Original Research Article

Exploring the Sequence of Science Contents in theIntended Primary Curriculum of Bangladesh

Abstract:

This study aimed to explore the sequence of contents in the Primary science curriculum of Bangladesh at the intended level. The current Primary curriculum has been in implementation throughout Bangladesh since 2013 where all the students study 'Science' as a unified and compulsory subject at Primary level which consists of grade One to Five. There is no textbook of science for grade One and Two while National Curriculum and Textbook Board (NCTB) has developed teacher-manual for these grades. Science textbooks for grade Three, Four and Five have been developed and distributed by NCTB.The research questions of this study focus on how science contents are sequenced within a chapter of a specific grade and how science contents are sequenced vertically from one grade to another in the curriculum as well as in the textbooks.For conducting this study,qualitative research approach has been followed. Document analysis of the curriculum and textbookshas been done by adapting selected frameworks.A checklist which is based on the works of Print (1993)has been used for exploring the principle of sequencing contents while a framework based on Bruner (1960),Harden (1999) and Johnston (2012) has been used for exploring spiral-sequencing.This study findsthat the intended Primary science curriculum and textbook is not fully well-organized in terms of sequencing.For sequencing content within a chapter, no principle is followed in most cases while 'Simple to Complex' principle has been followed in some cases. For sequencing contents vertically from one grade to another, 'Simple to Complex' has been followed or partially followed in most cases whereas no principle is followed in the rest.'Spiral sequencing' is either partially followed or not followed in the curriculum and textbooks.As literatures emphasize on well-sequenced curriculum and textbook for ensuring successful and effective learning, this study recommends that curriculum developers as well as textbook authors may make efforts to make the science contents well-organized in the curriculum and textbooksby following the principles of sequencing.

Keywords:sequence of content, intended curriculum, science curriculum, science textbook, Primary science

Introduction

"Curriculum is an interrelated set of plans and experiences that a student undertakes under the guidance of educational institution and it is concerned with both the planning and execution phases" (Marsh & Willis, 2003).Mulenga (2018) asserted that "curriculum is all the educational experiences provided to learners consciously or unconsciously under the school

authority".“Curriculum has three main forms or levels – Intended, Implemented and Attained” (Akker, 2004). Gilbert (2012) described “intended curriculum as the most common idea of curriculum since it comprises the formal statements of aims, intended list of content (knowledge or competencies) to be learnt in the program of study and demonstrated in assessment”.Content is one of the four main elements of a curriculum along with objectives, methods and evaluation (Marsh, 2008) and contentsneeds to be organized properly to achieve the stated goals and objectives(Edith Cowan University, 2001). According to Arafeh (2016), Ehsan (1997) and Print (1993), “sequence of contents is considered as one of the most important aspects of organization of contents in a curriculum”. “Sequence of contents refers to the order in which contents are presented to learners” (Print, 1993). Several literatures have recognized the importance of appropriate sequence of content in a curriculum. Stroganovand Tsvetkov (2020) as well as Malamed (2016) asserted that meaningful and logical sequence helps students in learning.

In Bangladesh, National Education Policy was finalized in 2010. Based on this policy, National Curriculum-2012 was developed and it has been in implementation since 2013. The current education system of Bangladesh is divided into three levels- Primary, Secondary and Tertiary. The Primary level consists of five grades (from grade One to grade Five). For grade One and Two, Science is taught as a coordinated subject with Social Science and there is no textbook of Science for these grades though National Curriculum and Textbook Board (NCTB) has developed teacher-manual. All the students study elementary science as a compulsory and unified subject at grade Three, Four and Five. Science textbooks for these grades have been developed and distributed by NCTB. The subject ‘Science’ at Primary level includes contents from different sub-discipline of sciencei.e. Physical Science, Biological Science, Earth and Space Science, Health science, Environmental Science, Technology etc. National Education Policy-2010(Ministry of Education, 2010) and National Curriculum-2012 (National Curriculum and Textbook Board [NCTB], 2012) have declared that Primary-science will emphasize on developing scientific mindset along with other scientific values like inquisitiveness, questioning, innovations, debunking superstitions etc. as well as on linking science knowledge to practical situations. All these are aligned with the basic concept of scientific literacy asscientifically literate students are expected to use scientific knowledge, recognize scientific questions, identify what isinvolved in scientificinvestigations, relate scientific data to claims andconclusions, and to communicate these aspects of science (Organization for Economic Co-operation and Development [OECD], 2003).But we experienced that a large number of students in Bangladesh do not behave consistently with the concept of scientific literacy. With this issue in our mind, we have explored the sequence of content in the current Primary science curriculum and have tried to identify if there is any gap in this aspect as the Education Bureau of the government of the Hong Kong (2016) has recognized the appropriate and logical sequence of content as one of the important aspects of effective and successful learning.

