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THE EFFICACY OF CLASSES VII AND VIII SCIENCES:

Investigating the transition from lower secondary science to class IX chemistry

Dissertation

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THE EFFICACY OF CLASSES VII AND VIII SCIENCE: INVESTIGATING THE TRANSITION FROM LOWER SECONDARY SCIENCE TO CLASS IX CHEMISTRY

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APPROVAL PAGE

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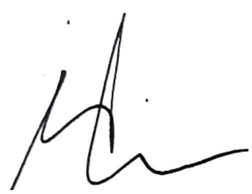

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ABSTRACT

The curriculum is the key element of an education system and thus one of the prime purposes of curriculum is to bring coherency, consistency and co-ordination of content and concepts throughout pre-primary, primary and secondary education. Hence, it is paramount importance to review the existing curriculum every after certain years of its implementation. Therefore, this study explored on the efficacy of classes VII and VIII science and also investigated conceptual transition from VII science to class IX chemistry, students learning difficulty in IX chemistry and challenges faced by science teachers in teaching VII and VIII science. Mixed method design using survey and semi-structured interviews were employed to collect data besides documents analysis. The study employed 321 participants comprising of students (n=296) and teachers (n=25) from three HSS and one MSS of Samtse Dzongkhag. The descriptive statistics and thematic analysis were employed to analyse the database. The findings revealed that, about 50% of the concepts required to learn IX chemistry are not introduced and familiarized in classes VII and VIII science. Therefore, the level of transition in terms of chemistry concepts from VII science to IX chemistry is not smooth. Further, the progression and the coherency of chemistry concepts are not significantly aligned in a spiral nature. As a result, the students lack most of the concepts required to learn class IX chemistry. Consequently, over 59% of the students under study face difficulties in the learning of class IX chemistry. In addition, the study also found that the teachers face challenges in teaching of integrated science specifically outside an area of their subject specialism. Therefore, the study recommends the need of review on alignment and coherency of the chemistry concepts from VII science to IX chemistry and also the introduction of bifurcated science in classes VII and VIII.

Keywords

Efficacy, Transition, Learning Progression, Integrated Science, Bifurcated Science, Conceptual Foundation, Spiral Curriculum

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DEDICATION

To my late parents, Mr. Hem Bdr. Rai and Mrs. Dhan Lachi Rai whom I missed along with this journey of endeavour. I remember them as a great inspirer of my life.

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LIST OF ABBREVIATIONS

BCSEA	Bhutan Council for School Examination and Assessment
CPDD	Curriculum Planning and Development Division
CTDD	Curriculum and Textbook Development Division
CISCE	Council for Indian Certificate Examination
DCRD	Department of Curriculum and Research Development
HSS	Higher Secondary School
MSS	Middle Secondary School
OECD	Organization for Economic Co-operation and Development
PISA	Programme for International Student Assessment
REC	Royal Education Council
TMSS	Trends in International Mathematics and Science Studies
UNESCO	United Nation Educational Scientific and Cultural Organization
SPSS	Statistical Package for Social Science

1. INTRODUCTION

1.1. Introduction

This chapter provides 1.2, brief background of the study, 1.3, statement of the problem, 1.4 purpose of the study, 1.5, research questions, 1.6, significance of the study, 1.7, limitations of the study, 1.8, conceptual definitions of terminologies used, 1.9, outline of the dissertation.

1.2. Background to the Study

Science education in Bhutan was introduced in 1960s with the inception of a modern education system. Since then, the science curriculum has undergone number of changes at different time. In mid 1980s, education department started Bhutanizing of the science curriculum by making it more innovative within a Bhutanese context. Therefore, in 1986, with an introduction of new approach to primary education system, an innovative curriculum that required teachers to adapt new approach of teaching and learning, focusing more towards child centered learning Bhutan, began to develop her own science curriculum (Zangmo, 2016).

In the initial phase, the primary science curriculum for classes IV-VI were introduced taking more account on teaching and learning of science based on natural and social environment of Bhutan. Subsequently, later in the year 1999 and 2000, the teaching of science through three distinctive science disciplines (physics, chemistry and biology) in classes VII and VIII was replaced by a single integrated science mainly to localized the curriculum, to discourage memorization of scientific facts and figures and to bring the curriculum in line with the classes IV-VI science curriculum. Thus, the curriculum from classes IV - VIII became an integrated science curriculum and bifurcated science for classes IX-XII and for classes PP-III, the science is studied through an integrated environmental study taught in Dzongkha (Zangmo, 2016).

However, after the fourteen years of its implementation there was a growing concern among the general public on content and the delivery of primary science curriculum therefore, in 2001, the textbooks were revised mainly to add content and to make the learning activities more relevant and further, owing to such general concern over the quality of science curriculum, a major reform on science curriculum for classes PP- XII was launched during the 10th Five Year Plan, by the Ministry of Education (DCRD, 2012). Thus, to initiate the curriculum reform, an in-depth needs assessment of science education was conducted in 2007 which guided in designing of the science curriculum framework for classes PP-XII. Since classes VII and VIII science was an integrated science therefore, the needs assessment was strongly in required, of a study on classes VII -VIII science curriculum. Thus, several studies were conducted on VII and VIII integrated science curricula by different researchers.

For instance, the study on the relevancy of integrated science by (Tenzin & Lepcha, 2012), teachers' perceptions on the integrated science by (Sherpa, 2007) and science education in Bhutan and its issues and the challenges by (Childs et al., 2012). These studies found similar findings such as, the lack of progression in terms of the scientific concepts across classes, big jumps from classes III-IV and VIII-IX, the contents were overloaded particularly in higher classes. Similarly, the balance in contents of biology, chemistry and physics were required across all the level of classes and the integrated science curriculum for classes VII and VIII was more of biology focused.

Therefore, all these findings have guided the Department of Curriculum Research and Development (DCRD) to develop a science curriculum framework for classes PP-XII that brings together the EVS curriculum (classes PP-III), integrated science curriculum (classes IV-VIII) and the single science curriculum (classes IX-XII) and in 11th five- year plan, based on the science curriculum framework the Royal Education Council (REC) brought a major reformation in the science curriculum for classes PP-XII. The reformed general science curriculum for classes IV-VI were implemented in 2013 and the science for classes VII-VIII in 2014 and 2015 respectively. Similarly, the newly developed bifurcated science curricula for classes IX and XI in 2016 and for classes X and XII in 2017. However, the science curriculum for PP to class III is taught as integral part of environmental science in Dzongkha (Wangdi & Utha, 2020).

According to Gyelmo (2013) the revised science curricula is said to be a spiral curriculum which repeats the study of a content at different class levels, with higher level of difficulty and in greater depth at each higher class and is expected to build a better foundation in the subject. However, after the implementation of new reformed science curricula, not a single study was conducted in Bhutan focusing on the efficacy of classes VII and VIII science and conceptual transition of students from lower secondary science to middle secondary chemistry therefore, it motivated a researcher to carry out the study with the intend to find out the efficacy of current classes VII and VIII science and the conceptual transition of students from lower secondary science to class IX chemistry.

1.3. Statement of the Problem

The level of science education is one of the key measures of growth and the development of any nation and to fulfill that, the quality of science education is equally important which is determined by the quality of science curriculum (Nwachukwu, 2012). According to the Ministry of Education and Employment (2012) Malta, one of the main purposes of science curriculum is to maintain smooth conceptual transitions and learning progression of students in seamless nature across different level of classes. Similarly, curriculum with organized and aligned concepts in the sequential nature is a means towards progressive learning and smooth transition of students across different level of classes (Stevens et al., 2010). However, the discontinuity of concepts and progression across the different level of classes hinders the smooth transition of students conceptually (Jindal-Snape et al., 2019). Therefore, the introduction of science concepts in a spiral approach by familiarizing with the key concepts at the lower classes is important as it enhances students learning proficiency in the next higher classes. (Perez et al., 2020). Further, the Curriculum Development Council and Hong Kong Examination and Assessment Authority (2007) reported that, the students will explore greater strength in the subject, if they have studied the basic foundation of the topics and concepts at lower classes. On the contrary, those students without adequate basic concepts face difficulty in understanding the more complex concepts in higher classes (Osman & Sukor, 2013; King'aru, 2014).

The science curriculum in Bhutan is said to be a spiral in nature and the current science curricula of classes VII and VIII is said to have both concepts and content link to the secondary science curriculum where the subject is taught bifurcated to biology, physics and chemistry (DCRD, 2012). However, the Review Report on Quality of Education (2016) reported that, the students find it difficult in comprehending the main idea, scientific concepts and principles in science when they go to higher classes. Similarly, a study conducted by Wangdi and Dema (2020) also, concluded that the learning of physics, chemistry and biology from a single textbook in classes VII and VIII science develops less foundations and conceptual understanding towards learning bifurcated science from class IX. This is mainly because, some of the basic concepts are not covered in detail and even omitted at lower secondary science. Further, when students reach to class IX, the chemistry teachers observed that, the students are facing with numerous difficulties in comprehending the chemistry concepts, scientific terms, laws and principles introduced in class IX chemistry. The similar issue is raised by many other chemistry teachers in the field. This observation is based on researcher 's experiences of teaching classes VII and VIII science and IX chemistry for nearly a decade.

Therefore, the researcher felt the need of study on the efficacy of classes VII and VIII science curriculum and the quality of transition from lower secondary science to IX chemistry since, it has a direct impact on students learning and also, the current study is first of its kind in Bhutan after the implementation of reformed science curriculum of classes VII and VIII in 2014 and 2015 respectively and IX chemistry in 2016. Thus, the findings of this study are expected to provide an insight on the efficacy of classes VII and VIII science and the quality of conceptual transition from the lower secondary science to IX chemistry, to the respective stakeholders in the Ministry of Education.

1.4. Purpose of the Study

The main purpose of this study is to find out the efficacy of current classes VII and VIII science and to investigate the transition from lower secondary science to class IX chemistry. Therefore, the study is designed to achieve the following objectives:

i. To examine the introduction of IX chemistry concepts in classes VII and

VIII science.

ii. To investigate the students' conceptual transition from the lower secondary science to class IX chemistry.
iii. To find out the students' learning difficulties in class IX chemistry including in terms of gender.
iv. To determine the relationship between the quality of conceptual transition of students from lower secondary science and learning difficulty in IX chemistry.
v. To identify the challenges faced by science teachers' in teaching VII and VIII science.

1.5. Research Questions

1.5.1. Main question

What is the status of classes VII and VIII science in terms of efficacy and its impacts on students' conceptual transition and learning of IX chemistry?

1.5.2. Subsidiary questions

1. What are the teachers and students view on introduction of IX chemistry concepts in VII and VIII science?
2. What are the teachers and students view on conceptual transition from lower secondary science to class IX chemistry?
3. What are the students' difficulties in learning of class IX chemistry including in terms of gender?
4. Is there a relationship between quality of conceptual transition and learning difficulty of IX chemistry?
5. What are the difficulties faced by the science teachers in teaching classes VII and VIII science?

1.6. Significance and Scope of the Research Study

The main purpose of this study is to find out the efficacy of current classes VII and VIII science and to investigate the transition from lower secondary science to class IX chemistry. Therefore, the significance is organized into three tiers as:

i. Knowledge Contribution for Future Researchers
The current study carried out to examine the efficacy of classes VII and VIII science and to investigate the transition from lower secondary science to class IX chemistry is a preliminary study in Bhutan therefore, the findings of this study will open an avenue for baseline data for future researchers.
ii. Students, Teachers, REC and MoE
Results from this study would provide an insights and relevant information on efficacy of classes VII and VIII science and on students' conceptual transition from lower secondary science to IX chemistry.
iii. Educator, REC, MoE and other Responsible Stakeholders
Based on this research finding, the informed decisions can be made on future curriculum reviews and changes.

1.7. Limitations of the Study

The study is associated with the following limitations.

i. The study included only a small number of schools, teachers and students as a sample. Therefore, it resulted in limited data collection for the study. Hence, the findings of this study may not be generalized to the whole population.
ii. The current study is also limited by the quality of research site selection. As per the convenient of researcher, all four schools (1 middle secondary and 3 higher secondary) included for this study are from Samtse dzongkhag.
iii. The participants such as school principals and REC officials are not included in this study due to limited time for data collection.

1.8. Conceptual Definitions of Terminologies

The various key terms and concepts used in this study are defined and explained briefly as follows:

i. **Efficacy** refers to the quality of being effective or effectiveness of curriculum.
ii. **Class VII and VIII science** is a current interdisciplinary Integrated Science curriculum.
iii. **Bifurcated science** means the three disciplines of science subjects that are biology, chemistry and physics.
iv. **Content of the curriculum** refers to the topics and concepts of science within the curriculum.
v. **Coherence** refers to free of academic gaps, aligned across subject areas and grade levels.
vi. **Learning progression** means the purposeful sequencing of learning across different grade levels.
vii. **Transition** refers to the promotion of students across various levels of classes.
viii. **Spiral curriculum** refers to the course of study in which students will see the same concepts however, with increasing complexity in next higher classes.
ix. **Lower secondary science** means science curriculum of classes VII and VIII.
x. **Reformed science curriculum** is a new curriculum implemented by Royal Education Council from 2013.

1.9. Outline of the Dissertation

This dissertation comprises of six chapters. The first chapter introduces a study by providing the background of the research study which encompasses a brief outline on science education in Bhutan and reforms on science curriculum, research purpose, research problem, and its significance. The second chapter provides a review of the existing literatures, relevant to the current study. The third chapter presents the broad design and plans of the study and a detailed discussion on the quantitative and qualitative data collection and analysis procedures. The fourth chapter presents the results obtained from quantitative and qualitative data. Similarly, fifth chapter highlights the detailed interpretation and discussion on databases collected through mixed method research design. Finally, the sixth chapter presents on conclusion drawn from study and the recommendations based on findings along with some suggestions for future study.

2. LITERATURE REVIEW

2.1 Introduction

The first section of this chapter presents the theoretical perspectives of spiral learning and spiral curriculum which guided the entire process of current thesis. The second section presents impacts of introducing chemistry concepts in spiral approach. The third section of this chapter discusses on the significance of transition and learning progression. Forth section highlights on students' difficulty in learning chemistry. The fifth section describes the learning difficulty of chemistry based on gender. The sixth section presents an overview of the interdisciplinary integrated science. The seventh section highlights on teaching of integrated science curriculum. The eight section on challenges of teaching integrated science curriculum. The ninth section of this chapter presents briefly on conceptual framework that guided researcher to carry out current study and finally, the concluding summary of the chapter.

2.2 Theoretical Perspectives of Spiral Learning and Spiral Curriculum

The spiral curriculum developed by Jerome Bruner in 1960s is a curriculum design in which the key concepts are presented repeatedly throughout the curriculum, but with deepening layers of complexity or in different applications (Liu, 2016).

Different authors have given different definitions for spiral curriculum. For instance, spiral curriculum is a design where an iterative revisiting of concepts, topics or themes coexists throughout the course of study (Harden & Stamper, 1999). Likewise, Lohani et al., (2005) defines that it is a revisiting of basic concepts and ideas repeatedly until the students has grasped the concepts distinctly. Similarly, Howard (2007) explains that it is design in which fundamental concepts and ideas identified should constantly revisited and re-examined so that understanding deepens over time.

According to Drew (2020) the spiral curriculum approach has three key principles. The first one is cyclical which means that, students should return to the same concepts and the topics for several times throughout their school career. Likewise, the second is the increasing depth which means that each time a student returns to the concepts or the topics, it should be learned at a deeper level and explore more complexity.

Finally, the third principle is a prior knowledge. The students' prior knowledge should be utilized when a concepts and topics is returned, so that students advance concepts with the help of their basic conceptual foundations. In United Kingdom, Coelho and Moles (2016) conducted a survey at Peninsula School of Dentistry, through an anonymous voluntary questionnaire with the intend to evaluate the students' thoughts and experiences of a spiral curriculum. The study found that the spiral learning is not just a repetition of previously delivered concepts and topics rather an opportunity for consolidation of previous concepts that helps students to deepen their understanding in the learning process. Further, the clarity on the depth of knowledge at each stage prevents students from information overwhelmed.

Moreover, Ozdem-Yilmaz and Bilican (2020) claimed that, one of the main objectives in science education is not to make the students memorizes the scientific concepts and knowledge. The spiral learning provides longer retention and transfer of concepts and knowledge with greater understanding in breadth and depth (Corpuz, 2014). Further, students can recap, analyse and learn using their prior knowledge whenever complex concepts evolved in the learning process (Clabaugh, 2010) because new knowledge and skills are linked directly to the learning of previous concepts therefore, the learning of previous materials is a fundamental to the future learning (Davis, 2008). The spiral learning not only allows the logical sequencing of the concepts in a hierarchy from simple to complex but also, enhances the smooth conceptual transition of the students. Thus, the theoretical framework for this research study is based on the theory of spiral learning that guided the intend of the study to find out the efficacy of lower secondary science and the transition from VII science to IX chemistry.

2.3 Impacts of Introducing Chemistry Concepts in Spiral Approach

The introduction of science concepts in a spiral approach produces a positive learning outcome (Perez et al., 2020). Moreover, in the disciplines like science, language and mathematics the increased in students' achievement and motivation were documented by organizing the concepts in a spiral approach (Davis, 2015). Therefore, familiarizing of key concepts at the lower classes enhances students learning proficiency in the next higher classes. On the other hand, the lack of anchored concepts hampered learning proficiency and makes difficulty in grasping the totality of concepts in the next higher level of classes (Orale & Uy, 2018).

An evaluative study conducted by Brighton (2019) on the spiral nature of physical chemistry carried out in University of Witwatersrand South Africa, found that physical chemistry curriculum was not align to the features of spiral curriculum since most of the concepts on electrolysis that are required to learn in XII physical chemistry were not introduced in class X and class XI chemistry hence, students encounter challenges in coping up with such topics in XII chemistry.

Several studies have shown the positive outcomes of introducing the spiral approach of science curriculum. A qualitative, case-study approach using interviews conducted by Grove et al., (2008) at the Miami University, Oxford found that there was about 30- 50% of students' attrition rate in an organic chemistry course before the introduction of the spiral approach of curriculum. However, the attrition rate reduced to 13.1% after the introduction of spiral approach of curriculum in organic chemistry. Therefore, this finding indicates that the introduction of spiral approach of curriculum helps students to understand the concepts on organic chemistry more easily and as a result the attrition rate of the students reduces drastically from an organic chemistry course.

