Memory Retention and Retrieval in K–12 Spiral Progression Approach in Science: A Curriculum Issue Analysis

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Retrieval of students' prior knowledge, or memory, as needed to connect to the new lesson of higher complexity is oftentimes a problem encountered by teachers in the implementation of the K–12 Science curriculum using the spiral progression approach. Using the theoretical lenses of the intended curriculum considering J. Bruner's spiral curriculum model with the Integrated Model of Progression in Science as well as the multistore model of memory, implications regarding the implementation of the currently implemented curriculum are generalized, and a set of challenges are posed for all stakeholders in education in a way to strengthen and/or improve the new curricular reform of the country. Ensuring a meaningful and lifelong learning experience in the students through authentic performance tasks is important as it is associated with the long-term memory development of the learner that guarantees memory retrieval whenever it is needed. This is vital towards a more successful implementation of the spiral curriculum which remains to be a great challenge to all facilitators of learning — the teachers. This paper offers potential interventions for the teachers, the students, the school principal, the curriculum review committee, and the parents which will contribute to strengthening or improving the country's new curricular reform as well as its implementation aspect.

Keywords: Spiral Progression, Spiral Curriculum, Memory Retention and retrieval

INTRODUCTION

Rationale of the Study

One of the significant features in the new basic education curricular reform, the K–12 curriculum, is ensuring an integrated and seamless learning through spiral progression (Jugar, 2017) in Science and Mathematics disciplines. Focusing on Science, the concepts and skills in the four core domains of learning in Life Sciences, Physics, Chemistry, and Earth Sciences are presented in a spiral progression with increasing levels of complexity from Grades 3 to 10 which pave the way to a much deeper understanding of core concepts. This setup is quite different from the previous curriculum whereby students in the different year levels are taught in specific domains of learning, i.e., learning Earth Sciences in the freshmen year, Life Sciences in the sophomore year, Chemistry in the junior year, and Physics in the senior year or fourth year in high school. The spiral approach in Science in the new curricular reform that was officially launched in 2013 through the RA 10533 or the Enhanced Basic Education Act allows an integration of concepts across Science topics and other disciplines which is expected to lead to a more meaningful understanding of concepts and its application to real-life situations in the students (DepEd Curriculum Guide, 2016). This is one promising feature of the currently implemented curriculum. Oftentimes, however, it is a common scenario for teachers expressing concerns about not materializing their prepared instructional plans as intended due to having students without the necessary prerequisite knowledge to connect to the lesson at hand, thereby, affecting the instructional time and focus of the teacher. Then, it is a valid point to ask whether the spiral progression approach in Science teaching in the K–12 curriculum is effective as theoretically intended to result to understanding the concepts in depth and in breadth or, simply, that it is moving towards the opposite direction of having shallow learning considering the students' memory retention and memory retrieval issues. It is in this context that this study is done to analyze the implemented curriculum using some theoretical lenses to draw out significant interventions for the improvement of Science teaching and Science learning in general. This study is considered to be relevant

and timely since the K–12 Science curriculum is still in its early transition period and potential interventions can be articulated to do further fine tuning in Science teaching in full attainment of the primary aims of Science education, i.e., to develop Science literacy among the students which will prepare them to be informed and become participative citizens who can make informed judgments and decisions regarding the applications of scientific knowledge that are of social, health, or environmental impacts.

Specifically, this paper seeks to answer the following queries:

1. With Chemistry discipline as the point on case in the JHS-Science curriculum, are the provisions aligned with the intended curriculum in terms of its scope and sequence as well as the learning competencies using the Integrated Model of Progression in Science incorporating the spiral curriculum model of J. Bruner as theoretical lens?
2. With the Junior High School (JHS) K–12 Science curriculum using the spiral progression approach, what implications can be generalized in relation to memory retention of students and subsequent retrieval of prior knowledge using the multistore model with the working model of memory as theoretical lens?
3. What possible interventions can be done to strengthen the implementation of the spiral progression approach in teaching Science as practiced?

It is hoped that this paper will serve to inform all stakeholders in education (the learners, the teachers, the school administrators, the curriculum review committee, and the parents) towards a more successful endeavor in the implementation of the K–12 Science curriculum in the Philippines.

Review of Related Literature

The spiral progression approach, inspired by the spiral curriculum model of Jerome Bruner (1960), is described by Harden and Stamper (1999) to have an iterative revisiting of topics, subjects, or themes that are logically sequenced in successive levels of difficulty in which each return visit of the basic concepts brings (1) new knowledge or skill relating to the theme or topic, (2) more advanced application of areas previously covered, and (3) an increased proficiency or expertise through further practical experience. Bruner (1960, cited in Harden & Stamper, 1999) proposed that spiral progression helps learners organize their knowledge, connect what they know, and master it and that teachers should make sure that, in preparing lessons, learners are able to revisit previously encountered topics. On the same vein, Corpus (n.d.) added that, as more facts and principles on each topic are encountered, students' understanding grows in breadth and depth creating a metaphorical spiral. As Kabara (1972, cited in Harden & Stamper, 1999) put it, spiral curriculum is like a spiral of information with productive repetition and constant reinforcement of learned skills and facts.

One may ask what triggers the shift in the curriculum in teaching Science and Math in the country from the usual disciplinal approach that involves teaching a specific area or domain by the grade level throughout the high school program in the old curriculum. The last participation of the Philippines in international surveys such as the 2003 Trends in International Math and Science Study (TIMSS) in the account of Marbella (2014) showed that the Philippines ranked 34th out of 38 countries in high school-II Math and 43rd out of 46 countries in high school-II Science, and for the Grade 4 level, the Philippines ranked 23rd of 25 participating countries in both Math and Science subjects. Additionally, based on the result involving only the science high schools in the country participating in the advanced Math category in TIMSS in 2008, the Philippines ranked lowest among 10 countries. This could be the triggering point for the shift to improve Science and Math proficiency among Filipino learners.

Corpus (n.d.) considered the spiral curriculum to be more advantageous compared to the traditional disciplinal approach in the old curriculum because of the integrative and multidisciplinary nature of teaching, thereby, ensuring a vertical articulation and seamless progression of competencies; the end result of which is mastery of concepts and improved retention. This account is supported in the argument of Herr as cited in Johnston (2012) that the reason of a stronger performance of students in Chinese schools can be attributed to their revisit of each of the basic sciences each year compared with that of students in some schools in the United States whose curriculum is "layered" that is, studying one

subject per year. Duncan (2009) stressed that learning progressions hold the promise of transforming Science education by providing better alignment between curriculum, instruction, and assessment. The aforementioned positive outcome of having the spiral progression approach in teaching Science and Math, as it is implemented in the Philippines in 2013, must be the main basis of the Department of Education to do the shift from the usual disciplinal or layered approach in the old curriculum to the spiral progression approach.

Resurreccion and Adanza (2015) noted, however, on the average that teachers in selected private and public high schools in Cavite devote less than 30 minutes of instructional time across an entire year to 70% of the topics and that many students fail to master important concepts because of the current curriculum in its first few years of implementation. Also, in the dissertation work of Hongcuay (2016), reservations of the teachers on the use of spiral progression approach have been noted. Firstly, ineffectiveness of the new setup is possible especially when students did not learn the intended concepts in the previous grade level leaving no choice for the teachers to do repeat teaching sessions (Bea in Hongcuay, 2016) which has an implication on the accomplishment of the expected coverage of topics and learning competencies within the quarter. Secondly, the new setup may lead to shallow understanding especially when the Science concepts are taught as chunks of different concepts and when there is no integration between Science disciplines from the previous learning to the current learning (Carl in Hongcuay, 2016) in every grading period, and throughout the whole course after all, these disciplines are then part of a big whole, which is Science (Anne in Hongcuay, 2016).