Besides, the contemporary curriculummodels see the curriculum process as a continuous process, constantly in a state of change as new information or practices become available (Print, 1993). Ehsan (1997) also argued that as ‘the best curriculum’ is a vague notion, in reality curriculum development and implementation continues as a never ending process. That’s why he emphasized that after implementing a curriculum, it needs to be reviewed, analyzed and evaluated. According to National Council for Curriculum and Assessment (NCCA, 2005), curriculum analysis and review is a key to improving the quality as it sets the foundation for further development by analyzing the current situation. Marsh (2003) also recognized its significance and emphasized on the review of current curriculum for further development of the curriculum.In Bangladesh, the Government is trying to enhance the

quality of education by updating curriculum. A new competency based curriculum for grade Six and Seven has already been developed and it has been implemented in 2023. Similarly, initiatives have already been taken for developing a new curriculum for the Primary level (grade One to grade Five). This study aims to inform thecurriculum developers, textbook writers and other stakeholders of Primary education about the sequence of content in the current Primary science curriculum so that necessary actions can be taken for improving the sequence of content in the future curriculum.

The purpose of this study was to explore the sequence of contents in Primary Science Curriculum of Bangladesh at intended level. For conducting this study, we have considered Primary science curriculum and textbooks as the intended curriculum. The research questions of this study are:

1. How are science contents sequenced within a chapter in the intended Primary science curriculum?
2. How are science contents sequenced vertically from one grade to another in the intended Primary science curriculum?

2.Literature review

Sequence of content refers to the order in which content is presented to the learners (Print, 1993; see also Edith Cowan University, 2001). Muller (2006) considered sequence of content as an important aspect of curriculum design while Arafeh (2016) stated that content should be sequenced logically.Stroganov and Tsvetkov (2020) added that contents should be sequenced based on logical connectivity.Edith Cowan University (2001) also put emphasis on this logical approach and argued that content can be sequenced based on what is closer or more meaningful to the learner. Print (1993, as cited in Edith Cowan University, 2001) described four principles of sequencing content as following:

- **Simple to complex:** Progression from simple and subordinate components to complex structures which are composed of the subordinates
- **Pre-requisite learning:** Considering pre-requisite learning as the base of further learning in any educational activity
- **Whole to part:** Understanding the whole makes the understanding of partial or constituent phenomena possible
- **Chronology:** Sequencing content according to the chronology of time (forward or backward)

If the sequence of content involves multiple revisits of key topics for further development of the concepts, it is called spiral sequencing (Edith Cowan University, 2001; Harden, 1999), seeFigure 1. According to Johnston (2012) and Rhalmi (2011), spiral sequencing is mainly based on Bruner's learning theory (Bruner, 1960).

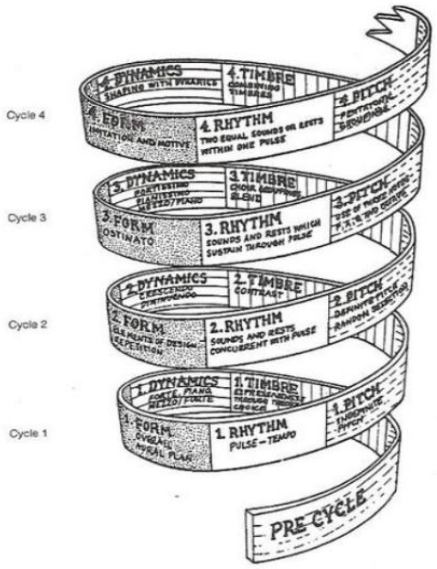

Figure 1:A spiral curriculum concept from the Manhattanville Music Curriculum Project (Edith Cowan University, 2001, pp. 70-71)

According to Harden (1999), the features of spiral curriculum are:

1. Topics are revisited
2. There are increasing levels of difficulty
3. New learning is related to previous learning
4. The competence of students increases with each visit

Johnston (2012) also described three key features of spiral sequencing as following which is based on Bruner's work (Bruner, 1960).

