



Effectiveness of Classes VII and VIII Science towards Enhancing the Learning of Class IX Physics

Norbu Wangdi^{1*} and Yeshi Dema²

¹Gongzim Ugyen Dorji Central School, Ministry of Education, Post Office Box 15001, Haa, Bhutan.

²Katsho Lower Secondary School, Ministry of Education, Post Office Box 15001, Haa, Bhutan.

Authors' contributions

This work was carried out in collaboration between both authors. Author NW designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author YD managed the analyses and the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

This study aims to find out the effectiveness of classes VII and VIII science towards enhancing the learning of class IX physics. The sample of the study consists of 130 students and 12 science teachers of three secondary schools. The collection of data were administered using survey questionnaires and focus group interviews. The quantitative data was analyzed using SPSS and the interview data was coded based on themes. The study revealed that the basic concepts of class IX physics is already introduced in classes VII and VIII science textbooks. However, students face difficulties in understanding class IX physics. The study suggest that when three separate sciences are combined into a single science textbook, some concepts were not covered in detail. Therefore, the study recommends Ministry of Education, Bhutan to work towards developing bifurcated science: Physics, Chemistry and Biology for classes VII and VIII.

Keywords: Integrated; difficulty; effectiveness; basic-concepts; challenges; bifurcated.

*Corresponding author: Email: norbuwangdi5@education.gov.bt;

ABBREVIATIONS

REC: Royal Education of Council; CAPSS: Curriculum and Professional Support Section; CTDD: Curriculum and Textbook Development Division; SPSS: Statistical Package for Social Sciences; SD: Standard Deviation; DCRD: Department of Curriculum research and Development; PISA: Programme for International Student Assessment; OECD: Organization for Economic Cooperation and Development; UNESCO: United Nations Educational, Scientific and Cultural Organization.

1. INTRODUCTION

1.1 Background

Modern education in Bhutan started very late. Before an advent of modern education, the formal monastic education was introduced in 1622 with an establishment of formal monk body at Chari monastery, Thimphu [1]. The modern school in Bhutan was built in 1914 currently known as Gongzim Ugyen Dorji Central School. The subjects taught were Hindi, English, Mathematics and Dzongkha. This process marked the beginning of modern education in Bhutan. In those days Bhutan did not have any curriculum specialist and so curriculum were imported from outside.

The number of schools in the country significantly grew in early 1960s. With the launch of first five-year development plan (1961-1965), the Royal government of Bhutan has constructed number of schools across the country. This marked the beginning of modern education in the country. In 1985 landmark history took place in Bhutanese Education System with an establishment of Curriculum and Textbook Development Division (CTDD). Later in 1996, CTDD was renamed as Curriculum and Professional Support Section (CAPSS) under the Department of Education. In 2010 CAPSS was upgraded to Department of Curriculum research and Development (DCRD) and now it is functioning as Royal Education Council (REC).

The major reformation of Bhutanese science curriculum took place in 11th five-year plan (2013 to 2018). The REC as a responsible agent for taking care of school curriculum completed framing of National Science Curriculum Framework from classes PP to XII in 2012. Based on the curriculum framework, REC started reforming science textbooks for classes IV to XII.

The reformed general science for classes IV to VI was implemented in 2013, followed by science for classes VII and VIII in 2014 and 2015 respectively. The separate science for classes IX and XI were developed and implemented in 2016. In the following year, three separate sciences for classes X and XII were implemented. However, science subjects for classes PP to III is being taught as a part of environmental science in Dzongkha [2].

1.2 Problem Statement

Science is important foundation for education of the children. School science curriculum and textbooks should allow students to explore their world and discover new things. The curriculum should stimulate students' curiosity and interest to learn science. Therefore, it is important for curriculum and textbook designers to develop school science containing hands-on experimental activities. This will make learning of science enjoyable and interesting for young and active students.

The current single science textbook for classes VII and VIII was developed by REC and implemented in the year 2014 and 2015 respectively. However, when students reach in class IX, physics teachers observed that students are facing difficulties in understanding scientific terms and terminologies introduced in class IX physics especially at the beginning of the academic session. The above statement is based on the researcher's experiences of teaching classes VII and VIII science and class IX physics for last 10 years. Moreover, the researcher observed that many physics teachers in the field were raising the same issues.

