnicity effect. Similiarly, Hafza's (2012) study revealed that ethnicity alone was not significant in regards to attitude towards physics but a significant gender by ethnicity interaction was seen.

The findings of the studies that have focused on the possible impact of race and ethnicity on attitudes towards science vary depending upon the ethnicities studied and these studies have generally focused on difference in representation (Garrison, 2013). However, studying about the attitudes of students towards science across ethnicities helps one appreciate differences in groups' attitudes and behaviours towards science. As a result of these differences, it is imperative that the group will develop a more favourable attitude towards science.

2.5.4 Parents or guardians' involvement at home

Parents are the first people with whom a child comes in contact and who plays a very important role in their children's lives. Therefore parental involvement with their children have a great potential for affecting both positively and negatively of their children's attitudes (Alrehaly, 2011), self- concept and self- esteem and also on the student's behaviour (Rinchen, 2003). Research findings about the influence of parental involvement on their children are multi- dimensional like the many different forms of parental involvement. Parental involvements are of many forms ranging from good parenting at home to parents involvement in school (Desforges & Abouchaar, 2003).

Parental involvement of any forms leads to measurable gains in student achievement (Dixon, 1992) but the form and extent of parental involvement is affected by many factors like family social class, maternal level of education (Susan & Kinley, 2014), maternal psycho-social health, material deprivation (Desforges & Abouchaar 2003), the biological age of children (Stouffer, 1992; Desforges & Abouchaar, 2003) and the single parent status (Wanat, 1992). However, good parenting at home form has a significant positive effect on children's achievement followed by parental involvement in school activities (Desforges & Abouchaar, 2003).

Parental involvement at home also has many forms and many factors interact with it making it difficult to measure (Desforges & Abouchaar, 2003). However, in the present study, parents or guardians' involvement in science at home is associated with discussing and rendering assistance in school science activities and monitoring the child's after school activities. An "ineffective or inadequate parental assistance may lead a child to feel overwhelmed and consequently to withdraw from school" (Astone & Mclanahan, 1991, p.310 as cited in Panastasiou & Panastasiou, 2004) or "If a parent shows no interest in the child's school or in what the child is learning, the message given to that child is that education is not important" (Warner & Curry 1997, p.4 as cited in Panastasiou & Panastasiou, 2004) leading to poor achievement and many youth problems like juvenile delinquency, unemployment, drug abuse alcoholism, suicide cases, school dropouts, teenage pregnancy, etc.(Susan & Kinley, 2014). Parental involvement in school activities leads to a network of relationship between parents and teachers and principal making it more likely for the students to receive common messages from school and home about the schools' importance and the importance of staying in the school and working hard. Such network of relationship is understood by the child with the passage of time.

Differences in parents' involvement are also noticed between educated parents and parents who lacked formal educations. Parents who are educated tend to have more interactions with their children than the parents who lacked formal education (Rinchen, 2003) or in other words a positive correlation is found between the parents' overall level of schooling and the amount of time parents and children spend together (Tare, French, Frazier, Diamond & Evans 2011). Educated parents are able to cause efficient parental involvement by monitoring and guiding their children in home assignments and other school-related activities. They tend to have higher expectations of their children and make their children realize the importance of science and technology, with regard to scientific professions. On the other hand, parents who lacked formal education causes inefficient parental involvement depriving their children of educational aids and games (Rinchen, 2003).

Chapter 3

Research Methodology

The purpose of this chapter is to discuss the methodology used in the present study and to outline the specific methods and procedures that were used to find out the sample size, the site that the samples are taken from, the inclusion criteria of the subjects, the instrument used for the data collection, the procedure used for the data collection and analysis of data

3.1 Research design

Both the quantitative and qualitative methods were employed in this study to completely understand the research problem under consideration and to balance the limitation of one method by the strength of the other method (Creswell & Clark 2011). The mixed method designs adopted was explanatory sequential design where quantitative data collection and its analysis in the first phase were followed by qualitative data collection and its analysis in the second phase. The second qualitative phase was connected to the first quantitative phase through the development of the interview questionnaire based on the quantitative results, and thus enhanced the richness of the quantitative results with the further explanation.

3.2 Quantitative approach

The quantitative method used simple descriptive survey questionnaires to collect quantitative data. The survey questionnaire was preferred because it is very practical and large amount of information through self-reported beliefs and opinions of large number of participants (David & Sutton, 2004) can be collected within a short period of time. In addition, the questionnaires can be analyzed more scientifically and objectively.

3.2.1 Population

The number of students enrolled in Grade 10 and 12 science streams in public middle and higher secondary schools in Thimphu district was 2,071 students according to the *Thromde* Education office and Thimphu *Dzongkhag* Education office records of May, 2015. Therefore, the total population for the present study was 2,071 students. The main reason for choosing the Thimphu district as the site of the study was due to the fact that it has more number of students and schools compared to other districts in Bhutan. Moreover, all the schools are accessible by roads. In other districts, schools are less in number, scattered and some are not accessible by a proper road.

3.2.2 Sample size and its characteristics.

A proportional stratified random sampling technique was used to have samples representative of Grade 10 and 12 and also to have the sample size of each stratum proportional to the population size of the stratum. The sample size was calculated from the total population of 2,071 using Yamane's (1967, p. 886) formula as follows:

$$\mathbf{n} = \frac{N}{1+Ne^2}$$

Where, 'n' is the sample size

'N' is the population size

'e' is the acceptable sampling error at level 0.05.

$$n = \frac{2071}{1+2071\ X.05^2}$$

$= 335.25$

$= 335$

Therefore, the sample size as per the formula was 335 students but during the actual data collection the number was increased to 383 students (see Table 6) to account for possible attrition. By calculating the proportions, it was determined that the sample size of 383 student participants should include 319 Grade 10 and 64 Grade 12 science students. The main reason for the choice of Grades 10 and 12 students as sample for the study was that they are at the end of their middle and higher secondary education which is the most crucial stage in the life of Bhutanese students, who will be in a better position to compare experiences across the three disciplines of science (physics, chemistry and biology) and form genuine opinions after having studied them separately for at least one year.

3.2.3 Sampling method

Sampling was performed with the following steps:

Step 1: Few schools were selected from the total schools in Thimphu district, according to the grade levels of student under study. As the grades of student under study were 10 and 12, the levels of the school were middle and higher secondary schools. Therefore, there were 11 public schools (9 middle and 2 higher secondary schools).

Step 2: From the total 11 schools, the selection of school samples was done mainly by the method of stratified sampling to include both middle and higher secondary levels followed by simple random sampling in a way of drawing lot to select middle secondary schools

Step 3: The total number of Grades 10 and 12 students to be included in the sample was calculated by proportional to size sampling method from the total Grade 10 and 12 science students in schools.

Step 4: The number of sample students from a selected school is calculated by proportional to size sampling method from the total number of Grade 10 and 12 students in that school.

Step 5: The individuals were sampled by means of simple random sampling in the way of drawing lots.

Table 6 The sample size of the students in Thimphu district

Schools	Number of schools	Number of school sample	Name of the school sample	Number of Grade 10 and 12 students in the school sample	The number of sample students
Middle Secondary School	9	6	1. Babesa	134	26
			2. Changangkha	131	30
			3. Khasadrapchu	54	25
			4. Loselling	105	27
			5. Lungtenzampa	398	80
			6. Zilulka	79	20
Higher Secondary School	2	2	1. Motithang	129 (XII)	34
				299 (X)	49
			2. Yangchenphug	180 (XII)	30
				329 (X)	62
Total	11	8		1,838	383

3.2.4 Instrumentation

The research instrument used for the quantitative data collection was the survey questionnaire consisting of three sections- A, B & C. The first (section A) related to background information and demographic data, the second (section B) measured the students' attitude towards science and consisted of 60 items. These 60 items represented the seven components of attitude towards science construct (see Table 7) adopted from the two studies of Kind et al, (2007); and Shah & Mahmood, (2011).

Table 7 Division of 60 items into seven components of attitude towards science

Description	Items
1. Self- concept in science	1-9
2. Keenness to learn science	10-18
3. Enjoyment in science learning	19-27
4. Disinterest	28-33
5. Teacher interaction	34-40
6. Practical work in science	41-44
7. Future participation in science	45-60

Each of the 60 items in the questionnaire was rated on 5-point Likert scale that ranged from "strongly agree" to "strongly disagree" (see Table 8). The possible minimum score of a student is 60 and the maximum is 300. The mean score of answers obtained was the attitude of the students towards science. The attitude was classified into five levels of attitude based on the class interval (see Table 9) that took into account the space between the adjacent limits to regard the score as the real upper limits and real lower limits of the intervals.

Table 8 Measurement scale of attitude towards science

Attitude	Scores
Strongly Agree	5
Agree	4
Neutral	3
Disagree	2
Strongly Disagree	1

Table 9 Criteria for interpreting the means of attitude level

Mean scores	Level of Attitude
1.00 -1.50	Very low Attitude
1.51-2.50	Low Attitude
2.51-3.50	Moderate
3.51-4.50	High Attitude
4.51-5.00	Very high Attitude

The third section measured parents or guardians' involvement in science at home, and consisted of 16 items rated on 5-point Likert scale that ranged from "always" to "never" (see Table 10). The possible minimum score of a student for this scale is 16 and the maximum is 80. The level of parents or guardians' involvement in science at home was considered from mean score of the answers and was classified into 5 levels of involvement (see Table 11).

Table 10 Measurement scale of parents or guardians' involvement at home

Attitude	Scores
Always	5
Usually	4
Often	3
Sometimes	2
Never	1

Table 11 Criteria for classifying the means of parents or guardians' involvement

Mean Scores	Level of parents or guardians' involvement
1.00-1.50	Very Low involvement
1.51-2.50	Low involvement
2.51-3.50	Moderate
3.51-4.50	High involvement
4.51-5.00	Very high involvement

3.2.4.1 Adoption of the scale

The items included in the questionnaire to assess attitude in the study investigated both 'attitude towards science' and 'attitude towards science learning' because the students attitude towards science often serve both as an outcome and as well as a factor that can affect science learning in schools (Akcay, Yager, Iskander & Turgut, 2010). Moreover, according to Ma (1994) the cognitive component of attitude may be highly related to the student's learning approach.

The 'attitude towards science learning' (AtSL) components (keenness to learn science; enjoyment in science learning; disinterest; teacher interaction) were adopted from the study of Shah & Mahmood (2011), and the items under these components in the questionnaire required the respondents to reflect on their experiences during their daily routines of their science learning both in schools and at home in order to elicit their general attitude which will be more regular (Shah, Mahmood & Harrison, 2013). Furthermore, the scale reliability or Cronhbach alpha (α) for AtSL was .86 and for sub-factors, the 'α' ranged between .75-.61.

Three more components (self- concept in science; practical work in science; and future participation in science) from Kind et al.'s (2007) study representing 'attitude towards science' was added to the above four components. All the components from Kind et al.'s study were not adopted because it was reported that some of the components used have one general attitude towards science construct. Thus, only three which the researcher felt was relevant to the Bhutanese students was used. The 'attitude towards science' items sought the respondents opinions on their self concept in science, practical work in science and shifted their attention from daily routines of science learning into past experiences and future exposure plans with science. In addition, all the measures used in Kind et al.'s study was reported to have high internal reliability of Cronbach alpha (α) greater than .7. Many of the items in attitude scale were directly conceived from the existing scales and a few were adopted from other related studies after carefully studying the items.

Regarding the parents or guardians' involvement in science scale, the items were adopted from the related studies after carefully examining the items based on the things which parents or guardians can generally do with their children relating to school science learning activities at home.

3.2.4.2 Validity of the research instrument.

The content validity of questionnaire to have the close-ended items representing the specified construct's domain measures of "attitude" and "parents or guardians' involvement in science" in the scale was checked through the review by the panel consisting of at least three experts having background relevant to the study. The content validity was examined using the score of the items from the three experts. If at least two out of three experts approved the relevancy of each item in the questionnaire or if the average score of the three experts for each item was greater than 0.5 (see Appendix) the item was retained. The experts' suggestions were also taken into consideration.

The questionnaire was pre-tested with 30 students (15 Grade 10 and 15 Grade 12 science students) from a public higher secondary school in Thimphu before the actual data collection. These subjects were not included in the sample group during the actual data collection. To gauge the reliability of the scale, a popular measure of reliability which determines the internal consistency or average correlation of items in the instrument was analyzed by means of Cronbach's alpha-coefficient (Cronbach, 1951),

$$\boldsymbol{\alpha} = \frac{\boldsymbol{n}}{\boldsymbol{n-1}}\left(\mathbf{1} - \frac{\sum \boldsymbol{S^2 t}}{\boldsymbol{S^2 t}}\right)$$

Where α = Coefficient of reliability

n = Number of items on the scale (questionnaires)

$\sum S^2 t$ = the sum of variance of each item

$S^2 t$ = the variance of the questionnaire.

The coefficient of reliability (α) for the questionnaire that measured the dependent variable 'attitude towards science' and the independent variable 'parents or guardians' involvement in science at home' was .92 and .81 respectively.

3.3 Qualitative approach

To reduce the risk of conclusion being drawn at the end of the study from reflecting the limitations or systematic biases of a particular quantitative method and to allow the researcher to gain a better assessment of the validity and generality of the explanations that the researcher develops (Maxwell, 1996), the qualitative study was employed after the initial quantitative study. For the qualitative study, the most common source of data is an interview (Brikci & Green, 2007) which is of three fundamental types- structured, semi-structured and unstructured interviews. One-on-one semi-structured interview was chosen for the qualitative approach of the present study because the standardization of at least some of the questions increases data reliability.

3.3.1 Development of interview questions

Interview questions are what the researcher asks people in order to gain the understanding of the research problem. Understanding of the research problem depends on whether the interview questions will provide the data that will contribute to answering the research questions (Maxwell, 1996), and also on how the interview questions or guide actually work in practice. Thus good interview questions or guide development requires creativity and insights.