1. The student revisits a topic, theme or subject several times throughout their school career
2. The complexity of the topic or theme increases with each revisit
3. New learning has a relationship with old learning and is put in context with the old information.

Recent literatures including a study by University of Detroit Mercy (2022) report that spiral sequencing impacts positively on students' learning.

3. Methodology

3.1 Nature: The nature of this study was qualitative. It aimed to explore the sequence of content in the intended Primary science curriculum, which was the central phenomenon of the study. According to Creswell (2012), qualitative research is the most suitable approach for exploring and developing a detailed understanding of a central phenomenon.

3.2 Source of data and sampling technique

Data have been collected from Primary science curriculum and textbooks. For time constraints and as there is no textbook for grade One and Two, this study has explored science textbooks for grade Three, Four and Fivealong with thePrimary science curriculum.

Besides curriculum, textbooks have also been used because textbooks are the de-facto curriculum in Bangladesh context (Siddique, 2007) since NCTB develops a single textbook for every respective subject. The current science curriculum and textbooks for Primary level were selected purposefully as the sources of data since they are rich in information that are needed to answer the research questions of this study. Purposeful sampling is powerful and logical as it allows selecting information-rich cases for in depth study (Patton,1990). Details of the Science curriculum and textbooks used as the sources of data:

a. Asgar, A., Huque, M. A., Jahanara, Q. A., & Siddique, M. N. A. (2018a). *Elementary Science: Class Three*. National Curriculum and Textbook Board (NCTB).
b. Asgar, A., Huque, M. A., Jahanara, Q. A., & Siddique, M. N. A. (2018b). *Elementary Science: Class Four*. National Curriculum and Textbook Board (NCTB).
c. Asgar, A., Huque, M. A., Jahanara, Q. A., & Siddique, M. N. A. (2018c). *Elementary Science: Class Five*. National Curriculum and Textbook Board (NCTB).
d. National Curriculum and Textbook Board (NCTB). (2012*). JatiyoShikkhakrom 2012- PrathomikBigyan[National Curriculum 2012- Primary Science]*. NCTB.

3.3 Collection and Analysis of Data

Document analysis was used as the method to collect and analyze data from the current Primary science curriculum and textbooks as Bowen (2009) stated that document analysis is effective for collecting qualitative data from written documents. A checklist for principle of sequencing contents and four key questions for spiralsequencing have been used during the document analysis. All these tools were developed by the same authors for an earlier study (Bain & Siddique, 2017)which explored the organization of contents in the junior secondary science curriculum of Bangladesh. The mentioned tools are explained below:

For exploring the sequence of content in the curriculum and textbooks, a checklist was used. Four principles of sequencing content described by Print (1993, as cited in Edith Cowan University, 2001) were used as the components of the checklist, see Figure 2.

- Simple to Complex
- Pre-requisite Learning
- Whole to Part
- Chronology

For exploring the status of spiral sequence in the Primary science curriculum, four key questions (KQ) were used which were developed based on the work of Bruner (1960), Harden (1999) and Johnston (2012). The key questions were:

1. Does the concept appear in multiple grades (within the Primary level)?
2. Has the learning from previous grade(s) on the same concept been referred in the textbook?
3. Has the learning from previous grade(s) on the same concept been used as the base of future learning?
4. Have the breadth and complexity of the concept been increased from the previous grade?

The decision about spiral sequencing was determined based on the responses against the key questions (KQs), see Table 1.