In addition, Bhutan participated in PISA-D assessment test conducted by OECD in 2017 along with 7 PISA-D member countries. This marked Bhutan's first-ever participation in an international assessment test after introduction of modern education in 1960s. A total of 2,457 students representing 10725 of class IX students sat for two-hour test in reading, numeracy and scientific literacy. The findings of the study showed that Bhutanese students scored only 45.3% in scientific literacy much below OECD average [3]. The finding indicates that classes VII and VIII science textbooks do not give foundational scientific knowledge for the learners. Therefore, this study proposes to explore the effectiveness of current science textbooks of classes VII and VIII

towards enhancing the learning of class IX physics.

2. LITERATURE REVIEW

2.1 Brief History of Integrated Science in Global and Bhutanese Context

According to Oludipe [4], integrated science curriculum in Nigeria was started back in 1972. It was commissioned by group of science teachers under the directives of Federal Ministry of Education. Atomatofa and Ewesor [5] pointed out that the integrated curriculum of Nigeria was developed towards building basic foundational knowledge in scientific investigation, scientific literacy and necessary technological knowledge for students of Nigeria.

USA saw the discussion on integrated science in 20th century. However, an integrated science was introduced in 1970s. During this same period, largest international organizations such as UNESCO started gearing towards development of science education which published report on new trend in integrated science teaching [6].

The history of integrated science in Bhutanese Education System dates back to 1980s. In 1986, the Ministry of Education erstwhile Department of Education started to frame science curriculum for classes IV and VI. In 1999 and 2000, the three distinct science disciplines for classes VII and VIII were replaced by single integrated science in order to align with primary science. Thus, the science textbooks for classes IV and VIII became an integrated science based in Bhutanese context [7]. The current single science textbooks for classes VII and VIII consist of biology, physics and chemistry as separate chapters in single textbook.

2.2 Types of Integrated Science in Practice

There are different types of integrated science in practice by different countries, states and schools across the world. In Hong Kong, integrated science was designed by combining physics and chemistry, biology and physics, and chemistry and biology [8]. In a similar way, some European countries have a semi-integrated approach. In Spain, science is divided into two combined subject areas: biology and geology, which are taught together and physics and chemistry are taught together.

In France, life and earth sciences are taught together, while physics and chemistry make up another subject. Likewise, in New French, government encourages schools to teach life and earth sciences, chemistry, physics and technology as a single integrated subject for classes VII and VIII. Moreover, in a few European countries, the teaching of separate science subjects is organized as common themes. In Lithuania, the integration between biology, chemistry and physics are taught as energy, system, evolution, macro and micro-systems and change [9].

Bhutanese science for classes VII and VIII is slightly different from integrated science taught in other parts of the world. The textbooks have topics from physics, chemistry and biology, which are discussed in a single textbook. However, there is a clear distinction of chapters as biology, chemistry and physics. For instance, unit 1 of classes VII and VIII science textbooks consist of 4 biology chapters, while unit 2 has 4 chapters of chemistry. The last unit has 5 chapters of physics.

Thus, there are more than three types of integrated science in practice across the globe. However, it is very complex and difficult to study the details of integrated science as integrated science differs from countries to countries, states to states, districts to districts and even schools to schools.

2.3 Merits and Demerits of Integrated Science

Literature studies pointed out that there is an ongoing debate about the merits and demerits of integrated science. Grant and Paige [10] state that integrated science can introduce interconnections among the ideas that capture the learner's imagination and allow the child to work in preferred areas of interest and styles. Similarly, Harrel [11] admits that one of the advantages of integrated science curriculum can show how knowledge across each science subject is related and connected in a natural world, as compared to single-subject that narrow students' perspectives and are less efficient in learning process.

In addition, Curriculum Development Council [8] reports that the reason for introducing integrated science is to develop a broad and sound knowledge base to meet the challenges of living in a technological world. Students learning integrated science will benefit from science

concepts from different disciplines of science in contexts which are expected to have enduring learning. In contrast, Tytler [12] claims that learning of an integrated science will much underestimate the value of science. Society may perceive that science education is less important than learning history, geography, economics and mathematics. Also, Tamassia and Frans [13] reported that learning of integrated science does not improve students' scientific literacy.

