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Grade 10 and 12 Bhutanese Students' Attitudes toward Science in the Thimphu District of Bhutan

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ABSTRACT

Attitudes toward science have received substantive research, mainly because they influence students' science learning, their achievements, and their participation in science. Therefore, this study, conducted using mixed methods sequential explanatory design, examined the effects of gender, grade, ethnicity, and the parents or guardians' involvement on students' attitudes toward science. A total of 383 Grade 10 and 12 students completed a questionnaire measuring attitudes toward science and their parents or guardians' involvement in science. The data was analyzed using *t*-tests, one-way ANOVA, and Pearson's correlations. Based on the quantitative results, 13 students and 15 science teachers were interviewed. The qualitative findings supported the quantitative results. Gender had no significant effect on students' attitudes toward science, while attitudes based on grade were significantly different. The parents or guardians' involvement in science was positively correlated with students' attitudes toward science. The study suggests that students' attitudes toward science at higher grades can be improved by offering science as a subject to interested students, depending on their science performance in previous grades.

Keywords: attitudes toward science; Bhutan science curriculum; mainstream and science stream students; parental involvement.

INTRODUCTION

Background: Science Education in Bhutan

Bhutan, a small landlocked country between the world's two most populous countries—China and India—introduced science education (borrowing the curriculum from India) to its school children with the inception of a modern education system, which was a part of the modernization process that began in 1961. Since its inception, the science curriculum has undergone several revisions at different times, in various ways and in an unplanned manner, mainly with a view to "Bhutanize" it or make it more innovative within a Bhutanese context (Childs, Tenzin, Johnson, & Ramachandran, 2012).

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The government's 10th five-year plan (2008–2012) prioritized the reform of the science curriculum, and in order to have a detailed study well- informed perspectives for major science curriculum reformation and also to recognize and understand the issues and challenges presented by the number of revisions the science curriculum had undergone, a needs assessment for science education from different stakeholders' perspectives was conducted (Childs et al., 2012). The findings of this needs assessment led to a further revision in the curriculum's content and the implementation of a reformed "spiral curriculum" is currently still in process.

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 (Royal Education Council, 2012; p. v)

Science knowledge and education are critical for a developing country's developmental process. Bhutan, like other developing countries, places great importance on its science education and has spent a considerable amount of money on science education, as judged by its investments into the various revisions of its science curriculum, as well as its investments into science laboratories, science equipment, and in-service training for science 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 abstract and Bhutanese people, especially students, have found science to be difficult (Rinchen, 2003) in a number of ways. This is unfortunate because the beliefs or opinions of students may indicate an unfavorable attitude toward science, which can influence students' performance in ways that reinforce lower achievement (Güzel, 2004; Kan & Akbaş, 2006; Papanastasiou & Papanastasiou, 2002).

Students' attitudes toward science can serve both as an outcome and as a factor (Akçay, 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 the pre-primary level through Grade 3, then as an integrated common course for all students from Grades 4 through 8, and finally as three specialized subject disciplines (physics, chemistry, and biology) for Grades 9 through 12. The students' experience of learning science in their science classes thus varies by grade level, with a change in teaching mode from student centered to teacher centered as students move from lower to middle secondary school, which has probably helped to shape students' attitudes toward science (Childs et al., 2012; Movahedzadeh, 2011).

The students' attitudes toward science are a leading factor that can influence their science learning (Perkins, Adams, Pollock, Finkelstein, & Wieman, 2005) because an individual student with a favorable attitude toward science often looks forward to science classes and laboratory experiments. Moreover, there is growing evidence that individual students who possess favorable attitudes toward science perform better academically in science 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; Yaşar & Anagün, 2009). In addition, attitude seems 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 the science education

literature will be aware that students' attitudes toward science—along with the 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.