Table 1: Decision about spiral sequencing based on response against KQs

Type of response	Decision
Yes against all 4 KQs	Truly spirally sequenced
Yes against most of the KQs	Spirally sequenced
Yes against 2 KQs and No against 2 KQs	Partially spirally sequenced
No against most of the KQs	Not spirally sequenced
No against all 4 KQs	Not spirally sequenced at all

4. Results and Discussion

4.1Results

4.1.1 For sequencing contents within a chapter, no principleof sequencing contents is followed in most cases while 'Simple to Complex' principle has been followed in some cases

From the document analysis, it has been found that for sequencing content within a chapter in the Primary science curriculum and textbooks, in most cases no principle of sequencing content as described by Print (1993) is followed. In addition, 'Simple to Complex' is followed as the principle in some cases while in only a few cases, some of the other principles described by print are followed.

For sequencing content within a chapter, no reflection of any principle described by Print (1993) is found in the following chapters, see Table 2.A very few chapters ('Food' from grade Three and'Energy and Matter', 'Healthy Lifestyle' and'The Universe' from grade Five)from Table 2, have attempted following principle described by Print (1993) occasionally but it is not consistent for the entire chapter. Therefore, these chapters are considered as the chapters with no principle of sequencing content.

Table 2: Chapters with no principle of sequencing content

Grade	Name of the Chapter	
Three	Food (Chapter 7)	No principle described by Print (1993) is followed for sequencing contents within a chapter
	Energy (Chapter 9)	
	Information and Communication (Chapter 11)	
	Population and Natural Environment (Chapter 12)	
Four	Living Things and Environment (Chapter 1)	
	Plants and Animals (Chapter 2)	
	Healthy Lifestyle (Chapter 5)	
	The Universe (Chapter 8)	
	Weather and Climate (Chapter 10)	
	Life safety and First Aid (Chapter 11)	
	Information in Our Life (Chapter 12)	
Five	Environmental Pollution (Chapter 2)	
	Water for Life (Chapter 3)	
	Air (Chapter 4)	
	Energy and Matter (Chapter 5)	
	Food for Good Health (Chapter 6)	
	Healthy Lifestyle (Chapter 7)	
	The Universe (Chapter 8)	
	Technology in Our Life (Chapter 9)	
	Information in Our Life (Chapter 10)	
	Weather and Climate (Chapter 11)	
	Climate Change (Chapter 12)	

For example, contentsin the chapter named 'Energy' (grade Three) are sequenced as following, see Table 3.

Table 3: Sequence of content in the chapter named 'Energy'

Content in the curriculum	Content presented in the textbook
• Light and its use • Electricity in various use • Heat and its necessity • Concept of light, electricity and heat as Energy	**Lesson 1: Energy in our life** • How do we use energy? • Use of light, electricity and heat **Lesson 2: What is energy?** • What can be done by using energy? Relocating things, producing sound, light and heat

None of the above mentioned sequence from the curriculum and textbook seems to be consistent with any of the principles of sequencing content as described by Print (1993).

It has also been found that some chapters follow ‘Simple to complex’which is one of the principles described by Print (1993) for sequencing content within a chapter, see Table 4. In these chapters, simpler content is presented first and then complexity of the contents increase graduallywith the progression of the chapter.

Table 4 :Chapters where ‘Simple to complex’ principle is followed for sequencing content

Grade	Name of the Chapter	
Three	Our Environment (Chapter 1)	**‘Simple to complex’ is followed as principle for sequencing contents within a chapter**
	Living and Nonliving Things (Chapter 2)	
	Different Types of Matter (Chapter 3)	
	Water for Life (Chapter 4)	
	Air (Chapter 6)	
	Hygiene (Chapter 8)	
Four	Soil (Chapter 3)	
	Food (Chapter 4)	
	Matters (Chapter 6)	
	Natural Resources (Chapter 7)	
	Population and Natural Environment (Chapter 13)	
Five	Our Environment (Chapter 1)	
	Natural Resources (Chapter 13)	
	Population and Natural Environment (Chapter 14)	

For example, contents in the chapter named ‘Water for Life’ (grade Three) are sequenced as following, see Table 5.