2.4 The Impact of Nature of Classes VII and VIII Science

There are different types of integrated science offered for classes VII and VIII in different parts of the world. However, many countries offer bifurcated science for classes VII and VIII. Among 29 European countries, 16 offer three bifurcated sciences after class VI, while only Ireland and Norway offer integrated science till class VIII. But some of the European countries have empowered schools to have their own autonomy to carry out the curriculum [9].

In general two different types of science being taught for classes VII and VIII across the world. Broadly, these two can be classified single and bifurcated science. However, there is not much literatures related to the impact of classes VII and VIII science towards learning higher science. Hence, it is difficult to point out which of the science is better in providing scientific literacy skills to the learners.

In Finland, Finnish education system offers separated science for classes VII and VIII unlike in Bhutan. The science education in Finland starts from class I and is being taught as single science till class IV and separated science starts right from class V. In lower secondary schools, classes VII to IX, the separation between physics, chemistry, biology and geography turns to be more distinguished. Although there is no examination during lower secondary school period, Finnish students' performance in PISA test has been consistently recorded on the top since the establishment of PISA assessment in 2001 [14].

Similarly, Singaporean Education system offers three types of science for lower secondary schools which starts from class VII. According to Curriculum Planning and Development Division [15], based in Singapore, three subjects of science are being offered for lower secondary students. Singapore was one of the top

performing countries in 2009 and 2012 PISA assessment [16,17]. They were ranked number one among the participating countries in latest PISA assessment carried out in 2015.

In Japan, science education begins from class III. The science for lower secondary schools are being taught in two disciplines: physical science and biology and earth science. According to PISA results, Japan is also considered as one of the top performers in international assessment. For instance, in latest PISA report of 2015, Japan was ranked next to Singapore. The report states that Japanese students have maintained consistent performance in PISA assessment from 2006 till date [16].

Likewise, in India, the science for classes VII and VIII is being taught as separate subjects. According to Council for the Indian School Certificate Examinations (CISCE) [18], it is reported that teaching of science for classes VII and VIII is bifurcated into physics, chemistry and biology. In 2009, students from two the Indian states of Tamil Nadu and Himachal Pradesh participated in PISA assessment with 74 participating countries. However, it is reported that Indian students could not perform well in PISA assessment. India was placed 72nd among 74 participating countries [19].

In Bhutan, the learning of formal science starts from class IV. Till class VI science is taught as general science. For classes VII and VIII, three separate sciences are prescribed in one textbook and taught as a single subject. Bhutan participated in PISA-D assessment in 2017 along with 7 developing countries. The finding showed that Bhutanese students scored at par with PISA-D top performing countries in all the three domains but when compared with OECD average, it is definitely low [3].

Therefore, it is concluded that learning of separated sciences in classes VII and VIII build strong foundation for learning science in higher grades. The countries that performed well in international scientific literacy test offer bifurcated science for classes VII and VIII. For instance, Finland and Singapore offer three separated sciences for classes VII and VIII, while Japan offers two separate subjects. Bhutan scored only 45.3% in scientific literacy which is much below OECD average. It is possible that it is due to learning of single science in classes VII and VIII. However, this cannot be the sole reason that

determines the performance of students in scientific literacy test, there might be other factors as well.

3. METHODS

This study was carried out using mixed method. Researchers claim that mixed method is widely used in social science research. Bryman [20] analyzed 232 social science journal articles and the study found that majority of the research articles have employed mixed method combining survey methods and qualitative interviews. Similarly, Doyle, Brady and Byrne [21] identified eight benefits of using mixed methods. Further, Creswell, Fetters, and Ivankova [22] argue that data triangulation design is one of the most prominent designs used by the researchers.

In order to triangulate the findings of the study, convergent parallel mixed method is employed. Since the study is intended to find out both the teachers and students opinion on effectiveness of classes VII and VIII science towards enhancing the learning class IX physics, it is important to use both the quantitative and qualitative facts to solidify the findings. The use of survey and interview provided detailed and comprehensive data for interpretation. Mixed method was used by administering a survey questionnaire and semi-structured interviews for both, teacher and students.