Similarly, Shin et al., (2019) conducted a study on impact of using coherent curriculum on the students' understanding of core ideas in chemistry by involving 1225 students of classes VI-VIII and 51 teachers from the 6 different schools located under different states in United States. The study was specifically focused on the impact of the logical sequencing related to chemistry concepts from classes VI-VIII. The findings from the study revealed that the coherent curriculum which is spiral in nature shows a promising effect on the students learning with continuous growth of conceptual understanding in chemistry across the classes from VI-VIII.

With regards to the Bhutanese science curriculum, the alignments, coherency and the consistency of the concepts and contents are well maintained from PP-XII (DCRD, 2012). This is also in agreement with the study conducted by Wangdi and Dema (2020) who admitted that the hierarchy of physics concepts and contents are well maintained from classes VII science to IX physics. However, the Review Report on Quality of Education (2016, p. 17) mentioned that the students face difficulty in comprehending the main idea, scientific concepts and the principles in science when they go to higher classes from IX to X, and from XI to XII due to the haphazard sequencing of concepts and contents that creates confusion and difficulty for students to learn smoothly.

In the current study, researcher specifically focuses on the introduction of class IX chemistry concepts and the contents at lower secondary science and its alignment and coherency from the lower secondary science to class IX chemistry.

2.4 Significance of Transition and Learning Progression

One of the main purposes of science curriculum is to maintain the smooth transition and learning progression of contents and concepts in seamless nature across different level of classes (Ministry of Education and Employment, 2012, p.33). However, to maintain the smooth transition, familiarization of the basic concepts at lower classes is significant in order to comprehend and understand the more complex concepts at the next higher classes (King'aru, 2014; Osman & Sukor, 2013).

According to Department of Curriculum Research and Development (DCRD, 2012) the science curriculum framework for classes PP-XII was designed incorporating the spiral curriculum approaches to bring consistency co-ordination and coherency of the concepts and contents in systematic and progressive nature throughout pre-primary, primary and secondary education giving high priority on significance of transition and learning progression across various level of classes. However, to maintain the smooth transition of students conceptually, the progressive nature of learning from simple to complex concepts is indispensable. According to Ornstein and Hunkins (2018) in order to affirm the smooth transition of students conceptually across various levels of classes, the nature of learning should be from a part to a whole learning and therefore, a bit of information must be grasped before other bits can be comprehended. Moreover, the curriculum with organized and aligned concepts in the sequential nature is a means towards progressive learning and smooth transition of the students across different level of classes (Stevens et al., 2010).

Similarly, de Ramos-Samala (2018) conducted a case study on the spiral progression approach in teaching of science at Polytechnic University of Laboratory High School in Philippines by involving 133 student participants and the science teachers teaching classes IX and X. The data were collected through structured interview, focus group discussion and interview/focus group discussion questionnaires in order to support the respondents' responses. The data gathered in the study were assessed through the open and axial coding system. The study concluded that, the teaching of science in the spiral progression approach provides the deep understanding of science concepts. Further, it serves as a bridge of knowledge from one lesson to the next, across a program of study. Likewise, a study conducted by Resurreccion & Adanza (2015) also found that, the teaching of science in a spiral progression approach had a great significance in learning progression and conceptual transitions of students across various level of the classes, particularly in an area of science like physics, chemistry, biology and earth science.

On the contrary, lack of progressive learning impedes the smooth transition of students conceptually across the different level of classes and that makes the students trouble in understanding the more advanced concepts at the next higher classes (Osman & Sukor, 2013; Zangmo, 2016). Therefore, smooth conceptual transition and the learning progression are important towards promoting the students learning competencies.

2.5 Students Difficulty in Learning Chemistry

Chemistry is one of the three main branches of pure science and is important subject because the knowledge of chemistry is required in all chemical industries both in the developed and developing countries (Yaayin, 2018) however, many students perceived chemistry as difficult subject (Sirhan, 2007).

Several previous studies found different causes of learning difficulties in chemistry. A quantitative study was conducted by Uzezi et al., (2017) on assessment of conceptual difficulties in chemistry syllabus of the Nigerian science curriculum as perceived by students in Jalingo metropolis, Nigeria. The study employed a total of 193 class XII students that were randomly selected from 6 secondary schools offering the science subjects within Jalingo metropolis, Nigeria. The study concluded that, the majority of chemistry concepts (63.2%) introduced in the secondary school chemistry curriculum were perceived difficult to understand by high school students. Therefore, the students face challenges in the learning of chemistry.

Similarly, a study conducted by Uchegbu et al., (2016) on perception of difficult topics in chemistry curriculum by senior secondary school students in Imo State, Nigeria also revealed that, the senior secondary school students perceived difficulty in learning and understanding the topics on stoichiometry and organic chemistry. The study concluded that, the bulky chemistry syllabus, numerous calculations involved in the topics, lack of the qualified chemistry teachers and students' perception of chemistry as being too abstract were some of the reasons for the difficulties in understanding of the chemistry topics by the students.

Gafoor and Shilna (2015) conducted a survey study in Kerala to identify the chemistry units in IX standard that are perceived as being difficult by the students. The study involved 1382 class X students, both males and females, from 3 high schools in Kerala. The study found that, majority of class IX students (61%) faces difficulty in learning the units on periodic table and chemical bonding.

While several other studies revealed that, the topics like organic chemistry, chemical equilibrium, mole concepts and stoichiometry as the most common units in chemistry where the maximum students' experiences challenges in understanding the concepts. The studies confirmed that, students' poor foundation and the conceptual knowledge on stoichiometry, organic chemistry, chemical equilibrium, and mole concepts, makes students to perceived difficulty in learning those topics (Salame et al., 2019; Yaayin, 2018; Uce, 2009; Cardellini, 2012). Moreover, the students also, faces the difficulties in solving various numerical problems related to chemical equilibrium, stoichiometry and the mole concepts in chemistry which makes the students to perceived chemistry as a difficult subject (Moyo, 2018).

The discontinuity of concepts and progression across different level of classes hinders the smooth transition of students conceptually (Jindal-Snape et al., 2019) which causes incomplete understanding of the concepts (Osman & Sukor, 2013). Therefore, students merely memorize the concepts without actually understanding the chemistry concepts (Gafoor & Shilna, 2015).

Kyalo (2016) conducted a study, on school factors influencing students' performance in chemistry in Kenya certificate of secondary education at Mbooni east sub county, Kenya. The study used descriptive survey design and employed 12 school principals, 24 chemistry teachers and 192 students from 12 public secondary schools in Kenya. The findings from the study concluded that, when students develop negative attitude towards subject, they perceived chemistry as difficult subject.

Ali (2012) conducted a qualitative case study on common difficulties experienced by classes IX and X students in chemistry classroom, Pakistan. The study involved 4 high school chemistry teachers and the data for the study were collected through in-depth interviews with teachers, classroom observation and post observation discussion with the teachers. The study found that, there are multiple reasons contributing students' failure towards engaging in meaningful learning of chemistry. One of the main reasons confirmed by the study was students' inability to demonstrate a good understanding of very basic concepts of the subject. Therefore, the huge gaps in students' understanding of fundamental concepts, unable teachers to engaged the students in in-depth learning of advanced level content in chemistry classrooms.

On the contrary, several other literatures highlighted that, students perceived chemistry as difficult subjects due to other factors like, students lack of scientific literacy, poor teaching methods, non-contextualised chemistry curriculum, students lack of interest in chemistry and lack of resources like textbooks and equipped laboratory (Gongden et al., 2011; Engida, 2014; King'aru, 2014; Ültay & Çalık, 2012; Woldeamanuel et al., 2014).

2.6 Learning Difficulty of Chemistry Based on Gender

Kousa et al., (2018) conducted a survey in Finland on low-achieving students' attitudes towards learning chemistry and chemistry teaching methods. The study involved 2949 class IX students of age 15 years in the survey from 133 Finnish or Swedish speaking schools. The study found that, the girls usually find chemistry as a boring and difficult subject whereas the boys usually like the subject and find easier to learn chemistry. Similarly, in Malaysia, Veloo & Seung (2015) conducted a survey study on gender and ethnicity differences manifested in chemistry achievement and self-regulated learning. In total 358 students of matriculation science one-year programme selected through random sampling method took part in the survey study. The findings from the study revealed that, the boys perceived chemistry easier than the girls. Moreover, the boys outperform girls in chemistry achievement test.

Students self-concepts also plays a key role towards learning chemistry (Ferla et al., 2010). Self-concept here refers to students' perceptions on their capabilities to succeed in learning of chemistry. Likewise, Rüschenpöhler and Markic (2020) found that male students have strong or positive chemistry self-concepts than female students hence, the male students show persistent interest in learning of chemistry.

A study conducted by Kang et al., (2019) in Eastern University of Finland also found that the male students have greater interest in learning chemistry than female students. The study confirmed that the male students perceived learning of chemistry as more fun, interesting and easier than female students. On the other hand, the female students perceived biology as more interesting and easier to learn than chemistry.

On the contrary, a quasi- experimental research study conducted by Ajayi and Ogbeba (2017) on effect of gender on senior secondary chemistry students' achievement in stoichiometry using hands-on activities in Nigeria found that, both male and female students were equally successful in learning chemistry. Likewise, another survey study was conducted by Upahi and Ramnarain (2020) involving about 665 students from 19 chemistry departments in Nigerian Universities. The study found that, female students outperformed their male counterparts in the chemistry open ended problem-solving test. Therefore, based on literatures it is difficult to conclude weather male or female students are better performers in chemistry.

2.7 An Overview of Interdisciplinary Integrated Science

There is no concrete definition of integrated science since different authors, curriculum developers, educators and the policy makers use a term integration with different meaning (Tamassia & Frans, 2014). Nonetheless, the integration of science occurs within a subject and also between subjects. It can be integrated into a single science subject, different science subjects and also between science subjects and subjects outside the science. The integration between science subjects and subjects outside the science is called trans-disciplinary integration and integration within different science subjects (physics, chemistry, biology) is called interdisciplinary integration (Astrom, 2008).

Interdisciplinary integrated science presents insights of all three discipline of science (physics, chemistry and biology) is visible and also, recognizable within a single science textbook (Lederman & Niess, 1997). Therefore, teaching and learning of an interdisciplinary integrated science apparently crosses subject boundaries to facilitate comprehensive understanding and better learning experience for the students (Broggy et al., 2017). Moreover, it encourages the students to explore and integrate the multiple perspectives from different subject disciplines (Golding, 2009).

The current Bhutanese VII and VIII science curriculum is a type of interdisciplinary integrated science because the science textbooks consist of four chapters on biology, four chapters on chemistry and five chapters on physics both in classes VII and VIII.

2.8 Teaching of Integrated Science Curriculum

The teaching of integrated science curriculum requires a very able teachers with broad knowledge in all three disciplines of science and the failure to assure that, the teachers have broad subject and scientific knowledge in biology, chemistry and physics to teach an integrated science can perpetuate science misconceptions that, result in the creation of gaps in scientific/subject knowledge which is required to achieve a scientific literacy

(Harrel, 2010). Therefore, the conceptual content knowledge in all three discipline of science is a basis for supporting integrated science teaching (Lang & Olson, 2000). Further, an integrated science is a subject that attempts to put aside the various single science subject boundaries and sees the science as one that lays foundation for further study of science (Atomatofa & Ewesor, 2008).

Therefore, it is indispensable to prepare pre-service science teachers towards fostering their ability on content knowledge and pedagogical content knowledge with respect to all the three discipline of sciences for teaching integrated science curriculum (Cirkel et al., 2017). In Bhutan science teachers are trained to teach only two elective subjects from the three disciplines of science or specialized in one discipline of science however, the integrated science is not taken as an elective subject during the course of their training (Sherpa, 2007).

A survey conducted by Morgan (2012) in the University of South Australia found that many science teachers struggle with the feelings of inadequacy and incompetence to be science literate and good science teachers in teaching integrated science. Similarly, a study conducted in Norway by Klepaker and Almendingen (2017) also reported that science teachers are generally with the lower self-confidence in teaching the chemistry and physics topics compared to biology topics of integrated science.

In Bhutanese context, a study conducted by Tenzin and Lepcha (2012) on relevancy of integrated science for classes VII and VIII in Bhutan and by Wangdi and Utha (2020) on teachers' difficulty in teaching classes VII and VIII sciences in Bhutanese schools also reported that the teachers are not that confident and equally competent in teaching all three discipline of sciences in integrated science. Parker et al., (2018) conducted a mixed method research study in Ghana by employing 70 science teachers teaching integrated science from 1 private and 6 government junior high schools in Ghana. The study concluded that, the teacher's subject knowledge or content knowledge is one of the main factors which enhances the competencies and self- confidence of teachers towards teaching an integrated science.

Likewise, Mizzi (2019) in republic of Malta, explored on the challenges that science teachers, who are non-chemistry specialists, encounter when teaching chemistry topics from the integrated science syllabus through qualitative research approach. The study employed 3 volunteer science teachers teaching integrated science and the in-depth interviews and classroom observation were used as a data collection tools. The study concluded that, besides teachers' content knowledge, the pedagogical knowledge is also equivalently substantial. Moreover, the study also, confirmed that, the teachers' pedagogical knowledge generates major impacts on the quality of content and concepts delivery in the teaching integrated science. Therefore, both subject and pedagogical knowledge are equally important for better and smooth teaching of integrated science curriculum.

2.9 Challenges in Teaching Integrated Science Curriculum

Teachers encounters numerous challenges in teaching integrated science curriculum for instance, lack of confidence when teaching topics outside their area of expertise, choosing and devising activities and analogies to aid students' learning, answering students' question, linking and applying various concepts and principles to everyday life situation, generating students' interest and passion for integrated science and also, impacts on development of teachers pedagogical content knowledge, self- confidence and attitude in teaching integrated science curriculum due to inadequate subject or content knowledge (Childs & McNicholl, 2007; Wangdi & Utha, 2020; Davis et al., 2006; Mizzi, 2019; Tenzin and Lepcha, 2012; Sherpa, 2007).

Mizzi (2019) stated that, the teachers often become frustrated when teaching outside specialism because they may not be that confident to deliver and engage students in lesson as same way they could do when teaching within their area of expertise. Similarly, a study in Ghana found that the teachers attribute more self-confident when teaching within their subject of specialism and less confident and more anxious when teaching outside specialism (Parker, 2018). However, to overcome such challenges teachers seek helps from their experienced colleagues or subject expertise, conducts research through reading books or internet to improve content knowledge and to search lesson activities (Mizzi, 2019) in a way teacher gains both content and pedagogical knowledge from their subject specialist or more experienced colleagues in the schools (Mizzi, 2019; Hobbs & Törner, 2019; Ríordáin et al., 2019).

While some previous studies have shown other factors, which contributes challenges in teaching integrated science curriculum. In Nigeria, Otarigho and Oruese (2013) carried out a quantitative study on problems and prospects of teaching the integrated science in secondary schools. Study employed 360 students from five public secondary schools and five private secondary schools. The finding from the survey study revealed that the teachers inappropriate teaching methodology causes challenges in teaching and learning of integrated science. Further, the study also, concluded that the teachers teaching integrated science were not specialist in teaching integrated science. Thus, teachers were unable to give equal justice in teaching integrated science.

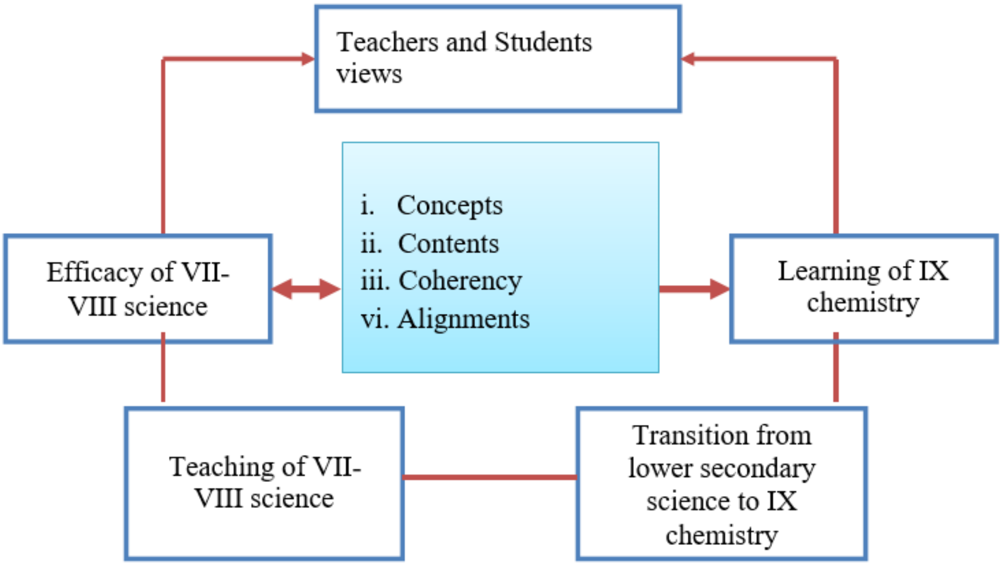
Similarly, Boakye and Ampiah (2017) in Ghana, explored on the challenges that newly qualified teachers faced in teaching and learning situation of integrated science and how they addressed their challenges through qualitative research design. The study employed 5 newly qualified teachers teaching integrated science in junior high schools in Ghana. The data were collected through observation, interview and content analysis. The inductive and deductive analytic methods were applied to analysed the data. The study found that the lack of resources for teaching and learning, teachers' deficiency in the content knowledge, students' inability to understand the lessons taught, student indiscipline, students' lack of interest in science and teachers' inability to complete the integrated science syllabus on time were some of the challenges faced by teachers in teaching integrated science. Study also, found that the teachers often used improvising the equipment, modifying their teaching methods and talking with the parents to solve their challenges in teaching integrated science.

2.10 Conceptual Framework

The conceptual framework as illustrated in figure 2.1, guided the researcher to carry out the whole process of this current study to achieve its goal and objectives. The main purpose of this study was to find out the efficacy of current VII and VIII science and to investigate the transition from lower secondary science to IX chemistry.