Table 5: Sequence of content in the chapter named ‘Water for Life’

Content in the curriculum	Content presented in the textbook
• Source of water • Potable and non-potable water • Importance of water in human life • Prevention of misuse of water	**Lesson 1:** Sources of water **Lesson 2:** Uses of Water (includes saving of water) **Lesson 3:** Safe water and unsafe water (fresh water, salty water, arsenic contaminated water) **Lesson 4:** Water pollution

Both of the above mentioned sequences (from the curriculum and textbook) are consistent with ‘Simple to complex’ principle. Here, simpler content is presented first, then complexity of the contents increased gradually and finallythe chapter end with the most complex content.

This study has also found that some other principles described by Print (1993) are followed within a chapter in only a few cases, see table 6.

Table 6: Chapters where other principles are followed for sequencing content

Grade	Name of the Chapter	Principle of sequencing content
Three	Soil (Chapter 5)	Pre-requisite Learning
	Introduction to Technology (Chapter 10)	Whole to Part
Four	Technology in Our Life (Chapter 9)	Whole to Part
Five	None	

For example, the chapter named 'Soil' (grade Three) follow 'Pre-requisite learning' since the components of soil are discussed first and later when discussing different types of soil,it is stated explicitly that component of soil or substance soil contains is one of the bases of this classification. Again, when discussing which soil is suitable for which cropin the later part of the chapter, contents presented earlier (components of soil, different types of soil and their characteristics)are used as the base of the new learning.

One of the principles 'Whole to Part' was followed quite explicitly in the chapters named 'Introduction to Technology' (grade Three) and 'Technology in Our Life' (grade Four). In these chapters, content was presented as a broad theme first and then different parts of the theme were discussed in detail. For example, at the beginning of the chapter 'Introduction to Technology' (grade Three), the concept of technology and use of it in our life was discussed in a general sense (as a whole) and then in the later part of the chapter, use of technology in various aspects of our life like transport, education, agriculture (as parts) were discussed in detail. The chapter named 'Technology in Our Life' (grade Four) also followed 'Whole to Part' as the principle of sequencing contents within it in a similar way.

4.1.2 For sequencing contentsvertically from one grade to another (inter-grades sequence), 'Simple to Complex' has been followed or partially followed in most cases whereas no principle is found to be followed in the rest

This study has found that for sequencing contents vertically from one grade to another (inter-grades sequence) in the Primary science curriculum and textbooks, 'Simple to Complex' has been followed or partially followed as the principle in most cases. Besides, no principle of sequencing content as described by Print (1993) has been followed in the rest cases.

For the inter-grades sequence of contents, 'Simple to Complex' principle as described by Print (1993) is followed or partially followed in the following cases, see Table 7.

Table 7: Inter-grades vertical sequenceof content with 'Simple to Complex' as the principle

Grade - Three	Grade- Four	Grade- Five	Principles being followed
Our Environment (Chapter 1)		Our Environment (Chapter 1)	Simple to Complex
		Environmental Pollution (Chapter 2)	
Water for Life (Chapter 4)		Water for Life (Chapter 3)	Simple to Complex
Air (Chapter 6)	Content on properties of Air in the chapter named Matters (Chapter 6)	Air (Chapter 4)	Simple to Complex (partially)
	Weather and Climate (Chapter 10)	Weather and Climate (Chapter 11)	Simple to Complex
		Climate Change (Chapter 12)	
	The Universe (Chapter 8)	The Universe (Chapter 8)	Simple to Complex
Different Types of Matter (Chapter 3)	Matters (Chapter 6)	Energy and Matter (Chapter 5)	Simple to Complex
Energy (Chapter 9)		Energy and Matter (Chapter 5)	Simple to Complex
Food (Chapter 7)	Food (Chapter 4)	Food for Good Health (Chapter 6)	Simple to Complex (partially)
Hygiene (Chapter 8)	Healthy Lifestyle (Chapter 5)	Healthy Lifestyle (Chapter 7)	Simple to Complex(partially)
Introduction to Technology (Chapter 10)	Technology in Our Life (Chapter 9)	Technology in Our Life (Chapter 9)	Simple to Complex(partially)
Information and Communication (Chapter 11)	Information in Our Life (Chapter 12)	Information in Our Life (Chapter 10)	Simple to Complex (partially)
Population and Natural Environment (Chapter 12)	Population and Natural Environment (Chapter 13)	Population and Natural Environment (Chapter 14)	Simple to Complex (partially)