3.1 Research Site

This study was conducted in various schools under three western districts of Bhutan. The research site was selected based on the convenience of the researcher and the proximity to each other. The schools included for data collection are; Bajothang Higher Secondary School of Wangduephodrang district, Khuruthang Middle Secondary School of Punakha district and Bjishong Central School in Gasa district.

3.2 Sampling

In research, sample is subset of individuals or animals from a larger population. Due to large number of class X students in selected schools, this study employed Cochran (1977) formula to determine the number of participants. Using the formula, the sample is arrived at 130 students. The formula is stated below.

$$n_0 = \frac{Z^2 pq}{e^2}$$

Where, n_0 is the sample size, z is the z -score of selected critical value of desired confidence level, p is the estimated proportion of an attribute that is present in the population = $1-p$, and e is the desired level of precision.

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

Where; n_0 is the sample size derived from above equation, and N is the population size.

The procedure for calculating sample is stated below;

$$n_0 = \frac{1.96^2 \times 0.5 \times 0.5}{0.05^2} = 384$$

$$n = \frac{384}{1 + \frac{384 - 1}{200}} = 130$$

In case of teacher participants, teachers teaching class IX physics in all the selected schools were included in the study.

3.3 Data Collection Tools

3.3.1 Survey questionnaires

For this study, two sets of survey questionnaires were prepared, one for the students and the other for the teachers. The survey questionnaires included Likert-scale items measuring the students and teachers' perception on effectiveness of class VII and VIII science towards enhancing the learning of class IX physics. The items are designed in such a way that they allow the respondents to express their opinions on several items under each group. Since, this study intends to find out the effectiveness of classes VII and VIII science in supporting learning of class IX physics, it is necessary to include both students and teachers to get in-depth information for this study.

3.3.2 Interview

The type of interview applied in this study is focus group interview that was administered through semi-structured questions. The well-planned interview questions contain both open-ended and closed-ended questions to get deeper understandings of the study. Two different focus groups, teacher focus group and student focus group were used to gather qualitative data. The

student focus group consists of 2 males and 2 females. But in teachers' focus group, same number of male and female could not be arranged due to unequal number of genders in the selected schools. For both the focus groups, different questions were administered.

3.3.3 Document analysis

In this study, public record documents were used. The science textbooks for classes VII and VIII, and class IX physics textbook were analyzed to find out the inclusion of physics concepts in classes VII and VIII science. At the same time, the researcher also looked at the progression and coherency of content from classes VII-VIII science to class IX Physics textbook.

3.4 Data Analysis Procedure

The survey questionnaire completed by the teachers and students were documented. In order to analyze the data, separate numeric codes were encoded to the data of the both teachers and students. Then data were punched in statistical package for social sciences (SPSS) and analyzed using descriptive statistics through measures of mean and standard deviation. The results generated by SPSS were exported to excel for edition of features. In case of interview data, the interviews were recorded. The recorded interview data were transcribed verbatim. Transcribed data was read for several times to find the codes. Lastly, the codes were merged together to create themes. The result was analyzed based on the derived themes.

4. RESULTS

The data obtained from survey questionnaires are presented using tables for easy interpretation and references. For presenting the findings of the interview data, the pseudonym of 'T' and 'S' are used for teachers and students. The pseudonym is used for easy reference and understanding. Based on the survey questionnaires and interview codes, three major themes were identified for result interpretations. In terms of survey questionnaires, mean and standard deviation are used to interpret the results. In addition, science textbooks of classes VII-VIII science and IX physics were analyzed to find out the basic concepts and the content progression from classes VII-VIII science to class IX physics.

The findings from interview and survey questionnaire were triangulated with document analysis to confirm the findings. The themes generated from survey and interview are; Basic Physics concepts in classes VII and VIII science, Progression of content from class VII science to class IX physics and Learning of class IX physics.