While developing the questions for one-on–one semi-structured interview, the questions were developed keeping in mind the above mentioned points by Maxwell (1996) and the researcher also put herself in respondents' place and anticipated how the respondent would react to those questions. A few sets of concise and open ended questions each for the teachers and the students (see the Appendix) were developed and it basically sought explanations to the 'why' and 'how' of the quantitative results with regard to the students' perception and opinion of science, their feeling about science, students' future plans with science, their views about parents or guardians' involvement and its effect on attitude towards science, barriers to parents or guardians' involvement and the factors causing the differences in attitude between the genders, grades and among the four ethnicities.

To ensure the validity of questions prepared, it was presented to the panel of three experts who ensured the suitability of each and every interview questions. Necessary changes were adopted as per the experts' feedbacks.

3.3.2 Selection of informants and sample size

The selection of the right respondents or informants to engage within the research is very important. The selection of right respondents depends on what the researcher is trying to do in the research. Since, the present study intends to find the attitudes of students towards science, the researcher decided to interview the students and few science teachers. The selection of the student and teacher participants for the interview was based on purposeful sampling technique and the following inclusion criteria for the students and teachers were also followed.

Inclusion criteria for the students

a. Presently studying in Grade 10 and 12 (science stream)
b. Students who like science and who do not like science
c. Is a Bhutanese citizen.

Inclusion criteria for the science teachers

a. Teachers who have science teaching experience of at least 5 years.
b. Teachers with degree level education and above.
c. Is a Bhutanese citizen.

After the selection of the right respondents, the next concern was "how many interviews should a researcher carry out?" According to Mason (2010), number of issues affects the sample size in qualitative research but the concept of saturation should be the main guiding principle during the data collection. However Alan Bryman (as cited in Baker & Edwards, 2012) explains that interviewing respondents till the achievement of saturation is a “challenging approach because it forces the researcher to combine sampling, data collection, and data analysis, rather than treating them as separate stages in a linear process” (p-5). In addition, the number of interviews depends on the resources, the degree of importance of the question to the research and how many respondents are necessary to satisfy a dissertation committee members (Harry Wolcott as cited in Baker & Edwards, 2012) and also upon “one’s methodological and epistemological perspective” (Baker & Edwards, 2012, p.5). However, some research experts have given numerical guidance which is usually smaller than those used in quantitative studies. Ragin (as cited in Baker & Edwards, 2012) suggest “20 for an M.A thesis and 50 for a Ph.D. dissertation” (p. 5). According to Brikci & Green (2007) for a short term study, the more practical method is to estimate the sample size as around 15 participants based on age, gender, skills, etc. Adler and Adler (as cited in Baker & Edwards, 2012) has advised graduate students to sample between 12 and 60 with 30 being the mean. Thus for the present study the researcher glibly decided the number of samples as 28 participants (13 students and 15 science teachers).

3.4 Quantitative and qualitative data collection procedure

A letter from the head of the Department of Education under the Faculty of Education of the university, seeking permission (see Appendix) to conduct the study in the selected middle and higher secondary schools in the Thimphu district was presented by the researcher to the Director General of the Department of School Education under the Ministry of Education, Bhutan. Subsequent to the department's approval, Thimphu *Dzongkhag* Education and the *Thromde* Education offices, each issued an official letter asking the principals of the schools under their jurisdiction to provide help and support to the researcher. Next, the researcher met the principals of the schools; the purpose of the study was explained and the appointments to administer the survey questionnaires to the students and to conduct the interviews of a few teachers and students were made.

As per the appointments given by the principals of the selected schools, the survey questionnaires were administered to the randomly selected students of Grades 10 and 12 during the reading period. This year (2015) schools all over Bhutan were observing 'Reading Year' in commemoration of the 60^{th} birth anniversary of the fourth king, Jigme Singye Wangchuck. Therefore, the schools have a reading period and reading activities every day, unlike the past years where reading and its activities were conducted only during the reading week. The readings by the students were done either early in the morning before the normal classes or at the end of the normal classes. The survey questionnaires were administered to students in classrooms or multipurpose hall or audiovisual room or library during their reading period. The students were given 30-40 minutes to complete the questionnaires. The quantitative data collection from eight schools selected was completed within one and half months (mid July to August 2015) and then analyzed.

The quantitative data analysis was then followed by the qualitative data collection. The teachers and students were interviewed during their free periods, reading periods and during their recess. Care was taken to not include the respondents to the survey questionnaire in the interview to avoid the survey and interview questions influencing each other. Before the start of the interview, informed oral consent was sought of the interviewee and confidentiality of the interviewee was ensured. The nature and purpose of the research, why the participant has been chosen; and the expected duration of the interview were explained to the respondents. All the respondents were asked the same questions but with considerable variation in questions' order, the exact words in the question and follow- up questions. Observations and field note was used to note the respondents' gestures such as nods, smiles, and frowns, etc to supplement the interviews. The interviews were audio- recorded and each participant interview lasted for 20 -25 minutes. The qualitative interview data collection was completed within a month (mid September- mid October, 2015).

3.5 Data analysis

3.5.1 Quantitative data analysis

The quantitative data collected in this study was analyzed and interpreted by using the following statistical procedures:

1. Descriptive statistics: Mean, standard deviation and percentages
2. Inferential statistics: *t*-test, ANOVA, Pearson Correlation.
3. Graphical representation.

Demographic variables, including gender, ethnicities and grade levels were calculated using frequencies and percentages. To obtain the general attitude of students towards science; and the overall level of their parents or guardians' involvement in science, means were calculated using descriptive statistics. Using a *t*-tests, means and standard deviations were computed separately for both the genders; and for the two grade levels to determine whether the difference in attitude between the genders or the two grade levels are significantly different or not. The level of significance was set at .05.

To find the difference in attitudes towards science among the four ethnicities, the means and standard deviations was computed separately for each ethnicity for the attitude scale using descriptive statistics. One way ANOVA (Analysis of variance) followed by Tukey HSD (honest significant difference) test was employed to determine whether the four ethnicities differed significantly within themselves in their attitude towards science. Finally the correlation coefficient (Pearson's) between parents or guardians' involvement in science at home and the attitude towards science was computed to find the correlation between the two variables.

3.5.2 Qualitative data analysis

According to Baker and Edwards (2012) the interview data are our basic raw materials and for successful completion of the research study, how much we need, depends on what we want to make with it. It also depends on the quality of the analysis and the dignity, care and time taken to analyze interviews, and it is important to build a convincing analytical narrative based on 'richness, complexity and detail' rather than on statistical logic.

Interview recordings of participants were transcribed on an on-going basis at the end of the day. The transcription was then reviewed with the recordings and field notes to ensure that nothing was left out. The transcript was studied repeatedly to look for themes or patterns among the data through a process of discovery. The whole process was repeated and then coded with words or phrases related to topics or phrases. The researcher then interpreted the experiences, beliefs and opinions of the teachers and students to form a narrative description of the meaning the researcher ascribed interweaving the exact words of the participants. The findings were then validated by member checking.

Chapter 4

Data Analysis

This chapter presents the analysis of both quantitative and qualitative data.

4.1 Quantitative data analysis

The quantitative data from the survey was analyzed by using statistics, namely descriptive, *t*-tests, one-way ANOVA (analysis of variance) and Pearson's correlation.

4.1.1 Subject characteristics

A total of 383 students consisting of 319 Grade 10 and 64 Grade 12 students were surveyed.

Table 12 Frequency and percentage of students' demographic characteristics (N = 383)

Demographic characteristics		frequency	Percent
Grades:	10	319	83.3
	12	64	16.7
Gender:	Male	175	45.7
	Female	208	54.3
Ethnicity:	Sharchop	184	48.3
	Ngalop	115	30.0
	Lhotsam	78	20.4
	Others	5	1.3

Within these two different grades, 175 students were males and 208 were females. Additionally, 185 students were the Sharchop, 115 were Ngalop, and 78 were Lhotsam and only 5 were others (see Table 12).

4.1.2 General attitude of the students towards science and the overall level of parents or guardians' involvement in science with their children at home

The means obtained using descriptive statistics were used to identify the "general attitude of the students towards science" and the "overall level of parents or guardians' involvement in science" as reported by the students for the scales used.

The parents or guardians' involvement in science at home and the students' attitudes towards science were categorized into five different ranges of mean score levels. A mean above 4.51 expressed a very high attitude or a very high parents or guardians' involvement, a mean in the range of 3.51- 4.50 described high positive attitude or high parents or guardians involvement, a mean in the range of 2.51- 3.50 described feelings in the neutral –affect category or a moderate parents or guardians involvement and a mean scores below 2.51 denoted negative attitude towards science or a low parents or guardians' involvement in science at home.

The general attitude of 383 students towards science as reported by the scale was at high positive level with a mean score of 3.69 and a standard deviation of 0.43 (see Table 13). Likewise, these students reported the level of their parents or guardians' involvement in science as moderate with a mean score of 3.32 and a standard deviation of 0.77

Table 13 Overall mean scores for the students' attitudes towards science and the parents or guardians' involvement in science at home.

Source	N	Mean	SD	Result interpretation
Students' attitudes towards science	383	3.69	0.43	High positive attitude
Parents or guardians involvement.	383	3.32	0.77	Moderate involvement

4.1.3 Gender differences in students' attitudes towards science.

Since the normal data is an underlying assumption in parametric testing, the assumption of normality was evaluated using histograms (see Figure7a & 7b) and found tenable for the male and female groups.

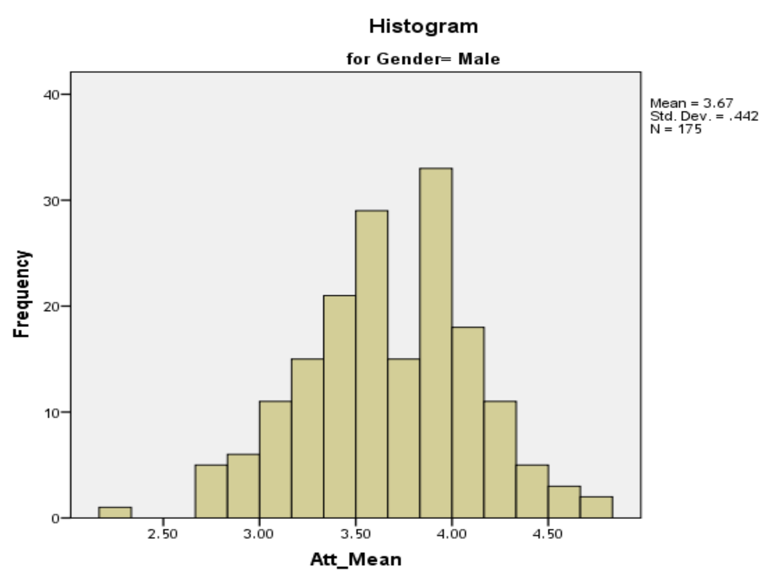

Figure 7a

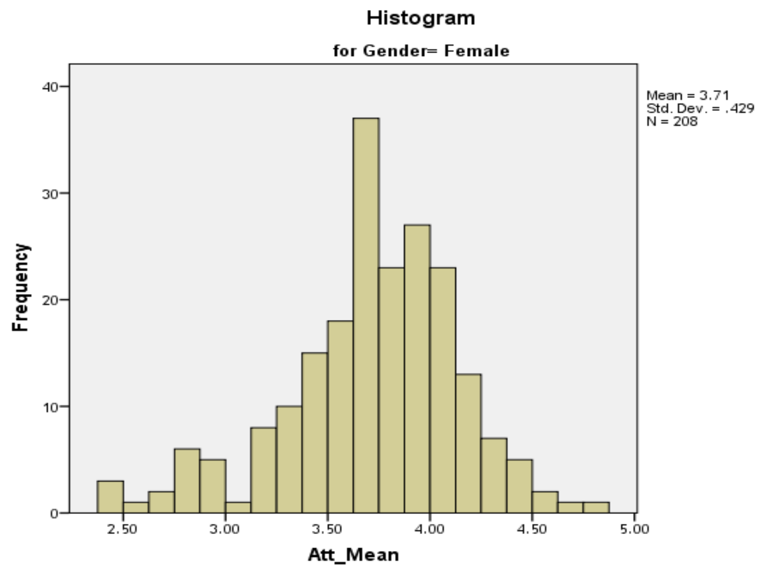

Figure 7b

Mean scores and standard deviation were computed separately for males and females on the scale. The results were then subjected to a *t*-test to determine any significant differences in attitudes between the males and females. The level of significance was set at .05.

Table 14 Results of descriptive statistics and *t*-test for attitude towards science by gender

			N	M	SD	*df*	t	*p*
Attitude towards science	Gender	Male	175	3.67	0.44	381	-.917	.359
		Female	208	3.71	0.43			

Generally, female scored higher (see Table 14) on the attitude scale than the males but no statistically significant differences in attitudes between male and female students towards science was observed.