Figure 2. 1

Research Conceptual Framework Illustrating the Participants Views on Respective Themes of the Study.



The efficacy of lower secondary science is determined by examining the introduction of IX chemistry concepts and contents in classes VII and VIII science and also through investigating the alignment and coherency of chemistry concepts and contents from VII science to IX chemistry. Besides efficacy, the teaching of VII and VIII science and the conceptual transition from VII science to IX chemistry is also investigated because all these factors are directly linked with the learning of IX chemistry. Therefore, the current study sought to provide an insight on efficacy of lower secondary science, teaching of VII and VIII science, conceptual transition from VII science to IX chemistry and learning of IX chemistry through seeking views from participants in the study as illustrated in figure 2.1.

2.11 Summary on the Review of Literature

Many literatures have highlighted the importance of familiarizing the students with the basic concepts in lower classes that promotes smooth conceptual transition. Further, the adequate conceptual foundation and the smooth transition of the students across various level of classes will overcome learning difficulty and produces positive learning outcome of students in next higher classes. Literatures also, highlighted that the introduction of chemistry concepts in lower classes is important, because the lack of basic foundations hinders students learning competencies in the next higher classes.

The Bhutanese science curriculum for classes VII and VIII is a type of interdisciplinary integrated science, where a syllabus consisted of few chapters from all three discipline of science (biology, chemistry and physics). However, the literature related to efficacy of VII and VIII science and transition from lower secondary science to IX chemistry is very limited both in the national and international literature platforms.

Several literatures have discussed on the competencies of science teachers in teaching integrated science and also the challenges they experience in the teaching integrated science. Amongst many factors the teachers lack of competent and confidence in teaching of subject outside their specialism was the major challenges that they face in teaching integrated science. However, seeking conceptual and pedagogical help from colleagues who are subject specialist or more experienced in teaching of integrated science in the school and also teachers doing independent researching through internet and other sources to improve their content and pedagogical knowledge were some of the strategies commonly used by the teachers to overcome the challenges in teaching integrated science.

The current study is intended to find out the efficacy of classes VII and VIII science curriculum and the transition from lower secondary science class IX chemistry. The efficacy of classes VII and VIII science were examined in terms of inclusion of IX chemistry concepts in lower secondary science and its logical sequences of chemistry concepts from VII science to IX chemistry.

3. METHODOLOGY

3.1. Introduction

This chapter presents the design, paradigm, and methods employed to achieve the aims and objectives of the research study. The research paradigm, which provides the theoretical underpinnings for the methodology, research design and methods adopted describes the research settings and details of the samples used in the study, highlights the instruments used in the study, outlines the procedure used and the timeline for completion of the study, discusses how the quantitative and qualitative data were analyzed, ethical considerations of the research, limitations and finally the chapter summary.

3.2. Research Paradigm

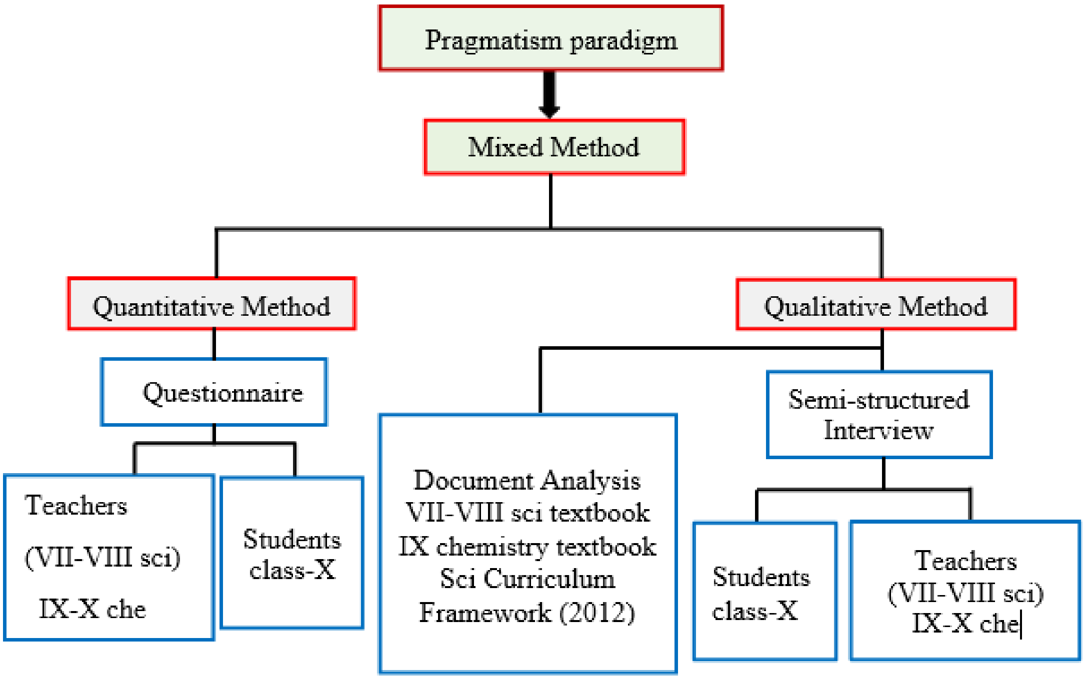
A paradigm is a basic set of beliefs that tend to guide human actions and behaviors, and a research paradigm comprises principles, which are human constructions that define the world view of the researcher (Creswell 2014). From the world view of pragmatists, individual researchers have a freedom of choice. They are free to choose the methods, techniques, and procedures of research that best meet their needs and purposes. Further, for the mixed methods researcher, pragmatism opens the door to multiple methods, different worldviews as well as to different forms of data collection and analysis in the mixed methods study (Creswell, 2014).

Therefore, pragmatism will be most suitable paradigm for this study since researcher need to employ the multiple data collection tools and analyses procedure. Further, the research paradigm also, given a researcher the freedom to choose methods, technique and procedure that best meet the needs and purpose of the current study. Moreover, validity of data through triangulation analysis enhances the credibility of findings.

3.3. Research Design and Methods

Method is a particular research technique or a way to gather evidence about a phenomenon. It includes those specific tools used in research projects in order to fully understand a phenomenon under study (Namgyel, 2011). The current study was carried out using mixed method design in which the researcher tends to base knowledge claims on pragmatic grounds. It employed strategies of inquiry that involves collecting data simultaneously to best understand research problems. The data collection also involves gathering both numeric information as well as text information so that the final database represents both quantitative and qualitative information (Creswell, 2014).

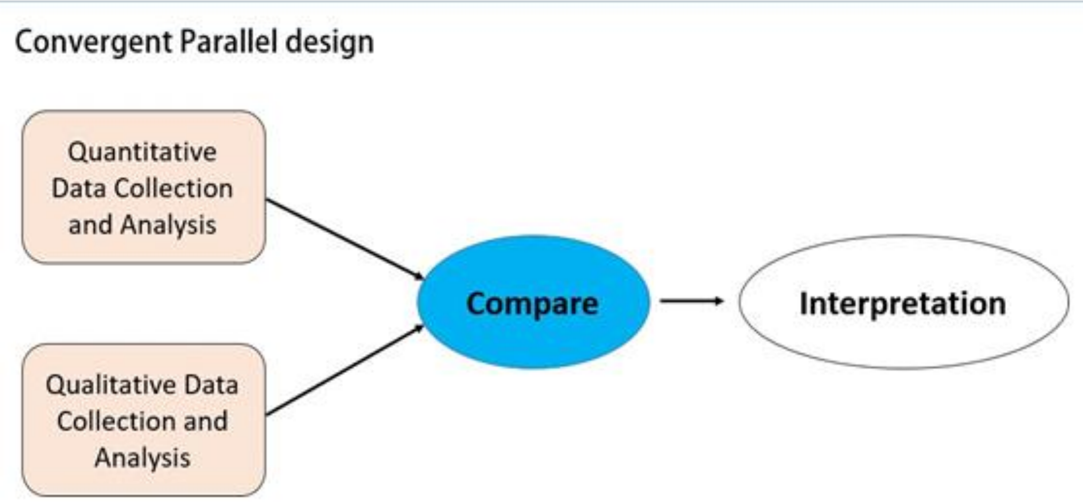
Figure 3. 1. *Flow Chart Showing a Conceptual Map of the Research Design*



According to Creswell & Clark (2011), mixed method design provides the strengths that offset the weaknesses of both quantitative and qualitative study. Moreover, it also provides a more complete and comprehensive understanding of the research problem than either quantitative or qualitative approaches alone.

The triangulation of data, offsetting weaknesses and providing stronger inferences, answering different research questions, explanation of findings, illustration of data, hypothesis development and testing, instrument development and testing are other benefits of mixed method (Doyle et al., 2009). Likewise, mixed method provides cross validations by triangulations and helps in gaining complementary results by using the strength of one method to improve the other method (Dang 2015).

Figure 3. 2 *Types of Mixed Methods Designs*



Adapted from Creswell, 2014, p 541.

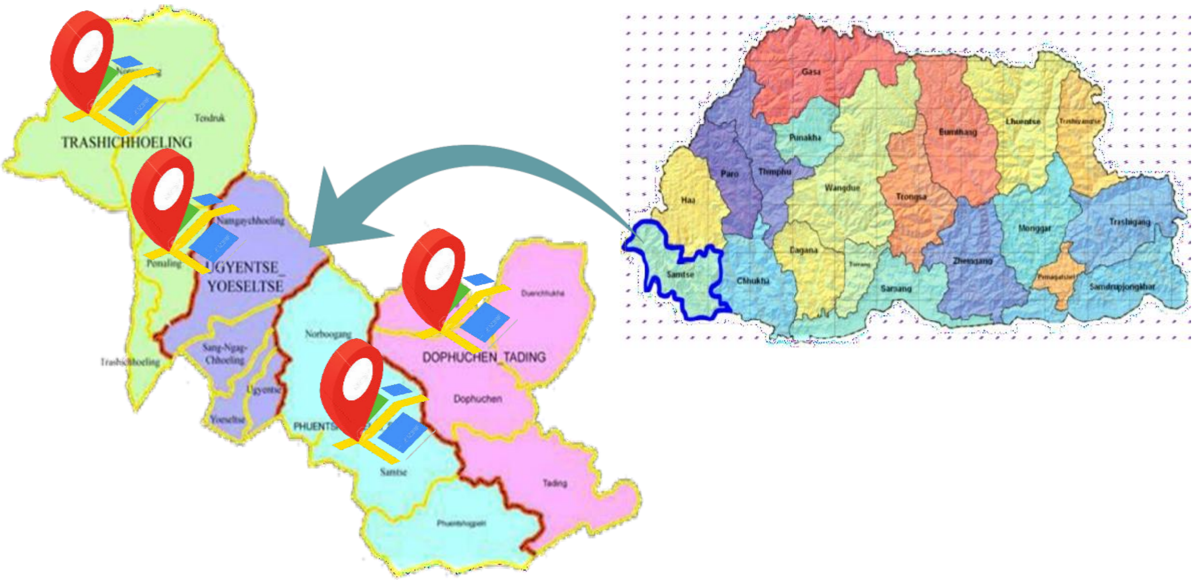
According to Creswell (2014), the convergent parallel mixed method, explanatory sequential mixed method and exploratory sequential mixed method are the three types of mixed method. When researcher collects both forms of data at the same time and integrates the information during interpretation of findings is called convergent parallel mixed method. Likewise, in explanatory sequential mixed method quantitative data is collected first, analyzed and then uses the results to plan on qualitative data collection and finally in the exploratory sequential mixed method qualitative phase is followed by quantitative phase.

The current study employed the convergent parallel mixed method in order to have greater credibility and solidification of finding through triangulation of quantitative data and qualitative information since the study is intended to find out both the teachers and students' opinion on efficacy of classes VII-VIII science and transition from lower secondary science to class IX chemistry. For current study, the focus of data collection was the administration of survey questionnaires and semi-structured interview for both the teachers and students. Further, the analysis of documents like current VII -VIII science textbook, IX chemistry textbook and science curriculum framework would solidify the findings.

3.4. Area and Population of the Study

As per the convenient of researcher, all four schools included in this study were from Samtse Dzongkhag. The population of the study comprised students of class X and teachers teaching classes IX and X chemistry and VII and VIII science in different middle secondary and higher secondary schools under Samtse Dzongkhag. For current research study 3 central schools and 1 higher secondary school were selected with the total population of 1145 class X students and 13 teachers teaching IX-X chemistry and 12 teachers teaching VII-VIII science. It was from this population that the sample were drawn for the study.

Figure 3. 3 *Map of Bhutan and Samtse Dzongkhag with Dzongkhag Boundaries*

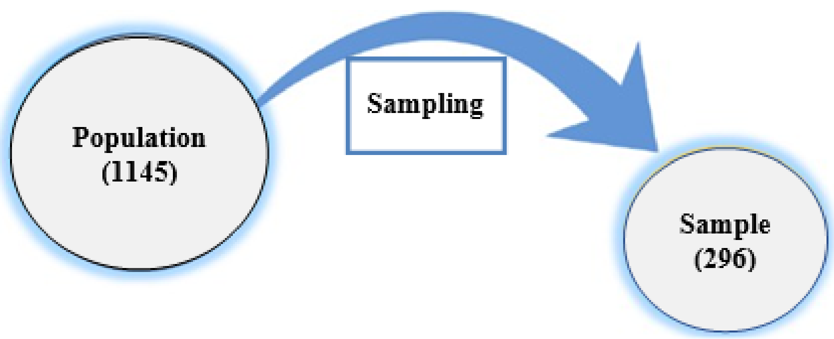


Source: http://www.mapsland.com/maps/asia/bhutan/largepolitical-map-of- bhutan, 21.10.2019

3.5. Sample and Sampling Techniques

The sample is the group of participants in a study selected from the target population from which the researcher generalizes to the target population. The size of the sample should not be very large or too small and it should be optimum (Creswell, 2014). According to Kothari (2004) the optimum sample size fulfills the requirement of efficiency, representativeness, reliability, and flexibility. Sampling is the process in which small proportion or sub-group or sample of a population is selected for analysis. The quality of the data and the inferences greatly depends on the type of strategy selected for the sample (Mertens, 2010). However, researcher may not be able to acquire sufficient information from the whole populations due to factors like time, expenses and accessibility (Cohen et al., 2005).

Figure 3. 4. *Purposive Sampling Technique*



The sample size is calculated from the total population of 1145 class X students using Yamane's (1967, p. 886) formula as follows:

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

'N' is the population size

'e' is the acceptable sampling error at level 0.05

Total sample size for the study: 296 students and 25 teachers.

3.5.1. Purposive Sampling Technique

For this study, purposive sampling technique were used to have sample representative of class X students and teachers teaching class IX- X chemistry and class VII-VIII science. According to Cohen et al., (2005) in the purposeful sampling technique the researchers, choose the sample based on who they think would be appropriate and satisfy the needs of the study. The intend of this study is to find out the efficacy of current class VII and

Table 3.1 *The Sample Size of the Class X Students under Study*

Sl. No	Number of Schools	Class	Students Male	Female	Total
1	School I	X	34	34	68
2	School II	X	42	42	84
3	School III	X	40	40	80
4	School IV	X	40	40	80
					312

VIII science and to investigate the transition from lower secondary science to class IX chemistry. Therefore, teachers teaching classes VII and VIII science, classes IX and X chemistry and class X students were chosen for this study through purposive sampling technique from 3 central schools and 1 higher secondary school from Samtse dzongkhag.

The reasons for taking only class X in the current study was because these students are the one who have just completed studying class IX chemistry after studying the integrated science in classes VII and VIII. Moreover, the timeline to collect data from the field was right after the re-opening of new academic session 2020 and thus including of class IX students in a current study as a sample will not fulfill the intend of the current study. Therefore, taking class X students as a sample of population will be appropriate to satisfy the needs of research study.

Table 3.2 presents the sample size of teachers teaching classes VII - VIII science and IX-X chemistry. teachers teaching classes VII- VIII science and IX-X chemistry were selected as sample of population to meet the intend of the study.

3.6. Research Instruments

An instrument is a tool for measuring, observing, or documenting quantitative data that contains specific questions and response possibilities that are developed in advance of the study (Creswell, 2014). In this study, the researcher used survey questionnaires for teachers and students, interview for teachers and students and document analysis of VII

Table 3.2 *The Sample Size of Teachers Teaching Class VII - VIII Science and IX- X Chemistry*

Sl.No.	Number of Schools	Teachers		Total
		Male	Female	
1	School I	3	1	4
2	School II	5	3	8
3	School III	5	2	7
4	School IV	5	1	6
				25

and VIII science textbooks, IX chemistry textbook and science curriculum framework PP-XII as the research instruments.

3.6.1. Survey Questionnaire

According to Rowley (2014) the surveys questionnaire has become one of the most frequently used means of collecting information and if constructed properly they permit the collection of reliable and reasonably valid data in a simple, cheap and timely manner. In addition, questionnaires generate quantifiable data ready for statistical analysis. In case of a questionnaire, as there is no one to explain the meaning of questions to respondents, it is important that the questions are clear and easy to understand. Also, the layout of a questionnaire should be such that it is easy to read and pleasant to the eye and the sequence of questions should be easy to follow. A questionnaire should be developed in an interactive style. This means respondents should feel as if someone is talking to them (Kumar, 2018).

The main advantages of using survey questionnaire are, as we do not interview respondents, we save time, human and financial resources. Thus, it is comparatively convenient and inexpensive method of data collection. It also offers greater anonymity as there is no face-to-face interaction between respondents and interviewer, thus provides greater anonymity. In some situations where sensitive questions are asked it helps to increase the likelihood of obtaining accurate information (Kumar, 2018).

Table 3.3 *Division of 30 Items into 4 Components in Students' Survey Questionnaire*

Descriptions	Items
1 Efficacy of class VII and VIII science.	1-8
2 Teaching of VII and VIII science	9-17
3 Transition from lower secondary science to IX chemistry	18-24
4 Learning of IX chemistry	25-30

There are different types of survey questionnaires with dichotomous questions, multiple choice questions, rating scale, and open-ended questions. In this study, the researcher selected five points Likert Scale survey questionnaires because it is advantageous over dichotomous questions and is considered useful devices as they build in a degree of sensitivity and differentiation of response but still generate a number (Cohen et al., 2005).