4.1 Basic Physics Concepts in Classes VII and VIII Science

Most of the teacher participants expressed that basic scientific terms and terminologies required in class IX physics are already introduced in classes VII and VIII science. Among twelve teachers, 70% of them pointed that the textbooks of classes VII and VIII science have required concepts to impart basic knowledge of class IX physics. This is clear from the statement made by T6:

I feel that there are enough concepts and information in classes VII and VIII science which would help students to cope up with class IX physics.

Teachers are of the opinion that basic physics concepts are embedded in classes VII and VIII science and students also agree to the teachers' opinion. From students' interview, all the participants unanimously stated that basic key physics concepts are already introduced in classes VII and VIII sciences. Participants explicitly expressed that the content of classes VII and VIII is properly aligned to class IX physics. Students also mentioned that they were able to understand class IX physics better because the topics taught in classes VII and VIII sciences are repeated in class IX physics. Further, most of the students reported that in class IX their understanding is deepened based on whatever they have learned in classes VII and VIII science. This is clear from the statement made by S6.

I think it is because of basic concepts we were taught in classes VII and VIII; we don't struggle much while studying class IX physics. Thereby, we save the time and energy of teachers and ourselves. Teachers really do not need to start from basic level. They can directly introduce deeper concepts.

In line with the interview data, the survey questionnaires data of both the teachers and students also revealed the similar result as discussed below.

As reflected in Table 1 the average mean of the statements of this category is 3.45 (high rank) and standard deviation is 1.0. This high average mean indicates that most teacher participants agreed that present science textbooks of classes VII and VIII provide basic concepts to learn class IX physics. The small value standard deviation indicates that there is less dispersion of ratings by the teacher participants.

The students' survey questionnaire data also shows similar findings as shown in Table 2. The average mean of the statements is $M = 4.1$, which falls under high ranking which indicates that students strongly agree that fundamental concepts of class IX physics are being discussed in classes VII and VIII science. The average standard deviation of the statements

($SD = 1.09$) indicates that there is no significant difference in terms of ratings of the students.

Moreover, the document analysis of textbooks corroborates with the findings of both interview and survey questionnaire data. The content of the given chapters of current classes VII and VIII science textbooks have included adequate concepts to build foundations for class IX physics.

On the contrary, about 30% of the participants expressed that class IX students are not familiar with scientific terms and terminologies required to learn class IX physics. The participants reported that students face difficulties in understanding basic terms like, distance, displacement, vector and scalar quantities (T1).

Table 1. Teachers' rating on basic physics concepts in classes VII and VIII science

Statements	N	Mean	SD	Rank
I find current science textbook for classes VII and VIII is well presented and prescribed.	12	4.17	0.8	Very High
The classes VII and VIII science textbooks has required concepts to learn class IX physics.	12	3.5	1.0	High
I find the basic concepts of class IX physics is being introduced in classes VII and VIII science textbooks.	12	3.58	1.0	High
I find that classes VII and VIII science textbooks provide basic foundational knowledge for learning physics in class IX.	12	3.5	1.1	High
I find my students competent enough to learn class IX physics after completion of class VIII.	12	2.67	0.9	Moderate
I find my students using prior knowledge of classes VII and VIII science when introducing the topics in class IX physics.	12	3.33	1.1	High
Average		3.45	1.0	

Table 2. Students' rating on basic concepts of classes VII and VIII science

Statements	Mean	SD	Rank
I learned basic concepts of class IX physics in classes VII and VIII science.	4.22	1.04	Very High
In classes VII and VIII science, I learned basic concepts on forces and motion.	4.32	1.02	Very High
In classes VII and VIII science, I learned basic concepts on light.	4.31	0.99	Very High
In classes VII and VIII science, I learned basic concepts on electricity.	4.27	0.92	Very High
In classes VII and VIII science I learned basic concepts on earth and beyond.	3.93	1.12	High
I find that classes VII and VIII science textbooks provide enough concepts to learn class IX physics.	3.57	1.05	High
I find many new concepts in class IX physics which I have never learned in classes VII and VIII science.	3.77	1.28	High
Average	4.01	1.09	

4.2 Progression of Content from Classes VII-VIII Science to Class IX Physics

Among twelve teacher participants, nine of them shared similar views stating that proper alignment exist between classes VII and VIII sciences and class IX physics. They admitted that much of the contents taught in classes VII and VIII science are connected to higher science. This is evident from the statement below.