4.1.4 Attitudes differences between Grades 10 and 12

Test of normality inspected using the histogram for Grades 10 and 12 revealed that the distributions are very near to normal (see Figure 8a & 8b). The mean scores and standard deviation for the attitude towards science scale was computed separately for the two grades and then subjected to *t*-test. The level of significance was set at .05. Levene's test for equality of variances was violated, F (1, 381) = 5.66, p = .018. Owing to this violated assumption, a *t*-statistic not assuming homogeneity of variance was computed. It revealed a significant difference (see Table 15) in the scores for grades ten (M = 3.67, SD = 0.45, n = 319) and twelve (M = 3.84, SD = 0.32, n = 64) at the .05 level of significance (t = -3.75, df = 117, p < .001, 95% CI for mean difference is -0.27 to -0.09). On average Grade 12 science students have more favourable attitude towards science than Grade 10 students

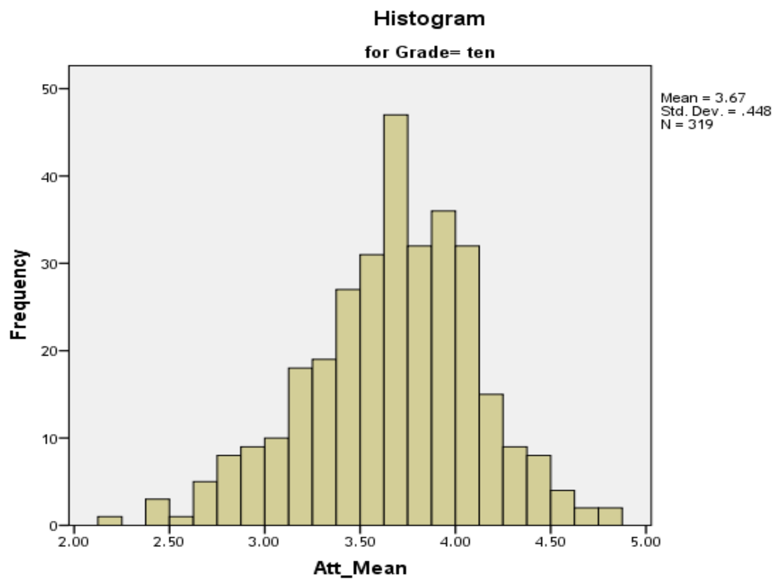

Figure 8a

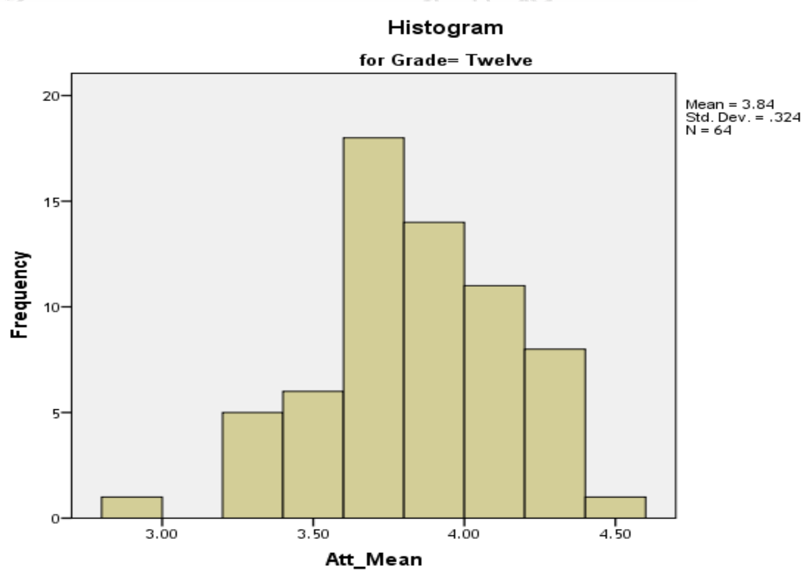

Figure 8b

Table 15 Results of descriptive statistics and *t*-test for attitude towards science by grades

			N	M	SD	*df*	t	*p*
Attitude towards	Grade	Ten	319	3.67	0.45	117	-3.75	.000
science		Twelve	64	3.84	0.32			

4.1.5 Differences in attitude towards science among the four ethnicities

Using descriptive statistics, the means and standard deviations for each of the four ethnicities: Sharchop (M = 3.64, SD = 0.45, n = 185), Ngalop (M = 3.71, SD = 0.44, n = 115), Lhotsam (M = 3.76, SD = 0.37, n = 78) and others (M = 4.26, SD = 0.34, n = 5) was computed.

The assumption of normality was evaluated using histograms (see Figure 9a, 9b, 9c & 9d) and found tenable for the three ethnic groups (Ngalops, Sharchops and Lhotsam) while a little deviation from the normality was observed for the 'others' category. This was because of the very small sample size in 'others' category as it constituted only a very small proportion of the total population. However, the assumption of homogeneity of variance was assessed and found tenable using Levene's Test, F (3, 379) = 1.15, p = .329. One-way ANOVA was employed to evaluate the null hypothesis that there is no difference in students' attitude towards science based on their ethnicities. The ANOVA was significant, F (3, 379) = 4.55, p = .004 (see Table 16) indicating that there was a significant difference in students' attitude towards science among the four groups of ethnicity.

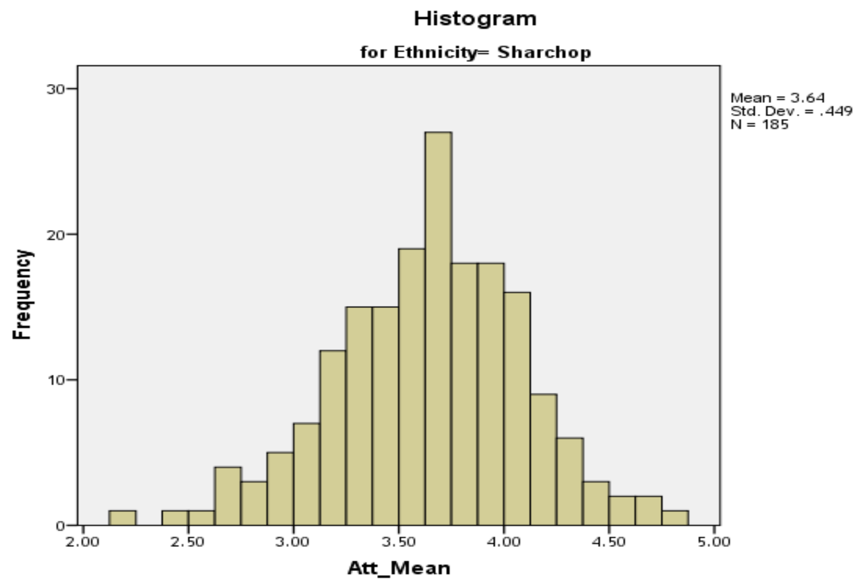

Figure 9a

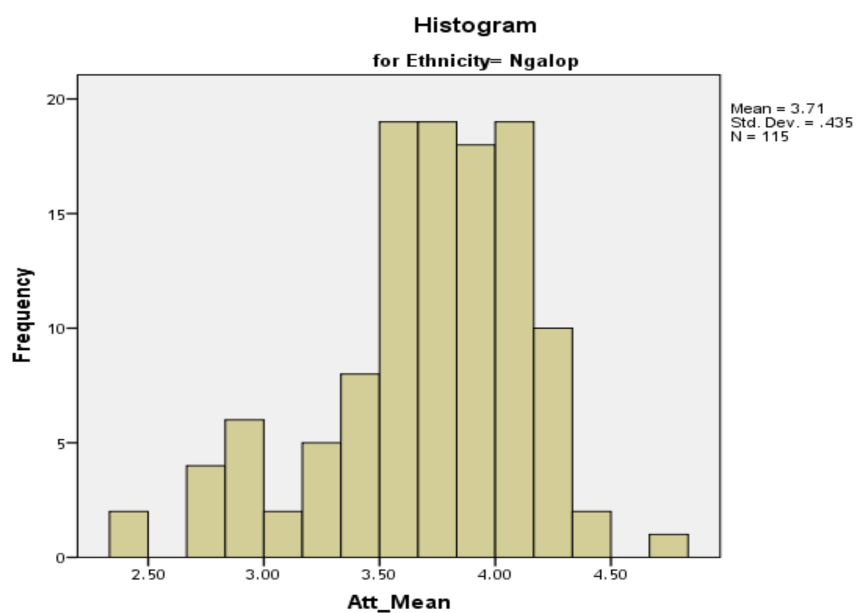

Figure 9b

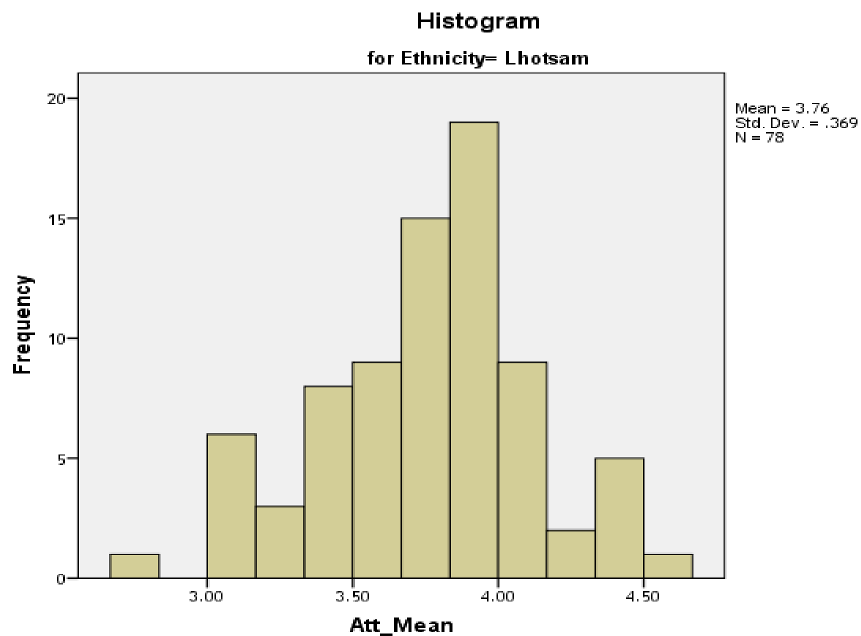

Figure 9c

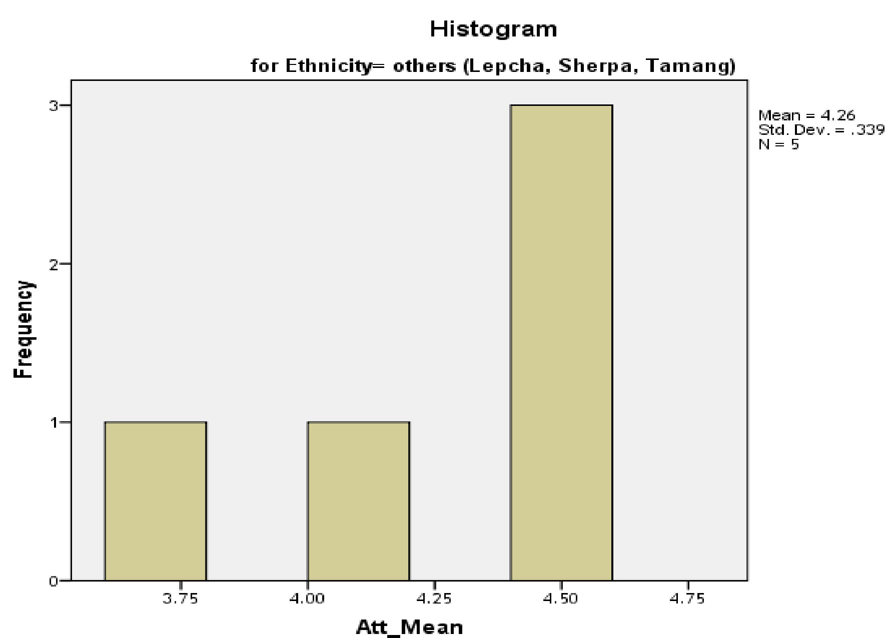

Figure 9d

Table 16 One-way ANOVA for the attitude towards science among the four different ethnicities (N = 383)

	source	sum of squares	*df*	mean square	F	*P*
Attitude	Between groups	2.51	3	0.84	4.55	.004
towards	Within groups	69.67	379	0.18		
science	Total	72.17	382			

A post hoc comparison to evaluate pairwise difference among the means of the four ethnic groups was conducted with the use of the Tukey HSD test since equal variances were tenable. The test revealed (see Table 17) significant pairwise differences between the mean scores of Sharchop and others ethnicities, p = .008; and also between Ngalop and others, p = .028; while no significant difference was observed between the Lhotsham and others, p = .055 or between any of the three ethnicities (Sharchop, Ngalop & Lhotsam)

Table 17 Tukey HSD comparison for attitude towards science

	Sharchop	Ngalop	Lhotsam
Ngalop	0.07 (p =.469)		
Lhotsam	0.12 (p =.178)	0.04 (p =.899)	
Others	0.62^{*} (p =.008)	0.55^{*}(p =.028)	0.50 (p =.055)

4.1.6 Correlation between students' attitude towards science and parents or guardians' involvements in science at home

To determine the correlation between students' attitude towards science and their parents or guardians' involvement in science at home, correlation coefficient (Pearson's) was computed and tested at the .05 significance level. The students' attitude towards science had a significant positive correlation with parents or guardians' involvement in science at home, that is, the more the involvement of parents or guardians' at home with their children in science, the more favourable will be the students' attitude towards science, *r* (381) =. 349, $p < .001$. Further analysis employing independent *t*-test was performed to find out whether there is a difference in parents or guardians' involvement in science between the students with high attitude towards science scores and students with low attitude towards science score. The attitude towards science mean scores along with parents or guardians' involvement in science mean scores of the total 383 sample students was arranged in descending order of their attitude towards science scores. From that arrangement, the first 96 students (25%) having high attitude towards science mean scores was taken as upper limit while last 96 students' (25%) with low attitude mean scores was taken as lower limit. An independent *t*-test findings revealed a significant difference (see Table 18) in the scores for the parents or guardians' involvement for upper limit-high attitude (M = 3.67, SD = 0.73, n = 96) and lower limit- Low attitude (M = 3.00, SD = 0.73, n = 96) at the .05 level of significance (t = 6.40, *df* = 190, $p < .001$, 95% CI for mean difference is -0.47 to 0.88). Thus, the parents or guardians' involvement in science at home affects the students' attitude towards science

Table 18 Results of descriptive statistics and *t*-test for parental involvement for students with high and low attitude towards science

			N	M	SD	*df*	t	*p*
Parents or guardians' involvement	Limits	High attitude	96	3.67	.73	190	6.40	.000
		Low attitude	96	3.0	.73			

4.2 Qualitative data analysis

In order to enhance confidence in the ensuing quantitative data findings, a qualitative data collected through interviews was analyzed. A total of 28 participants including 15 teachers (11 females and 4 males) and 13 students (7 boys and 6 girls) were interviewed. From the total of 13 students, 5 students (3 girls and 2 boys) were from Grade 12 and 8 students (3 girls and 5 boys) were from Grade 10. Out of 15 science teachers, 4 teachers (2 female and 2 male) were from higher secondary schools and 11 teachers (9 female and 2 male) were from middle secondary schools.

In the paragraphs that follows under the various headings -Students' perspective of science; Gender and attitude towards science; Grades 10 and 12 students' attitude towards science; Ethnicity and attitude towards science; Parents or guardians' involvement in science with their children at home; Problems faced by the science teachers and the students in teaching and learning of science- the researcher interpreted the experiences, beliefs and opinions of the teachers and students with the narrative description of the meaning the researcher ascribed interweaving the exact words of the participants with very few changes made in the interest of reader clarity.