For example, content on Matter is included in the science textbooks of grade Three (Chapter 3), grade Four (Chapter 6) as well as grade Five (Chapter 5). The grade Three textbook contains content onconcept, properties (very briefly) andthree states of matter while the grade Four textbook contains detailed content on properties of matter including volume and weight. On the other hand, molecular structure of matter and its role in determining the state of matter are presented in the grade Five textbook. Here, simplest content is presented in the lowest grade and then with the progression of the grade,complexity of the content increasegradually and finally the highest grade presents the most complex content. Thus the principle of

'Simple to Complex' has been followed while sequencing contents from one grade to the next.

From Table 7, 'Simple to Complex' has been followed partially in some cases for sequencing contents vertically. For example, there are chapters focusing on Technology in grade Three (Chapter 10), grade Four (Chapter 9) as well as grade Five (Chapter 9). Content on 'technology in agriculture' is common in these chapters and the complexity of the content increases with the progression of the grades. So 'Simple to Complex' principle has been followed for this particular portion. But for the remaining parts of these chapters, no principle as described by Print (1993) has been followed for sequencing contents vertically from one grade to the next. So we can say that, in this case, the principle of 'Simple to Complex' has been followed partially.

This study also finds that no principle of sequencing content as described by Print (1993) has been followed for sequencing contents vertically in some cases, see Table 8.

Table 8:Inter-grades vertical sequencewith no principle of sequencing contents

Grade - Three	**Grade- Four**	**Grade- Five**	**Principles being followed**
Living and Nonliving Things (Chapter 2)	Living Things and Environment (Chapter 1)		**No principle described by Print is found**
	Plants and Animals (Chapter 2)		
Soil (Chapter 5)	Soil (Chapter 3)		
	Natural Resources (Chapter 7)	Natural Resources (Chapter 13)	
	First Aid in the chapter named Life safety and First Aid (Chapter 11)		Not applicable (as it appears in only one grade within Primary level)
		Changes during the Puberty in the chapter named Healthy Lifestyle (Chapter 7)	Not applicable (as it appears in only one grade within Primary level)
		Concept and nature of Science and Scientific investigation in the chapter named Technology in Our Life (Chapter 9)	Not applicable (as it appears in only one grade within Primary level)

For example, Chapter 7 of grade Four and Chapter 13 of grade Five both present content on Natural Resources. Grade Four contains content on types on natural resources, uses of natural resources for energy production and conservation of natural resourceswhile grade

Fivecontains content on our resources (natural and man-made) and wise use of natural resources.
This inter-grades vertical sequence is not consistent with any of the principle of sequencing content as described by Print (1993). Besides, from Table 8, we can see that contents on first aid, changes during the puberty, concept and nature of Science and Scientific investigation appear only once within the Primary level. So in these cases, principle of inter-grades vertical sequence is not applicable.

4.1.3'Spiral sequencing' is partially followed in most casesfor sequencing contents vertically

This study has found that for sequencing contentsin the Primary science curriculum, 'spiral sequencing' has been followed in most cases, but it is done in a partial manner. In most cases, contents are labelled as partially spirally sequenced as they have got a combination of two affirmative and two negative responses against the four key questionsof spiral sequencing mentioned in the Methodology. In some cases, contents are not spirally sequenced (as they have got negative responses against most of the key questions) while in a very few cases, contents are not spirally sequenced at all (as they have negative responses against all of the key questions). The status of the Primary science curriculum in terms of spiral sequencing is shown in Table 9.