One of the most important factors affecting students' attitudes toward science is gender (Weinburgh, 2000). According to Brotman and Moore (2008), many studies, with a few exceptions, demonstrate girls' less favorable attitudes toward science in general and their lower levels of participation in science courses than boys. Also, they reported that girls prefer biological science and physical science topics related to their lives and society more than physical sciences, a trend similarly reported by Clewel and Campbell (2002). Another important factor affecting students' attitudes toward science is grade. With each higher grade, there is a decline in positive attitudes toward science (Greenfield, 1997; Neathery, 1997; Weinburgh, 2000) or the attitudes of older students are less favorable than the attitudes of younger students (Greenfield, 1997). One of the underlying reasons for the decline in attitudes is in how science is taught at upper grade levels (Weinburgh, 2000). According to Aydeniz and Kaya (2012), the learning among students in science classrooms at upper grade levels is limited to most teachers preparing students for tests, rather than promoting a conceptual understanding through active learning strategies. However, Shah, Mahmood, and Harrison (2013) found that students' attitudes toward science learning become more favorable as grade increases.

The research on the effect of ethnicity on students' attitudes toward science is limited in comparison to research on attitudes toward science as influenced by gender and grade. However, ethnicity is often thought to potentially influence students' attitudes toward science, their career interests, and their science achievements (Catsambis, 1995; Fnu, 2011; Neathery, 1997). However, Neathery (1997) found no correlation between ethnicity and attitude toward science. Similarly, Hafza (2012) also found that ethnicity alone did not influence students' attitudes toward physics but saw a significant interaction between gender and ethnicity. An individual's ethnicity sensitized him/her to negative gender stereotypes but gender failed to qualify the effect of ethnicity (Gonzales, Blanton, & Williams, 2002).

The research findings on the influence of parental involvement on students' attitudes toward science vary according to the many different forms of parental involvement. Parents' involvement has great potential for affecting their children's attitudes, both positively and negatively (Alrehaly, 2011), their self-concept and self-esteem, and their behavior (Rinchen, 2003), and may lead to measurable gains in student achievement (Desforges & Abouchaar, 2003; Porumbu & Necsoi, 2013). However, the forms and extent of parental involvement are affected by factors including the family's social class, the parents' overall level of schooling (Tare, French, Frazier, Diamond,& Evans 2011), the level of the mother's education (Susan & Kinley, 2014), the mother's psycho-social health, material deprivation, the biological age of the children (Desforges & Abouchaar, 2003), and single parent status (Wanat, 1992).

Most of the studies exploring students' attitudes toward science described above have been conducted elsewhere, and there have been only a few such studies in Bhutan .For example, Tshering (1995) investigated the relationships between Grade 10 students' attitudes toward science and their achievement in science, and concluded that science achievement was correlated with attitude toward science. Rinchen's (2003) study titled "Bhutanese Girls' Perception of Science and the Impact of Science on Career Choice" provides insights into the critical factors—like social and cultural practices, parental expectations, the effects of rapid growth of the school system, and a failure to recognize the importance of guidance and role models—that contribute to Bhutanese girls' liking or succeeding in science and their influence on career choice. Over the past decade, there have been no studies in Bhutan devoted to students' attitudes toward science, despite the fact that Bhutan's Annual Education Statistics have reported a large gender gap every year in the number of boys and girls

enrolling in the science stream and tertiary science–related fields. According to the Annual Education Statistics 2014, a total of 1,740 boys but only 1,144 girls enrolled in the 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 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), and science/mathematics (m = 342, f = 167), with the exceptions being nursing (m =122, f = 145) and architecture and design (m = 7, f = 8). Such inequalities in gender participation in most of the science-related fields have a negative impact in general on 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, 2003. 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' attitudes toward science from one time period to another, and also from one society to another. Therefore, research on attitudes must be an ongoing field of investigation (Barmby, Kind, & Jones, 2008). Thus, the aim of this study was to explore the attitudes of Grade 10 and 12 science stream students toward science in the context of contemporary science education in Bhutanese schools, and to understand how gender, ethnicity, grade, and parents' or guardians' involvement in science at home with their children affects Bhutanese students' attitudes toward science. The following research questions guided the study.