From the accounts mentioned above, the issue on students' memory retention and subsequent retrieval of information of their prior knowledge gained in the previous years is the main focus of this paper in relation to the implementation of the spiral progression approach in Science curriculum. Theoretical lenses are used to generalize implications for alignment and/or gap and to relate improved retention and mastery of concepts in the new approach used in teaching Science. Potential interventions to improve the implementation aspect can be deduced from the analysis.

Some theoretical lenses that are found relevant in the study include the following:

Theoretical Lens No. 1:

The Integrated Model of Progression in Science with Bruner's Spiral Curriculum Model

Below is the original account of Jerome Bruner in 1960:3–4 (cited in Braund, 2008) regarding spiral curriculum as the basis for the use of spiral progression approach in the K–12 Science curriculum:

> "I was struck by the fact that successful efforts to teach highly structured bodies of knowledge like Math, Physical Science, and even the field of History often took the form of a metaphoric spiral in which at some simple level a set of ideas or operations are introduced in a rather intuitive way and, once mastered in that spirit, were then revisited and reconstructed in a more formal and operational way, then being connected with other knowledge, the mastery at this stage then being carried one step higher to a new level of formal or operational rigor and to a broader level of abstraction and comprehensiveness. The end stage of this process was the eventual mastery of the connectivity and structure of a large body of knowledge."

Some key features in the model as depicted in the works of Johnston (2012) and Harden and Stamper (1999) include the following: (1) the topics are revisited several times throughout their school career, which for every visit, it can bring new knowledge or skill relating to the theme or topic; more advanced application of areas previously covered, and an increased proficiency or expertise through further practical experience; (2) the complexity of topics or themes increases; (3) new learning has a relationship with old learning and is put in context with the previous learning. The favorable outcome of which is increasing competence in the students. These aforementioned features are found incorporated in the Integrated Model of Progression in Science of Qualter et al. (1990, cited in Braund, 2008) with emphasis on a two-dimensional view of progression in Science learning, i.e., (1) being associated with the learning and understanding of concepts and (2) with the procedural understanding that is more on skills and process skills. These comprise the cognitive skills required to solve problems through practical activity (Gott & Dugan, 1995, cited in Braund, 2008), as illustrated in Fig. 1.

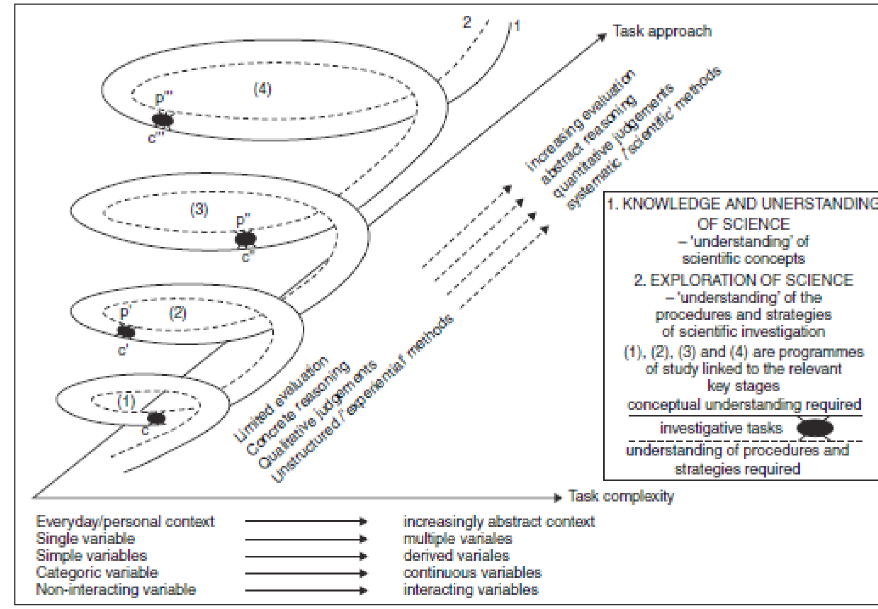

Figure 1. The Integrated Model of Progression in Science (Qualter et al., 1990:48, cited in Braund, 2008).

The model emphasizes on learning progression not just of conceptual understanding which includes the learners' ability to draw on the known facts, laws and theories of science, and models that have been devised to help explain a phenomenon to reach progressively more sophisticated levels of understanding of how the world works, but also the procedural understanding, that is, the thinking behind the doing relating to the skills and process skills in Science learning. Further, the model depicts four turns of a double spiral parallel to each other with each turn representing one of the key stages of the National Curriculum and that the two spirals representing conceptual (c) and procedural (p) understandings are linked by an 'experiential blob' representing practical experiences alluding to the fact that the level of the concept underpinning each investigation and the procedures necessary to carry out progress in terms of demand and complexity are in line with the content of the program of study for each key stage.

Specifically on the progression of process skills in procedural understanding, the literature adapted from Teacher Training Agency (2000b, cited in Braund, 2008) is found relevant in this paper as it proposes the following 'from–to' statements as inclusion on what to teach in the secondary level to ensure that learners of ages 11–19 will have to progress, as follows:

- from understanding of accepted scientific knowledge in a few areas to understanding in a wide range of areas including, where relevant, the links between areas
- from describing events and simple phenomena to explaining events and more complex phenomena
- from explaining phenomena in terms of their own ideas to explaining phenomena in terms of accepted scientific ideas or models
- from a study of observable phenomena to increasing use of formal and generalized ideas
- from an essentially qualitative view of phenomena to, where appropriate, a more quantitative and mathematical view
- from seeing Science as a school activity to understanding the nature and impact of scientific and technological activity beyond the classroom
- from experiment and investigation involving simple scientific ideas to those in which
  - more complex scientific ideas may be drawn upon
  - more than one variable may be pertinent
  - decisions have to be made about strategies and instruments for data collection
  - data is interpreted and evaluated in terms of strengths and limitations

And considering the seven process skills identified by Harlen (1997, cited in Braund, 2008), the illustration in Table 1 below shows the from–to statements indicating process skills progression being classified based on five subthemes which are (1) seeking patterns and describing relationships in results, (2) identifying and explaining anomalous results, (3) appreciating and explaining the degree of reliability in findings, (4) relating predictions to outcomes and suggesting scope for further enquiry, and (5) explaining findings in terms of existing or developing scientific knowledge and understanding. This is found relevant in the discussion of spiral progression in the implementation of K–12 Science curriculum.