Table 9: Status of the Primary science contents in terms of Spiral sequencing

Grade Three	**Grade Four**	**Grade Five**	**Status in terms of Spiral sequencing**
Our Environment (Chapter 1)		Our Environment (Chapter 1)	PARTIALLY Spirally sequenced
		Environmental Pollution (Chapter 2)	
Water for Life (Chapter 4)		Water for Life (Chapter 3)	PARTIALLY Spirally sequenced
Air (Chapter 6)	Content on properties of Air in the chapter named Matters (Chapter 6)	Air (Chapter 4)	PARTIALLY Spirally sequenced
	Weather and Climate (Chapter 10)	Weather and Climate (Chapter 11)	PARTIALLY Spirally sequenced
		Climate Change (Chapter 12)	
	The Universe (Chapter 8)	The Universe (Chapter 8)	PARTIALLY Spirally sequenced
Different Types of Matter (Chapter 3)	Matters (Chapter 6)	Energy and Matter (Chapter 5)	PARTIALLY Spirally sequenced
Energy (Chapter 9)		Energy and Matter (Chapter 5)	PARTIALLY Spirally sequenced
Food (Chapter 7)	Food (Chapter 4)	Food for Good Health (Chapter 6)	PARTIALLY Spirally sequenced
Hygiene (Chapter 8)	Healthy Lifestyle (Chapter 5)	Healthy Lifestyle (Chapter 7)	PARTIALLY Spirally sequenced
Introduction to Technology (Chapter	Technology in Our Life (Chapter 9)	Technology in Our Life (Chapter 9)	PARTIALLY Spirally sequenced

10)			
Information and Communication (Chapter 11)	Information in Our Life (Chapter 12)	Information in Our Life (Chapter 10)	PARTIALLY Spirally sequenced
Population and Natural Environment (Chapter 12)	Population and Natural Environment (Chapter 13)	Population and Natural Environment (Chapter 14)	PARTIALLY Spirally sequenced
Living and Nonliving Things (Chapter 2)	Living Things and Environment (Chapter 1) Plants and Animals (Chapter 2)		NOT Spirally sequenced
Soil (Chapter 5)	Soil (Chapter 3)		NOT Spirally sequenced
	Natural Resources (Chapter 7)	Natural Resources (Chapter 13)	NOT Spirally sequenced
	First Aid (in the chapter named Life safety and First Aid, Chapter 11)		NOT Spirally sequenced AT ALL
		Changes during the Puberty (in the chapter named Healthy Lifestyle, Chapter 7)	NOT Spirally sequenced AT ALL
		Concept and nature of Science and Scientific investigation (in the chapter named Technology in Our Life, Chapter 9)	NOT Spirally sequenced AT ALL

From Table 9, For example, there are contents on 'Matter' in the science textbooks of grade Three (Chapter 3), grade Four (Chapter 6) as well as grade Five (Chapter 5). The grade Three textbook contains concept, properties (very briefly) and three states of matter while the grade Four textbook contains properties of matter (detailed) including volume and weight. On the other hand, the grade Five textbook contains molecular structure of matter and its role in determining the state of matter. In this case, the responses against the key questions of spiral sequencing are shown in Table 10.

Table 10: Response against KQs in the case the of 'Matter'

Key Question No	Key question	Response (in the case of 'Matter')
1	Does the concept appear in multiple grades (within Primary level)?	**Yes**
2	Has the learning from previous grade(s) on the same concept been referred in the textbook?	**No**
3	Has the learning from previous grade(s) on the same concept been used as the base of future learning?	**No**
4	Have the breadth and complexity of the concept been increased from the previous grade?	**Yes**

So it has been found that 'Matter' has got a combination of two affirmative and two negative responses (affirmative responses against Key Questions no 1 and 4 and negative responses against Key Questions no 2 and 3) against the four key questions of spiral sequencing as mentioned in the Methodology. So it has been considered as partially spirally sequenced.

On the other hand, for example, both grade Three and grade Four contains a chapter named 'Soil'. The textbook of grade Three contains content on components of soil, types of soil and soil and crops while the textbook of grade Four contains content on the importance of soil, growth of soil fertility and soil pollution. In this case, the responses against the key questions of spiral sequencing are shown in Table 11.

Table 11: Response against KQs in the case of 'Soil'

Key Question No	Key question	Response (in the case of 'Soil')
1	Does the concept appear in multiple grades (within Primary level)?	**Yes**
2	Has the learning from previous grade(s) on the same concept been referred in the textbook?	**No**
3	Has the learning from previous grade(s) on the same concept been used as the base of future learning?	**No**
4	Have the breadth and complexity of the concept been increased from the previous grade?	**No**

Here, 'Soil' as contenthas negative responses against most of the key questions (Key Question no 2, 3 and 4).So it has been considered as not spirally sequenced.