Two sets of survey questionnaires were used one for the students and another for the teachers. The survey questionnaires included Likert-scale items measuring the students and teachers' views on efficacy of class VII-VIII science and transition from lower secondary science to class IX chemistry. The survey questionnaire for students and teachers consisted of two sections – A & B. The (section A) related to their background information and demographic data and (section B) measured the students' and teachers' experiences, opinion and perspectives on efficacy of current VII and VIII science and transition of lower secondary science to class IX chemistry.

The survey questionnaire of students consists of 30 items and each item in a questionnaire is rated on 5-point Likert scale that ranged from "strongly agree" to "strongly disagree" (see Table 3.3). The minimum possible score of a student is 30 and the maximum is 150. The mean score of answers obtained will determine the participants level of agreement on various section of each statement.

If the mean score obtained through survey questionnaire falls in between 1.0 - 1.80, the level of agreement will be very low. Likewise, if the mean score falls in between 4.21 - 5.0, the level of agreement will be very high during interpretation of findings.

Table 3.4 *Division of 25 Items into 3 Components in Teachers Survey Questionnaire*

Descriptions	Items
1 Efficacy of class VII and VIII science.	1-7
2 Transition from lower secondary science to IX chemistry	8-18
3 Learning of IX chemistry	19-25

The survey questionnaire of teachers consists of 25 items and each item in a questionnaire is rated on 5-point Likert scale that ranged from "strongly agree" to "strongly disagree" (see Table 3.4).

The possible minimum score of a teacher is 25 and the maximum is 125. The mean score obtained will determine the participants' level of agreement on various sections of each statement during the interpretations of findings of this thesis study.

3.6.2. Interview

The interview is a method of data collection that involves the presentation of oral-verbal stimuli and reply in terms of oral verbal responses (Kothari, 2004). The interview is used as the means of gathering information having a direct bearing on the research objectives and also used in conjunction with other methods of research undertaking (Cohen et al., 2005). It validates other methods of data collection as it yields a wide variety of responses from discussions.

According to Kumar (2018) there are several advantages of using interview as a data collection tools. Through interview it is possible for an investigator to obtain in-depth information by probing. Hence, in situations where in-depth information is required, interviewing is a preferred method of data collection. Information can be supplemented because interviewer is able to supplement information obtained from responses with those gained from observation of non-verbal reactions.

Other advantages are like in interview, questions can be explained and thus it is less likely that a question will be misunderstood as the interviewer can either repeat a question or put it in a form that is understood by the respondent. Also, an interview can

Table 3.5 *Measurement Scale of Survey Questionnaire*

Level of agreement	Score
Strongly Agree	5
Agree	4
Neutral	3
Disagree	2
Strongly Disagree	1

be used with almost any type of population like children, the handicapped, illiterate or very old individual.

Interviews can be structured; semi-structured and unstructured that can be conducted individually or in the group. According to Creswell (2014) semi-structured interviews allow informants the freedom to express their views in their own terms. It also provides reliable, comparable qualitative data. This method of interview has features of both structured and unstructured interviews and therefore use both closed and open-handed questions and also as the interview progresses, the interviewee is given opportunity to elaborate or provide more relevant information if he/she opts to do so. Therefore, in this study, the semi-structured interview has been used.

A total of 7 teachers teaching classes IX-X chemistry and VII-VIII science were involved in the interview. The focused group interview was conducted for students. For the focused group interviews, 16 students (4 students each from 4 focused group) were interviewed. The interviews were audio recorded, transcribed, and analysed using thematic coding. The anonymity of participants was maintained by using acronym like T_01, T_02, T_03, T_04, T_05 respectively for teacher 1, teacher 2, teacher 3 and so on. Similarly, students focus group of school 1 as SFG_01, students' focus group of school 2 as SFG_02, students focus group of school 3 as SFG_03 and students focus group of school 4 as SFG_04.

3.6.3. Document Analysis

Table 3.6 *Criteria for Interpreting the Overall Means Scores Obtained*

Mean Scores	Interpretation
1.00 - 1.80	Very Low
1.81 - 2.60	Low
2.61 - 3.20	Moderate
3.21 - 4.20	High
4.21 - 5.00	Very High

(Adopted from Moidunny, 2009)

According to Bowen (2009), document analysis helps researchers in collecting the qualitative data from the topics and statistical records of interest under study. Documents such as public records, personal documents and physical evidence are three different types of documents. The Public records include official ongoing record of an organization's activities, students' transcript, annual reports, policy manuals, students' handbooks, strategic plans and syllabi while the personal documents are the accounts of an individual's experiences and beliefs such as e-mails, scrapbooks, blogs, facebook post, reflections and journals. Likewise, O'Leary (2004) mentioned that the physical objects found within the study setting such as posters, agendas, handbooks and training materials are called physical evidence documents. Efficient, effective, manageable and stable data sources are the advantages of document analysis and also the researchers can review the documents time and again as and when required (Bowen, 2009).

In this study the science textbooks of classes VII-VIII, class IX chemistry textbook and science curriculum framework (PP-XII) were analysed to find out the introduction of IX chemistry concepts in VII and VIII science curriculum and also the transition of chemistry concepts from VII and VIII science to IX chemistry were investigated. Further, the intend and objective of science curriculum framework were examined.

3.6.4. Validity of the Instrument

The key indicators of the quality of a measuring instrument are reliability and validity of the measures (Kimberlin & Winterstein, 2008). The questionnaire and interview

Table 3.7 *The Reliability Statistics of Survey Questionnaire*

Teachers' survey reliability test.		Students' survey reliability test.	
Cronbach's Alpha	N of Items	Cronbach's Alpha	N of Items
0.776	25	0.808	30

questions of current research study were corrected by the expert educator in research study.

3.6.5. Reliability of the Instrument

The survey questionnaire of this study was pilot tested at Norbugang Central school, Samtse. 30 students and 6 science teachers were included for pilot study. The survey questionnaires were punched in SPSS for running reliability test. Reliability of the instruments was checked using Cronbach's Alpha. Likewise, the reliability of the interview questions was confirmed through expert review and peer review.

As reflected in the tables 3.7 above, the computed Cronbach Alpha value were 0.776 for teachers and 0.808 for students' survey respectively. The high alpha value of both survey questionnaires indicated that the survey designed for this study was reliable.

3.7. Quantitative and Qualitative Data Collection Procedure

The design used to carry out this research study was the convergent parallel design and the main reason for opting this design was to collect both quantitative data and qualitative data concurrently so that researcher will save time and other resources. Both survey questionnaire and semi-structured interview were used to collect the data. The quantitative data was collected through survey questionnaire administered to classes VII and VIII science teachers, IX and X chemistry teachers and class X students. Likewise, qualitative data was collected through semi-structured interview. Focused group semi-structured interviews were administered for students while face to face

Table 3.8 *Timeline for Data Collection*

Tools	Schools	Timeline
Questionnaire Interview	School-I	15-22 Feb, 2020
Questionnaire Interview	School-II	23-28 Feb, 2020
Questionnaire Interviews	School-III	1-8 March, 2020
Questionnaire Interview	School-IV	9-15 March, 2020

interview for teachers. Both quantitative and qualitative data were collected concurrently at one visit to the field.

3.8. Timeline for Data Collection

After getting approval letter from concern agency, data was collected in the following time frame as presented in table 3.8 from 15th February 2020 to 15th March, 2020 using English as a medium of communication.

3.9. Data Analysis Procedure

The process of examining and evaluating data using analytical and logical reasoning is called data analysis. The research design used in this study is convergent parallel design and thus the qualitative data and quantitative data were collected concurrently however, they were analyzed separately.

3.10. Data Cleansing and Compilation Procedure

The process of quantitative data cleansing and compilation started right after the data collection. The questionnaires were first arranged and filed according to school names both for teachers and students. The survey questionnaire employed for both teachers

Table 3.9 *Timeline for the Thesis Study*

Sl No	Activities	Months 2019 July-Oct	2019 Nov	2020 Feb-March	2020 Apr-June	2020 July- Nov	2020 Dec-Jan
1	Proposal Writing	■					
2	Proposal Defense		■				
3	Data Collection			■			
4	Data Analysis				■		
5	Report Writing				■		
6	Draft Report Submission					■	
7	Final Report Submission						■

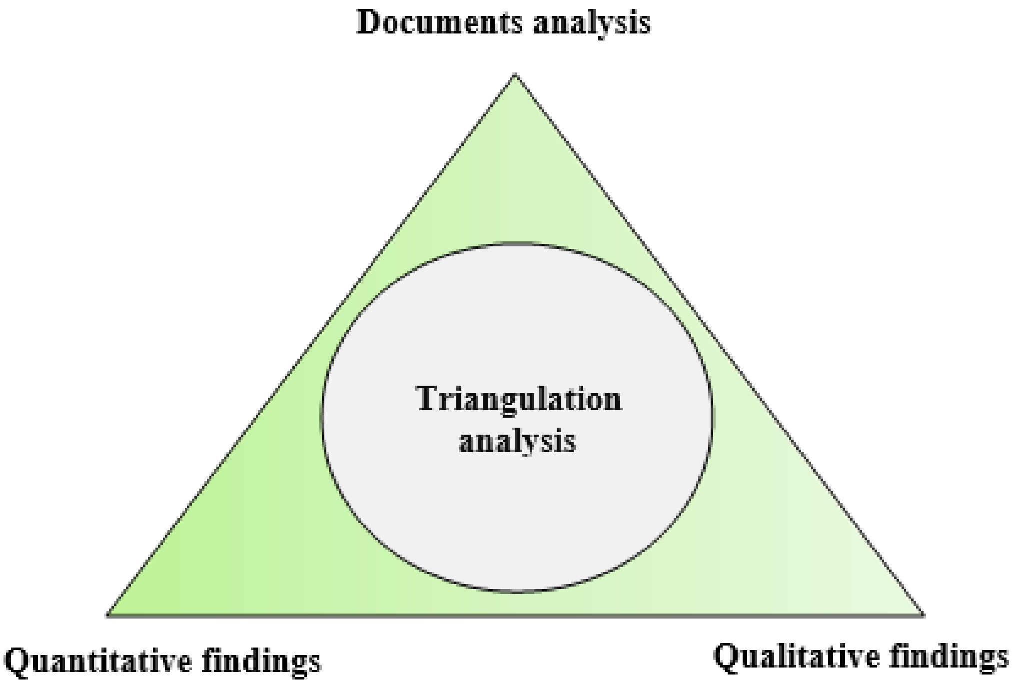
and students consisted of five-point Likert scale with pre-coded values and labels as (1= strongly disagree, 2= disagree, 3= neutral, 4= agree, 5 = strongly agree). The researcher, thoroughly checked the entire questionnaire serially and systematically to find out any missing responses against all the items of the questionnaire. Likewise, those questionnaires with double ticked in more than one options are excluded and not included for descriptive analysis. Out of 305 survey questionnaires administered for students, 9 questionnaires were excluded.

Similarly, for the teachers out of 18 survey questionnaires employed, none of the questionnaire were found with any missing responses or with multiple options attempted. Therefore, all the sample questionnaires were included for quantitative data analysis through simple descriptive analysis.

3.11. Quantitative Data Analysis

After data cleansing and compilation, the coding was done for quantitative data, then it was punched into Statistical Package for Social Sciences (SPSS) version 22 for simple descriptive analysis. In this study, the quantitative data were analysed using descriptive

Figure 3. 5 *Triangle of Data Triangulation Analysis Method*



statistics by taking mean, standard deviation, percentage and inferential statistics like simple correlation.

Also, wherever necessary the Microsoft Excel program was used, especially for converting SPSS output tables into APA format. The mathematical mean, standard deviation and percentage were used to analyse the participants' level of agreement on various statements of the survey. Likewise, tables, graphs and figures were used whenever required for easy view, readability and understanding of the interpretation.

3.12. Qualitative Data Analysis

According to Baker and Edwards (2012) for successful completion of the research study, the quality of the analysis, care and time taken to analysed interviews, building a convincing analytical narrative, based on richness, complexity and detail is vital rather than on statistical logic. Thematic analysis was done in order to understand the efficacy of class VII and VIII science and to investigate the transition from lower secondary science to IX chemistry. According to Braun and Clarke (2006) thematic analysis is the common method used for analysing qualitative data towards identifying and generating themes to address the intend of research study.

The collected qualitative data were analysed based on the procedures described in Creswell (2014). The audio recordings of interviews were transcribed, allowing sufficient time for the transcription process. The transcription was then reviewed with recordings to ensure nothing was left out. Then the transcribed text segments were studied several times to form patterns and categories. After categorizing the text segments under similar categories, repeated reading was carried out to identify the codes and the codes were merged together to generate the themes.

3.13. Triangulation

According to Heale and Forbes (2013) the main advantage of mixed method is that it allows the researcher to triangulate the results of different databases collected through quantitative method and qualitative method. The triangulation of databases helps in complete understanding of the phenomenon under study and also enhances the credibility of research study.

In this study, the findings from interviews and survey questionnaire were triangulated with the findings from document analysis of current classes VII and VIII science textbooks specifically focusing on chemistry parts of VII and VIII science curriculum, current IX chemistry and science curriculum framework (PP-XII) to compare, contrast, validate and solidify the results.

3.14. Research Quality Standards

Descombe (2014) mentioned that the reliability and validity are two main criteria used to evaluate the quality of research. Reliability is concerned with the consistency of the research instrument.

Therefore, in this study the measures of internal consistency were used to assess the reliability of survey instruments by calculating Cronbach's alpha coefficients for each scale of survey questionnaire. Internal consistency indicates how well the different items measure the same attribute.

On the other hand, validity deals with the accuracy and precision of the data associated with the appropriateness of the data in terms of the research questions being investigated. The internal validity is investigated through accurate interpretability of the results and external validity by generalizability of the results (Descombe, 2014). In the current study, the validity was established by triangulating the data collection methods and responses from the participants.

3.15. Ethical Consideration

The researcher has an obligation to respect the rights and needs of the informants. It is important to respect the site and to obtain the permission for the conduct of research study (Creswell, 2014). Therefore, in order to uphold the ethics of researcher, following procedures were taken seriously.

i. The college research ethics form was dully filled, signed and submitted to the supervisor (Refer Appendix H).
ii. Before visiting the schools, prior permission in written form was obtained from the Dzongkhag Education officer (Refer Appendix I).
iii. Similarly, at school level the approval was sought from the concerned school principal. The principal/Vice principal of the concerned school in consultation with the teachers, arranged for participants on voluntary basis, prioritizing on the minimal disturbance to the school activities.
iv. The purpose of the study was explained in detail to the participants and consent was obtained from the participants (Refer Appendix J and K).
v. Confidentiality and anonymity of participants were respected and maintained strictly and researcher took sole responsibility to ensure that all data records of the project were kept confidential at all times.

3.16. Summary of the Chapter

This chapter presented a wide range of practical procedures and methods employed to achieve the intend of the current study. From the world view of pragmatists, individual researchers have a freedom of choice. Researchers are free to choose the methods, techniques and the procedures of research that best meet their needs and purposes. Therefore, pragmatism was chosen as a paradigm for this study. The chapter also, presented detailed discussion on research design and methodology employed for this study. The current study employed the convergent parallel mixed method to have greater credibility and solidification of finding through triangulation of quantitative and the qualitative database. The survey questionnaire, semi-structured interviews and documents analysis were the data collection tools employed in this study. The purposive sampling techniques was used because researchers can choose the sample based on who they think would be appropriate and satisfy the needs of the study. The chapter also highlighted on the sample size, reliability and the validity test of research instruments used in the current study.

Finally, the last section of the chapter discussed on the data collection and database analyses procedures. The data were collected through survey questionnaire, interviews and document analysis. The quantitative data were analyzed by employing the simple descriptive statistics like mean, standard deviation, percentage and inferential statistics like simple correlations. Further, the research quality standard, triangulation of data and ethical consideration of research were also discussed in detail in this chapter.

4. RESULTS

4.1. Introduction

This chapter presents the reports on findings from quantitative and qualitative data analyses. As mentioned in chapter 3, this study employed convergent parallel mixed method to collect the data. From the pragmatist approach, the collection of data from multiple sources applying different methods and analyses of data applying multiple techniques and procedures provides a more complete and comprehensive understanding of research problem. Therefore, researcher has used multiple analyses techniques and procedures that best meet the need and purpose of the study.

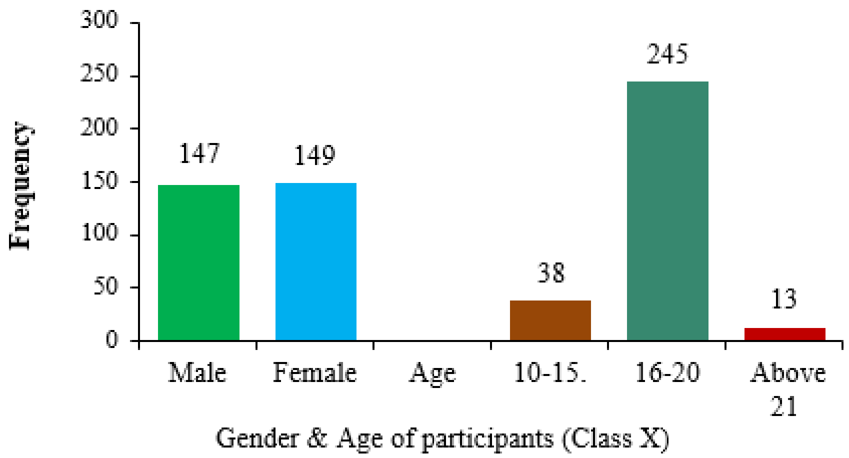
The current study aimed to find out teachers and students views on the efficacy of lower secondary science curriculum precisely on chemistry curriculum of VII and VIII science and the transition from lower secondary science to middle secondary chemistry. The quantitative data from the survey were analysed by using simple descriptive statistics like mean, standard deviation and percentage and inferential statistics like simple correlation. Likewise, the qualitative data were analysed by employing the thematic analysis. The anonymity of the interview participants was maintained using pseudonyms like T_01, T_02 … for teachers and SFG_01, SFG_02 for students' focus group interviews.

Further, the documents like class IX chemistry textbook, classes VII and VIII science textbooks and science curriculum framework (PP-XII) were analysed briefly keeping the intend and objectives of the current study. The documents analysis was focused on the introduction of IX chemistry concepts in current VII and VIII science curriculum and its coherency and alignment from VII to IX chemistry.