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

METHODOLOGY

a) Research Design

The present study employed a mixed methods sequential explanatory design, which implies collecting the quantitative data and obtaining the statistical results in the first phase, and then a follow-up with a few participants to help explain or elaborate on those statistical results 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

b) Respondents

A total of 383 students from a population of 2,071 completed the survey questionnaire. The selection was based on proportional stratified random sampling to have samples representative of Grades 10 and 12, and also to make the sample size of each stratum proportional to the population size of the stratum. By calculating the proportions, it was determined that the sample size of 383 study participants should include 319 (83.3%) Grade 10 and 64 (16.7%) Grade 12 students. Within the sample, 53.4% (208) were female and 45.7% (175) were male. Additionally, 185 (48.3%) students were of the Sharchop ethnicity, 115 (30%) were Ngalop, 78 (20.4%) were Lhotsam, and only 5 (1.3%) were others.

For the interview, 28 participants were sampled, consisting of 15 science teachers (11 females and 4 males) and 13 (7 boys and 6 girls) Grade 10 and 12 science-stream students,

using the purposive sampling technique. The selected science teachers had at least five years of science teaching experience.

The main reason for choosing Grade 10 and 12 science stream students as the respondents for this study was that they were at the end of middle and higher secondary education, which are the most crucial stages in the life of Bhutanese students, who will be in a better position to compare their 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.

c) Data Collection Tools

The survey questionnaire used in this study consisted of three sections. The first was related to background information and demographic data; the second measured the students' attitudes toward science and consisted of 60 items, with each item rated on a 5-point Likert scale (from 1 = *strongly disagree* to 5 = *strongly agree*); and the third section measured their parents' or guardians' involvement in science at home, and consisted of 16 items rated on a 5-point Likert scale (from 1 = *never* to 5 = *always*) for each item.

Since attitude toward science often serves as an outcome and also a factor of science learning (Akçay et al., 2010), the items included in the questionnaire to assess attitude in this study investigated both attitudes toward science (self-concept in science, practical work in science, and future participation in science) and attitudes toward science learning (keenness to learn science, enjoyment of science learning, disinterest, teacher interaction), which were adopted from the studies of Kind, Jones and Barmby (2007) and Shah and Mahmood (2011), respectively. The items on attitude toward science learning in the questionnaire required the respondents to reflect on their experiences during their daily routine of science learning, both in school and at home, to elicit their general attitude, which would be more regular (Shah, Mahmood & Harrison, 2013), while the "attitude toward science" items sought the respondents' opinions on a number of statements and shifted their attention from their daily routine of science learning toward their past experiences and future plans with regard to science. The coefficient of reliability, based on Cronbach's alpha for all of the items in the second section of the questionnaire, was .921. The third section of the questionnaire relating to parents or guardians' involvement in science at home asked the respondents to reflect on the things that parents or guardians can generally do with their children relating to school science learning activities at home. The Cronbach's alpha coefficient of reliability for that section of the questionnaire was .814. Both alpha values indicated that the survey questionnaire was suitable for use in this study.

The overall obtained means of the students' attitudes toward science and the parents or guardians' involvement in science were classified into five different levels (1.00–1.50 very low; 1.51–2.50 low; 2.51–3.50 moderate; 3.51–4.50 high; 4.51–5 very high) developed using the equal interval classification method.