4.2.1 Students' perspective of science

Despite the variation in opinions and responses about science from the Grades 10 and 12 science students; and from science teachers about the students' perspective of science, the overall students' perspective of science was fine and good enough. Basically, students loved science and considered it as a very important and an interesting subject to be studied. Students understood that everything an individual does in their daily life is related to science.

> Without science, life is impossible because our daily life depends on science directly or indirectly. And I think science is a key to everything in this world. (Student 5)

Students also found science fun and believed that science has the ability to prove facts, but at the same time they found science difficult. Students found science difficult, especially in grade nine due to the huge leap in the syllabus in integrated science in grades seven and eight to the three distinct disciplines of science in Grades 9 and 10. However, the students expressed that science is more interesting than difficult.

> Science is a bit of both (interesting and difficult) but I would say interesting will outweigh difficulties. (Student 2)

From the three disciplines of science, almost all of the student found biology easy, and some found physics easy while most of the students found chemistry difficult. Therefore, the students were not performing well in chemistry and physics compared to other subjects in the school. Moreover, those students, who disliked science, did not dislike science as a whole, but disliked it because of chemistry or physics.

> I am not that much interested in science because of chemistry and physics. My ambition is to become dermatologist but I know this can't be happening because I am not that much interested in chemistry and Physics. (Student 7)

In addition, there is a general belief that science is tough and such notion was put into the children's mind by their seniors or was reinforced by their science teachers unknowingly during the teaching course.

> While teaching in the class, we sometimes call on students' attention by telling them that if you don't pay attention, you will not understand and it's difficult. (Teacher 3)

However, almost all the students understood the fact that science has a wide career scope and everyone wanted to take science. But most of the students lacked hard work and the efforts they put into learning science was not up to the hard work an individual needs to put in considering the abstract nature of science subjects.

> Everybody tries getting in science because they have better job prospective with science but the problem is they don't work hard. (Teacher 4)

Despite understanding the fact that science offers a wider career scope, most of the students lacked knowledge about the different kinds of career in science fields with exception to the two high-profile jobs: doctor and engineer.

> When it comes to science, they always think of science as, after learning science they think of it as only doctor or engineers. Besides that they don't have any other knowledge. (Teacher 13)

In conclusion, the general perspective of the students about science was fine and balanced. The students loved science, but they also found it difficult. There are science disciplines within the three disciplines of science, which the student liked and disliked. In addition, the students were aware of the fact that science has a wide career scope, but they were not really aware of the various careers in science fields.

4.2.2 Gender and attitudes towards science

Science teachers and the current generation of students generally believed that there was no remarkable gender difference in attitude towards science that was noticeable.

> As such, we do not have much difference and I don't see that science is very good among boys or very good among girls. They do equally and as such there is no remarkable difference that can be easily noticed. (Teacher 13)

Both males and females were equally interested and most of the good performers in science were of equal number of males and females. However, the females were found to be hard working, but it was the males who performed well in examinations.

> It's the girls who are hard working in the class but then some of the boys get more marks and then they perform well than the girls who work hard. (Student 8)

In addition to females being a hard worker, females also took more optional subjects compared to males in grade twelve. In grade twelve, excluding the main subjects (English, Dzongkha, physics and chemistry) biology and mathematics are optional subjects-which mean students can take both the subjects or drop any one of them. Most of the females were noticed taking both the optional subjects.

> We have 44 students in our class and all the girls, including one boy are taking biology. So I think boys are more interested in mathematics than biology while more girls are taking both of the subjects –math as well as biology. I think girls are more interested in biology and boys are more interested in math. (Student 8)

The females took both the optional subjects as they were not so sure about their own potential in science. In addition the females have not yet completely decided what they wanted to be.

> I don't really have an aim because if I had an aim I would have dropped one of the optional subjects. I didn't drop any one of the optional subjects because I am scared that if I drop one optional subject and don't do better in the subject I take I wouldn't get any one of them-either in biological or engineering fields. So I am trying to take both and then I will go in whatever I get. I am thinking that way. (Student 8)

Thus, the females were learning one more science subject (biology) compared to males in grade twelve and hopped to go for either biological or engineering science fields depending on their science performance. Though females liked to learn biology, grade ten female students felt a little uncomfortable in biology class compared to the males while learning the particular chapters or topics.

> When we study biology, I feel little uncomfortable while studying certain chapters but I don't find that in boys. Rather they laugh and shouts making us feel uneasy. (Student 1)

Boys exhibited unfriendly behaviour which made the females feel uncomfortable and distracted them from paying attention in the class.

In conclusion, no remarkable gender difference in students' attitude towards science was noticed, but some differences between genders, like females being more hard-working compared to males, and the males performing better in examinations compared to females were noticed. Another difference between male and female students was in their optional subject choices in grade twelve science stream in which almost all the females took both biology and mathematics while most of the males took mathematics only.

4.2.3 Grades 10 and 12 students' attitudes towards science

> Since I thought science would be more fun and interesting, I studied hard in science in grade ten and I am in science now, but then as I proceed I think it's getting harder and my scores in science subjects are decreasing. And I don't feel good about science anymore. (Student 8)

It's obvious from what the student said above that as learners moves up the grade levels their attitude towards science decreases due to increase in complexities in science lessons and the more effort that they had to put in learning science. But the students also had a different thing to say about science at higher grade levels.

> When I was kid, science was very simple and I didn't enjoy it very much. But now we do much detail study than what we used to do in our lower

> classes and learn new things which make me more intrigue and inspires me to learn more. (Student 2)

In addition to the fact that attitude towards science is influenced by the grade levels, it is also influenced by how the science is provided (general or optional) at these two grade levels

> In class ten students take all subjects. Including the science, they take history, geography, economics/IT (optional) and language subjects. In total they have lots of subjects- about nine. And their subjects of study are not narrowed down just to science. They have broad and diverse learning areas but in Class 12, when you pass from Class 10, we are allowed to choose our stream- commerce, art and science. There our subjects get narrowed down according to our individual's interest of stream that we have opted. If we take science stream, we are learning only science besides the language subjects. So, therefore I feel that the subject that they are learning is of their interests. Therefore their attitudes towards science should be better I suppose. (Student 13)

Due to the difference in the way science is provided at these two grade levels, the sciences are also treated in different ways (major/ minor) at this two grades in the education system. In Grade 10, since students have more numbers of subjects to study, many of the subjects are combined and considered as a single minor subject; some are uncombined single minor and major subjects. Thus, the three sciences- physics, chemistry and biology are combined and considered as a single minor subject while assessing students' performance. Therefore, it doesn't matter if the score of one of the three science subjects' is below the average pass mark of the subject but the total mark of the three science subjects must meet the total average required marks of the three sciences.

> They usually combine the three science subjects and as long as you score well in one or two science subjects, it will be okay even if you spoil the other because when we calculate the average, your mark goes up. (Student 12)

Unlike Grade 10 students, Grade 12 science stream students study a less number of subjects and the three sciences are not combined. Physics and chemistry are considered as the major subjects while biology and mathematics are optional subjects. A good qualifying score (above certain requirements for the admission into a particular professional course in university) in each of the major subjects and the optional subject (either biology or mathematics) must be obtained to continue for the further studies in colleges and university. Moreover, since Grade 12 students have already decided in a future in science and have a particular objective in their mind, unlike Grade 10 students, they are more focused in science.

> For the Class 12 science students, their life depends on those subjects. It decides their career, so if they do well in science, they could get better jobs or else they land up nowhere. But for the 10, it's optional because they have three choices. They can go to any stream they like but for the Class 12 science, they have already made their choice in science and then they have to focus on it. It's like do or dies for them." (Student 12)

Finally thoughts and beliefs like, the one who takes science is considered intelligent or felt more superior or science stream is better than any other streams seem to exist which affected the attitude of students towards science. Though most students of Grade 10 were interested in taking science in Grade 11, yet there were many who were influenced to take science because of such thoughts and beliefs. Therefore, though Grade 10 students were interested or were influenced by such beliefs and hopped to take science in Grade 11, they are required to qualify in Grade 10 board examinations and are not very sure about for which stream they would qualify. Thus, their attitude towards science was less favourable compared to Grade 12 students who were already in science stream and such belief or thought made them feel superior and had some positive effect on their attitude towards science.

In contrary to superiority thoughts and beliefs about science, negative thoughts and beliefs in the society about taking science also affected students' attitude towards science negatively

> In the morning, I was just asking to some of the students about what stream they would take up? And I was asking to those students in Grade 10 who are actually good in science. They were saying, if they do not qualify for further studies or if they do not get professionals, they really hope to take art and commerce. (Teacher 5)

It is believed that, taking science in Grade 11 after having scored good marks in science and mathematics in Grade 10 is of no use or scope less if one does not qualify for further studies or for professional after the twelfth grade.

From the preceding paragraphs, it is very clear that there are many factors that caused the difference in attitude towards science between Grade 10 and 12, but the main factor that caused the difference in attitude towards science between these two grade might be the difference in the ways of how science is provided- whether science is provided as general or optional- at these two grade levels. When science is provided as optional as in Grade 12 science streams, students exhibited more positive attitude towards science compared to those students who are taking science as general in Grade 10.

4.2.4 Ethnicity and attitudes towards science

Many of the science teachers and students interviewed expressed that they have never looked into or haven't noticed the differences in attitude towards science among the different ethnicities.

> I have not witnessed such kind of differences until now. Actually I have just not tried to look into see if the ones who are not doing well are from which part of the country and the ones who are doing well are from which part of the country. They all seem kind of similar. Because, honestly, if you just see the people in the class, it's hard to distinguish who is from where, mostly they look the same. (Student 9)

The students of the four different ethnicities more or less seem to have the same physical appearance and their performance in science depended on an individual's capability and interest in science.

> No matter from where and what type of family background an individual comes from, I think learners who are learning science are learning as per their capability and interest. (Teacher 5)

In addition, many believed that students' attitude towards science depended mainly on how an individual was brought up or how their parents or guardians got involved with their children and not because of their ethnicity.

> I don't think that ethnicity has any rule over it. Well, it mainly depends on the difference in how they are brought up and how they are exposed and

> helped in science by their parents and not because of whom they are or from where they came. (Teacher 6)

In conclusion, it is apparent that an individual’s ethnicity might not have affected their attitude towards science, but there are other factors like the difference in how the children are helped in science by their parents at home among different families which might have influenced students’ attitudes towards science.

4.2.5 Parents or guardians’ involvement in science with their children at home

According to the teachers interviewed, the parents or guardians’ involvement with their children at home is as important as the teachers in the school because the children of involved parents do well in schools.

> We have observed that students who are well guided by parents at home not only performs well academically but also behaviour wise, while the students who are not so well guided at home does well only in some cases and most of the time they don’t do well. (Teacher 13)

In addition, teachers also expressed that they were unable to interact personally with each and every student in the class while the parents would be able to get involved with their children and be informed about what their children are learning in schools and how they are faring in studies.

Though parental involvement is important and it helps the children to do well in schools, it was not really happening as per its importance because there were many parents who were not aware of the need to be involved and rarely got involved in the academic performance of their children and believed that teaching is the responsibility of the teachers only and left it up to the schools. While there were only few educated parents who understood the value of sitting with their children and discussing what their children learned in the school and hence got involved in the academic performance of their children.

Children as an independent learner while learning the most abstract and complex concept in science needs someone at home besides their teachers in the school to guide and help them learn and understand the science better. An educated parent with science background is able to help their children in science education in comparison to parents who lacked science knowledge. Besides advising, providing moral support, materials and help in seeking information and pictures for science projects through the Internets for their children, parents with science knowledge often got involved in simple experiments using the materials available at home and often made science learning a part of play or game.

> When we are spending times together, they ask questions that are related to science, making it a part of play and games. We try to answer them and finally we understand something that is behind that. (Student 9)

In addition, those parents who could afford Internet facilities often taught their children how to look for the information through the net. However, as the students moved from middle to higher secondary schools, parents' involvement in science decreased.

> When I was small, they would guide me to study and help me do my homework. But now, I do it myself and I guess that is how it should be. (Student 9)

Students felt they were grown up and mature enough to study on their own. Parents even wanted their child to learn science independently at home as parents failed to know the subject matter or they were busy with their work; and those parents who could afford, sent their children for science tuitions.

However, some parents who were unable or who never got involved with their children, but are worried about their children's future started showing concerns once their children were at the crucial stage of their school lives which decided their future, by talking about the existing job scenarios and making them understand the competitive situations in the job markets.

> When I was young my parents didn't advise me that much but as I have reached Class 10, then they started talking to me about Royal Civil Service Commission examinations, the job markets and the total number of graduates graduating every year. (Student 4)

Parental involvement with their children in science at home is believed to have an influence on students' attitude towards science. When the parents are involved with their children in science, the children felt supported and believed that learning science is important and a good thing because their parents supported it and it encouraged them to learn more. In addition, children also felt inspired to learn more science when the children saw their parents who were unaware of, being fascinated upon hearing some interesting common science facts shared by them after having learned in the science class.

> "Last year in chemistry, when I first learned about silicon, I was so intrigued because I never knew and neither did my parents know that the little packet

> (silica gel) was kept in our clothes and leather shoes to absorb moisture. So I told them about that and they seemed fascinated and I get even more inspired by science. (Student 2)

However, there were many barriers to parental involvement in science. The main barrier to parents' involvement in science was the parents' lack of science knowledge or they were illiterate. To help the children learn science at home, parents need to have an adequate scientific knowledge and background.

The type of relation the parents have with their children or how the parents got involved in the academics of their children from their early years also acted as barrier to parental involvement. From the very young age of the child, if parents were not much involved with their children, parents found difficulty in guiding their children in the higher classes. In addition, if the parents were strict, children never felt free to open up to their parents.

Working parents was also one of the barriers to parental involvement in science. The working parents were busy working to provide their children with basic needs, that they had no time to spare for their children and were unaware of what their children were learning in the schools every day.

In conclusion, parental involvement in science with their children at home is very important. Though, there are differences in parental involvement in science with their children between educated parents with a science background and parents without a science background or illiterate parents, students are always benefitted with involved parents.