Table 1. *'From–to' statements for seven of the process skills in science.*

(From)	**(To)**
Observation	
• Describing objects, phenomena and events in some detail. • Understanding that human senses sometimes need assistance. • Making repeated observations to check results.	• Justifying why and saying how observations are made. • Choosing appropriate aids to make observations. • Linking quality and quantity of observations to concepts of evidence.
Measurement	
• Measurements of basic quantities (mass, length, time, volume, temperature). • Choosing equipment suitable for the type of measure to be made. • Reading major scale divisions.	• Repeated and accurate measures of basic and derived quantities (for example, velocity/rate). • Choosing the appropriate measuring range of a piece of equipment. • Reading minor scale divisions.
Predicting	
• Making a statement of based on limited expectation scientific reasoning. • Giving some idea of the sequence, order or magnitude of events or effects.	• Justifying predictions in terms of science ideas. • Using evidence to give reasoned predictions of the sequence, order or magnitude of events or effects.
Planning	
• Identifying some effect factors and realizing that one has to be changed while others are controlled.	Identifying most of the key factors that might have an effect. Selecting factors to control.
Recording and communicating (graphs)	
• Realizing when line graphs and bar graphs should be used. Constructing graphs with some help. • Beginning to decide on axes and scales for graphs.	• Constructing line graphs. • Choosing appropriate axes and scales for graphs.
Interpreting evidence	
• Recognizing simple trends and patterns in results.	Describing detailed patterns in results, for example, changes over time.
Evaluating evidence	
• Knowing when some results do not fit the pattern and beginning to wonder why. • Realizing that single results might not occur again. • Beginning to reflect on experimental design.	• Identifying and explaining anomalous results. • Linking reliability of findings to the spread of readings. • Linking reliability to experimental design where appropriate.

Source: Braund et al., 2004: 2–3.

The currently implemented K–12 Science curriculum based on the May 2016 edition will then be viewed using Theoretical Lens #1 on spiral curriculum and progression model, i.e., with (1) having a repetitive nature, (2) with increasing level of complexity, and the emphasis on (3) whether there is an inclusion of progression of both the conceptual and procedural understanding stressed in the integrated model of progression.

Theoretical Lens No. 2

The Multistore Model of Memory with the Working Model of Memory in Relation to Memory Retention and Retrieval Mechanism

"Life without memory is no life at all. Our memory is our coherence, our reason, our feeling, even our action. Without it, we are nothing." The given statement was adapted from Bunuel (1983, cited in Mullally & Maguire, 2014). Learning the concepts and the process skills in science does require students' memory at work. It is the cerebral cortex, i.e., the outer layer of the cerebrum component of the human brain that is considered the seat of complex thought (Lewis, 2016) which in this paper can be related to the discussion on memory retention. In particular, the cerebral cortex consisting of four different lobes, it is the temporal lobe with the hippocampus and amygdala parts that play roles in the person's memory and emotion, respectively. As to the general mechanism of encoding of information, storing it, as well as the retrieval aspect of memory, it is illustrated in Fig. 2.

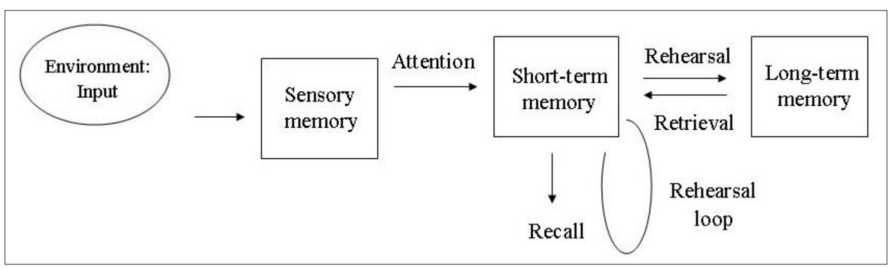

Figure 2. The multistore model of memory (Atkinson and Shiffrin, 1968, cited in Mcleod, 2007).

As shown, any information that is detected by the sense organs enters the sensory memory. With attention, the information gets processed, and this enters as an encoded message to the short-term memory (STM) storage which is accordingly transferred to the long-term memory (LTM) upon rehearsal or repetition of information (Atkinson & Shiffrin, 1968, cited in Mcleod, 2007). This information as LTM is known to last for a lifetime as shown in Table

2. Significantly, as depicted in the model, without the maintenance rehearsal (through repetition of information), the information is simply forgotten and lost from STM store through the process of displacement or decay. The model is of great significance in this paper to relate to memory retention of students as well as retrieval mechanism of information previously gained for further building up of knowledge in the higher grade level. Other than maintenance rehearsal is the recognition of elaborative rehearsal in the account of Shiffrin (2003, cited in Mcleod, 2007) in agreement to what was proposed by Baddeley and Hitch (1974, cited in Mcleod, 2007) in their working model of memory indicating that elaborative rehearsal also lead to a better recall of information. The key factor for better recall or retrieval of information is when there is more meaningful analysis that is involved, for example, images, thinking, and associations of information. And the use of visualization techniques and multimedia approaches in content delivery will facilitate minimal cognitive distraction and improved attention, thereby, promoting mastery of concepts and improved memory retention. Additionally, Baddeley and Hitch (1974, cited in Mcleod, 2007) indicated that motivation, effect, and strategy like having mnemonics are also being considered as factors that lead to long-term memory development.

On the other hand, it was also recognized that the role of rehearsal is not necessarily the only way to transfer information from STM to LTM store, that is, it is not the only way to let the memory lasting at the LTM storage. In fact, there are pieces of information or events that one could recall without any rehearsal at all, like swimming, yet unable to recall information which are being rehearsed, like reviewing one's notes for an examination (Mcleod, 2007).

Table 2 shows the distinction between STM and LTM in terms of encoding, storing, and its duration.

Table 2. *Distinction of the Memory-stores in relation to the multistore model of memory.*

Memory Stores	Characteristic Parameters		
	Encoding	Capacity	Duration
Sensory memory	Sense specific (e.g., different stores for each sense); all sensory experiences	(v. large capacity)	¼ to ½ second
Short-term memory (STM)	Mainly auditory	7 (+/−) 2 items	0–18 seconds

Long-term memory (LTM)	Mainly semantic (but can be visual and auditory)	Unlimited	Unlimited

Although both the short-term memory (STM) and long-term memory (LTM) are being regarded of equal importance in one's personal mental being, LTM will receive greater attention to be able to relate to the students' memory retention and retrieval mechanism in Science learning. It is thus important to take note on the taxonomy of LTM which is classified into different types, namely, the declarative (as explicit LTM) to which the episodic memory (i.e., memories of events) and semantic memory (i.e., memories of facts) belong and the nondeclarative (or implicit LTM) which includes the procedural memory (i.e., memories of skills and habits) and the simple classical conditioning (i.e., memories on emotional responses and skeletal musculature), among others in Squire and Zola-Morgan (1996, cited in Mullally & Maguire, 2014). This is depicted in Fig. 3.

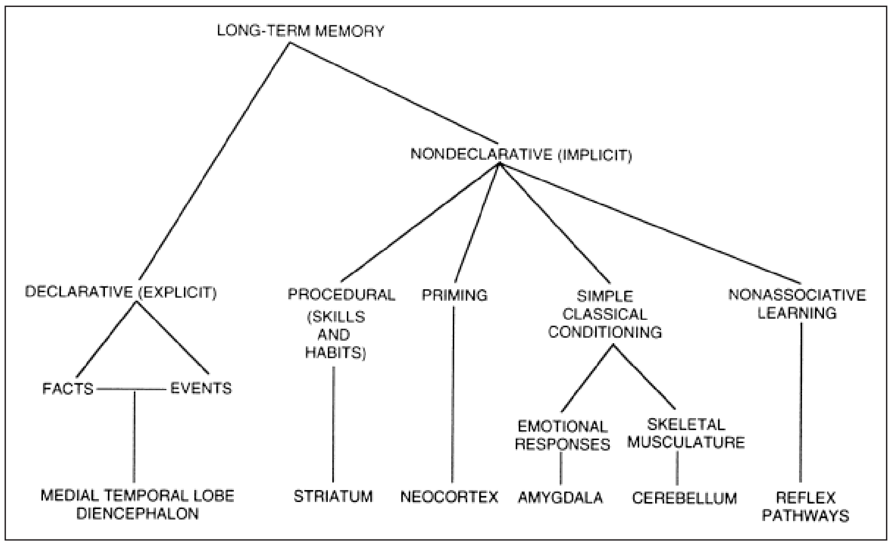

Figure 3. A Taxonomy of Long-term Memory (LTM) with the Brain Structures (adapted from Squire & Zola-Morgan, 1996, cited in Mullally & Maguire, 2014).