The findings from survey, interviews and document analyses were triangulated to validate and solidify the results. The study consisted of four major themes namely introduction of IX chemistry concepts in VII and VIII science, transition from lower secondary science to IX chemistry, learning of IX chemistry and teaching of VII and VIII science.

4.2. Demographic Information of Participant

Figure 4. 1 *Frequency of Students' Participant in Terms of Gender and Age in Survey*



The figure 4.1 presents the frequency of students' participant in terms of gender and age in survey. The survey questionnaire was administered to 296 classes X students taking almost equal sample of male and female participants in order to maintain the gender equality.

Table 4.1 *Student Respondents' Profile for the Focused Group Semi-Structure Interview*

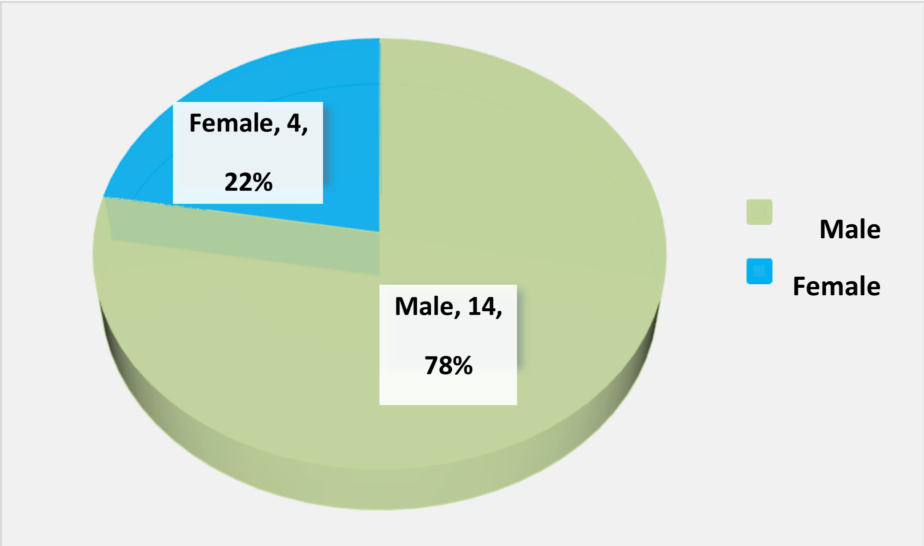
Sample Category	Number of schools	Students		Total
		Male	Female	
Central schools	3	6	6	12
HSS	1	2	2	4
Total	4	8	8	16

As shown in table 4.1, 16 students in total, 4 from each school were administered in the focused group interview. The gender equality was maintained by taking equal numbers of male and female participants from each school. In total 8 male and 8 female participants have participated in interview from 4 different schools.

A total of 18 teachers teaching VII-VIII science and IX-X chemistry were administered for the survey questionnaire. The gender equality of the respondents was unable to maintain due to unequal ratio of male and female teachers teaching VII-VIII science and

IX-X chemistry in the schools. As shown in figure 4.2, 78% of participants were male however, only 22% of participants were female.

Figure 4.2. *Teacher Respondents' Profile for the Survey Study*



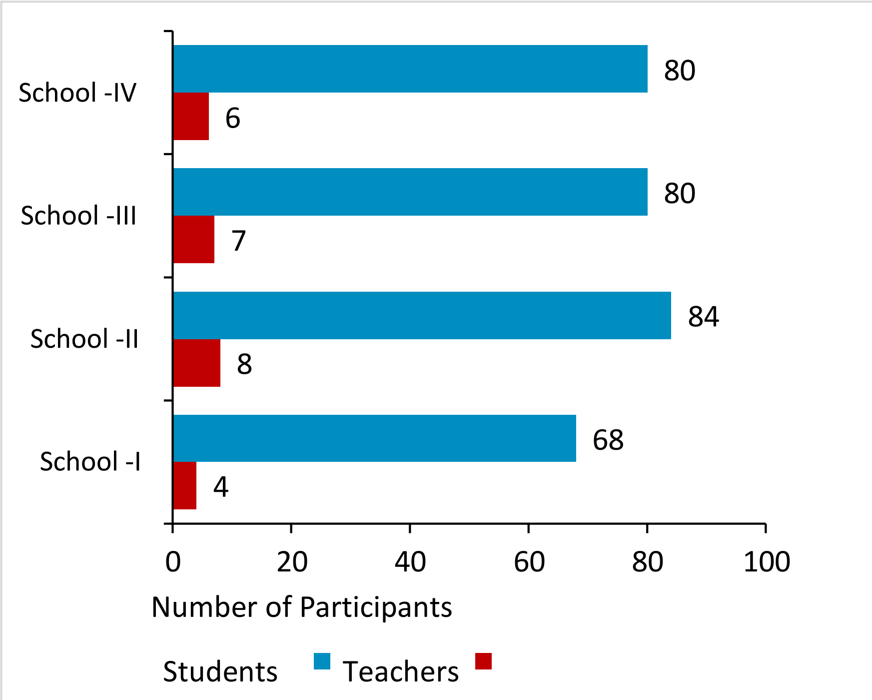
In total 7 teachers comprising of 71% male and 29% female teachers teaching VII- VIII science and IX-X chemistry have participated in face-face semi-structured interview. There was unequal ratio of male and female teachers teaching VII-VIII science and IX-X chemistry therefore, gender equality was unable to maintain.

Table 4. 2 *Teacher Respondents' Profile for Face-Face Semi-Structure Interview*

Sample Category	Number of schools	Teacher		Total
		Male	Female	
Central schools	3	4	1	5
HSS	1	1	1	2
Frequency	4	5	2	7
Percent		71	29	100

In total 312 classes X students and 25 teachers teaching VII-VIII science and IX-X chemistry have participated in this study. The four major themes were generated from the survey and interview. The themes are as follows: Introduction of IX chemistry concepts in VII and VIII science curriculum, Transition from lower secondary science to middle secondary chemistry, Learning of IX chemistry and finally, The teaching of current VII and VIII science.

Figure 4.3. *Sample Size of Teacher and Student Participants in Current Study*



4.3. Introduction of IX Chemistry Concept in Class VII and VIII Science

The introduction of IX chemistry concepts in classes VII and VIII science refers to the inclusion of class IX chemistry concepts in classes VII and VIII science curriculum. About 80% of student interviewees were with the view that the key concepts of IX chemistry were only partially introduced in current VII and VIII science curriculum and therefore, they encountered challenges to cope up with IX chemistry. Further, most of the participants felt that it is important to introduce more IX chemistry concepts in VII and VIII science while others expressed that it would be better to introduced bifurcated science from class VII itself to have strong foundations towards learning IX chemistry. The students' views on introduction of IX chemistry concepts in VII and VIII science curricula are reflected in the following comments:

We find many new concepts in class IX chemistry which we have not learned in class VII and VIII science, like stoichiometry, thermodynamics, chemical bonding, green chemistry, organic chemistry, mole concepts (SFG_02).

It is important to introduce the basic concepts on mole concept, organic chemistry, stoichiometry, chemical bonding, thermodynamics and green chemistry in VII and VIII science because it will be easier for teachers to teach and also for students to learn once they reached class IX (SFG_04).

If bifurcated science is introduced from class VII itself, we will be equipped with more concepts that will make easier to study chemistry when we reach class IX (SFG_01).

Similarly, 70% of teachers shared parallel views like that of students. They expressed that though the current VII and VIII science is serving its purpose however, adequate concepts of IX chemistry were not introduced in VII and VIII science. This is evident from the following comments:

I feel that chemistry foundation is given, however the IX chemistry concepts embedded in VII and VIII science is very less (T_06).

What i feel is that, classes VII and VIII science have certain part of chemistry in it, but comparatively when we see all the chapters in class IX chemistry, we find class VII and VIII science lacks most of the concepts required to learn IX chemistry (T_05).

Majority of teacher participants also shared that, it is important to introduce the basic concepts on topics like organic chemistry, thermodynamics, mole concepts, chemical bonding, stoichiometry right from class VII itself, because these chapters are the one in which students face lots of challenges to cope up in IX chemistry. This point is exemplified in the following comment by one of the teacher interviewees:

The basic concepts on organic chemistry, thermodynamics, mole concepts, chemical bonding and stoichiometry could have introduced from class VII itself, so that students feel comfortable once they reached class IX because these are the chapters our students are facing difficulties once they reached class IX (T_01).

Further, teachers were also with the views that there is a curriculum gap between lower secondary science and IX chemistry. Therefore, to benefit both students and teachers it is necessary to introduce more IX chemistry concepts in VII and VIII science. For example, one of the teacher interviewees pointed out:

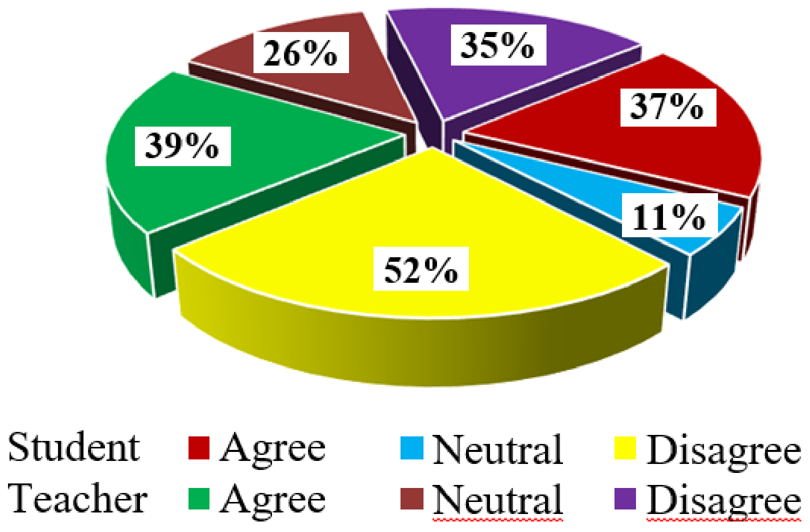
Table 4.3 *Students View on Introduction of IX Chemistry Concepts in VII and VIII Science (N: 296)*

Items	Mean	SD	Level of Rating
1. In class VII and VIII science, I learned basic concepts on organic chemistry.	2.04	1.24	Low
2. In class VII and VIII science, I learned basic concepts on stoichiometry.	1.97	1.12	Low
3. In class VII and VIII science, I learned basic concepts on types of chemical bonding.	2.71	1.47	Moderate
4. In class VII and VIII science, I learned basic concepts on mole concept.	2.13	1.18	Low
5. In class VII and VIII science I learned basic concepts on thermodynamics.	2.10	1.18	Low
6. In class VII and VIII science I learned basic concepts on periodic table.	4.48	1.00	High
7. In class VII and VIII science I learned basic concepts on green chemistry	2.67	1.39	Moderate
8. The chemistry syllabus of class VII and VIII science was found little less.	3.64	1.22	High
Overall Mean Score	2.72	1.23	Moderate

Yes, definitely it is important to include the basic concepts of these topics in VII and VIII science because there is a big jump from class VIII science to IX chemistry so if we introduce these topics in classes VII and VIII definitely it will be helpful for our students and lighter for teachers in teaching the concepts in IX chemistry (T_07).

In contrast, few teachers expressed different views. They explained that the concepts or contents embedded in current VII and VIII science are enough for our students to gain basic concepts required to learn IX chemistry because the syllabus is activity based and also teachers get sufficient time to complete the syllabus. Moreover, it will be little bulky for students

Figure 4. 4 *Participants Views on IX Chemistry Concepts in VII and VIII Science*



according to their age if more IX chemistry concepts are introduced in VII and VIII science. One of the teacher interviewees commented:

I think the content of VII and VIII science is enough for our students to gain the basic concepts to learn IX chemistry because it is activity-based and our students get hand on practices and we have ample time for completion of syllabus moreover, it will be little bulky for them at these ages if more concepts are introduced (T_04).

Turning now to quantitative data, the findings were concurrent with the findings from teachers' and students' interview. Most of teachers and students were with the view that the IX chemistry concepts in VII and VIII science were not significantly adequate to impart basic concepts required to learn IX chemistry.

The table 4.3 below gives the value of mean and standard deviation to portray the students view on introduction of IX chemistry concepts in VII and VIII science. The scores are adopted and interpreted using (Moidunny, 2009) as mentioned in Chapter 3 section 3.6.1. The results obtained were triangulated with the findings from interviews and document analysis.

The overall mean score on the introduction of IX chemistry concepts in VII and VIII science was 2.72 (SD, 1.23). This result indicates that, most of the students were with the view that the IX chemistry concepts introduced in current VII and VIII science is not sufficiently adequate to have enough basic foundation towards learning class IX chemistry. Moreover, it is evident from the table 4.3 that, most of the items received low mean score. This result confirms that majority of the students did not support on having enough IX chemistry concepts in VII and VIII science.

Similarly, the findings from teachers' survey corresponded with the result of students' survey on introduction of IX chemistry concepts in VII and VIII science. The overall mean score from teachers' survey was 2.95 (SD, 0.94).

The low value of mean score indicates that, most of the teachers were with the opinion that, the lower secondary science curriculum consists of inadequate class IX chemistry concepts. The minimum dispersion in teachers' views was indicated by low score of standard deviation (SD, 0.94).

It is also evident from the teachers' survey (item 5); I find many new concepts in class IX chemistry which they have never learned in class VII and VIII science with high mean score 3.56 (SD, 1.04). This result suggests the teachers view on inadequate IX chemistry concepts introduced in current VII and VIII science curriculum.

Further, teachers were also with the opinion that it is important to introduce more IX chemistry concepts in class VII and VIII science in order to build adequate foundation towards learning IX chemistry. This is evident from the teachers' survey (item 7); The basic concepts on thermodynamics, chemical bonding, mole concept, stoichiometry, organic chemistry and green chemistry must introduce in class VII and VIII science so as to have adequate foundation towards learning class IX chemistry, which received high mean score value 3.56 (SD, 1.29).

4.3.1. Participants View on IX Chemistry Concepts Introduced in Class VII and VIII Science

From the figure 4.4 above, only 37% of student and 39% of teacher participants were with views that there is adequate IX chemistry concepts introduced in current VII and VIII science. However, 52% of student and 35% of teacher participants were with the view that the introduction of IX chemistry concepts in classes VII and VIII science curriculum is inadequate. On the other hand, 11% of students and 26% teachers were neutral to this statement. This statistical summary presents that, a greater number of participants were with the view that the IX chemistry concepts were not adequately introduced in current VII and VIII science.

Similarly, the findings obtained from teachers and students survey and interviews were concurrent with the content analysis of current VII and VIII science textbooks and IX chemistry textbook. The analysis was focused on the introduction of IX chemistry concepts in VII and VIII science and on the coherency and alignment of the chemistry concepts from VII science to IX chemistry.

From the in-depth content analysis, it was found that most of the IX chemistry concepts were not introduced in VII and VIII science. For example, chapter 7 of IX chemistry is on organic chemistry however, the basic concepts on organic chemistry were neither introduced in VII nor in VIII science. Likewise, chapter 6 and 5 of IX chemistry is on green chemistry and on rate of chemical reaction respectively, many key concepts on green chemistry and rate of reactions were not introduced in VII and VIII science.

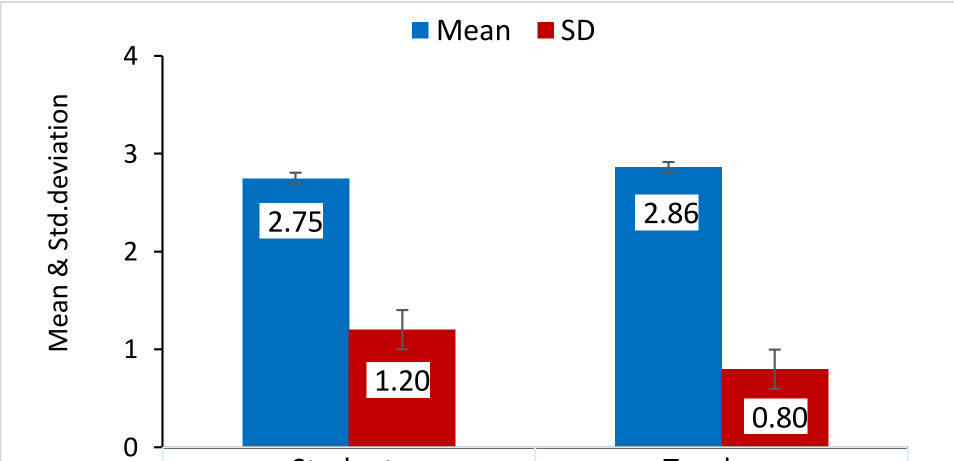
Similarly, many basic concepts required to learn chapter 4 of IX chemistry on chemical reactions and stoichiometry were not introduced in VII and VIII science. However, most of the key concepts on chapter 3 of IX chemistry that is on reactivity of metals were introduced both in VII and VIII science. Many key concepts required to learn chapter 2 and chapter 1 of IX chemistry that is on chemical bonding and periodic table respectively were also not introduced either in VII or VIII science.

Further, the analysis of science curriculum framework (PP-XII) also, shows the similar findings. Therefore, the findings obtained from the document analysis were concurrent with the findings from the survey and interviews.