4.2.6 Problems faced by the science teachers and the students in teaching and learning of science

Though there were many problems faced by the science teachers and students in teaching and learning of science, lack of proper laboratory facilities, lack of informational technology (IT) facilities and time constraint were the three main problems faced by the science teachers and students.

One of the most common problems faced by the students and science teachers in almost all the eight schools in the Thimphu district was lack of proper laboratory facilities. Teachers believed that students learned science better when the students are taught practical, but with each year that sees the ever increasing number of students, the laboratories in the schools failed to accommodate all the students of a class for science practical. In addition, there were other problems like lack of chemicals and apparatus for experiments. Therefore, most of the time teachers demonstrated the science experiments and rarely allowed the learners to perform experiments. When the science experiments are demonstrated, teaching and learning of science is not as effective as it would have been if the students are actively involved in the experiments.

> One of the most prominent difficulties that they face is they do not get to actually interact with the real concepts. They do not get hands on practice to actually see what is happening. (Teacher 5)

Another common problem faced by both the teachers and students was the time constraint. Science, with its abstract nature requires more time for teaching and learning, but because of the large science syllabus most of the teachers no matter how hard they tried; they were forced to teach more within a short time sacrificing quality teaching for quantity. Thus, teachers were not able to dedicate enough time relating between a particular theory topic and it's practical for the better understanding of the scientific concepts by the students.

> If we relate theories with practical and perform practical, then we will never finish the syllabus on time. (Teacher 10)

Lack of IT facilities was also one of the problems in most of the schools. Some teachers expressed that hours and hours of time were spent in teaching very simple concepts using the conventional teaching methods which otherwise could have been taught much more effectively with the use of IT facilities.

4.3 Summary

In this chapter the characteristics of the subjects were addressed and the findings of the study revealed. The overall means for the 'attitude towards science scale' was at high positive level, while the overall means for the 'parents or guardians' involvement scale' was at moderate level. The correlation between the students' attitude towards science and the parents or guardians' involvement in science at home was positive. A difference in optional subject choices between the male and female students of Grade 12 science stream was observed while the gender had no effect on the students' attitudes towards science. A significant difference in attitudes towards science between Grades 10 and 12 science students was observed with Grade 12 science students having a more favourable attitude than Grade 10 students. The factors that might have caused the differences between these two grade levels were presented. There were significant differences in attitude towards science between- Sharchop and Others ethnicities; Ngalop and Others ethnicities-but no significant difference in attitude towards science was observed between Lhotsam and others or between any of these three ethnicities (Sharchop, Ngalop & Lhotsam). Teachers and students expressed that they have never looked into nor noticed the difference in attitudes towards science among ethnicities. And believed that students' attitude towards science is not influenced by their ethnicity.

Chapter 5

Result and discussion

This very study conducted using the mixed methods of sequential explanatory research design attempted to explore the attitude held by randomly selected Grades 10 and 12 students towards science. It also investigated the influence of ethnicity, gender and grade on students' attitudes towards science, and determined the relationship between students' attitudes towards science and their parents or guardians' involvements in science at home. A total of 383 Grade 10 and 12 students from six middle and two higher secondary schools participated in the survey which measured the students' attitudes towards science and their parents or guardians' involvement in science at home. The survey questionnaire was analysed using the inferential statistics (*t*-test, one way ANOVA and Pearson's correlation). Based on the quantitative results, one-to one semi-structured interview of the15 science teachers and 13 students was conducted for the qualitative data collection. The interviews were recorded and analysed. The findings from both quantitative and qualitative data were as follows.

- The general attitude of students towards science was at high positive level and their perspective of science was fine and balanced.
- No significant difference in students 'attitudes towards science between males and females was observed but a difference in optional subject choice was observed between males and females students of Grade 12 science stream.

- Grade 12 science stream students had significantly more a favourable attitudes towards science in comparison to Grade 10 students. Many factors caused the difference in attitudes towards science between these two grades.
- Significant differences in attitude towards science among the four ethnicities were found between Sharchop and others ethnicities; and between Ngalop and others. Teachers believed that students' attitude towards science depended on how the parents got involved with their children in science at home and not on their ethnicity.
- A positive correlation was found between students' attitude towards science and their parents or guardians' involvement in science at home. Teachers interviewed expressed the view that students' of those parents who got involved with their children at home in school activities did well in schools.

5.1 Students' overall attitudes towards science.

The students' overall attitude towards science as measured by the survey questionnaire was at a high positive level. This result is similar to a prior finding in Bhutan by Tshering (1995), who found that Grade 10 students (in the 1993 academic year) in middle and higher secondary schools had positive attitudes towards science. However, the scales used to measure the students' attitudes towards science in her study and in the present study are different. Tshering used the TORSA (Test of Science-Related Attitudes) developed by Fraser (1978) while the scale used in this study was adopted from the studies of Kind et al (2007) and Shah & Mahmood (2011). Despite the difference in scales used, the general attitudes of students towards science obtained under both were positive. Thus, the students having favourable attitudes towards science in Bhutan are valid based on the present study and the previous study by Tshering (1995). In addition, the teachers' opinion about the students' perception of science and the students' own opinions about science were closely aligned, fine and balanced. Students, basically loved science as they found it fun, understandable and relatable to their environment. They also wanted to follow science in the future as they understood the importance of science, including the fact that science gives them a wide career scope. Unfortunately most of the students lacked the knowledge of the different careers in scientific fields with the exception of two high profile jobs- doctor and engineer. Students seemed to have the notion that they have to become either doctors or engineers after taking science. The possible explanation for such notion of students could be due to the fact that students might have encountered only these two science related careers or might have heard about these careers from seniors, especially their family members expecting them to take either doctor or engineer profession which implies that teachers and parents need to make these students (of grade ten and twelve science stream) more aware of the different kinds of careers in the science fields as soon as they join the middle secondary school so that they can make a proper choices with enough information at the crucial stage of their school lives.

5.2 Gender and attitudes towards science.

No significant differences were found in students' attitude towards science in terms of gender. Science teachers and the current generation of students generally did not perceive females to be less interested in science or as having an unfavorable attitude towards science compared to males or vice-versa but rather believed that females and males were equally proficient and capable in science. This finding is comparable to the results of other studies (Kelly, Bradley & Gratch 2008; Neathery, 1997; Sorge 2007; Tshering 1995; Yilmaz & Timur 2012;) which also found no difference in students' attitude towards science between males and females.

Although gender had no effect on students' attitude towards science, a difference in optional subject choices among male and female students in Grade 12 in the science stream was observed with most females taking more or both the optional subjects (biology and mathematics) while males were more inclined to take mathematics and to drop biology (Greenfield, 1996). Thus, it seems that males are more interested in mathematics, and the engineering and technology fields while females were more interested in biology related fields (Desy, Peterson & Brockman, 2011); but at the same time, females also took mathematics as it had high subject value (since a basic level of mathematics is used in science subjects) and they wanted to keep their options open in both mathematics and biology related career courses for admission into colleges. Such decisions by females also tended to indicate that the females were not as confident about their own academic ability (Craker, 2006) and have not yet completely decided what career they want to follow. Females appeared to have less positive belief in their own abilities in science and were concerned over thoughts like- "What if I don't perform well in the optional subject that I take after dropping the other one?" Thus, they did not want to take risk. The males, on the other hand are more confident of their intellectual abilities and their own estimation of the difficulty of the optional subject that they had taken and dropped.

In addition, girls have been seen to exhibit dependent behaviors, unlike boys, and tend to receive more advice on a future science career from teachers compared to boys (Paludi, 1998). Thus, their teachers advised them to take both of the optional subjects to have a wider choice of careers in both biology and mathematics related fields.

5.3 Grades and attitudes towards science.

The results indicated that Grade 12 science stream students had significantly more favorable attitude towards science than Grade 10 general students. This finding is similar to Yilmaz and Timur's (2012) who found eighth grader students to have a more positive attitude compared to seventh graders; and Shah, Mahmood & Harrison (2013) who found that students' attitudes towards science learning becomes more favourable with increasing grade levels. But this result cannot be directly compared with the results of several previous studies (Barmby et al., 2008; Butler, 1999; Francis & Gibson and Chase, 2002; Greenfield, 1997; Greer, 1999; Murphy & Beggs, 2003; Neathery,1997; Weinburgh, 2000), which observed a decline in positive attitude towards science with each successive grade, because the present study compared the attitude towards science of students in science streams (Grade 12) and those in the mainstream (Grade 10) finding that there were few similarities and more differences. Thus, the homogeneity of variances between these two grades while employing a *t*-test was violated. This explains the unusual and distinctive quality of this study.

There are many factors which caused the difference in attitude between these two grades particularly how science is treated at these two grade levels in the education system while assessing the students' performance in science, the need to prepare for national board examinations and social beliefs about science. But the main factor which is more important than all other factors is the difference in how science is offered (as a general or optional subject) in the mainstream at Grade 10 and in the Grade 12 science stream. As Grade 10 is a basic education level, science is studied as a general subject (along with six other subjects English, *Dzongkha*, mathematics, history & civics, geography, economics/IT). At Grade 11 (post basic education level) students joining the science stream to study science along with two language subjects -English & *Dzongkha*, have a choice between three streams (art, commerce and science), which they join mainly depending on their performance in science and mathematics in Grade 10 board examination and also on the students' interest. Since, only those students who have scored good marks in science and mathematics in Grade 10 and those who are interested or those who have decided on a future in science opt for the science stream in Grade 11, their attitude towards science is more favourable in Grade 12 than in Grade 10. Thus, the study concluded that if science is provided by the school to interested students depending on their science performance in previous grades, students' attitude towards science would be better at higher grade level.

In addition to the factors mentioned above, the second most important factor causing differences in attitude towards science between Grades 10 and 12 is the difference in the number of years that student have studied science in its three separate disciplines. Up to Grade 8, science is studied as an integrated subject. Then in Grade 9 through 12, science is learned according to the three scientific disciplines- physics, chemistry & biology). It takes time for the students to fully understand the three different sciences, and to bridge the gap in concepts between the science taught as an integrated subject and the three disciplines of science. In Grade 10, students have had less than two years to become comfortable with learning science according to the three scientific disciplines while Grade 12 science students have learnt science based on the three disciplines for the last three years and are thus more comfortable and have a more favourable attitude towards science. Therefore, even the science teachers noticed that teaching science to students in Grade 11and 12 is easier compared to teaching science to Grade 9 and 10.

5.4 Students' attitudes towards science among the ethnicities; and the parents or guardians' involvement in science

The study examined the difference in attitude towards science among the four ethnicities (Sharchop, Ngalop, Lhotsam and others) and the quantitative findings showed a statistically significant difference in attitude towards science between Sharchop and others; and Ngalop and others. However, this finding is not conclusive as it might be distorted by limitation of a relatively small sample in 'others' category (as this group is very small in the population itself) and there were no differences in students' attitude towards science between any two of the three major ethnicities (Sharchop, Ngalop and Lhotsam). Moreover, this finding could not be compared with the previous two studies on attitude towards science in Bhutan as the "ethnicity" factor was not studied in either of those previous studies. In addition, almost all teachers and students interviewed generally expressed the opinion that they had never looked into nor noticed any difference in attitude towards science among different ethnicities. However, teachers expressed the opinion that the difference in attitude towards science might be due to the difference in parental involvement in science at home among families or due to the difference in how children are helped in science by their parents or guardians and might not be due to their ethnicity. However, it is apparent that the pattern and amount of parental involvement differs in among families or ethnic groups (Hill & Taylor, 2004; Henderson & Mapp, 2002) and it is recommended that future research should be conducted to investigate the patterns and amount of parental involvement among the different ethnicities in Bhutan.

As expected, a significant positive correlation was also found in this study between students' attitude towards science and parents or guardians involvement in science at home with their children. This finding is in accordance with the results of Alrehaly, (2011); Oundo, Poipoi and Were, (2014); and Oluwatelure and Oloruntegbe (2010). When parents or guardians are involved in science, the children valued science learning and felt supported and motivated to learn. However, only the educated parents with a science background were able to be more involved with their children's science education in comparison to parents who lacked scientific knowledge. This is in agreement with the findings of Rinchen, (2003) and Alrehaly (2011). Educated parents with science background not only assisted their children with science, but often got actively involved in simple science experiments at home with their children and made science learning fun through a play or game. Though illiterate parents or parents who lacked a scientific background could not assist much in the science learning of their children, they were able to motivate their children to learn more science when the children saw their parents fascinated upon hearing some interesting common science facts shared by them after having learned them in a science class. Therefore, it is apparent that it is not necessary for the parents' level of education to be high in order for them to motivate or support their children's learning at home (Hoover- Dempsey & Sandler (1997) and that students can benefit in various ways from the involvement of their parents (Henderson & Mapp, 2002) including students developing favourable attitude towards science. This implies that schools and teachers should encourage parents to be actively involved in their children's science activities at home and to support their children's science learning even though there may be significant barriers to parental involvement.

5.5 Implication

With the conclusion of the study, it gave the researcher new insights to become an able teacher and a guardian. As a guardian or parents, we seem to fail in providing guidance and are least bothered in assisting the students in science learning at home and rarely get involved with the students in science activities. It is evident from the present study that parents or guardians' involvement in science at home positively influences students' attitudes towards science. This implies that parents need to participate in their children's science learning at home and help their children in every possible way. And if teachers want their students to be inspired and motivated in learning, school and teachers need to make parents understand that students are always benefitted with involved parents and should encourage parents' involvement.

Teachers also need to create awareness in children about the various science careers as soon as the students join middle secondary schools as it is evident from the findings of the present study that students were not aware about the different careers in the science field. Most of the students thought that they will have to pursue either doctor or engineer professions after taking science, which mostly was the reflection of the expectations of their parents or their family members. Therefore, parents also need to reinforce what the teachers shared with regard to scientific professions and develop understanding of their children's interest, provide support and encouragement.

5.6 Recommendation

The present study represents the perception of science and the attitude towards science of those students who were at the most crucial stage (Grade 10 and 12 students) of their school lives. It also provides significant insights into -the difficulties or challenges faced by science teachers and student in science learning in schools; the difference in choices of the optional subjects between the male and female students of Grades 12 science stream; how the parents got involved with their students' science at home; and the factors that caused Grade 12 science students to have a more favourable attitude towards science in comparison to mainstream Grade 10 students. Therefore, it is very much apparent from these findings that the administrators, schools, teachers and parents can do something in order to effectively confront the problems faced by students in science learning and improve students' attitude towards science.