For qualitative data collection, a set of questions developed based on the quantitative results was used for the one-on-one semi-structured interviews. The questions were concise and open-ended, and basically sought the explanations to the "why" and "how" of the quantitative results, with regard to the students' perceptions and opinions of science, their feelings about science, the students' future plans with science, their views about their parents or guardians' involvement and its effect on attitudes toward science, barriers to parents or guardians' involvement, and the factors causing the differences in attitude between the genders and grades, and among the four ethnicities. The questionnaire was validated through the experts' review.

d) Data Collection Process

Approval to conduct the survey and interviews in middle and higher secondary schools in the Thimphu District was sought from the Department of School Education under the Ministry of Education, Thimphu, Bhutan. Subsequent to the department's approval, the Thimphu *Dzongkhag* (district) Education and the *Thromde* (municipality) Education offices each issued an official letter asking the principals of the schools under their jurisdiction to provide me with help and support. As per the appointments given by the principals of the selected schools, the survey questionnaires were administered to the randomly selected students. The students were given 30–40 min to complete the questionnaires. The quantitative data collection from the eight schools selected was completed within one and half months (from mid-July to August 2015), and the quantitative data was analyzed. The quantitative data analysis was then followed by the qualitative data collection. The teachers and students were interviewed. 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 interview, the oral consent of teachers and students was sought and the interviews were recorded. Each participant interview lasted for 20–25 min. All of the participants were asked the same questions but with considerable variation in the questions' order, the exact words in the question, and follow-up questions. The interviews were all completed within a month (mid-September to mid- October 2015).

e) Data Analysis

The quantitative data was analysed using independent sample *t*-tests to compare the differences in attitudes toward science between the genders and between Grade 10 and 12 students. One-way analysis of variance (ANOVA) followed by Tukey honest significant difference (HSD) test were employed to determine the difference in attitudes toward science among the four ethnicities. A Pearson's correlation coefficient was computed to determine the relationship between students' attitudes toward science and their parents or guardians' involvement in science at home.

For qualitative data analysis, the interview recordings of the participants were transcribed on an ongoing basis at the end of the day and reviewed with the recordings 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. I interpreted the experiences, beliefs, and opinions of the students and teachers to form a narrative description of the meanings that I ascribed, interweaving the exact words of the participants, which I integrate with the quantitative results and presented under the Results and Discussion sections of this paper.

FINDINGS

Quantitative Data

The overall parents or guardians' involvement in science at home was at a moderate level (M = 3.32, SD = 0.77), while the general attitude of students toward science was at a high, positive level (M = 3.69, SD = 0.43). Females scored higher (M = 3.71, SD = 0.43) than males (M = 3.67, SD = 0.44) in their attitudes toward science, but an independent samples *t*-test showed no statistically significant difference at the $p < .05$ level in attitude toward science between genders (see Table 1). Levene's test for equality of variances for Grades 10 and 12 was violated, $F(1, 381) = 5.66$, $p = .018$. Due to the violated assumption of homogeneity of variance, a *t* statistic that did not assume homogeneity of variance was computed. A significant difference in the scores for Grades 10 (M = 3.67, SD = 0.45, n = 319) and 12 (M = 3.84, SD = 0.32, n = 64) at the .05 level of significance [$t = -3.75$, $df = 117$, $p < .001$, 95%

confidence interval (CI) for mean difference −0.27 to −0.09] indicated that the Grade 12 science students had more favorable attitudes toward science than tenth graders (see Table 1). The ANOVA was significant, $F(3, 379) = 4.55$, $p = .004$ (see Table 2), for the students' attitudes toward science among 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 ($M = 4.26$, $SD = 0.34$, $n = 5$)—and the assumption of homogeneity of variance was tenable using Levene's test, $F(3, 379) = 1.15$, $p = .329$. A post hoc comparison conducted using the Tukey HSD test revealed a significant pairwise difference between the mean scores of Sharchop and other ethnicities ($p = .008$) and also between Ngalop and other ethnicities ($p = .028$), while no significant differences were observed between the Lhotsam and others or among any two of the Ngalop, Sharchop, or Lhotsam ethnicities (see Table 3). The students' attitudes toward science was found to have a significant positive correlation with parents or guardians' involvement in science at home with their children, $r (381) = .35$, $p < .001$.