4.4. Transition from Lower Secondary Science to Middle Secondary Chemistry

In the current study the transition from lower secondary science to middle secondary chemistry refers to coherency, alignment and progression of chemistry concepts from VII science to IX chemistry. The mean scores obtained from survey ratings were used to determine the teachers' and students' views on transition. The scores are adopted and interpreted using

Figure 4.5 *Overall Mean and Standard Deviation of Students and Teachers View on Transition*



	Students	Teachers
Mean	2.75	2.86
SD	1.20	0.80

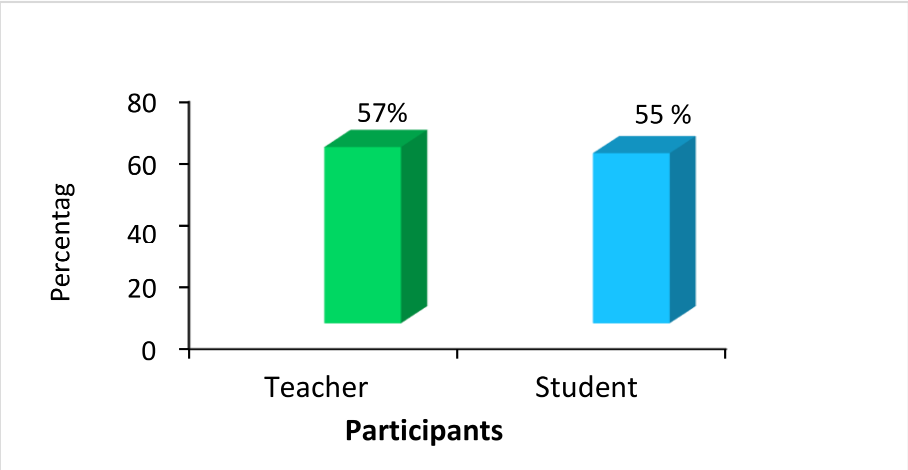
(Moidunny, 2009) as mentioned in Chapter 3 section 3.6.1. Further, survey findings were triangulated with the findings obtained from interviews and document analysis.

Focused group interviews with the students found that the 70% of student interviewees were with the view that there is only moderate level of transition in terms of chemistry concepts from VII science to IX chemistry. They believed that the degree of transition is not smooth. Students who were interviewed generally perceived difficult to cope up many new terms and terminologies introduced in IX chemistry and they believed that could be due to lack of smooth transition. This is evident from the comment below:

In regards to chemistry we are facing difficult to cope up with new terms and terminologies due to weak transition and many new concepts introduced in class IX chemistry (SFG_01).

Likewise, the student participants explained that, some of the teachers usually set more questions in exams from biology and physics parts compared to chemistry parts in VII and VIII science. Students were with the view that the chemistry parts in VII and VIII science were given less priority and importance compared to physics and biology. They shared that such trend would impede the degree of transition level.

Figure 4.6 *Teachers and Students View on Transition from VII Science to IX Chemistry*



They also mentioned that comparatively the chemistry parts of VII and VIII science lack connection of concepts with IX chemistry. The participants expressed that the physics and biology parts of VII and VIII science has good connection and coherency of concepts with class IX physics and biology. Therefore, they believed that conceptual transition is much more effective and smoother in case of biology and physics subjects than in chemistry. For instance, one of the focused group participants commented:

Only few topics have connection, but topics like mole concepts, organic chemistry and green chemistry are totally new concepts for us in class IX. So, in general there is more connections of concepts in regards to biology and physics but we feel that there is not much connection in regards to chemistry. (SFG_04)

Similarly, 70% of teacher views shared in interviews were consistent with the view shared by students. Generally, teachers were with the opinion that, most of the students lack the basic concepts and pre-existing knowledge required to learn IX chemistry. Teacher interviewees believed that the lack of smooth transition from lower secondary science to IX chemistry could be one of the factors.

They explained that although there is a moderate level of conceptual transition from VII science to IX chemistry however, lack smooth transition. Majority of the teacher participants were with the opinion that, the quality of conceptual transition can be enhanced by introducing more IX chemistry concepts in VII and VIII science. This statement was explained by a teacher as follows:

If we look into the classroom situation, when our students learn concepts on chemistry for the first time, we see that our students don't have the prior knowledge, so when we teach them, they feel that it is completely new, so i cannot say like there isn't any transition but my say will be like, there is not much smooth transition, but we can enhance this by introducing more IX chemistry concepts in classes VII and VIII science (T_02).

Teachers were also with the view that generally most of students perceived difficulty in coping up with IX chemistry concepts and they believed that this could be due to weak transition from lower secondary science to middle secondary chemistry. This point is substantiated by the following comment made by one of the teachers:

I think there isn't a smooth transition, because not many concepts of IX chemistry are introduced in classes VII and VIII science, so our students are not feeling that they are smoothly sailing in their learning process of IX chemistry. (T_01)

Some other teachers were with the opinion that the mean marks score at national level appears usually low in science compared to other subjects. They mentioned that this could be due lack of smooth transition and curriculum gap. Teachers shared the need of review for VII and VIII science specifically chemistry portions. This opinion was mentioned by one of the teachers as follows:

There is a big jump from class VIII science to IX chemistry, and this is the reason science mean marks at the national level is low every year comparing to other subjects, therefore, though the syllabus is ok, but in terms of the contents there should be some review for VII and VIII science especially chemistry part (T_07).

On the contrary, 30% of teacher participants were with the view that there is a good transition from VII and VIII science to IX chemistry. They explained that the present VII and VIII science curriculum serves well from the perspective of cognitivism and age level. For instance, one of the teacher interviewees commented:

Yes, there is transition in general so, according to the age and cognitive level of our students the present VII and VIII science curriculum is serving well (T_04).

The finding from quantitative data on transition from lower secondary science to IX chemistry was similar with findings from interviews. The figure 4.5 below presents the statistical summary of the overall mean and the standard deviation for students and teachers views on conceptual transition from VII science to IX chemistry.

The overall mean score of student and teacher participants view on the transition from lower secondary science to IX chemistry was 2.75 (SD, 1.20) and 2.86 (SD, 0.80) respectively. The low overall mean scores indicated that approximately over half of the participants were with the opinion that the level of transition in terms of the class VIII chemistry concepts, coherency and the alignments of contents is not significantly smooth from VII science to IX chemistry.

4.4.1. Participants View on Transition from VII Science to IX Chemistry

In the current study 296 students and 18 teachers were administered in the survey. The figure 4.6 below provides the percentage of teachers and students view on transition from lower secondary science to IX chemistry.

The results revealed that only 57% of teacher and 55% of student participants believed that there is a moderate level of transition from VII science to IX chemistry in terms of concepts and contents. However, 43% of teacher and 45% of student respondents in the survey are with the views that, there is a lack of smooth conceptual transition of students from VII science to IX chemistry.

Concurrently, the findings from documents analysis were similar with the findings of survey and interviews. The content analysis of classes VII and VIII science textbooks and IX chemistry textbook found the lack of coherence, progression and alignment of chemistry concepts from VII science to IX chemistry. For instance, the basic concepts required to learn periodicity, ionization enthalpy, electron affinity, electronegativity, properties of noble gases in chapter 1 of the IX chemistry are neither introduced in class VII science nor in class VIII science.

Likewise, the key concepts on electrovalent, coordinate and covalent bonding which are essential to learn chapter 2 in class IX chemistry is not introduced in both VII and VIII science. However, most of the key concepts required to learn the chapters 3 of IX chemistry on reactivity of metals are discussed in VII and VIII science.

Similarly, the key concepts on types of chemical reactions, law of conversion of mass, balancing of chemical reactions, physical and chemical change necessary to study the chapter 4 on chemical reaction, conversation of mass and stoichiometry of class IX chemistry are introduced in classes VII and VIII science. However, the basic concepts on stoichiometry, mole and mole concepts, different gas laws are not introduced either in class VII science or in class VIII science.

The basic concepts on collision theory and exothermic/endothermic reactions required to learn the rate of reaction and energy transfer in chapter 5 of class IX chemistry are incorporated in VII and VIII science however, the key concepts on the rate of chemical reactions, enthalpy, law of thermodynamics, entropy, factors affecting rate of chemical reactions significant to learn the same chapter in IX chemistry are not introduced in classes VII and VIII science.

Further, the basic concepts on carbon cycle, fossil fuel and acid rain are discussed in classes VII and VIII science. On the other hand, the key concepts on polymers, hazards of polymers, fertilizers, causes of global warming are not introduced in classes VII and VIII science. These key concepts are essential to study chapter 6 on green chemistry in class IX chemistry.

Finally, the basic concepts on saturated and unsaturated hydrocarbon, alkane, alkene, alkyne, naming of nomenclature, isomers and isomerism required to learn chapter 7 on organic chemistry in class IX chemistry are neither discussed in VII science nor in VIII science. Simultaneously, the review of science curriculum framework (PP-XII) also, exhibited the parallel findings. Therefore, these findings suggest that the coherency and transition of key chemistry concepts are not properly aligned from VII science to IX chemistry and thus, the findings from document analysis are concurrent with the findings from survey and interviews.

4.5. Learning of IX chemistry

In this study the learning of IX chemistry refers to the ease and challenges of students towards learning IX chemistry after completion of lower secondary science. The mean scores from survey ratings have been used to determine the teachers' and students' views on learning of IX chemistry. The scores are adopted and interpreted using (Moidunny, 2009) as mentioned in Chapter 3 section 3.6.1. Further, the survey results were triangulated with the interview findings.

About 80% of student interviewees expressed that they encountered challenges in learning IX chemistry. They were with the view that lack of basic chemistry concepts made difficulties in learning IX chemistry. Majority of the students believed that they have not received adequate basic IX chemistry foundation in lower secondary science. Interviewees explained that IX chemistry curriculum consisted of many new concepts which they have not learnt in classes VII and VIII science. They have also shared a view that they encountered less difficulty to cope up with the concepts discussed in lower secondary science. This is evident from the following comment:

When we reached class IX, we find that chemistry subject is a difficult subject because, in class VII and VIII science we did not studied the basic concepts of many topics that are introduced in class IX chemistry, but topics like periodic table, balancing chemical equation etc. is easier for us because the basic concepts on such topics we have already studied in class VII and VIII science (SFG_01).

Some of the students also revealed that they need to memorize the concepts, formulae, laws and other scientific terms because they don't understand the concepts of many topics introduced in class IX chemistry. Students believed that lack of fundamental chemistry concepts required in learning class IX chemistry encountered them with these challenges.

Many students were the view that if more IX chemistry concepts were introduced in lower secondary science learners may face fewer challenges to cope up with class IX chemistry curriculum. They believed that current VII and VIII science curriculum is not sufficient in building adequate foundation to learn IX chemistry. For instance, one of the student interviewees commented:

Table 4.4. *Mean Score of Response on Learning Difficulties of Chemistry by Students (N:296)*

	Items	Mean	SD	Level of Rating
1	In class IX chemistry, many new concepts are introduced which are not embedded in VII and VIII science.	4.06	1.24	High
2	I find many new terms and terminologies in IX chemistry which i have never learned in VII and VIII science.	3.94	1.29	High
3	I came across few new topics while learning class IX chemistry which i have not learned in class VII and VIII science.	2.01	1.09	Low

4	I came across many topics while learning IX chemistry, which i have not learned in class VII and VIII.	3.84	1.17	High
5	I find chemistry is the most difficult subject in class IX.	3.53	1.36	High
6	I find easy to learn class IX chemistry after learning class VII and VIII science.	2.93	1.33	Moderate
	Overall Mean Score	3.39	1.25	High

When we reached class IX, we find that chemistry subject is a difficult subject because, we not only have to understand the concepts but also, we have to memorized the topics and concepts because we lack basic concepts and thus have to memorized the laws, formulae and tables (SFG_03).

Face to face interviews with teachers also discovered consistent views with that of students. About 70% of those interviewed teachers felt that majority of the students experienced difficulties in learning IX chemistry. They believed that lack of adequate progression and transition of concepts from lower secondary science to IX chemistry could be one of the major factors. This view was explained by a teacher as follows:

Table 4.5. *Mean Score of Response on Learning Difficulties of Chemistry by Teachers (N:18)*

	Items	Mean	SD	Level of Rating
1	My students are not able to cope up with new concepts, terms and terminologies introduced in class IX chemistry.	3.89	0.90	High
2	Most of the topics present in IX chemistry are already introduced in VII and VIII science.	2.83	0.86	Moderate
3	I find students perceive class IX chemistry as an easy subject after studying VIII science.	2.39	0.98	Low

4	I came across many topics while teaching IX chemistry which they have not learned in VII and VIII science.	3.56	1.04	High
5	I find students perceive class IX chemistry as difficult subject after studying VIII science.	3.72	1.07	High
6	I came across few new topics while teaching IX chemistry which they have not learned in VII and VIII science.	2.17	0.99	Low
7	My students can easily cope up with concepts of class IX chemistry after completion of the class VIII science.	2.89	0.96	Moderate
	Overall Mean Score	3.06	0.97	Moderate

Most of them around 70-80 % students roughly face difficulties in learning chemistry this is mainly because of lack of smooth progression from classes VII and VIII to IX chemistry (T_01).

Teachers were also with the opinion that, students perceived chemistry as a difficult subject not only due to lack of smooth transition. They believed that current textbooks written by foreign authors consisted of numerous definition and examples which were not contextualized into Bhutanese context and therefore, many students' experience difficulties to understand the concepts clearly and also even for teachers as well. For example, one of the teacher participants pointed out:

Chemistry as a difficult subject is not only because of transition, there are also other factors like usually these books are written by Indian authors so the definition and examples that they have given is not very clear, at times it is very difficult for teachers to understand as well (T_07).

Some teachers were with the view that, students' negligence towards subject is another reason to consider chemistry as a difficult subject. They explained that usually some students when they reached class IX, they tend to give more interest towards biology and physics compared to chemistry.

They believed that students were with the notion that even if they do not perform well in chemistry subject, their aggregate marks get pulled up from biology and physics subjects. This point is supported by the following comment made by one of the teacher participants:

Some students are there, who think that even if I do not manage chemistry, I can do better in physics and biology, and that will help me to pull up my marks, so some leniency is there in our students' part (T_05).

On the other hand, 30% of teachers were with the views that, the current VII and VIII science curriculum provides enough competencies towards learning IX chemistry. They explained that current class VII and VIII science contain all three discipline of science (physics, chemistry and biology) organized chapter wise systematically. Therefore, some of the teacher participants believed that, the lower secondary science provides enough conceptual foundation towards learning IX chemistry.

They commented that students perceived chemistry as difficult subject because they dislike the subject. Teachers were with the view that if the students exhibit motivation and interest, they can easily cope up to learn IX chemistry. For instance, one of the teacher interviewees pointed out:

I think they can cope up because now they have divided science into three parts unlike before all mixed together so those students who have interest on chemistry can learn more though all students cannot cope up but students who have interest in chemistry can cope up to learn chemistry (T_03).

The findings from quantitative data on learning difficulties of IX chemistry were similar with the findings from interviews. The table 4.4 and 4.5 below provides teachers and students' average mean and standard deviation of each item on learning difficulties of IX chemistry. Based on Moidunny (2009) score interpretation, the students perceived learning difficulties in IX chemistry.

Based on Moidunny (2009) score interpretation, students rated high level of learning difficulties with overall mean score 3.39 (S.D, 1.25) as shown in the table 4.4 above.

Further, (item 5) *I find chemistry is the most difficult subject in class IX* was rated high by student respondents with the mean score of 3.53 (S.D, 1.36). This result indicates that majority of the students were of the opinion that they face a learning difficulty in class IX chemistry. Furthermore, 80% of student interviewees shared that they face learning difficulties in class IX chemistry. Likewise, from the content analysis of current VII and VIII science textbooks and IX chemistry textbook, it was found that the majority of basic concepts required in learning IX chemistry are not introduced and familiarized in classes VII and VIII science. Therefore, all these data indicate that the students face learning difficulties in class IX chemistry.

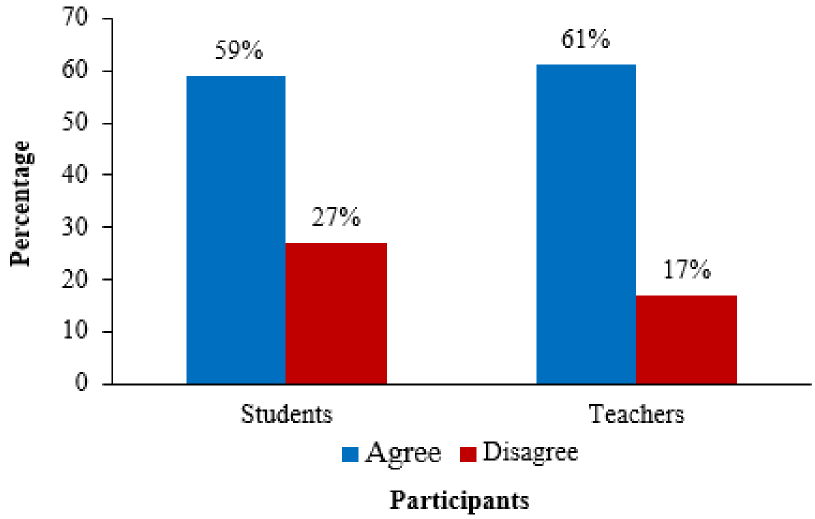
The overall mean score on learning difficulty of IX chemistry was 3.06 (S.D, 0.97). Based on Moidunny (2009) score interpretation, the teacher participants have rated the moderate level of students learning difficulty in IX chemistry.

However, (item 1) My students are not able to cope up with new concepts, terms and terminologies introduced in class IX chemistry was rated high by teacher respondents with the mean score of 3.89 (S.D, 0.90). Similarly, (item 5) I find students perceive class IX chemistry as difficult subject after studying VIII science was rated high with the mean score of 3.72 (S.D, 1.07).

This result indicates that most of the teachers were of the opinion that the students face learning difficulty in IX chemistry. Similarly, 70% of teacher interviewees shared that students face learning difficulty in class IX chemistry.

4.5.1. Participants Outlook with Regards to Learning of IX Chemistry

Figure 4.7 *Frequency of Responses in Percentage for IX Chemistry as Difficult Subject*



To find out the number of participants who responded agree and disagree on (item 5) statement of both teachers and students' survey, that is on *class IX chemistry as difficult subject,* the frequency of participants responses was calculated in terms of percentage as shown in the figure 4.7 above.

From the figure above, 175 (59%) of students agreed that they perceived IX chemistry as difficult subject whereas only 79 (27%) of the student participants disagreed on the statement IX chemistry as difficult subject from a total of 296 student participants.