5.6.1 Recommendation for administrators

Administrators must ensure that the school has well equipped laboratory and informational technology (IT) facilities. Students and teacher often expressed that one of the ways through which students' attitude towards science can be improved is by teaching or learning science through practical or with the use of IT facilities. When science lessons are taught through hands on experiences performing practical, it resulted in better understanding of the science lessons and developed interests and curiosity in the learners. However, the experiences shared by teachers and students in the present study indicated that most of the science teaching and learning was confined to the four walls of the classroom or textbooks with very less practical classes. This limited number of practical classes were always conducted in groups of minimum 5 students or more or rarely conducted. Thus, when science practical classes are rarely conducted or conducted in groups of more than two; learners do not really enjoy learning science. Therefore, the administrator must see that the schools are very well equipped with enough equipment and material to conduct practical alone or at least in a pair so that the students develop laboratory skills and enjoy learning science.

Along with the active SPEA[3] (School- based Parents Education and Awareness) programs in most of the schools, school administrators should discuss with parents about their children's performance and provide parents with information on how to get involved in the academics of their children. So that parents can aid their children at

---

[3] SPEA programs was innovated by Save the children in 2000, mainly to facilitate communication between the teachers, parents or guardians and their adolescent children to address the emerging problems facing Bhutanese youth with the changing environment brought about by development and other influences.

home with assignments and encourage children to pursue science and science related careers. School administrators should also conduct workshops with teachers to discuss on students' failure to do well in science and involve teachers in the planning and implementation of programs.

5.6.2 Recommendation for teachers and parents or guardians

Parents are the first important persons that a child comes in contact with and once the children are admitted in school teachers are the second parents or guardians of the children. Thus, educating a child is a shared responsibility of both the parents and teachers. However, it is evident from this study that the parents or guardians' involvement in science at home with their children was 'moderate' implying that the parents or guardians need to get more involved with their children in science at home. Thus, the schools and teachers need to find ways of enhancing parental involvement with their children in science at home and such programs should be made attractive to parents or guardians. The schools and teachers should also play a major role in educating the parents or guardians about the importance of science and encourage parents or guardians to get involved with their children in science at home.

Parents or guardians should guide their children in school learning activities at home. Parents should also help their children make a proper choice of optional subjects in Grade 11 and then in 12 as many students took both the optional subjects and dropped one of the optional subjects at the last minute after having studied it for one and half years (in Grade 11 and then till midterm in Grade12) or to help them decide for themselves whether is it wise enough to take both the optional subjects if they are to follow a particular career or if they are not sure of which career to follow.

5.7 Direction for future studies

Future research should continue to study students' attitude and perception of science with special emphasis on the following issues

- Though the overall attitude of students towards science in general was positive; and their perception of science was fine and good enough, students had different perceptions and opinions when science was discussed in three separate disciplines- physics, chemistry and biology. From the three disciplines of science, almost all the students found biology easy; some found physics easy while most found chemistry difficult. Physics and chemistry are the main subjects in Grade 12 and prerequisite for any science degree program after 12. Most of the students in Grade 10 were not performing well in physics and chemistry compared to other subjects in the school. Moreover, those students, who disliked science did not dislike science as a whole, but said that they didn't like science because of physics or chemistry. There is a need for future researchers to investigate students' perception and attitudes towards science, particularly physics and chemistry. And this study will be a stepping stone for more future studies in science education, as there is not a single study in Bhutan at present with regard to students' attitude towards physics and chemistry.

- In this study, teachers and students did mention the difference in parental involvement among ethnicities that affected students' attitude towards science. Here, the researcher was not able to explore the difference in parental involvement. Other researchers (e.g., Hill & Taylor, 2004; Henderson & Mapp, 2002) have also noted that the patterns and the amount of parental involvement differ in different ethnicities. Thus, there is a need to investigate the parental involvement among the different ethnicities in Bhutan.

- The present study was conducted in schools located in an urban area. There is a need to carry out similar studies in schools located in urban and rural areas to see how the location of the school in particular communities affects the students attitude towards science and their parents or guardians' involvement in science at home.

- Future researchers replicating this study should include parents as respondents in their studies to know the views and opinions of parents, and not just the views and opinions of teachers and students about parental involvement as in the present study. With parents or guardians included as respondents, it would enable the researcher to find out the perception and attitude of parents towards parental involvement in science with their children at home. A mixed method of qualitative and quantitative approach is recommended to get in-depth information about parents' involvement at home with their children in science.

References

Aiken, L.R., & Aiken, D.R. (1969). Recent research on attitudes concerning science, *Science Education*, *53*(4), 295-305.

Akcay, H., Yager, R.E., Iskander, S.R & Turgut, H. (2010). Change in student beliefs about attitudes toward science in grades 6-9, In *Asia-Pacific Forum on Science learning and Teaching*, *1*(1), 1-18.

Alrehaly, E.D. (2011). *Parental Attitudes and the Effects of Ethnicity: how they influence children's attitudes toward science Education*. Retrieved from ERIC database (ED515978)

Angelis, Z. (2003). *The structure of attitudes towards science*. (Master's thesis) Available from ProQuest Dissertations and Theses database. (UMI No. MQ84206)

Atwater, M.M., Lance, J., Woodard, U., Johnson, N.H. (2013). Race and Ethnicity: Powerful Cultural forecasters of Science learning and Performance. *Theory Into Practice*, *52*(1), 6-13. doi: 10.1080/07351690.2013.743757

Aydeniz, M & Kotowski, M.R. (2014). Conceptual & Methodological Issues in the Measurement of Attitudes Towards Science. *Electronic Journal of Science Educations*, *18*(3), 1-24.

Baker, S.E., & Edwards, R. (2012). *How many qualitative interviews is enough? Expert voices and early career reflections on sampling and cases in qualitative research*. Retrieved from National Centre for Research Methods websites: eprints.ncrm.ac.uk/2273/4/ how_ many_ interviews.pdf

Barmby, P., Kind, P.M, & Jones, K. (2008). Examining changing attitudes in secondary school science. *International Journal of Science Education, 30*(8), 1075-1093. doi: 10.1080/0950069070134496

Booth, M.Z., Curran, E.M., Frey C.J., Gerarad, J.M., Collet B., & Bartimole, J. (2014). Ethnic identity, Gender and Adolescent Attitude toward school: Adaptive Perspectives in Diverse settings. *Mid-Western Educational Researcher (Akron, Ohio: 1991), 26* (2), 3-27.

Brewster, B.H.(2005). History of the concept of the attitude in Social Psychology. Retrieved from https://www.academia.edu/1747510/History_of_the Concept_of_the_Attitude_ in_Social_Psychology

Brikci, N., & Green, J. (2007). A Guide to Using Qualitative Research Methodology. Retrieved from http://hdl.handle.net/10144/84230

Butler, M. B. (1999). Factors associated with students' intentions to engage in science learning activities. *Journal of Research in Science Teaching, 36*(4), 455–473. doi: 10.1002/(SICI)1098-2736(199904)36:4<455::AID-TEA4>3.0.CO;2-T

Cacioppo, J.T., Petty, R.E., & Crites, S.L. Jr.(1994) "Attitude Change". In V.S. Ramachandran (Ed), *Encyclopedia of human behaviour, pp.* 261-270.San Diego: Academic press. Retrieved from http://psychology.uchicago.edu/people/faculty/cacioppo/pubs.shtml#1994

Catsambis, S. (1995). Gender, Race, Ethnicity and Science Education in the Middle grades. *Journal of Research in Science Teaching, 32*(3), 243-257. doi: 10.1002/tea.3660320305

Chadderton, C., Rhamie, J., & Miah, S. (n.d). *Race, Ethnicity and Education*. Retrieved on October 15, 2015 from British Educational Research Association (BERA) website: https://www.bera.ac.uk/group/race-ethnicity-and-education

Childs, A., Tenzin, W., Johnson, D., & Ramachandran, K (2012). Science Education in Bhutan: Issues and Challenges, *International Journal of Science Education, 34*(3), 375-400, doi: 10.1080/09500693.2011.626461

Clewell, B. C, & Campbell, P.B. (2002). Taking Stock: Where We've Been, Where We Are, Where We're Going. Journal of Women and Minorities in Science and Engineering, 8 (3&4), 255-284.

Collins,B.E & Ashmore, R.D. (1970). *Social psychology: Social influence, attitude change, group processes and prejudice*. Reading, Mass: Addison-Wesley publishing company.

Craker, D. E. (2006). Attitudes towards science of students enrolled in introductory level Science courses at UW-La Crosse. *UW-L Journal of Undergraduate Research IX*, 1-6.

Creswell, J. W., & Clark, V. L.P., (2011). *Designing and Conducting Mixed Methods Research.* (2nd ed). Los Angeles: Sage Publication.

Cronbach, L.J. (1951). Coefficient alpha and the internal structures of tests. *Psychometrika. 16*(3), 297-334.

David, M., & Sutton, C.D. (2004). *Social Research: The Basics.* London: SAGE publications.

Deki, T. (2012, September 14). Gender Effects Observed In Teacher- Student performances. *The Bhutanese*. Retrieved from http://www.thebhutanese.bt/gender-effects-observed-in-teacher-student-performances/

Desforges, C. & Abouchaar, A. (2003). *The Impact of Parental Involvement, parental Support & family Education on Pupil Achievements and Adjustment: A Literature Review*.(Research report No.44). Nottingham: DfES Publications.

Desy, E.A,. Peterson, S, A & Brockman, V. (2011). Gender Differences in Science – related attitudes and interest among middle school and high school students. *Science Educator, 20*(2), 23-30.

Dixon, A. (1992). Parents: Full partners in the decision-making process. *NASSP Bulletin, 76*(543), 15-18. doi: 10.1177/019263659207654305

Dunne, M., & Rennie, L. (1990). The influence of gender, ehtnicity and rurality upon perception of science. *Research in science education, 20*, 57-65.

Ebenezer, J.V., & Zoller, U. (1993). Grade 10 students' perception of and attitudes towards science teaching and school science. *Journal of Research in Science Teaching, 30* (2), 175-186.doi: 10.1002/tea.3660300205

Eccles, J., Midgley, C & Adler, T. F (1984). Grade- related changes in the school environment: Effects on achievement motivation. *Advances in motivation and achievement*, (3), 283-331.

Fishbein., M & Ajzen, I. (1975). *Belief, Attitude, Intention, and Behaviour: An Introduction to Theory and Research.* Retrieved October 16, 2014 from http://people.umass.edu/aizen/f&a1975.html

Fnu, M. (2011). *Relationship between ethnicity and performance in AP courses: Results from a longitudinal study examining years 2001, 2005 and 2010.* (Doctoral Dissertation). Available from ProQuest Dissertation and Thesis database. (UMI No. 3482444).

Fraser, B.J (1978). Development of a test of science- related attitudes. *Science Education*, 62 (4), 509-515.

Francis,L.J & Greer, J.E (1999). Measuring Attitude Towards Science Among Secondary School Students: the affective domain. *Research in Science & Technological Education*, *17*(2), 219-226.

Garrison, H. (2013). Underrepresentation by Race-Ethnicity across Stage of US Science and Engineering Education. *CBE Life Sci Educ. 12*(3), 257-363. doi: 10.1187/cbe.12-12-0207

George, R. (2006). A cross-domain analysis of change in students' attitudes toward science and attitudes about the utility of science, *International Journal of Science Education, 28*(6), 571-589.

Gibson, H. L. & Chase, C.(2002). Longitudinal impact of an inquiry-based science program on middle school students' attitudes toward science. *Science Education 86*(5):693–705. doi:10.1002/sce.10039

Gonzales,P., Blanton, H. & Williams, K.J. (2002). "The Effect of Streotype Threat and Double- Minority Status on the Test Performance of latino Women." *Personality and Social Psychology Bulletin 28*, (5), 659-670 doi: 10.1177/0146167202288010.

Greenfield, T.A. (1996). Gender, Ethnicity, Science Achievement, and Attitudes. *Journal of Research in Science Teaching, 33*(8), 901-933.

Greenfield, T.A. (1997). Gender-and Grade-Level Differences in Science Interest and Participation. *Science Education, 81*, 259-276. doi: 10.1002/(SICI)1098-237X(199706)81 :3<259::AID-SCE1>3.0.CO;2-C

Gyelmo, D. (2013, August 7). Balanced science text for class VII from 2014. *Kuensel Online*. Retrieved from http://www.kuenselonline.com/balanced-science-text-for-class-vii-from-2014/#.VBfa6PldUpw

Hafza, R.J. (2012). *Attitudes about high school physics in relationship to gender and ethnicity: a mixed method analysis.* (Doctoral dissertation). Available from ProQuest Dissertation and Thesis database. (UMI No. 3528438)

Henderson, A. T., & Mapp, K.L., (2002). *A New Wave of Evidence: The Impact of School, Family, and Community Connections on Student Achievement.* Annual Synthesis 2002. Retrieved from ERIC database (ED536946).

Hill, C., Corbett, C., & Rose, A.S. (2010). *Why So Few? Women in Science, Technology, Engineering and Mathematics.* Retrieved from ERIC database (ED509653).

Hill, N.E., & Taylor, L.C. (2004). Parental School Involvement and Children's Academic Achievement: Pragmatics and Issues. *Current Directions in Psychological Science, 13*(4), 161-164.

Hoover-Dempsey, K.V., & Sandler, H. M. (1997). Why do Parents become involved in their children's Education? *Review of Educational Research, 67*(1), 3-42.

Johnson, D., Childs, A., Ramachandran, K., & Tenzin, W. (2007). *A Needs Assessment of Science Education in Bhutan*. Paro: Ministry of Education.

Jones, M.G., Howe, A., & Rua, M.J. (2000). Gender Differences in Students' experiences, Interest, and Attitudes towards Science and Scientists. *Science Education 84* (2) 180-192. doi: 10.1002/(SICI)1098237X(200003)84:2<180 ::AID-SCE3>3.0.CO;2-X.