Transition and hierarchy of the science subject is well maintained from lower secondary to middle secondary, basic concepts are introduced and students are made to familiarize with basic terminologies as per their cognitive level (T11) and (T6).

However, one of the participants expressed that there isn't a strong link between classes VII-VIII sciences and class IX physics,

Certain concepts of class IX physics are covered in great detail within classes VII and VIII textbooks. For those chapters that are covered students generally possess a mild conception and understanding. The contents available in class IX physics but aren't available in classes VII and VIII has to be kick-started with fresh beginning (T4).

There was also a participant who refused to comments reasoning that it is quite early to share as science for classes VII and VIII was implemented recently in our education system (T8).

Students' views are also in line with majority of the teachers as discussed in Table 3. The average mean calculated from the statements is $M = 3.96$, which shows that there is strong link between classes VII-VIII science and class IX physics in terms of content presentation. It is also clear from the rating that participants do not have

significant differences in ratings as the average standard deviation is only 1.1.

However, some students find new concepts in class IX physics which they didn't learn in classes VII and VIII science. It is clear from the rating on statement; I came across few new concepts while learning class IX physics which I have not learned in classes VII and VIII science, which has received mean response $M = 3.66$. Correspondingly, the findings obtained from data agree with document analysis of the textbooks. As per the document analysis, it is found that there is smooth flow and progression of content from classes VII-VIII science to class IX physics.

4.3 Learning of Class IX Physics

Though progression of the topics exists from classes VII-VIII science to class IX physics, students still find difficulties in learning class IX physics. All the teacher participants expressed various difficulties faced by the students in learning class IX physics. Most of them mentioned that students face difficulties at the start of academic session in class IX. One of the respondents shared that in-depth concepts are not taught from classes VII and VIII science. The participant further explained:

Probably because the students learn concept from a single textbook in classes VII and VIII, on arrival to class IX, students are observed to be conceptually challenged, while the terminologies and fundamentals are already introduced in class VIII, owing to its brief description, the ability of the students to make link and connection with what they have learnt is not always resourceful and encouraging. This creates a vacuum in learning physics due to the fact that the basic information learnt in previous standard is not explicitly expressed and applied or accurately connected in its best scientific manner (T4).

Table 3. Students' rating on connection between classes VII-VIII science and class IX physics

Statements	Mean	SD	Rank
I find, there is appropriate connection in topics and concepts between class IX physics and science of classes VII-VIII.	4.07	1.1	Very High
I came across few new concepts while studying class IX physics which I have not learned in classes VII and VIII science.	3.66	1.2	High
I find present classes VII and VIII science is good enough to provide concepts to study class IX physics.	4.01	1.0	Very High
I find that present classes VII and VIII science prepare us to study class IX physics.	4.1	1.1	Very High
Average	3.96	1.1	

Similar views are expressed by other teachers. Some of them suggested to address these challenges and difficulties it would be good to bifurcate classes VII and VIII science into three separate sciences: Physics, Chemistry and Biology. This is evident from the following quote.

Academically speaking, the reintroduction of science as a separate disciplines of physics, chemistry and biology in class seven and eight can be noble idea. By this, they can distinctly draw a transparent understanding in the concept of physics, chemistry and biology as they reach to class IX and above (T6).

In this context, students' opinion didn't differ much from that of teachers. Student participants pointed out that though content learned in classes VII and VIII science is useful in learning class IX physics, they also come across some new concepts that are difficult for them to understand. Some students expressed that they get scared when introduced with three disciplines of science in class IX affecting their interest to learn. In addition, another student said that learning three separated sciences after learning single science makes us difficult to understand class IX physics.

From my point of view, I feel that there should be three separate sciences from lower classes itself, because if we are introduced with more basic terminologies from lower classes then it would be better for us to understand and learn class IX physics (S8).

5. DISCUSSION

5.1 Basic Science Concepts for Studying Class IX Physics

A curriculum is one of the most important components of teaching and learning. One of the prominent curriculum designs is spiral curriculum. Spiral curriculum is designed in a way that students' previous learning connects to higher level of learning. It emphasizes on strengthening the learner's retention and development of skills since the design is organized through repeated learning from simple to complex ideas.