The general ways to facilitate transfer of STM to the LTM store as LTM, are the following: (1) the rehearsal factor — as maintenance or elaborative; (2) motivation based on a meaningful learning experience; (3) making consolidation of knowledge, i.e., establishing connections or making links of gained input; and

(4) the use of similes, metaphors, analogies, and other short mnemonics. All these can be helpful in improving memory retention which is associated with long-term memory development. It then appears that our brains are better at retaining information when it is structured, context-based, and goal-oriented. Additionally, it has been generalized in Nagi (2015) that, whenever feasible, visualization techniques and use of multimedia approach in content delivery are encouraged for use as they could help minimize cognitive distraction and, thus, improve retention. Furthermore, Immordino and Damasio (2007, cited in Nagi, 2015) indicated the importance of linking knowledge and reasoning with emotional implications and learning to establish meaning and motivation. This makes it become significant in the real world and, therefore, improve memory retention. These are for considerations to strengthen the implementation aspect of the K–12 Science curriculum.

The study habits of the learners as well as the teachers' current practices in facilitating Science learning with the students can be viewed through Theoretical Lens No. 2.

Theoretical Lenses 1 and 2 will be used to spot check for alignment and/or gap in the currently implemented curriculum, particularly in the study of matter (Chemistry discipline); to reconcile on some felt concerns in the implementation aspect of the spiral curriculum in Science, e.g., in the manifestation of students' inability to recall and relate prior knowledge as needed to link to the next lesson; and above all, to offer interventions based on some findings in this curriculum issue analysis to help in the implementation aspect of the five-year-old K–12 Science curriculum using the spiral progression approach in Science teaching in the country towards a more fruitful gain, i.e., to produce Filipino learners who are scientifically, technologically, and environmentally literate; one who is (1) a critical/creative problem solver, (2) a responsible steward of nature, (3) an innovative/inventive thinker, (4) an informed decision maker, and (5) an effective communicator (Department of Education, 2012, cited in Ferido, n.d.).

The Currently Implemented K–12 Science Curriculum

As stated in the conceptual framework of the K–12 Science curriculum (2016) that both the science content and science processes are being intertwined in the curriculum, this is theoretically consistent with the Integrated Model of Progression in Science by Qualter, et al. (1990, cited in Braund, 2008). It is worthwhile to show the topic coverage, as well as the learning competencies in the study of matter (in Chemistry area) as reflected in the K–12 Science curriculum, May 2016 edition for the analysis aspect. Fig. 4 shows the topic coverage progression from Grades 7 to 10 in the Junior High School program.

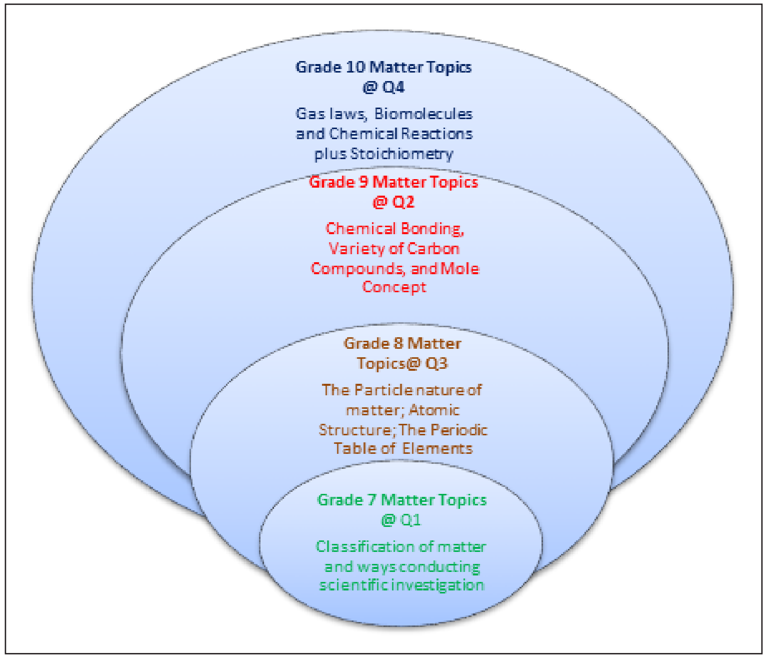

Figure 4. Sequence of Topics in Chemistry Discipline from Grades 7 to 10.

In terms of the grade-level topic-coverage from Grades 7 to 10, the degree of complexity of the topics increases with the topics in the upper grade level being highly connected with the ones at the lower grade level. From the topics depicted in Fig. 4, it would seem very difficult for the students to learn chemical reactions (as one of the topics in Grade 10) without the necessary prior knowledge on the atoms of elements in the periodic table (as a Grade-8 topic) and the chemical bond formation (as a Grade-9 topic), and the basic concepts about the atom in the study of complex molecules and its reactivity need to be revisited every now and then. The curriculum in the study of matter considering the detailed scope and sequence with the learning competencies will be viewed using the Integrated Model of Progression in Science. Table 3 shows the currently implemented curriculum based on the May 2016 edition

of the K–12 Science curriculum.

Table 3. *The K–12 Science Curriculum in the Study of Matter (Chemistry). (Lifted from the May 2016 ed. of K–12 Science Curriculum Guide)*

Scope and Sequence of Topics and Learning Competencies and the Time-table of Engagement from Grades 7 to 10

Grade 7 Matter at Quarter 1

Grade-level Std.: The learners can distinguish mixtures from substances through semiguided investigations. They realize the importance of air testing when conducting investigations.

Topics:

Doing Scientific Investigations

1. Ways of acquiring knowledge and solving problems;
2. Diversity of Materials in the Environment
   2.1 Solutions
   2.2 Substances and Mixtures
   2.3 Elements and Compounds
   2.4 Acids and Bases
   2.5 Metals and Nonmetals

Learning Competencies (LCs): *The learners should be able to...*

1. describe the components of a scientific investigation;
2. investigate properties of unsaturated or saturated solutions;
3. express concentrations of solutions quantitatively by preparing different concentrations of mixtures according to uses and availability of materials;
4. distinguish mixtures from substances based on a set of properties;
5. recognize that substances are classified into elements and compounds;
6. investigate properties of acidic and basic mixtures using natural indicators; and
7. describe some properties of metals and nonmetals such as luster, malleability, ductility, and conductivity.

Grade 8 Matter at Quarter 3

Grade-Level Std.: The learners can explain the behavior of matter in terms of the particles it is made of. They recognize that ingredients in food and medical products are made up of these particles and are absorbed by the body in the form of ions.