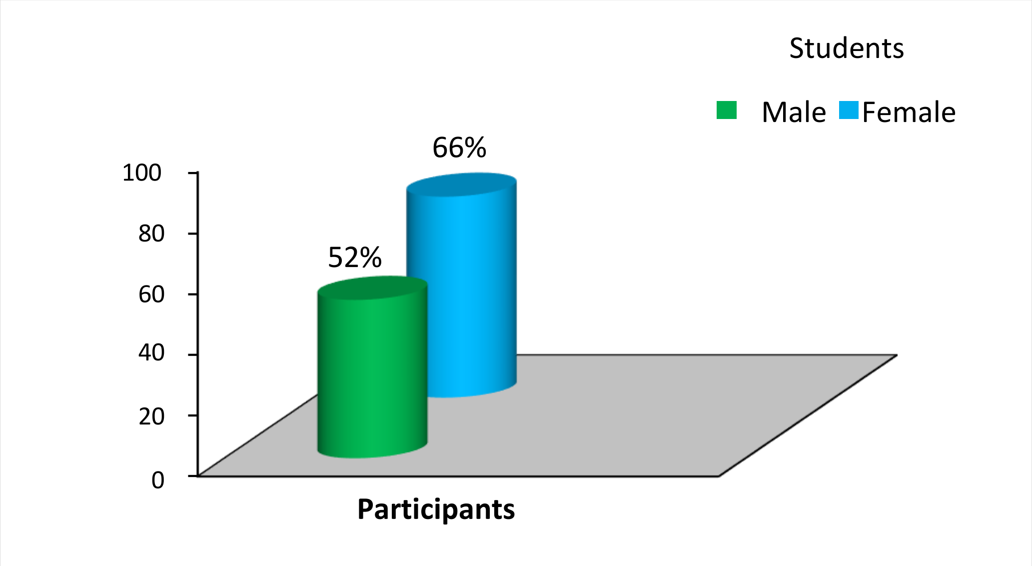
Likewise, of total 18, 11 (61%) of teachers agreed that students perceived IX chemistry as difficult subject and only 3 (17%) disagreed. However, 42 (14%) of students and 4 (22%) of teacher participants were neutral to the statement.

This result suggests that, majority of the participants were of the opinion that, students perceived IX chemistry as difficult subject.

4.5.2. Learning Difficulty of IX Chemistry in Terms of Gender

In the current study, of total 296 students who participated in the survey, 147 were the male and 149 were the female students. The students learning difficulty of IX chemistry is presented and compared between in terms of gender as shown in the figure 4.8 below.

Figure 4. 8 *Learning Difficulties of IX Chemistry in Terms of Gender*



As presented in the figure 4.8 above, the result from cross tabulation revealed that 52% of male students and 66% of female students perceived IX chemistry as a difficult subject after the completion of lower secondary science.

Further, this result also, provides an important insight that, in general female students perceived more learning difficulty in IX chemistry than male students. Similarly, this result is parallel with the findings from students' interviews where comparatively more female interviewees have mentioned on having learning difficulties in IX chemistry than male interviewees.

4.5.3. Correlation Between Transition and Learning of IX chemistry

Similarly, in order to determine the relation between the level of transition and learning difficulties of students in IX chemistry, a simple Pearson correlation was computed and tested at (.05) significance level.

The table 4.6 presents correlation between transition and learning difficulties of IX chemistry. The conceptual transition from lower secondary science to IX chemistry have a significant negative correlation with learning difficulties of class IX chemistry ($r = -.324$, $P = 0.001$). In other words, smooth level of transition in terms of concepts and content from lower secondary

Table 4.6 *Correlation Between Transition and Learning Difficulty of IX Chemistry*

		Learning difficulty of IX chemistry
Transition from lower secondary sci to IX chemistry	Pearson Correlation	$-.324^{**}$
	Sig. (2-tailed)	0.001
	N	296

**. Correlation is significant at the 0.01 level (2-tailed).

science to IX chemistry will reduce the challenges towards coping up with the concepts and content introduced in IX chemistry however, a weak level of transition elevates challenges towards learning IX chemistry.

4.6. Teaching of Classes VII and VIII Science

The teaching of classes VII and VIII science in this study refers to the challenges and competency of science teachers teaching VII and VIII science. The mean scores from survey ratings have been used to determine the participants views on challenges and competency of science teachers teaching VII and VIII science. The scores are adopted and interpreted using (Moidunny, 2009) as mentioned in Chapter 3 section 3.6.1. The survey results were triangulated with the interview findings.

About 90% of student interviewees shared that their teachers were more confident in teaching biology part than chemistry and physics parts in classes VII and VIII science. Students were with the view that the biology portions of VII and VIII science have good concepts links therefore, they understand the concepts taught easily. The students were of the opinion that their teachers taught biology portions explicitly with greater details and extra conceptual information in classes VII and VIII science.

Other interviewees were with the view that it depends on the subject background of the teachers. They explained that a single teacher cannot teach all three discipline of science effectively, a teacher with biology background would teach biology portion more effectively than physics and chemistry portions. They also mentioned that, their teachers were more competent in teaching biology portion because it is an easy subject without much complex concepts like physics and chemistry. The students' views on teaching competency of teachers in VII and VIII science are reflected in the following comments:

Our teacher has taught us biology part very well, because we feel like biology part of class VII and VIII has good link of topics also our teacher has given us extra information on subject (SFG_01).

Our teacher has taught us biology part very well, because our teacher got biology background (SFG_03).

The face-to-face interview with the teacher interviewees also, found concurrent views with that of students. About 60% of those interviewed teachers mentioned that it will be difficult for a single teacher to teach all three discipline of science effectively. They explicitly explained about their subject specialization and the professional training that they have acquired. Many teachers were with the opinion that the subject background directly associates with the effectiveness of teaching lower secondary science. This is evident from the following comment made by one of the teacher interviewees:

I am more comfortable in teaching biology and chemistry portions since my background is biology and chemistry and whenever, I face difficulties in physics part, I used to get help from physics teachers (T_04).

Some teachers were also with the view that dilution of content can occurred when a single teacher teaches all three discipline of science in VII and VIII. They explained that a teacher with physics background would focus more on physics part and same with chemistry and biology therefore, it hampers in the quality of lesson delivery.

Teachers shared that this type of issue prevails mostly in middle and higher secondary schools where classes are from VII to XII. This issue was explained by a teacher as follows:

Table 4.7 *Students Rating on Competency of Teachers in Teaching VII and VIII Science*

(N:296)

	Items	Mean	SD	Level of Rating
1	I understood all the concepts of class VII and VIII science taught by my teacher.	3.34	1.07	Moderate
2	My science teacher taught chemistry part very well.	3.69	0.94	High
3	My science teacher taught physics part very well.	3.78	0.96	High
4	My science teacher taught biology part very well.	3.94	0.99	High
5	I found, my science teachers in VII and VIII have rich content knowledge in chemistry.	3.44	1.05	Moderate
6	I found, my science teachers in VII and VIII have rich content knowledge in physics.	3.62	1.00	High
7	I found, my science teachers in VII and VIII have rich content knowledge in biology.	3.80	1.01	High
8	Very often my science teacher created link between concepts of two subjects.	2.64	1.07	Moderate
9	Teachers often created link among the concepts of physics, chemistry and biology.	2.40	1.12	Low
	Overall mean score	3.41	1.03	High

This is a concern and issues that we are facing in every schools, what happens is that if he/she is a physics teacher they focus more on physics parts and same with biology teachers focusing more on biology parts if a teacher has chemistry background, they will focus more on chemistry part. So, the level of understanding and the delivery of the content is compromised and at the same time there is a dilution of contents. (T_07)

On the other hand, 40% of teacher participants were with the view that since VII and VIII science was just a basic level of science; teachers may not face much difficulties in delivery of classes VII and VIII science lessons. They shared that, every teacher got a basic level of all three disciplines of science till class X or class XII during their schooling period therefore; it would be enough for any teacher to teach the basic level of science in VII and VIII. While others shared that they do not experienced any sort of difficulties because they have basic subject knowledge of all the three disciplines of science. This is evident from the following comments:

I think as per my opinion teaching science subjects in class VII and VIII by a single teacher will not face any problems, because it's all about basic level and we all learnt science till class X and XII (T_01).

Personally, for me I have no any challenges while teaching class VII and VIII science, because my background is chemistry and physics and biology I have studied till class XII (T_03).

Now proceeding to quantitative data, in order to determine students rating on teachers' competency in teaching of classes VII and VIII science, mean and standard deviation were computed as shown in table.4.7 below.

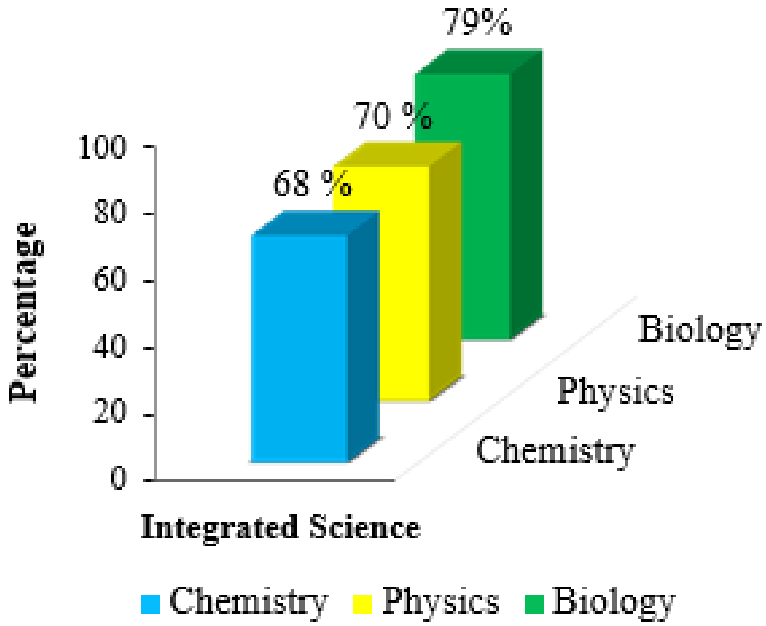
The overall mean score was 3.41 (SD, 1.03). Therefore, based on Moidunny (2009) interpretation score, the students have rated high on teachers' competency in teaching classes VII and VIII science.

However, among the three parts of science, *competency in teaching chemistry* (item 2) received the lowest mean score of 3.69, physics with 3.78 and biology with 3.94. This result indicates that the students were of the opinion that, science teachers were more competent in teaching biology portions than chemistry and physics portions in VII and VIII science. This result also corresponded with the views shared by 90% of student interviewees in focused group interview.

4.6.1. Science Teachers Proficiency in Teaching of Lower Secondary Science

The rating of student participants with regards to teachers confident and proficiency in teaching of lower secondary science were examined in terms of percentage as shown in figure 4.9.

Figure 4.9 *Proficiency and Confidence of Teachers in Teaching Lower Secondary Science*



From a total of 296 student participated in the survey, 236 (79%) of students rated that teachers were more confident and proficient in teaching the biology chapters of classes VII and VIII science. Similarly, 208 (70%) of students have rated in teaching the physics parts of classes VII and VIII science.

However, only 203 (68%) of student participants have rated that their teachers were more confident and proficient in teaching chemistry parts of lower secondary science. This result suggest that teachers felt more comfortable to teach biology portions of VII and VIII science compared to physics and chemistry portions.

Further, this result was concurrent with the findings from students' interview where the 90% of interviewees expressed that their science teachers were more proficient with high self- confidence in teaching biology portions in lower secondary science.

4.7. Summary of the chapter

This chapter presented detailed findings from quantitative and qualitative data. The results from survey, interviews and document analysis were triangulated in order to have greater credibility and solidification of findings. The section 4.3 of this chapter presents detailed findings on introduction of IX chemistry concepts in current VII and

VIII science. The findings reveal that both students and teachers were with the views that VII and VIII science contained inadequate IX chemistry concepts.

Section 4.4 provides participants view on level of transition in terms of concepts from lower secondary science to IX chemistry. The participants were with the opinion that although conceptual transition prevails from VII science to IX chemistry however, there isn't a smooth conceptual transition from class VII science to class IX chemistry. Further, the results are triangulated with the findings from analysis of documents. The results are illustrated clearly with the help of figures and graphs where ever required and necessary.

Likewise, section 4.5 of this chapter presents students and teachers views on learning difficulty of IX chemistry. The findings were illustrated with tables, graphs and figures in different sub-sections for better interpretation of results. The learning difficulty of IX chemistry in terms of gender, correlation between transition and learning difficulty of IX chemistry were interpreted in subsequent sub-sections. The findings present that the students and teachers were with the views that the students perceived IX chemistry as difficult subject.

The final section 4.6 of this chapter presents the findings based on teacher and student participants' views on the competency of science teachers in teaching lower secondary science and the challenges faced by science teachers in teaching science. The findings revealed that teachers were more confident and competent in teaching biology portions of VII and VIII science and also, the teachers face challenges in the delivery of lessons for the topics that do not fall under their subject of specialism.

5. DISCUSSION

5.1. Introduction

In this chapter, the main findings are discussed and interpreted in relation to the six subsidiary research questions. The introduction of IX chemistry concepts in VII and VIII science is discussed in section 5.2. Likewise, conceptual transition from lower secondary science to IX chemistry under section 5.3. The students learning difficulty in IX chemistry in section 5.4 and challenges in teaching lower secondary science in section 5.5 of this chapter. The current study employed mixed method design which is advantageous in terms of data sources and data analyses due to multiple data collection methods and the interpretations that results in multiple perspectives on the topic under study and thus, enhances the credibility of its findings. Further, from the pragmatist perspective, cross validation of findings through triangulation of database provides greater validity to best answer the research questions.

5.2. Introduction of IX Chemistry Concepts in VII and VIII Science

The first and second research questions of this study gave an insight of teachers and the students' views on introduction of IX chemistry concepts in lower secondary science curriculum.

Research sub-question. 1

What are the teachers' views on introduction of IX chemistry concepts in VII and VIII science?

Research sub-question. 2

What are the students' views on introduction of IX chemistry concepts in VII and VIII science?

With respect to the first and second research question, the results from the descriptive statistics revealed that IX chemistry concepts are not adequately introduced in lower secondary science.

The findings from qualitative data were also consistent with the results of quantitative data. Most of the interview comments made by both teachers and students supported the low overall means score shown by statistical analyses. The findings of the study revealed that, teachers and students' interviewees admitted that the chemistry concepts required to learn IX chemistry is not adequately introduced in current lower secondary science. Both teachers and the students' participants believed that, it is significant to introduce IX chemistry concepts in lower secondary science. For instance, 'I feel that chemistry foundation is given, however the IX chemistry concepts embedded in VII and VIII science is very less' (T_06, teacher 6, face to face interview).

Likewise, from SFG_02, student 4, focused group interview shared 'we find many new concepts in class IX chemistry which we have not learned in VII and VIII science like, stoichiometry, thermodynamics, chemical-bonding, green chemistry, mole concepts and organic chemistry. Therefore, it is important to introduce the key concepts of these topics in the lower secondary science to maintain and have better conceptual alignment and coherency from VII science to IX chemistry. Further, the teachers were also, with the view that, only 50% of IX chemistry concepts and the contents are introduced and familiarized in current classes VII and VIII science.

Further, the content analysis of IX chemistry textbook, VII-VIII science textbooks also revealed the haphazard sequencing of concepts and contents from VII science to class IX chemistry. Majority of the basic concepts required to learn class IX chemistry were not adequately introduced in lower secondary science. Therefore, most of the students find it difficult in comprehending the scientific concepts and principles in class IX chemistry since; several topics introduced in class IX chemistry are conceptually new for students. This finding is consistent with the Review Report on Quality of Education (2016) where the report, clearly mentioned under the section of curriculum progression and textbook sequencing in science, that the students face challenges in understanding certain scientific concepts and principles when they reach classes IX and above due to steep gradient and haphazard sequencing of concepts and contents.

Therefore, findings of this study do not completely support on the design of current science curriculum to be completely spiral in nature because the findings from the study showed that the majority of the IX chemistry concepts are not been introduced in classes VII and VIII science.

However, the possible explanation for this finding could be because the learning of science in Bhutanese curriculum is organized into five key stages identified according to Piaget's cognitive theory (DCRD, 2012). In key stage 1(PP-III) the learning of science is embedded in environmental science which is taught in Dzongkha.

In key stage 2 (IV-VI) integrated science is offer as science subject. In key stages 3 (VII-VIII) three discipline of science are compiled in a single textbook and in key stage 4 (IX-XII) the students are offer with the bifurcated science. Therefore, the coherency and alignment of key concepts are not adequately maintained between VII-VIII science and IX chemistry, may be because they belong to different key stages.

The findings from this study also, differ from the previous report by Gyelmo (2013) who reported that the revised science curricula are said to be a spiral curriculum in which the topics learned in lower classes are connected to higher classes with concepts from simple to complex, deepening the concepts based on previous study.

On the contrary, the finding from this study is similar to an evaluative study conducted by Brighton (2019) in the University of Witwatersrand South Africa, where he also found that the chemistry curriculum was not align to the features of spiral curriculum since most of the concepts required to learn XII chemistry are not introduced in class X and class XI chemistry.

However, the finding of this study is not analogous with the study findings by Wangdi and Dema (2020). Their study found that, the physics curriculum from VII science to IX physics are maintained in logical and progressive sequencing of physics concepts and content in a spiral design. However, the current study found that, the chemistry concepts and the contents from VII science to IX chemistry are not adequately maintained in a progressive and spiral nature because most of the concepts and contents presented in IX chemistry are not introduced and familiarized in VII and VIII science. The probable reason for this contrast in findings could be due to the different subject focused under study. They conducted a study in physics curriculum whereas; the current study focuses in chemistry curriculum. The contradictory in findings also, indicates that, the majority of the concepts required to learn IX physics are introduced and familiarized in classes VII and VIII science. Therefore, the efficacy and conceptual transition of students from class VII to IX is better in physics than in chemistry.

5.3. Transition from Lower Secondary Science to IX Chemistry

The third and fourth questions in this study sought to determine teachers and students' views on transition from lower secondary science (VII and VIII) to IX chemistry.

Research sub-question. 3

What are the teachers' views on transition from lower secondary science to IX chemistry?

Research sub-question. 4

What are the students' views on transition from lower secondary science to IX chemistry?

In reference to third and fourth sub-questions, the descriptive analyses revealed that there is only moderate level of chemistry conceptual transition from VII science to IX chemistry. The findings from qualitative data were parallel with the findings from the descriptive analyses. About 70% of teacher and student interviewees admitted that, there is only a moderate level of conceptual transition from class VII science to IX chemistry. They believed that there is a lack of smooth conceptual transition from the lower secondary science to IX chemistry and consequently, students face challenges in coping up with new concepts introduced in IX chemistry.