Kelly, J., Bradley, C. & Gratch, J. (2008). *Science simulations: Do they make a difference in student achievement and attitude in the physics laboratory?* Retrieved from ERIC databases. (ED 501 653).

Khan, G.N., & Ali, A.(2012). Higher Secondary School Students' Attitude towards Chemistry. *Asian Social Science, 8*(6), 165-169. doi:10.5539/ass.v8n6p165

Kind, P., Jones, K., & Barmby, P. (2007). Developing attitudes towards science measures. *International Journal of Science Education, 29* (7), 871-893. doi:10.1080/09500690600909091

Kipkorir, B.P. (2013). Differences in performances between boys and girls in secondary school science subjects in Keiyo district, Kenya. *International Journal of Advanced Research, 1*(5), 449-454.

Klawe, M. (2002). Girls, Boys, and Computers. *ACM SIGCSE Bulletin-Women and Computing, 34*(2),16-17. doi>10.1145/543812.543818

Lovelace, M. & Brickman, P (2013). Best practices for measuring students' attitude towards learning science. *CBE-Life Science Education, 12*(4), 606-617. doi: 10.1187/cbe.12-11-0197.

Ma, K. (1994). *The relationship between achievement in and attitude towards Science, approach to learning and classroom environment* (Masters' Thesis). Retrieved from HKU Theses Online (HKUTO)

Majare, I.S., Role, E., & Makewa, L.N. (2012). Gender Disparity in Self-concept, Attitude and Perception in Physics and chemistry. *Atlas Journal of Science Education, 2*(1), 61-69. doi:10.5147/ajse.2012.0097

Margolis, J., & Fisher, A (2003). *Unlocking the Clubhouse: Women in computing*. Massachusetts; The MIT press.

Mason, M. (2010, August). Sample Size and Saturation in PhD Studies Using Qualitative Interviews [63 paragraphs]. *Forum: Qualitative Sozialforschung / Forum: Qualitative Social Research 11*(3). Retrieved from http://nbn-resolving.de/urn:nbn:de:0114-fqs100387

Maxwell, J.A. (1996). *Qualitative research design: An interactive approach (3Edn).* Washington,DC: SAGE publications

Ministry of Education, RGOB. (2013). *Annual Education Statistics 2013*. Retrieved from http://www.education.gov.bt/statistic

Ministry of Education, RGOB. (2014). *Annual Education Statistics 2014*. Retrieved from http://www.education.gov.bt/statistic

Mitchell, S.N., & Hoff, D.L.(2006). (Dis)Interest in Science: How Perception About Grades May Be Discouraging Girls. *Electronic Journal of Science Education, 11*(1), 10-21.

Mohammad, N., Ebrahimitabass, E., Dehghani, A., & Rezaei, M. (2012). Students' Attitude towards Science and Technology. *Interdisciplinary Journal of Contemporary Research in Business, 3*(10), 129-134.

Morrell, P.D. & Lederman, N.G. (1998). Students' attitude towards school and classroom science: Are they independent Phenomena? *School Science and Mathematics, 98(2)*, 76-83.

Movahedzadeh, F. (2011). Improving students' attitude towards science through blended learning. *Science Education & Civic Engagement, 3* (2), 13-19. Retrieved from http://seceij.net/seceij/summer11/movahedzadeh_im.html

Murphy, C & Beggs, J. (2003). Children's perception of school science. *School Science Review, 84* (308), 109-116. Retrieved from http://www.pd.infn.it/~lacaprar/ProgettoScuola/Biblio/Children_perceptions_science.pdf

Narmadha, U & Chamundeswari, S. (2013). Attitude towards Learning of science and Academic achievement in Science among students at the secondary level. *Journal of Sociological Research, 4* (2), 114-124.

Neathery, M.F (1997). Elementary and secondary students' perception towards science and the correlation with Gender, Ethnicity, Ability, Grade and Science Achievement. *Electronic Journal of Science Education, 2*(1), 1-11.

Olasehinde, K.J., & Olatoye, R. A. (2014). Scientific attitude, Attitude to Science & science Achievement of Senior Secondary School Students in Katsina state, Nigeria. *Journal of Educational & Social Research*, 4(1), 445-452. doi: 10.5901/jesr.2014.v4n1p445

Osborne, J., Simon, S & Collins, S. (2003). Attitudes towards science: a review of the literature and its implications. *International journal of science education, 25* (9), 1049-1079. doi: 10.1080/0950069032000032199

Osborne, J., Simon, S & Tytler, R. (2009, April). *Attitudes towards science: An Update.* Paper presented at the Annual Meeting of the American Educational Research Association, San Diego, California. Retrieved from http://science.teachingjournalclub.org/wp-content/uploads/2012/06/Attitudes-Toward-Science-OsborneSimon-Tytler.pdf

Oundo, E.N., Poipoi, M.W., & Were, D.S. (2014). Relationship between parents' attitude towards educational involvement and academic performance of day secondary school students in Samia- Kenya. *International Journal of Human Resource Studies*, *4*(3), 147-157. Doi:10.5296/ijhrs.v4i3.5964

Oluwatelure, T.A., & Oloruntegbe, K.O. (2010). Effects of parental involvement on students' attitude and performance in science. *African Journal of Microbiology Research*, 4(1), 001-009.

Paludi, D. (1998). *Sex and gender: the human experience* (4th ed). New york: The McGraw- hill Companies.

Papadimitriou, M. (2004). What Girls Say About Their Science Education Experiences; Is Anybody Really Listening? Canada: Trafford Publishing.

Papanastasiou, C., & Papanastasiou, E.C. (2002). The process of science achievement. *Science Education International, 13*(2), 12-24.

Papanastasiou, C., & Papanastasiou, E.C. (2004). Major Influences on Attitudes Toward Science. *Educational Research & Evaluation, 10* (3), 239-257.

Perkins, K.K., Adams W.K., Pollock, S.J., Finkelstein, N.D., & Wieman C.E (2004). *Correlating Students Beliefs with Student Learning using the Colorado Learning Attitudes about Science Survey. PERC Proceedings*. Paper presented at the AIP Conference, Sacramento, California (USA). Retrieved from http://dx.doi.org.sci-hub.cc/10.1063/1.2084701

Ramadas, J. (2003). Science and Technology Education in South Asia. In E. W., Jenkins (Eds), *Innovations in science and technology education*, vol. III. Paris, France: UNESCO publishing.

Rinchen, S. (2003). Bhutanese girls' perception of science and the impact of science on career choice. *RABSEL the CERD Educational journal*, *3,* 17-44. http://www.pce.edu.bt/sites/default/files/Rabsel%20Volume%20-%20III.pdf

Royal Education Council, Bhutan. (2012). The National Education Framework (NFE): Shaping Bhutan's Future [Adobe Digital Editions version] Retrieved from http://www.ibe.unesco.org/curricula/bhutan/bt_alfw_2012_eng.pdf

Sarjou, A.A., Soltani, A. & Kalbasi, A (2012). A study of Iranian students Attitude towards science and technology, school science and Environment based on ROSE project. *Journal of Studies in Education*, *2*(1), 90-103. doi:10.5296/jse.v2i1.961

Shah, Z.A., & Mahmood, N. (2011). Developing a scale to measure Attitude towards science learning among school students. *Bulletin of Education and Research*, *33*(1), 71-81.

Shah, Z.A., Mahmood, N., & Harrison, C. (2013). Attitude towards science learning: An exploration of Pakistani students. *Journal of Turkish Science Education, 10*(2), 35-47.

Sorge, C. (2007). What Happens? Relationship of age and gender with science attitudes from elementary to middle school. *Science Educator*, 16 (2), 33-37.

Stouffer, B. (1992, April). We can increase parent involvement in secondary schools. *NASSP Bulletin, 76*(543), 5-9. doi: 10.1177/019263659207654303

Susan,I.V.,& Kinley (2014). Awareness of Parents and Teachers on Parental Involvement in Education under Trashigang District. *International Journal of Information & Futuristic Research*, 1(5), 1-13.

Tare, M., French, J., Frazier, B. N., Diamond, J., & Evans, E. M. (2011). Explanatory parent–child conversation predominates at an evolution exhibit. *Science Education, 95*(4), 720-744.

Tshering, K.D. (1995). *Relationships between Grade 10 Students' Attitude Towards Science and their Achievement in Science in Bhutan*. Unpublished thesis for the Master of Education degree, University of New Brunswick, Fredericton, NB.

UNESCO (2003). *UNESCO's gender mainstreaming implementation framework (GMIF) for 2002-2007*. Retrieved from http://unesdoc.unesco.org/images/0013/001318/131854e.pdf

Wanat, C.L (1992). Meeting the needs of single-parent children: School and parent views differ. NASSP Bulletin, 76(543), 43-48. doi: 10.1177/019263659207654310

Weinburgh, M. (1995). Gender difference in student attitudes toward science: A meta-analysis of the literature from 1970 to 1991. *Journal of Research in Science Teaching, 32*(4), 387-398.

Weinburgh, M.H. (2000). Gender, Ethnicity, and Grade Level as predictors of Middle School Students' attitude towards Science (Report no. 143). Retrieved from ERIC database (ED442662)

Yamane, T. (1967). Statistics: An Introductory Analysis, 2nd Ed., New York: Harper and Row.

Yilmaz, S., & Timur, B. (2012). Investigation of Primary education 6th, 7th and 8th grade students' attitudes towards science and technology lesson. *The Online Journal of New Horizons in Education, 2* (3), 25-41

APPENDIX

MoE 0521.2.0703/ 091

Department of Education, Faculty of Education,
Prince of Songkla University, Pattani Campus
Rusamilae, Meaung, Pattani, Thailand 94000
Tel. (66-73) 313 928 ext.1604
Fax. (66-73) 348 322
Website: http://eduit.pn.psu.ac.th

June 12 , 2015

Ministry of Education
Royal Government of Bhutan
Thimphu district, Bhutan

Subject: Request for Permission to Collect Research Data
Enclosure: Thesis Summary

Sir/Madam,

The Department of Education, Faculty of Education, Prince of Songkla University; Thailand, would like to inform you that Miss SANGAY ZANGMO is one of our Master's students in Education for Sustainable Development. In partial fulfillment of her Master's program she is conducting a study through a thesis project entitled "Attitudes of grades ten and twelve students towards science in Thimphu district of Bhutan", which is being advised by Assoc. Prof. Dr. CHIDCHANOK CHURNGCHOW, Assoc. Prof. Dr. THEERAPHONG KAENIN and Dr. NATTINEE MOPHAN. For the thesis summary please find the attachment.

In this connection, I, the undersigned would like to ask your permission for Miss SANGAY ZANGMO to collect the necessary data for her study from the students and teachers of schools in Thimphu district and ensures that all information that is received will be kept confidential. I would also like to certify that the research will not impact or affect your organization.

Therefore, I would like to appreciate your assistance and support in this particular research endeavor.

Thank you very much for your cooperation.

Yours sincerely,

Mrs. YuppadeeYoswarissakul
Head, the Department of Education
Faculty of Education
Prince of Songkla University, Pattani Campus, Thailand

Instrument validation Experts scores for Attitude towards science items.

Statement of Attitude	E1	E2	E3	Total	Ave
Self –concept in science 1. I find science difficult	+1	+1	+1	3	1
2. I am just not good at science.	+1	+1	+1	3	1
3. I get good marks in science.	+1	+1	+1	3	1
4. I learn science quickly	+1	+1	+1	3	1
5. Science is one of my best subjects.	+1	+1	+1	3	1
6. I feel helpless when doing science.	+1	+1	+1	3	1
7. In my science class I don't understand each and everything.	0	+1	+1	2	0.67
8. School science has made me more critical and skeptical.	+1	+1	+1	3	1
9. Sharing science facts that I know makes me feel great.	+1	+1	+1	3	1
Keenness to learn science 10. I follow a regular schedule to study science subject(s) at home	+1	+1	+1	3	1
11. I understand science lessons taught by the teacher in the class	+1	+1	+1	3	1
12. I can focus the science lesson during the whole class	+1	+1	+1	3	1
13. I revise the science lesson daily at home	+1	+1	+1	3	1
14. I complete the science homework before going to play.	+1	+1	+1	3	1

Statement of Attitude	E1	E2	E3	Total	Ave
15. During science lectures, I comprehend important points.	+1	+1	0	2	0.67
16. While studying science class, I fully concentrate on the topic.	+1	+1	+1	3	1
17. I can explain science lessons in my own words	+1	+1	+1	3	1
18. I usually relate the previously learned lessons with new science lessons.	+1	+1	+1	3	1
Enjoyment in science learning 19. I like to learn science because it is an interesting subject.	+1	+1	+1	3	1
20. I feel real pleasure in science class.	+1	+1	+1	3	1
21. I usually allocate most of the time to the subject of science as I like it more than other subjects.	+1	+1	+1	3	1
22. My desire to attain success in science subject, urges me for more hard work.	+1	0	+1	2	0.67
23. I like science lessons	+1	+1	+1	3	1
24. Knowing science facts makes me feel good.	+1	+1	+1	3	1
25. I feel like day dreaming during science class.	+1	+1	+1	3	1
26. I hate to study science out of doors.	+1	+1	+1	3	1
27. I like to make science drawing.	+1	+1	+1	3	1
Disinterest 28. Science lessons become a source of boredom for me.	+1	+1	+1	3	1
29. The lessons taught in science classes are not interesting.	+1	+1	+1	3	1

Statement of Attitude	**E1**	**E2**	**E3**	**Total**	**Ave**
30. I can't understand the science lessons, after the class.	+1	+1	+1	3	1
31. I don't find it interesting to discuss science topics after the school time	+1	+1	+1	3	1
32. I don't take interest to complete my homework of science subject(s).	+1	+1	+1	3	1
33. Doing science project at home is annoying	+1	+1	+1	3	1
Future participation in Science 34. I would like to study more science in the future.	+1	+1	+1	3	1
35. I prefer opting science subjects in next classes/at university.	+1	+1	+1	3	1
36. When I leave school, I would like to have a job working with science.	+1	+1	+1	3	1
37. I would like to become a science teacher.	+1	0	+1	2	0.66
38. I would like to become a scientist.	+1	0	+1	2	0.66
39. A career in science would be dull and boring	+1	+1	+1	3	1
40. My future career is independent from science knowledge.	+1	+1	+1	3	1
Teacher interaction 41. Whenever I want to ask any thing about science subject, I immediately consult to the teachers.	+1	+1	+1	3	1
42. Any topic(s) that I can't understand during the science class, I consult the teacher	+1	+1	+1	3	1
43. The important point that teacher explain during teaching, help me in learning	+1	+1	+1	3	1
44. My science teacher encourages me to learn more	+1	+1	+1	3	1

Statement of Attitude	E1	E2	E3	Total	Ave
science.					
Practical work in science 45. Practical work in science is exciting**.**	+1	+1	+1	3	1
46. I enjoy using mathematics in science experiments.	+1	+1	+1	3	1
47. Looking through a microscope is not my idea of fun.	+1	+1	+1	3	1
48. I would like more practical work in my science lessons.	+1	+1	+1	3	1
49. We learn science better when we do practical work.	+1	+1	+1	3	1
50. I look forward to doing science practical.	+1	+1	+1	3	1
51. I think that working in a science laboratory would be fun	+1	+1	+1	3	1
52. I feel doing experiment is not as good as finding out information from teachers.	+1	+1	+1	3	1
53. I dislike repeating experiment to check that I get the same result.	+1	+1	+1	3	1
54. I would rather agree with other people than do an experiment to find out for myself.	+1	+1	+1	3	1
55. It is better to ask the teacher the answer than to find it out by doing experiments	+1	+1	+1	3	1
56. I get nervous when I do practical works in science.	+1	+1	+1	3	1
57. In science experiments, I report unexpected results as well as expected ones.	+1	+1	+1	3	1
58. Our science teacher makes drawings or uses	+1	+1	+1	3	1

Statement of Attitude	E1	E2	E3	Total	Ave
pictures in each practical works.					
59. I hate to keep records of science experiments in note book.	+1	+1	+1	3	1
60. I don't mind doing an experiment several times to check the answer.	+1	+1	+1	3	1

Instrument validation expert scores for parents or guardians' involvement in science at home items.