From this study, it is found that the science curriculum in Bhutanese education system was developed based on the guiding principles of

spiral curriculum. This is because, the findings of the study revealed that the basic concepts of physics are already introduced in classes VII and VIII science textbooks. Most of the topics presented in class IX physics were already introduced in classes VII and VIII science textbooks. In class IX physics, students' learning is further deepened with the introduction of related concepts.

The findings of this study closely corresponds to the study by Masters, Kenneth, and Gibbs [23] who identified spiral curriculum as one in which the topics learned in lower classes are connected to higher classes. However, it is not simply repetition of the topics taught in lower classes. It requires deepening of the concepts and building knowledge on the previous topics. Thus, this study confirms that students' learning in class IX physics is further deepened based on the concepts taught in classes VII and VIII science.

5.2 Progression and Coherency of Content

This study finds a smooth progression and coherency of almost all content from classes VII-VIII science to class IX physics. It is found that the transition and hierarchy of science subject is well maintained from classes VII-VIII science to class IX physics. The basic key concepts are in place and students are made familiar with basic physics terms as per their cognitive level.

The finding of the study corresponds with the intention of science curriculum framework for PP-XII developed by Royal Education Council, Bhutan. As per REC [24], the intention of science curriculum is to bring coordination, consistency and coherence to the science curriculum. The other intention highlighted in the framework is to give science education for Bhutanese students that are developmentally proper and progressive approach through the stages of learning.

5.3 Learning Class IX Physics

In general, learning of physics is considered as difficult by Bhutanese students due to its abstract concepts. Moreover, the learning of physics deals with laws, formulae and calculations, which makes it more complicated to learn. One of the findings of this study further shows that Bhutanese students are struggling to learn class IX physics in spite of basic concepts

being introduced in classes VII and VIII science. Students face difficulties in understanding the terms and terminologies of physics at the start of academic session.

This finding is in line with the study conducted by Ekici [25], who reported that class IX students of Denizli, Turkey, face difficulties in learning class IX physics at the beginning of academic session. Similarly, a study conducted by Angell, Guttersud, Heriksen and Isnes [26] reported that generally physics is recognized as being conceptually difficult for students to learn. Likewise, same findings were reported by [27] and [28].

The finding of this study also shows that students tend to develop fear when they are introduced to three separate sciences class IX. Thereby, students seem to lose their interest in learning class IX physics. This is due to limited concepts discussed in a single textbook in classes VII and VIII science. Some of the concepts in classes VII and VIII science are not explicitly expressed and accurately connected to class IX physics. This finding closely concurs with the study reported by European commission. It was reported that learning combined science in lower classes develops less foundational and conceptual understanding since certain topics are not covered in detail or even omitted due to bulkiness of syllabus [9].

6. CONCLUSION

The finding of this study shows that classes VII and VIII science provides adequate basic concepts of class IX physics and there is proper alignments and progressions of content from classes VII-VIII science to class IX physics. However, there are several evidences emerged from this study which suggests an ineffectiveness of classes VII and VIII science towards enhancing the learning of class IX physics. These evidences of the study suggests that at the beginning of academic session students seem to face difficulties in understanding class IX physics.

In addition, students tend to develop a sense of fear when physics is introduced as a separate subject in class IX. Since students have learned physics, chemistry and biology using single textbook from classes IV to VIII, some of the basic concepts were not covered in detail and even omitted. Therefore, learning physics, chemistry and biology from single textbook in

classes VII and VIII science develops less foundation and conceptual understanding of class IX physics. Thus, this study recommends Royal Education Council to develop bifurcated science from class VII onwards. Findings of this study may not be generalized as the study has some limitations. One of the limitations lies in the sample size. Moreover, all three schools included for this study is based in western region of Bhutan.

CONSENT AND ETHICAL APPROVAL

The ethical issue in this study is taken into an account by the researchers. Prior to collection of data, written approval to conduct the study in respective schools were obtained from the concerned authority. In addition, consent letters were duly signed by all the participants before completing survey questionnaire and interview

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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