Topics:

1. The Particle Nature of Matter
   1.1 Elements, Compounds, and Mixtures
   1.2 Atoms and Molecules
2. Atomic Structure
   2.1 Protons
   2.2 Neutrons
   2.3 Electrons
3. Periodic Table (PT) of Elements
   3.1 Development of the PT
   3.2 Arrangement of elements
   3.3 Reactive and nonreactive metals

Learning Competencies: *The learners should be able to...*

1. explain the properties of solids, liquids, and gases based on the particle nature of matter;
2. explain physical changes in terms of the arrangement and motion of atoms and molecules;
3. determine the number of protons, neutrons, and electrons in a particular atom;
4. trace the development of the periodic table from observations based on similarities in properties of elements; and
5. use the periodic table to predict the chemical behavior of an element.

Performance Standard

The learners shall be able to present how water behaves in its different states within the water cycle

Grade 9 Matter at Quarter 2
Grade-Level Std.: The learners can explain how new materials are formed when atoms are rearranged. They recognize that a wide variety of useful compounds may arise from such rearrangements.
Topics:
1. Chemical Bonding
    1.1 Ionic and Covalent Bonding
    1.2 Metallic Bonding
2. The Variety of Carbon Compounds
    2.1 Carbon Atoms
    2.2 Organic Compounds
3. Mole Concept
    3.1 Mass
    3.2 Moles
    3.3 Percentage Composition of a Compound

Learning Competencies: *The learners should be able to…*
1. explain the formation of ionic and covalent bonds;
2. recognize different types of compounds (ionic or covalent) based on their properties such as melting point, hardness, polarity, and electrical and thermal conductivity;
3. explain properties of metals in terms of their structure;
4. explain how ions are formed;
5. explain how the structure of the carbon atom affects the type of bonds it forms;
6. recognize the general classes and uses of organic compounds;
7. use the mole concept to express mass of substances; and
8. determine the percentage composition of a compound given its chemical formula and vice versa.

Grade 10 Matter at Quarter 4
Grade-Level Standard: Learners can explain the importance of controlling the conditions under which a chemical reaction occurs. They recognize that cells and tissues of the human body are made up of water, a few kinds of ions, and biomolecules. These biomolecules may also be found in the food they eat.
Topics:
1. Gas Laws
    1.1 Kinetic Molecular Theory
    1.2 Volume, pressure, and temperature relationship
    1.3 Ideal gas law
2. Biomolecules
    2.1 Elements present in biomolecules
    2.2 Carbohydrates, lipids, proteins, and nucleic acids
        2.2.1 Food Labels
3. Chemical reactions

Learning Competencies: *The learners should be able to…*
1. investigate the relationship between:
    1.1 volume and pressure at constant temperature of a gas
    1.2 volume and temperature at constant pressure of a gas
    1.3 explains these relationships using the kinetic molecular theory
2. recognize the major categories of biomolecules such as carbohydrates, lipids, proteins, and nucleic acids;
3. apply the principles of conservation of mass to chemical reactions; and
4. explain how the factors affecting rates of chemical reactions are applied in food preservation and materials production, control of fire, pollution, and corrosion.

METHODOLOGY

Literature searches of relevant studies of both global and local contexts

pertaining to spiral curriculum, spiral progression approach, principles of memory retention, and how the brain works from academic and peer-reviewed journals, periodicals, and dissertation works were done to shed light on the points of queries as mentioned above. Then, using the latest curriculum guide of the Department of Education which is the May 2016 edition of the K–12 Science Curriculum Guide, the curriculum issue analysis was conducted. The analysis generally focused on the Chemistry area in the K–12 Science Curriculum Guide considering its scope and sequence of topics and learning competencies as well as the instructional time or period of engagement within the school year of Chemistry classes in the study of matter from Grades 7 to 10 seeing the actual implementation on the angle of memory retention of the students using two theoretical lenses. These are as follows: (1) the spiral curriculum model of Bruner (1960) as cited in Harden and Stamper (1999) with the Integrated Model of Progression in Science of Qualter et al., 1990 as cited in Braund (2008) and (2) the multistore model memory with the working model of memory of Atkinson and Shiffrin (1968) and Baddeley and Hitch (1974), which are cited in Mcleod (2007). The first one will be used to analyze alignment and/or gaps in the current curriculum intended to improve the curriculum while the second one is used to relate to memory retention and the subsequent retrieval of students' prior knowledge to reenforce mastery of concepts in a classroom scenario. Generalizations on implications and challenges were deduced necessary to plot potential intervention to have a favorable outcome in the implementation of the K–12 Science curriculum.

CURRICULUM ISSUE ANALYSIS

A. Viewing the Scope and Sequence of the Implemented K–12 Science Curriculum on Matter (or Chemistry Area) through Theoretical Lens #1

Considering the lens of the intended curriculum with the use of the original account of Jerome Bruner on spiral curriculum as incorporated in the Integrated Model of Progression in Science based on Qualter et al. (1990, cited in Braund, 2008), the currently implemented curriculum is found to be consistent with it in the following aspects: (1) there is an increasing level of complexity in the topic-coverage as reflected in the learning competencies and (2) both conceptual understanding and procedural understanding are reflected to be intertwined in the grade level's learning competencies from Grades 7 to 10 in the study of matter. Table 4 shows the tabulated competencies that are labeled as conceptual (C) and procedural (P) understanding.

Table 4. *Classifying the Learning Competencies as either Conceptual or Procedural Understanding.*

Scope and Sequence of Topics and Learning Competencies and the Time-table of Engagement from Grades 7 to 10	**Remark** *(whether LCs falls under* ***Conceptual (C) or Procedural (P)*** *understanding based on the integrated model of progression as Lens 1)*
Grade 7 Matter at Quarter 1	
Grade-level Std.: The learners can distinguish mixtures from substances through semiguided investigations. They realize the importance of air testing when conducting investigations.	
Learning Competencies (LCs): *The learners should be able to…*	
1. describe the components of a scientific investigation;	C
2. investigate properties of unsaturated or saturated solutions;	P
3. express concentrations of solutions quantitatively by preparing different concentrations of mixtures according to uses and availability of materials;	P
4. distinguish mixtures from substances based on a set of properties;	C
5. recognize that substances are classified into elements and compounds;	C
6. investigate properties of acidic and basic mixtures using natural indicators; and	P
7. describe some properties of metals and nonmetals such as luster, malleability, ductility, and conductivity.	C
Grade 8 Matter at Quarter 3	
Grade-Level Std.: The learners can explain the behavior of matter in terms of the particles it is made of. They recognize that ingredients in food and medical products are made up of these particles and are absorbed by the body in the form of ions.	
Learning Competencies: *The learners should be able to…*	
1. explain the properties of solids, liquids, and gases based on the particle nature of matter;	C
2. explain physical changes in terms of the arrangement and motion of atoms and molecules;	C
3. determine the number of protons, neutrons, and electrons in a particular atom;	C
4. trace the development of the periodic table from observations based on similarities in properties of elements; and	C
5. use the periodic table to predict the chemical behavior of an element.	C
Performance Standard: The learners shall be able to present how water behaves in its different states within the water cycle	*P
Grade 9 Matter at Quarter 2	
Grade-Level Std.: The learners can explain how new materials are formed when atoms are rearranged. They recognize that a wide variety of useful compounds may arise from such rearrangements.	
Learning Competencies: *The learners should be able to…*	
1. explain the formation of ionic and covalent bonds;	C
2. recognize different types of compounds (ionic or covalent) based on their properties such as melting point, hardness, polarity, and electrical and thermal conductivity;	C
3. explain properties of metals in terms of their structure;	C
4. explain how ions are formed;	C
5. explain how the structure of the carbon atom affects the type of bonds it forms;	C
6. recognize the general classes and uses of organic compounds;	C
7. use the mole concept to express mass of substances; and	P
8. determine the percentage composition of a compound given its chemical formula and vice versa.	P
Grade 10 Matter at Quarter 4	
Grade-Level Standard: Learners can explain the importance of controlling the conditions under which a chemical reaction occurs. They recognize that cells and tissues of the human body are made up of water, a few kinds of ions, and biomolecules. These biomolecules may also be found in the food they eat.	
Learning Competencies: *The learners should be able to…*	
1. investigate the relationship between: 1.1 volume and pressure at constant temperature of a gas 1.2 volume and temperature at constant pressure of a gas 1.3 explains these relationships using the kinetic molecular theory	P
2. recognize the major categories of biomolecules such as carbohydrates, lipids, proteins, and nucleic acids;	C