Table 9 also shows that in a very few cases, contents are not spirally sequenced at all.Content on 'First Aid', 'Changes during the Puberty' and 'Concept and nature of Science and Scientific investigation'appears only once within the Primary level. In these cases, the responses against the key questions of spiral sequencing are shown in Table 12.

Table 12: Response against KQs in the case of 'First Aid', 'Changes during the Puberty', 'Concept and nature of Science and Scientific investigation'

Key Question No	Key Question	Response
1	Does the concept appear in multiple grades (within the Primary level)?	**No**
2	Has the learning from previous grade(s) on the same concept been referred in the textbook?	**No**
3	Has the learning from previous grade(s) on the same concept been used as the base of future learning?	**No**
4	Have the breadth and complexity of the concept been increased from the previous grade?	**No**

Since there are negative responses against all of the four key questions of spiral sequencing, these have been labelled as not spirally sequenced at all.

4.2Discussion

This study has found that for sequencing contents within a chapterin the Primary science curriculum and textbooks, no principle of sequencing contents as described by Print (1993) is followed in most cases while 'Simple to Complex' principle has been followed in some cases. In the case of intergrades vertical sequencingof contents, 'Simple to Complex' has been followed or partially followed in most cases whereas no principle is followed in the rest. Besides, 'Spiral sequencing' has been attempted in most cases but it is done only partially and rest of the contents is not spirally sequenced. So it is quite evident that Primary science curriculum has tried to sequence contents logically by following several principles but this practice is not consistent throughout the curriculum. Therefore, Primary science curriculum can be described as not completely well organized in terms of sequence of contents.

Literatures acknowledge the importance of well-sequenced content in the curriculum. Edith Cowan University (2001) described the principles described by Print (1993) as 'logical approach' and 'increasingly acceptable criteria for sequencing content'. Rezat et al. (2021) as well as the Education Bureau of the government of the Hong Kong (2016) stated that appropriate and logical sequence of content plays an important role in ensuring effective and successful learning. According to Stroganov and Tsvetkov (2020), contents should be sequenced based on logical connectivity as it is helpful for the learners.A meaningful and logical sequence has positive impacts on learners as it helps them to comprehend and retain the content better (Malamed, 2016). Besides, Harden (1999) and Johnston (2012) both described spiral sequencing as beneficial because knowledge is solidified with every revisit to the core concept and it allows logical progression from simpler to more complex content. According to Tirol (2022), spiral sequencing is a smart and advanced approach especially for science curriculum. A recent study by University of Detroit Mercy (2022) reportedabout the positive impact of spiral sequencing as it has been found that it helped students in learning more complex contents.Johnston (2012) asserted that spiral sequencing involves building new learning on prior learning. It ensures holistic understanding of concept as it involves active learning of students and use of prior experience to fit new information into the pre-existing structure (Rhalmi, 2011; Tirol, 2022). Johnston (2012) added that spiral sequencing improves students' performance and ensures learning for almost every student as it incorporates many research based approaches from cognitive science. As the Primary science

curriculum is not completely well-sequenced because of its lacking in following any principle in several parts and is not fully aligned with spiral sequencing in most cases, it may hamper students' learning when mentioned aspects are concerned.

5. Conclusion and Recommendations

This study has found that the current Primary science curriculum and textbooks of Bangladesh are not fully well-organized in terms of sequencing contents as no principle has been followed in most cases. These findings have implications for curriculum developers, textbook writers and teaching practitioner. Government has already taken initiatives to develop a new curriculum for the Primary level in Bangladesh. This study recommends that curriculum developers may make efforts to make the science contents well-organized in the curriculum by following the principles of sequencing and then textbooks needs to be written accordingly by the textbook authors. Future and current teachers may find the findings helpful for having a better understanding of sequencing science contents effectively in their teaching.

Consent

As per international standards or university standards, respondents' written consent has been collected and preserved by the author(s).

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