Table 1. *Comparison of t-Test Results for Attitudes Toward Science by Gender and Grade*

			N	Mean	Standard Deviation	Degrees of Freedom	*t*	*p*
Attitude toward science	Gender	Male	175	3.67	0.44	381	−0.917	.359
		Female	208	3.71	0.43			
	Grade	10	319	3.67	0.45	117	−3.75	.000
		12	64	3.84	0.32			

Table 2. *One-Way ANOVA for Attitudes Toward Science Among the Four Ethnicities*

		Sum of Squares	*df*	Mean Square	*F*	*p*
Attitude toward science	Between Groups	2.51	3	0.84	4.55	.004
	Within Groups	69.67	379	0.18		
	Total	72.17	382			

Table 3. *Tukey HSD Comparison for Attitudes Toward 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)

RESULTS AND DISCUSSION

a) General Attitudes of Students Toward Science and Their Perceptions of Science

The students' attitude toward 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 toward science. Moreover, the teachers' opinions about students' perceptions of science and the students' own opinions about science in the present study were closely aligned, fine, and balanced:

> Students, they love science but they find it difficult. They actually like science but because they don't have a proper base from Class 7, they cannot understand the concepts properly. So that's why they find it little difficult in higher classes—in 9 and 10. (Teacher 11, female, middle secondary school [MSS])

> Science is a fun subject but not always, though. Sometimes, it's hard to understand but then since it's everywhere around us, we can relate it to our environment and everything, and it's quite fun. (Student 12, female, Grade 12)

Among the three disciplines of science, almost all of the students found biology easy, and some found physics easy, while most of the students found chemistry difficult. However, the students basically loved science in general and wanted to follow science in the future, as they understood the importance of science, including the fact that science would give them a wide career scope. Unfortunately, most of the students had no knowledge about different careers in scientific fields, with the exception of two high-profile jobs: doctor and engineer professions.

> When it comes to science, they always think of science as, after learning science, they think of it as only doctors or engineers. Besides that, they don't have any other knowledge. (Teacher 13, male, higher secondary school [HSS])

This could be attributed to the fact that students might have heard about these careers from seniors or that they have encountered only these two science-related careers, which imply that teachers and parents need to make students in Grade 10 and 12 science streams more aware of the different kinds of careers in scientific fields, so that they can make proper choices with enough information at the crucial stages of their school lives. There is also a need for future researchers to investigate students' attitudes toward science, particularly chemistry and physics, to understand why students find chemistry and physics difficult and hence to plan a proper intervention.

b) Gender and Attitudes Toward Science

No significant differences were found in students' attitudes toward science in terms of gender. This finding is comparable to the results of the studies by Koç and Böyük (2012); Neathery (1997); Ong, Mesman, and Yeam (2014); Tshering (1995); and Yilmaz and Timur (2012). 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 toward science compared to males, or vice versa, but rather believed that females and males are equally proficient and capable in science.

> 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, male, HSS)

Although gender had no effect on students' attitudes toward science, a difference in optional subject choices between male and female students at Grade 12 in the science stream was observed, with most females taking more or both of the optional subjects (biology and mathematics), while males were more inclined to take mathematics and to drop biology (Greenfield, 1996).

> 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, female, Grade 12)

Thus, it seems that males were more interested in mathematics and the engineering and technology fields, while females were more interested in biology-related fields (Desy, Peterson, & Brockman, 2011; Özgün Koca & Şen, 2011); at the same time, females also took mathematics, as it has 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 would like to follow.

> 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 the 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, female, Grade 12)

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 I have taken after dropping the other one?" Thus, they did not want to take risk. The males, on the other hand, were 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 found to exhibit dependent behaviors, unlike boys, and tend to receive more advice on future science careers 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.