3. apply the principles of conservation of mass to chemical reactions; and	P
4. explain how the factors affecting rates of chemical reactions are applied in food preservation and materials production, control of fire, pollution, and corrosion.	C

As shown in the learning competencies throughout the Junior High School program, there appeared to be more learning competencies, about 71% (or 17 out of 24) that are related to conceptual understanding and 29% (or 7 out of 24) that are related to procedural understanding. This finding indicates that Filipino students are taught more on the content or being introduced to more conceptual understanding. Further, although the competencies stated in the Grade 8 level are noted to be all for the development of conceptual understanding because of theory-based topics in the study of the particulate nature of matter, the atomic structure, and the periodicity of elements in the periodic table, the indicated performance standard as reflected in the curriculum guide reflects a procedural understanding development. Requiring the learners to present how water behaves in its different states within the water cycle entails the necessary procedural and higher order thinking skills.

In another angle, the process skills from Grades 7 to 10 cannot be generalized to be of the same progression in terms of degree of complexity as that of the specified from–to statements as shown previously in Table 1. It is worth noting also that the progression based on the seven process skills mentioned by Harlen (1997, cited in Braund, 2008) from Grades 7 to Grade 10 is not explicitly shown in the stated learning competencies in terms of the terminologies used like observing, measuring, predicting, planning, recording and communicating graphs, interpreting evidence, and evaluating evidence. However, this does not necessarily mean that the teachers are not incorporating such process skills development in their Science teaching. On the same vein, the spiral progression approach as used in the currently implemented curriculum seemed to be silent in terms of progression of ‘process skills’ in science based on the five subthemes which include the following: (1) seeking patterns and describing relationships in results, (2) identifying and explaining anomalous results, (3) appreciating and explaining the degree of reliability in findings, (4) relating predictions to outcomes and suggesting scope for further enquiry, and (5) explaining findings in terms of existing or developing scientific knowledge and understanding. Discussion

of these things is relevant in this analysis as it bears implications towards the improvement of the curriculum, as well as for the improvement of Science teaching. Since teachers are expected to develop the cognitive skills of the students to solve problems in the real world, then it should be both the science content and science processes that are to be taught among students. In training high school students to do research works, for example, like in the making of science investigatory projects, the cognitive skills are highly valuable. In fact, as noted from the listed learning competencies in Table 4, three of the seven competencies identified as procedural understanding are all related to making investigations. Therefore, the ‘from–to’ input on process skills progression in Table 1 is considered important among the teachers and the curriculum development and review committee. This is considered as one of the challenges in the implementation aspect of the spiral progression approach.

Regarding the spiral progression approach in teaching Chemistry in the current curriculum as reflected in the learning competencies from Grades 7 to 10 in Table 4, the Grade 7 learning competency number 5 (VII-LC#5) can be connected with deepened learning to VIII-LC #1, then to IX-LC#1, and eventually to X-LC#1 in the study of water classified as a substance (as knowledge gained in Grade 7); as a molecule that consists of 1-Hydrogen atom and 2-Oxygen atoms with each of the component atoms having a specific number of subatomic particles, i.e., the electrons in the different orbitals and shells while the protons and neutrons are found in the nucleus of an atom (as knowledge gained in Grade 8); and that the H and O atoms establish a covalent bond being both nonmetals to form a covalent molecule with a chemical formula, H2O which can be quantified in terms of percent Hydrogen composition and percent Oxygen composition in definite proportion (as knowledge gained in Grade 9); and knowing about the effects of changes in temperature and pressure changes on the gaseous water molecule which can be related to real-life experiences like cooking with the use of a pressure cooker relating to Kinetic Molecular Theory (as knowledge expected in Grade 10). Please see Fig. 5 to visualize the spiral progression approach in action in the study of water, for example, from Grades 7 to 10, in which it is the teacher who facilitates the making of connection of prior learning to the current lesson that goes spiraling in terms of level of complexity and degree of difficulty as one goes up to the next grade level. The teacher reconsolidates information to achieve meaningful learning experiences in the students that consequently leads to a lasting and meaningful learning among them.

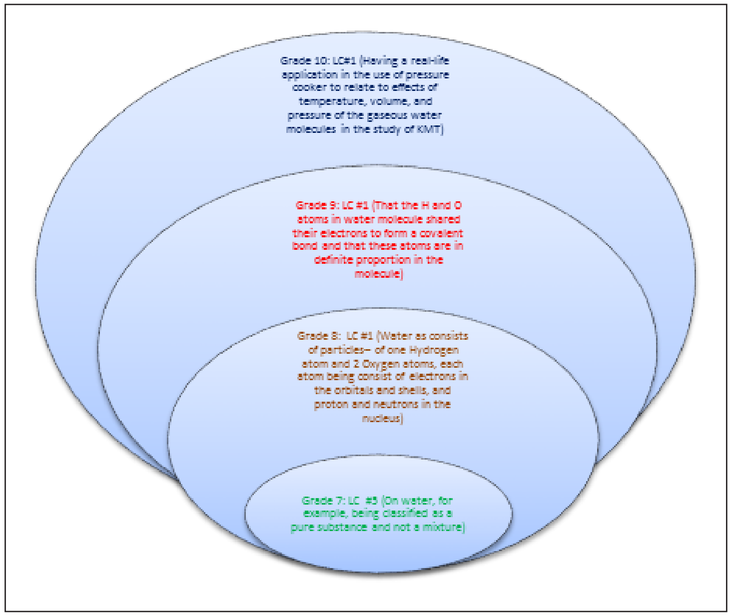

Figure 5. Relating the use of spiral progression approach in the study of water based on the expected learning of students from Grades 7 to 10.

Furthermore, although there is no clear indication that the basic concepts are revisited in each turn of the spiral, this does not necessarily mean that the teachers do not get back to the basic of things based on the previously learned and understood concepts and process skills in the lower grade level. Science teachers have that basic instincts to dig up information from previously learned concepts in order to connect to the new lesson; although, this also depends on the teacher's preparation factor in terms of pedagogical content knowledge. With the students' active role in the learning process and with the teachers' mindful facilitation of learning through eliciting prior knowledge and letting the students revisit some basic concepts, there can be more connection of things, thereby, maximizing learning in the students. Otherwise, repeat teaching sessions would be needed in cases that the majority (or all) of the students missed the important link towards the lesson at hand. The given scenario relates to memory retention and retrieval

of information concern of the learners which is also related to their study habits and significantly on how Science instruction is delivered to them.