Statements of parents' involvement at home	E 1	E2	E3	Total	Ave
1. My parents/guardian talk to me about what I learn in science in school	+1	+1	+1	3	1
2. My parents/guardian helps me with science homework	+1	+1	+1	3	1
3. My parents/guardian always checks my take-home assignments.	+1	+1	+1	3	1
4. My parents/guardian like science.	+1	0	+1	2	0.67
5. When I do not understand a science concept while studying at home, I discuss with my parents/ guardian to clarify my understanding.	+1	+1	+1	3	1
6. My parents/guardian talk to me about my science performance in school	+1	+1	+1	3	1
7. My parents/guardian has a high expectation from me in science.	+1	+1	+1	3	1
8. My parents/guardian encourage me to study science	+1	+1	+1	3	1
9. My parents/guardian seeks out opportunities to meet and get to know my science teachers.	+1	+1	+1	3	1

10. My parents/guardian asks me about the activities I do in school.	+1	+1	+1	3	1
11. My parents/guardian belief that I am competent in science.	+1	+1	+1	3	1
12. My parents/guardian limit the amount of time I can spent watching TV	0	0	+1	1	0.33
13. My parents/guardian limit the amount of time for going out with friends on school nights	0	0	+1	1	0.33
14. I find my mother/father/guardian at home when I return home from school.	+1	0	+1	2	0.67
15. I often talk to parents/guardian about the school activities or events of my interest.	+1	+1	+1	3	1
16. My parents/guardian tells me to do the science projects and science experiment my teacher ask me to do.	+1	+1	+1	3	1

INSTRUMENT (survey questionnaire for students)

Dear students,

This survey questionnaire consists of three parts**- Part A; Part B** and **Part C. Part A** is about your general information, **Part B** consists of statements about attitude towards science and **Part C** contains the statements about your parents or guardians' involvement in science with you at home. In **Parts B** and **C** of the questionnaire, you are asked to express your agreement on each statement. There is no "right" or "wrong" answers. Your opinion is what is wanted. Think about how well each statement describes your attitude towards science in **Part B** and your parents or guardians' involvement at home in **Part C** and put a tick in the response that describes it. Be sure to give an answer for all statements. If you change your mind about an answer, just cross it out and tick another. Some statements in this questionnaire are fairly similar to other statements. Don't worry about this. Simply give your opinion about all the statements.

Part A: General Information

Please **tick** in the following general information in the space provided**. Please be sure to give all the general information.**

1. **Gender:** Male ☐ Female ☐
2. **Ethnicity:** Sharchop ☐ Ngalop ☐ Lhotsham ☐ Others ☐
3. **Grade**: Ten ☐ Twelve ☐
4. **Whom do you stay with?**

   Parents ☐ Guardian ☐

PART B

Statement of Attitude	Attitude level				
	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly disagree (1)
Self –concept in science 1. I find science difficult					
2. I am just not good at science.					
3. I get good marks in science.					
4. I learn science quickly					
5. Science is one of my best subjects.					
6. I feel helpless when doing science.					
7. In my science class I understand more than 50% of the lesson.					
8. School science has made me more critical and skeptical.					
9. Sharing science facts that I know makes me feel great.					

Statement of Attitude	Attitude level				
	Strongly Agree (5)	**Agree (4)**	**Neutral (3)**	**Disagree (2)**	**Strongly disagree (1)**
Keenness to learn science 10. I follow a regular schedule to study science subject(s) at home					
11. I understand science lessons taught by the teacher in the class					
12. I can focus the science lesson during the whole class					
13. I revise the science lesson daily at home					
14. I complete the science homework before going to play.					
15. During science lectures, I comprehend important points.					
16. While studying science class, I fully concentrate on the topic.					
17. I can explain science lessons in my own words					
18. I usually relate the previously learned lessons with new science lessons.					

Statement of Attitude	Attitude level				
	Strongly Agree (5)	**Agree (4)**	**Neutral (3)**	**Disagree (2)**	**Strongly disagree (1)**
Enjoyment in science learning 19. I like to learn science because it is an interesting subject.					
20. I feel real pleasure in science class.					
21. I usually allocate most of the time to the subject of science as I like it more than other subjects.					
22. My desire to attain success in science subject, urges me for more hard work.					
23. I like science lessons					
24. Knowing science facts makes me feel good.					
25. I feel like day dreaming during science class.					
26. I hate to study science out of doors.					

Statement of Attitude	Attitude level				
	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly disagree (1)
27. I like to make science drawing.					
Disinterest 28. Science lessons become a source of boredom for me.					
29. The lessons taught in science classes are not interesting.					
30. I can't understand the science lessons, after the class.					
31. I don't find it interesting to discuss science topics after the school time					
32. I don't take interest to complete my homework of science subject(s).					
33. Doing science project at home is annoying					
Future participation in Science					

Statement of Attitude	Attitude level				
	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly disagree (1)
34. I would like to study more science in the future.					
35. I prefer opting science subjects in next classes/at university.					
36. When I leave school, I would like to have a job working with science.					
37. I would like to teach science when I leave school/university.					
38. I would enjoy having a job in a science laboratory in future.					
39. A career in science would be dull and boring					
40. My future career is independent from science knowledge.					
Teacher interaction 41. Whenever I want to ask any thing about science subject, I immediately consult to the teachers.					

Statement of Attitude	Attitude level				
	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly disagree (1)
42. Any topic(s) that I can't understand during the science class, I consult the teacher					
43. The important point that teacher explain during teaching, help me in learning					
44. My science teacher encourages me to learn more science when I consult him or her.					
Practical work in science 45. Practical work in science is exciting**.**					
46. I enjoy using mathematics in science experiments.					
47. Looking through a microscope is not my idea of fun.					
48. I would like more practical work in my science lessons.					

Statement of Attitude	Attitude level				
	Strongly Agree (5)	**Agree (4)**	**Neutral (3)**	**Disagree (2)**	**Strongly disagree (1)**
49. We learn science better when we do practical work.					
50. I look forward to doing science practical.					
51. I think that working in a science laboratory would be fun					
52. I feel doing experiment is not as good as finding out information from teachers.					
53. I dislike repeating experiment to check that I get the same result.					
54. I would rather agree with other people than do an experiment to find out for myself.					
55. It is better to ask the teacher the answer than to find it out by doing experiments					
56. I get nervous when I do practical works in science.					

Statement of Attitude	Attitude level				
	Strongly Agree (5)	**Agree (4)**	**Neutral (3)**	**Disagree (2)**	**Strongly disagree (1)**
57. In science experiments, I report unexpected results as well as expected ones.					
58. Our science teacher makes drawings or uses pictures in each practical works.					
59. I hate to keep records of science experiments in note book.					
60. I don't mind doing an experiment several times to check the answer.					

PART C

Parents or guardians' involvement at home with their children

Statements of parents or guardians' involvement at home	**Always (5)**	**Usually (4)**	**Often (3)**	**Sometimes (2)**	**Never (1)**
1. My parents/guardian talk to me about what I learn in science in school					
2. My parents/guardian helps me with science homework					
3. My parents/guardian always checks my take-home assignments.					
4. My parents/guardian helps me with science projects.					
5. When I do not understand a science concept while studying at home, I discuss with my parents/guardian to clarify my mis-understanding.					
6. My parents/guardian talk to me about my science performance in school					
7. My parents/guardian has a high expectation from me in science.					
8. My parents/guardian encourage me to study science					
9. My parents/guardian seeks out opportunities to meet and get to know my					

Statements of parents or guardians' involvement at home	Always (5)	Usually (4)	Often (3)	Sometimes (2)	Never (1)
science teachers.					
10. My parents/guardian ask me about the activities I do in school.					
11. My parents/guardian belief that I am competent in science.					
12. My parents/guardian spent few hours watching science movies/programs on TV with me.					
13. My parents/guardian limits the amount of time I go out with friends on school nights and advice me to spent time for science studies.					
4. I find my mother/father/guardian at home when I return home from school.					
15. I often talk to parents/guardian about the school activities or events of my interest.					
16. My parents/guardian tells me to do the science projects and science experiment my teacher ask me to do.					

Instrument (interview questions for students)

1. **How do you feel about science? Do you like or dislike science?**
    a. How do you consider science? Do you think it's important or not?
    b. Is science interesting or difficult to learn?
    c. What is in science that you like or dislike?
    d. What do you belief about your own ability in science? Why?
    e. What factors influence you from liking or succeeding in science?
    f. What kind of attitude do you have towards science? Why?
2. **How do you usually learn science in the class or home?**
    a. Do you understand everything that's taught in the class by your science teacher?
    b. What are the difficulties or challenges that you face in learning science?
    c. Do you revise what is learned in the class regularly at home? How?
    d. Do your parents or guardian help you with science at home? How?
3. **How do you usually work during laboratory classes in school?**
    a. Do you perform any experiment in the science class?
    b. Do you like performing science practical in the school? Why?
    c. How does your teacher help you during the science practical?
4. **Do you want to study science in next grade or at university? Why?**
    a. What careers are you hoping to follow? What are your plans for taking science in grade eleven or university or not taking science in grade eleven or university level?
    b. What influences your decision on not to or to participate in science in future?

5. Others……

a. Do you think that students attitude towards science changes with the grade level? How? Why?

b. Is there a difference in attitude towards science between male and female? Why?

c. Are there differences in attitude towards science across ethnicities? Why do you think so?

d. Is there any ways through which you can improve your attitude towards science? How?

Instrument (interview questions for science teachers)

1. What do you think of students' perspective of science? Why?
2. What are your perspectives on students' performance in science in middle or higher secondary schools? Why?
3. What are the difficulties or challenges that the student faces in learning science?
4. What kind of attitude do you think students have towards science? Why?
5. **What do you think of students' attitude towards science?**
   a. Is there any difference in attitude towards science between males and females? How?
   b. Is there any difference in attitude towards science between grades? How?
   c. Is there any difference in attitude towards science between ethnicities? How?
   d. Is there any difference in students' attitude towards science with the involvement of their parents or guardian in science at home with them? How?
   e. What factors influences students from liking or succeeding in science? How?
6. **Do you think the involvement of parents or guardian with their children at home is important?**
   a. What is your perception of parent or guardian involvement in science at home with their children?
   b. How does the parents or guardian involvement in science at home help their children?
   c. What do you think are the barriers to parents or guardians involvement in science at home with their children? How?

Instrument (participant observation form)

Participant observation No:………………. Date:....................................

School:... Site of interview:..

Name of the interviewee:………………………………………Gender:………………..

Grade level:…………………………… Staying with:……………………………............

Name of the interviewer:…………………………………………………………………...

Behaviour of participants	**Observations**
Behaviour includes non- verbal cues used by participants such as facial expression, nods and gestures. [**Note**: Be alert to non-verbal signs and behaviours which indicate how comfortable the person is with the interview]	

Detail of the participants quoted in qualitative data analysis

Students

1. Student 1- Female, grade 10
2. Student 2-Female, grade 12
3. Student 4- Male, grade 10
4. Student 5- Male, grade 10
5. Student 7- Female, grade 10
6. Student 8-Female, Grade 12
7. Student 9-Female, grade 12
8. Student 12-Female, grade 10
9. Student 13-Male, Grade 12

Teachers

1. Teacher 3- Female, Middle Secondary School (MSS)
2. Teacher 4- Female, MSS
3. Teacher 5- Male, MSS
4. Teacher 6-Female, Higher Secondary School (HSS)
5. Teacher 10- Female, MSS
6. Teacher 13- Male, HSS

VITAE

Name Sangay Zangmo

Student ID 5720121109

Educational Attainment

Degree	Name of Institution	Year of Graduation
Bachelor in Education (Secondary)	Samtse College of Education Samtse; Bhutan	2006

Scholarship Awards during Enrolment

The Thailand's Education Hub for the Southern Region of ASEAN Countries (TEH-AC) scholarship was awarded during the enrolment.

List of Publication and Proceeding (If Possible)

Zangmo,S., Churngchow, C., Kaenin, T., and Mophan, N. 2016. Grade 10 and 12 Bhutanese Students' Attitudes Toward Science in the Thimphu District of Bhutan. Journal of Turkish Science Education (submitted for publication).