c) Grade and Attitudes Toward Science

One of the results of this very study indicated that Grade 12 science stream students had a significantly more favorable attitude toward science than Grade 10 students. This finding is similar to that of Yilmaz and Timur (2012), who found eighth grade students to have a more positive attitude compared to seventh graders; and Shah et al (2013), who found that students' attitudes toward science learning became more favorable with increasing grade levels. But this result cannot be directly compared with the results of several previous studies (Barmby et al., 2008; Greenfield, 1997; Neathery, 1997; Weinburgh, 2000), which observed a decline in positive attitude toward science with each successive grade because the present study compared the attitudes toward science of students in science streams and those in the mainstream, 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 that have 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 in causing the difference in attitude toward science between the Grade 10 and 12, might be the difference in how science is offered (as a general or optional subject) in the mainstream 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*[1], math, 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 and *Dzongkha*, have a choice between three streams (arts, commerce, and science), which they join mainly depending on their performance in science and mathematics in the Grade 10 board examination and also on the students' interest.

> 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 Class12, 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 interest in the stream that we have opted for. If we take science stream, we are learning only science besides the language subjects. Therefore, I feel that the subject that they are learning is of their interests. Therefore, their attitudes toward science should be better I suppose." (Student 13, male, Grade 12)

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 attitudes toward science are more favorable in Grade 12 than in Grade 10. Thus, the present study concludes that if science is offered by the schools to interested students depending on their science performance in previous grades, their attitudes toward science will be better at higher grade levels.

In addition to the factors mentioned above, the second most important factor causing differences in attitude toward science between Grades 10 and 12 might be the difference in the number of years that students have studied science in its three separate disciplines. Up to Grade 8, science is studied as an integrated subject. Then, in Grades 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 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 favorable attitude toward science. Therefore, even the science teachers noticed that teaching science to students in Grades 11 and 12 is easier compared to teaching science to Grades 9 and 10.

d) Students' Attitudes Toward Science, Ethnicity, and Parent/Guardian Involvement

Significant differences in students' attitudes toward science between ethnicities (Sharchop and others; Ngalop and others) were found. However, this finding is not conclusive as it might be distorted by limitation of a relatively small sample in the "others" category (as this group is very small in the population itself), and there were no differences found in students' attitudes toward science between any two of the three major ethnicities (Sharchop, Ngalop, and Lhotsam). However, this finding could not be compared with the previous two

[1]national language of Bhutan

studies on attitude toward science in Bhutan as the "ethnicity" factor was not studied in either of those previous studies. In addition, almost all the teachers and students interviewed expressed the opinion that they had never looked into nor noticed any difference in attitude toward science among different ethnicities.

> I have not witnessed such a difference until now. Actually, I have just not tried to look to 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, female, Grade 12)

However, they expressed the opinion that the difference in students' attitudes toward science might be due to the difference in parental involvement at home among families or might be due to the difference in how children are helped in science by their parents or guardians and not due to their ethnicity.

> I don't think that ethnicity has any influence 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 who they are or from where they come. (Teacher 6, female, HSS)

However, it is apparent that the pattern and amount of parental involvement differs 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' attitudes toward science and parents' or guardians' involvement in science at home with their children. This finding is in accordance with the results of Alrehaly (2011) and Oundo, Poipoi, and Were (2014). 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 a scientific background, as well as advising their children, providing moral support, materials and assistance in seeking information, and pictures for science projects through the Internet, often became actively involved in simple science experiments with their children using the materials available at home and made science learning a part of play or games.

> When we are spending time 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 what is behind things. (Student 9, female, Grade 12)

Even 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.

> Last year in chemistry, when I first learned about silicone, I was so intrigued because neither I nor my parents knew 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 got even more inspired by science. (Student 2, female, Grade 12)

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 a favorable attitude toward science. This implies 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 even though there may be significant barriers to parental involvement.

SUGGESTIONS

The results of the present study add to previous evidence indicating that if science is offered to interested learners based on their performance in science in previous grade levels, students' attitude toward science will be better at higher grade levels.

There are several ways in which future research could extend the scope of this study and an interesting investigation might be to include parents or guardians as respondents in the study in order to understand the parents' perspectives on their involvement in science at home with their children, and to identify how parents or guardians' involvement varies among the four different ethnicities in Bhutan.

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