Science teaching is expected to enforce improved memory retention and mastery of concepts in the learners. To do this is to learn Science concepts and skills not in chunks but by linking these to the new knowledge and by consolidating these throughout the whole course or program (Mcleod, 2007). Otherwise, the foundation of learning is weak, and that information will not stick in the long-term memory store. Simply put, information becomes easily forgotten. Consolidation is the term attributed to the hypothetical transformation of a memory trace from an unstable short-term memory to a stable long-term memory (Nagi, 2015). It can be generalized, then, that the challenge for improved retention and mastery of concepts in the students lies greatly on the teachers as facilitators of learning; however, this does not negate also the responsibility of the learners for maximized learning from their end.

B. Viewing the Time-element of Science Instruction from Grades 7–10 and relating this to Memory Retention and Retrieval using Theoretical Lens No. 2

Considering that Science is learned together with the other disciplines including Math; English; Filipino; Social Studies; TLE; Music, Arts, PE, and Health or MAPEH; and Values Education and considering as well that the four domains or areas in Science are being distributed each in the different quarters of the school year period, plus the students' engagement to cocurricular and extracurricular activities in the school, there can be a great possibility for students to forget important concepts in class. This can affect building up of knowledge in the next grade level to learn the same area of Science, Chemistry, for example. This situation, without any intervention, would cause further negative outcome, in ripple effect, towards learning the next higher level competencies in the succeeding grade level in the currently implemented curriculum. And this generally results to noncoverage of the whole set of lessons expected in the grade level because of repeat teaching session by the teacher to make connections of concepts to the lessons at hand.

Theoretical Lens #2 using the multistore model of memory of Atkinson and Shiffrin (1968, cited in Mcleod, 2007) depicted forgetfulness as a fact of life. This is one reason why teachers only cover a portion of the whole set of competencies in the grading period with the students not mastering some important concepts as related in the account of Resurreccion and Adanza (2015). The multistore model, together with the working model of memory, indicates the importance of maintenance and elaborative rehearsal, plus the motivation and effect strategy to facilitate the transfer of short-term memory (STM) information to the long-term memory (LTM) storage as a LTM with which the information can last a lifetime as reflected previously in Table 2. The crucial aspect of consideration about improved memory retention is the provision of meaningful learning experiences. Understanding big ideas and performance of authentic tasks related to a particular lesson in Science can lead to transfer of learning in the students, and this is associated with long-term memory. When students acquire meaningful learning experience in school or perhaps acquire learning the hardest way, involving an extreme level of emotions of happiness and/or sadness, the gained learning input in this sense becomes more sticking to the brain as long-term memory (which is lifetime). This has implication to retrieval of prior knowledge as needed to bridge to the new learning in a spiral progression approach. Ensuring learning to be more enduring and meaningful is another challenge that teachers must consider to strengthen the implementation of the spiral curriculum.

C. Viewing the Spiral Progression approach features in terms of the long-term memory development in the multistore model of memory

Repetition of information as one important feature in the spiral curriculum has been proposed to improve normal retention and retrieval processes of information (Nagi, 2015). The above description showed consistency with the process of developing the long-term memory in the multistore model of memory of Atkinson and Shiffrin (1968, in Mcleod, 2007). The law of exercise, as one of the conditions to maximize learning, in addition to the law of readiness and law of effect of Edward L. Thorndike (1874–1949), is found aligned with the repetitive nature to revisit basic concepts in learning the higher competencies in the spiral progression approach in teaching

Science. For example, students need to study by reading once, twice, or thrice and may write down notes and study the jotted summarized notes once, twice, or thrice, and may associate the concepts understudied with images, sound, or certain facts and events, and also to be more religious in doing practice exercises of problem-solving items, and he/she/they will surely gain an improved memory retention, i.e., mastery of concepts and skills, via the law of exercise or rehearsal (i.e., law of repetition of information or action). In fact, doing rehearsals, may it be mentally or physically for psychomotor development, will lead to long-term memory development. Theoretically, it can be generalized that undertaking the spiral curriculum in Science in the year 2012 is considered an intelligent decision of the Department of Education (DepEd) to increase Science proficiency in the Philippines, i.e., improved memory retention and retrieval of information. However, the challenge is always on the implementation aspect.

Relating to the Department of Education (DepEd) guidelines on the assessment and rating of learning outcomes (DepEd Order 73, 2012) in the implementation of the K–12 Science curriculum, the rationale behind the given weights in the grade for Knowledge, Process, Understandings, and Product/Performances which are 15%, 25%, 30%, and another 30%, respectively, must be that it ensures meaningful learning experiences in the learner in the K–12 Science curriculum. The DepEd defines knowledge level to refer to facts and information that the student acquires; process level, as skills or cognitive operations that the student performs on facts and information for the purpose of constructing meanings or understandings; understanding level, as the enduring big ideas, principles, and generalizations inherent to the discipline which may be assessed using the facets of understanding or other indicators of understanding which may be specific to the discipline; and products/performances, as the real-life application of understanding as evidenced by the students' performance of authentic tasks. The 21st century learners are then assessed, not on mere rote memory, but also on authentic tasks performances that is even given a much greater weight.

Table 5 summarizes the curriculum analysis using the theoretical lenses with its implications to the issue on memory retention and subsequent retrieval in the context of Science teaching and learning.

Table 5. *Summary of Findings with Implications of K–12 Science Spiral Curriculum using the Theoretical Lenses.*

Theoretical Lens	Description	Significant Findings	Implications
#1 The Integrated Model of Progression in Science with Bruner's Spiral Curriculum model	The Integrated Model of Progression in Science emphasizes on two-dimensional view of progression in Science learning, i.e., (1) being associated with the learning and understanding of concepts and (2) with the procedural understanding that is more on skills and process skills. Bruner's model relates (1) that the topics are revisited several times throughout the students' school career, which for every visit, it can bring new knowledge or skill relating to the theme or topic; more advanced application of areas previously covered; and an increased proficiency or expertise through further practical experience; (2) the complexity of topics or themes increases; and (3) new learning has a relationship with old learning and is put in context with the previous learning.	▪ Both the conceptual and procedural understanding are reflected to be intertwined in the grade level's learning competencies from Grades 7 to 10 in the study of matter, with about 71% (or 17 out of 24) that are related to conceptual understanding development and 29% (or 7 out of 24) that are being related to procedural understanding; ▪ There is a manifestation of increasing level of complexity in the topic-coverage as reflected in the learning competencies of the K–12 Science curriculum; and ▪ The Science topics in the upper grade level are related in context with the previous ones.	With consideration of having both the conceptual and procedural understanding developed in the K–12 spiral curriculum in Science as reflected in the learning competencies would mean that the implemented curriculum itself is not remissed at providing opportunities for lifelong learning experiences to the students. This shows that Science content and Science processes are intertwined in the K–12 curriculum which allows learning of Science process skills be learned in context. ▪ The Chemistry topics, for example, are expected to be revisited as one goes up in the academic ladder from Grades 7–10, and this is within the facilitating power of the Science teachers.
#2 Theoretical Lens #2 using the multistore model of memory of Atkinson and Shiffrin (1968, cited in Mcleod, 2007)	The multistore model, together with the working-model of memory indicates the importance of maintenance and elaborative rehearsal, plus the motivation and effect strategy to facilitate the transfer of short-term memory (STM) information to the long-term memory (LTM) storage	As reflected in the related studies, the instructional time and scope of lesson coverage is somehow affected with the implementation of K–12 spiral curriculum in Science. ▪ Resurreccion and Adanza (2015) showed that teachers in selected private and public high schools in Cavite devoted less than 30 minutes of instructional time across an entire year to 70% of the topics and that many students fail to master important concepts;	Having these observations that are not so favorable with the implementation would mean that there is something that needs to be done to enforce learning with the K–12 spiral curriculum in Science. Teachers need to facilitate learning in a way to result to a meaningful and lifelong learning; one that would ensure long-term memory development for a subsequent retrieval of information deemed needed to scaffold or connect to the lesson at hand.