For instance, SFG_01, students from focused group 1, during interview unanimously shared ‘we are facing difficult to cope up with new terms and terminologies due to weak transition and many new concepts introduced in class IX chemistry’. Similarly, ‘I think there isn’t a smooth transition, because not many concepts of IX chemistry are introduced in classes VII and VIII science, so our students are not feeling that they are smoothly sailing in their learning process of IX chemistry’ (T_01, teacher 1, face to face interview).

Therefore, qualitative findings revealed that the level of conceptual transition from lower secondary science to IX chemistry is not significantly smooth although, there is a moderate level of transition in terms of chemistry concepts from class VII science to class IX chemistry. Further, the content analysis of classes VII and VIII science and class IX chemistry found that the hierarchy and progression of chemistry content and concepts from classes VII science to class IX chemistry is not smoothly maintained. Most of the key concepts required to learn IX chemistry are not familiarized in classes VII and VIII science. Therefore, this study found that although there is a transition however, the level of transition is not very smooth in terms of chemistry concepts and content from VII science to IX chemistry.

Thus, the findings of the current study partly contradict with the intension of science curriculum framework (PP-XII). As per the framework one of the main intentions of science curriculum is to bring coordination, consistency and coherence to the science curriculum. However, the study found the lack of smooth progression and coherency of many concepts and content from classes VII and VIII science to class IX chemistry. Nonetheless, this could be possibly because VII and VIII science and the IX chemistry belong to different key stages as discussed in section 5.2 of this chapter.

The study also revealed that in classes VII and VIII science, teachers generally set more questions from biology and physics parts in the exams. Therefore, such practices may compromise the overall quality of transition from VII science to IX chemistry. However, the possible reason for this could be because the science teachers may be more competent and comfortable with biology and physics portions of VII and VIII science because these subjects may be their subject of specialization. This probably explains why teachers set more questions from biology and physics parts in the exam. In addition, students generally perceived that physics and biology portion have greater connection and coherency in terms of concepts and contents from VII science to their respective discipline of IX science. The possible reason on this could be because the students are more familiarized with the basic concepts and contents of IX physics and IX biology in classes VII and VIII science compared to chemistry. This finding closely corresponded with a study conducted by Wangdi and Dema (2020) who also, reported that majority of the concepts required to learn IX physics are embedded in current classes VII and VIII science. Therefore, there is a logical sequencing and progression of physics concepts from class VII science to class IX physics and hence, the smooth transition of students conceptually.

The study also revealed that, most of the students face challenges in coping with the scientific terms and terminologists related to chemistry after completing class VIII science. The probable reason for this could be due to the lack of smooth conceptual transition from lower secondary science to IX chemistry. This finding is comparable to the results of previous studies (Ornstein & Hunkins, 2018; Stevens et al., 2010; Zangmo, 2016) who reported that the competency of students towards learning science increases if the sequences of concepts and contents in different level of classes are maintained in logical and progressive nature.

Further, the finding of current study fits well with the study conducted by King'aru, (2014) and by Osman and Sukor (2013) who also, admitted that in order to maintain smooth conceptual transition, familiarization of basic concepts at lower classes is significant to understand more complex concepts at higher classes.

Therefore, it is indispensable to introduce and familiarize with the required chemistry concepts in current VII and VIII science to maintain the smooth conceptual transition from VII science to IX chemistry.

5.4. Learning of Class IX Chemistry

The fifth research sub-question of this study intended to answer pertaining to students learning difficulties of class IX chemistry after completion of lower secondary science (classes VII and VIII).

Research sub-question. 5

What are the students' difficulties in learning class IX chemistry?

With respect to sub-question 5, the current study found that in general students face challenges in learning IX chemistry after completing the lower secondary science. The study revealed that, most of the students lack basic concepts required to learn class IX chemistry. Thus, majority of the students face challenges in learning new concepts and contents introduced in IX chemistry.

In addition, the content analysis of classes VII and VIII science and class IX chemistry textbooks also, shown that the basic concepts on organic chemistry, mole concepts, thermodynamics, chemical bonding and stoichiometry are directly introduced only in IX chemistry. Therefore, the students are not familiarized with such concepts in lower secondary science. Hence, the students face challenges in learning IX chemistry due to lack of several basic concepts that are required to learn IX chemistry.

The study also revealed that when the students get graduated from lower secondary science and enters into middle secondary chemistry most of the students' steps with insufficient fundamental chemistry concepts required to learn IX chemistry however, students encounter less difficulty in coping up with those concepts which are already introduced and familiarized in classes VII and VIII science.

For instance, SFG_01, students focused group 1, during interview unanimously shared that 'when we reached class IX, we find that chemistry subject is a difficult subject because, in class VII and VIII science we did not studied the basic concepts of many topics that are introduced in IX chemistry, but topics like periodic table, balancing chemical equation etc are easier for us because the basic concepts on such topics we have already studied in classes VII and VIII science'.

This finding is consistent with the report by Uzezi et al., (2017) in Nigeria, where they also found that when majority of concepts (63.2%) introduced in secondary school chemistry curriculum was new to students, they perceived difficult to cope up with the new concepts and contents. Thus, the students face challenges in learning of chemistry.

Gafoor and Shilna (2015) reported that when students do not understand the concepts, they merely memorize the concepts without profoundly understanding and thus, they perceived chemistry as a difficult subject. Similarly, the findings from qualitative data of this study also revealed that, the students perceive chemistry as a difficult subject because in lower secondary science they do not get sufficient conceptual foundation required to learn class IX chemistry. Hence, in IX chemistry, students often need to memorize the concept, formulae, laws, scientific terms and the terminologies without actually understanding the concepts profoundly and distinctly.

This is also consistent with Bruner's theory of spiral learning (as discussed in section

2.1 under chapter 2) that the progressive and logical sequencing of concepts enhances understanding of more complex concepts easily in the next higher classes and lack of basic concepts makes students difficult to understand the concepts.

Further, the qualitative data revealed that, since the current chemistry textbooks are written by foreign authors therefore, the content consisted of numerous definition and examples which are not contextualized into Bhutanese context. Hence, many students face difficulties in understanding the concepts clearly. This is in agreement with the study conducted by Ültay and Çalık (2012) in Turkey where they also found that the contextualized chemistry curriculum help students to understand the concepts more easily and also, promotes students' motivation towards learning chemistry.

Likewise, the finding of this study also showed that, generally most of the students show less interest in chemistry compared to biology and physics when they reached class IX and because of the lack of interest in the subject, students usually perceived chemistry as difficult subject. This finding is similar to the study finding at University of Jos Nigeria, by Gongden et al., (2011) where they also reported that the students' lack of interest in the subject is one of the major factors why students perceived chemistry as difficult subject.

Further, many of the students perceived chemistry as a difficult subject because they often experience challenges in the solving numerical problems in chemistry. There are many topics and concepts in chemistry where students need a lot of mathematical skills to solve the problems. The study conducted in Qatar by Moyo, (2018) reported similar findings that, students' difficulty in the solving numerical problems in chemistry also, makes them to perceived chemistry as a difficult subject due to lack of mathematical skills required to solve various numerical questions associated with different chemistry topics and concepts. The probable reason of having difficulty in the solving numerical questions by students could be because, they were not familiarized with the required formulas, principles and the laws in the lower classes which otherwise, enhances their mathematical skills towards solving numerical problems in higher classes.

The other reason why students generally perceived chemistry as difficult subject is due to attitude of the students towards subject. The study concluded that, when the students reached class IX usually most of the students believe that, even if they do not perform well in chemistry their aggregate marks can get pulled up by the biology and physics subjects. In a way many students show the negligence and develop a negative attitude towards chemistry. Teachers believed that such attitude and perception of the students often makes them to perceived chemistry as a difficult subject. This finding is firmly in agreement with the study conducted in Kenya by Kyalo (2016) who also, reported that when the students developed a negative attitude towards chemistry generally, they perceived chemistry as a difficult subject.

Comparison of students learning difficulty based on gender showed some differences. The study found that generally female students perceived more challenges in learning IX chemistry than male counterparts because generally female students find chemistry as difficult and boring subject compared to biology therefore, male students are better performers than female students in chemistry.

This finding is analogous to the study conducted in Eastern University of Finland by Kang et al., (2019) where they also found that, the male students' perceived learning of chemistry as fun, interesting and easier than female counterparts. On the other hand, female students generally perceived biology as more interesting and easier to learn than chemistry.

On the contrary, this finding is in contrast to the study finding in Nigerian Universities where they reported that the female students outperformed their male counterparts in the chemistry open ended problem-solving test (Upahi & Ramnarain, 2020). The contrast in the finding could be because at university level the female students may have higher interest and positive attitude towards subject than their male counterparts. The most striking result emerged from this study is that; there is a significant negative correlation between conceptual transition and the learning difficulty of IX chemistry. The transition in this study refers to the flow and hierarchy of concepts and contents in the progressive and logical manner from lower secondary science to IX chemistry. The quality of conceptual transition from class VII science to class IX chemistry will determines the intensity of students' learning difficulties in IX chemistry.

The smooth transition generally helps students to understand the concepts more easily in higher classes. On the contrary, the lack of smooth transition can cause challenges to understand the concepts in higher classes. This finding is in agreement with the study conducted in University of Dundee, Scotland by Jindal-Snape et al., (2019) who reported that the discontinuity of concepts and progression across different level of classes can hinders the smooth conceptual transition of the students and that causes the challenges in comprehending and grasping the concepts easily. This is also in lined with the theory of spiral learning as (discussed under section 2.1 of chapter 2) that the lack of smooth conceptual transition across different level of classes will hinders the learning proficiency of students. Thus, findings from this study confirms that the lack of smooth transition conceptually from lower secondary science to IX chemistry is one of the major factors that causes learning difficulty of students in IX chemistry.

5.5. Teaching of Lower Secondary Science (Classes VII and VIII)

The sixth research question of this study intended to find out the challenges faced by the science teachers in teaching classes VII and VIII science.

Research question. 6

What are the difficulties faced by the science teachers in teaching classes VII and VIII science?

The current science of classes VII and VIII consisted of numerous chapters from all three disciplines of science. In regard to sixth research sub-question, the findings from descriptive statistics revealed that the lack of science teachers' competency in teaching all three disciplines of science (physics, chemistry, biology) because of their different subject specialism is one of the main factors that cause challenges in teaching lower secondary science. Therefore, a single teacher teaching classes VII and VIII science will be unable to give an equal justice to all the topics and concepts of the integrated science due to their different subject specialism.

The findings from qualitative data also, revealed that the science teachers are generally more confident and competent in teaching biology parts of VII and VIII science. About 90% of the student interviewees strongly supported that their teachers were more proficient and confident in teaching biology parts in lower secondary science. The possible explanation on this finding could be because their subject of specialism may be biology therefore, teachers were more confident in teaching biology chapters in classes VII and VIII science. This is in agreement with Parker et al., (2018) where they also reported that subject knowledge or content knowledge is one of the main factors that enhance teachers' self-confidence towards teaching the integrated science.

From the study it is clear that, those teachers whose subject background are biology they feel more comfortable and confident in teaching biology parts of lower secondary science and similarly, teachers whose subject background are chemistry and physics they are more competent to teach chemistry parts and physics parts of lower secondary science respectively. Therefore, teaching of classes VII and VIII science by a single teacher will face several challenges like giving limited or less elaborated explanation to the concepts that are outside their specialism, often teachers face challenges to tackle students' questions and at times misinterpreting concepts that causes the dilution of contents and also sometimes creates misconceptions. This finding closely concurs with the study in University of Malta by Mizzi (2019) where she also found that the teachers encountered greater difficulties and challenges when teaching outside specialism than when teaching within their subject specialism.

This study also shows that, often teachers in the schools use strategies like conducting research through internet to improve their content knowledge and seeks help from their more experienced colleagues who are expertise on particular discipline of science, in order to overcome their challenges in teaching outside their subject of specialism.

For instance, T_04, teacher 4, face to face interview shared 'I am more comfortable in teaching biology and chemistry part since my background is biology and chemistry, however, when I face difficulties in teaching physics part, I used to get help from other physics teachers'. This clearly indicates that teachers often considered that asking help from subject specialist is quicker and more effective way of getting information. At schools, teachers frequently seek help on content knowledge and on strategies to teach particular concepts to the students so that the students gain maximum concepts. In this way usually non specialist teachers gain both pedagogical and content knowledge from subject specialist colleagues.

These finding ties well with the previous studies (Mizzi, 2019; Hobbs & Törner, 2019; Ríordáin et al., 2019; Şen et al., 2018) where they also reported that in schools usually the non-specialist and less experienced teachers often seek support from specialist and experienced teachers regarding the content, concepts and pedagogical knowledge. Therefore, the findings from this study confirms that the teachers lack of competency and proficiency in teaching all three discipline of science (physics, chemistry, biology) due to their different subject specialism is one of the major factors contributing the challenges in teaching lower secondary science. However, science teachers usually overcome such challenges by seeking help from other colleagues who are subject specialist or at times doing self-exploration on content, concepts and pedagogical knowledge and skills from other alternative sources like internet and multimedia in the schools.

5.6. Summary of the chapter

This chapter presented the detailed discussion on major findings from the study. The discussion in this chapter is thoroughly presented with respect to the six research sub-questions, authenticating the discussion by triangulating the quantitative results with the qualitative data and also by comparing and integrating with several relevant previous studies to solidify the discussion. Finally, the discussion from this chapter resulted some significant conclusions and accordingly recommendations are suggested in the next chapter of this dissertation.

6. CONCLUSION AND RECOMMENDATION

6.1. Introduction

The final chapter of this thesis presents the summary of the results in section 6.2, the significance of the study in section 6.3, followed by limitations of the study in section 6.4. The recommendation of the study is presented in section 6.5 and finally the chapter ends with the list of areas for further future research under section 6.6.

6.2. Summary of the Results

The findings from the study concluded that, about 50% of the concepts required to learn IX chemistry were not introduced in lower secondary science. Thus, majority of the students perceived that numerous concepts presented in IX chemistry are totally new for them as they were not familiarized with such concepts in VII and VIII science. Therefore, the current lower secondary science curriculum particularly the chemistry contents of VII and VIII science do not adequately builds the conceptual foundation, required towards enhancing the learning of IX chemistry.

The transition in terms of chemistry concepts from VII science to IX chemistry is not maintained smoothly because the sequencing and the coherency of chemistry concepts and contents are not appropriately aligned from VII science to IX chemistry as a result, students lack most of the concepts required to learn IX chemistry. The study revealed that about 59% of the students under study face challenges in learning of IX chemistry. Comparatively, the female students' experiences more challenges in the learning of IX chemistry than their male counterparts.

There is also, a significant correlation between the quality of conceptual transition of students from the lower secondary science and learning difficulty in IX chemistry. The smooth conceptual transition enhances the students comprehending of IX chemistry concepts more easily. On the contrary, lack of smooth conceptual transition from VII science to IX chemistry generates challenges in understanding IX chemistry concepts.

Therefore, the lack of smooth transition conceptually from lower secondary science to IX chemistry is one of the factors that cause the learning difficulty of students in IX chemistry. Further, the study also discovered that, the teachers often face challenges in teaching integrated science specifically outside an area of their subject specialism.

6.3. Significance of the Study

This study attempted to find out the efficacy of lower secondary science precisely the chemistry portion of classes VII and VIII science and also investigated the conceptual transition from lower secondary science to IX chemistry. Therefore, the current study made the following contributions.

Firstly, this is the first study of its kind in Bhutan since the implementation of new integrated science curriculum in 2014. Therefore, the current study contributed new knowledge and opened an avenue for baseline data for future researchers.

Secondly, the results from this study shall provide an insights and relevant information on the curriculum gap between lower secondary science more precisely the chemistry parts of integrated science and the current IX chemistry curriculum.

Thirdly, the finding from this study would also benefit MoE, REC, policy makers and other responsible stakeholders to plan and take decisions on future curriculum review and changes to ensure the efficacy of current chemistry curriculum of lower secondary science.

6.4. Limitations of the Study

Considering the sample size and research site employed in the study, the conclusions drawn from this study may not be reliable to generalize the whole population because the data were collected involving small number of participants within a short period of time from 3 HSS and 1 MSS of Samtse Dzongkhag.

The participants included in this study were only teachers and students however, the findings and conclusions derived from the current study would have been stronger if the participants such as REC officials, school administrators and curriculum officers were included in the study.

6.5. Recommendation of the study

Based on the findings from the study, following recommendations are made:

1. In order to enhance the efficacy of current VII and VIII chemistry curriculum, the study recommends that, Royal Education Council (REC) may consider the need of review on chemistry curriculum of lower secondary science.
2. The basic concepts on organic chemistry, the mole concepts, stoichiometry, chemical bonding and on green chemistry can be introduced from class VII science itself, in order to maintain strong conceptual foundation of the students towards learning IX chemistry.
3. In order to maintain the smooth transition of students conceptually from lower secondary science to IX chemistry, REC may need to work on alignment and the coherency of chemistry concepts from VII science to IX chemistry.
4. Ministry of Education in consultation with Royal Education Council may work on developing the bifurcated science in lower secondary science so that it builds strong foundation towards learning IX chemistry.
5. Based on the findings, the study also recommends Ministry of Education and Royal Education Council to provide additional training, workshop and seminar for teachers teaching lower secondary science to enhance their competency in teaching all three (chemistry, physics and biology) parts of integrated science.

6.6. Recommendation for Further Research

1. The current study was conducted in Samtse dzongkhag. Therefore, in order to validate, confirm and generalize the findings, the conduct of similar study other than in Samtse dzongkhag is recommended.

2. Current study included only the teacher and student as participants. Therefore, future studies can include REC officials, school administrators and curriculum officers in order to enhance the credibility of findings.

3. Present study investigated only the efficacy of classes VII and VIII chemistry curriculum, it would be interesting if both physics and biology curriculum of VII and VIII science are included to conduct the comparative study in terms of efficacy and quality of conceptual transition from lower secondary science to their respective discipline of IX science.

4. The current study focused on efficacy of classes VII and VIII science and the conceptual transition from lower secondary science to IX chemistry therefore, future researchers can focus on the efficacy and conceptual transition from the lower secondary science to X chemistry in order to seek better understanding on alignment and coherency of chemistry concepts from class VII to class X.

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