The overall outcome of this theoretical analysis of the curriculum is for the increased proficiency in Science in the long run of implementation. To the query on why take the shift from the disciplinal approach to the spiral progression approach, the answer then lies on long-term memory development that is catered through the repetitive action (of going back to the basic concepts with a deepened and widened understanding of new knowledge that is related to the same subject matter or theme) in a spiral progression approach, plus the fact on the consolidating aspect of knowledge that allows transfer of STM to LTM storage as a retrievable LTM, thereby facilitating learning with increased proficiency in Science.

From the analysis using the theoretical lenses, it is clear that the spiral curriculum offers a great potential and opportunity for increased proficiency in Science. However, it is on the implementation aspect especially on the facilitation roles of the Science teachers that remains a great challenge to make Science learning more motivating, enjoyable, and more meaningful and lifelong that it would yield to real-life application of Science concepts and Science process skills. Immordino and Damasio's (2007, cited in Nagi, 2015) argument regarding the vitality of linking knowledge and reasoning with emotional implications and learning to establish meaning and motivation is strengthened in this curriculum issue analysis. This makes it become significant in the real world and therefore improves memory retention. These are for considerations to reinforce the implementation aspect of the K–12 Science curriculum.

CONCLUSION

With Chemistry as the point on case in the Junior High School Science curriculum using the spiral progression approach following J. Bruner's spiral curriculum model (with its repetitive feature of getting back to the basic concepts or skills that are arranged logically in successive levels of complexity from a lower-to-higher grade level), in itself, the implemented curriculum provides opportunities for improved retention and mastery of concepts as depicted in the multistore model of memory in the process of long-term memory development which paves the way for deepened and meaningful learning experiences of students. Theoretically, the spiral curriculum is a promising curriculum undertaken for Philippine education, however, a number of things were needed to be done in the implementation to include open-communication and close coordination among stakeholders, as well as personal open-mindedness to undertake some control measures to maximize learning in the students and be able to reap the best harvest of favorable outcomes in the use of Spiral progression approach in Science.

The use of theoretical lenses of the intended curriculum helped in visualizing some interventions that can be done in order to strengthen and improve the implementation of the new curricular reform in the country. The teachers' role to facilitate learning among the students in a more meaningful and integrative way is considered crucial and the most challenging aspect in the implementation of the K–12 spiral curriculum in Science which potentially improves students' memory retention and subsequent retrieval of information in Science learning.

IMPLICATIONS AND CHALLENGES

For the Teachers

The following are for consideration by the teachers being facilitators of learning in a spiral progression approach in teaching Science, as follows:

1. *Progression of procedural understanding (i.e., of skills and process skills)*
   The teachers need to consider the 'from–to' statements on progression of the procedural understanding (i.e., the process skills in Science) proposed in Braund (2008) especially in the aspect of students' investigative works in Science like their research undertaking with Science investigatory projects. For example, in evaluating evidence, the students need to progress from knowing when some results do not fit in the pattern and from beginning to wonder why to identifying and explaining anomalous results; and from realizing that single results might not occur again to linking reliability of findings to the spread of readings.

2. *Ensuring students to connect prior knowledge to the lessons at hand*
   Teachers should make sure that, in preparing lessons, students are able to revisit previously encountered topics. This is to establish a link of the students' prior knowledge to his/her new learning in order to build up a more meaningful and integrated learning in the students. Otherwise, learning can become shallow, in the form of chunks which can lead into junks (i.e., being wasted or undergoing decay as a short-term memory due to lack of connection).

3. *Making the Science road map of learning visible to all, and walking through it*
   Considering the limitation of time to cover the lessons in the whole quarter as a continuation of the previous grade level's competencies and with the students' heavy study load in Junior High School, it would be good for the teachers handling each of the Science classes in the four Science areas from Grades 7–10 to have a curriculum map of the whole Junior High School Science program to be posted on the wall, visible to all, to ensure easy tracking of the lessons, and this will facilitate connectivity and integration of learning of the lessons that are placed vertically along the different grade

levels and horizontally across other Science areas in the grade level. In this manner, there will be a deepened and richer breadth of understanding of the concepts and process skills.

4. *Assessing students with authentic performance tasks and with the use of Higher-Order Thinking Skills (H-O-T-S)* to affect more meaningful learning and, therefore, lasting memory and accessible retrieval or recall of information.

5. *Motivational factor of the teachers can positively affect memory retention in the students.*

6. *Using visualization technique like the multimedia approaches in content delivery can enforce memory retention.*

7. *Consideration of the Primacy and Recency Effect in facilitating learning* (for example, letting the students express what they learn in class before dismissal time will lead to a more lasting learning, and at the same time, the teacher can have an opportunity to affirm and or edit student's learned concepts).

8. *Facilitating in class Experiential learning approaches and Problem-based learning* that match with the learner's cognitive ability to make learning more valuable.

9. *Cultivating in the learners the scientific attitudes and values* that will also contribute to long-term memory development since emotional responses are put to work. There is no mention about development of scientific attitudes and values in the K–12 Science Curriculum Guide. This must not be forgotten.

For the Students

Each learner is said to be a potential genius, however, no good students can survive the demands and tests without possessing good study habits that can be acquired or developed through the law of exercise of Thorndike and the rehearsal factor in the multistore model of memory for LTM development.

For example, religiously answering practice exercises, religiously summarizing notes of learned concepts in class, reading, reflecting, doing constant physical exercises, and doing constant practicing especially with developing the psychomotor skills like playing a musical instrument and dancing, all these, reinforce for long-term memory development and, therefore, improved retention. Important concepts gained in school might just be simply forgotten especially the short-term memory. Repetition of good study practices would lead to a good study habit which is a highly sustainable way to surviving and surpassing school challenges.

Significantly, repeated utterance of unfavorable and spoiled language and repeated remembrance of any bad motif of intention towards somebody will not do any good to the person. By virtue of the multistore model, the information from STM can transfer to LTM store and so, with constant repetition of negative/bad words, thoughts, or feelings, will lead to a lingering memory and can lead to potential harm. On the light side, overwhelming one-self with good thoughts, good and healthy lifestyle practices, and kind and grateful words will always lead to a positive outcome that will benefit not only the person, but also the nearest environ.

For the school administration like the School Principal and the Science Coordinator

It is noteworthy to have a constant and regular monitoring of the implementation of the curriculum and confer with the teachers as the main implementers, listen to their concerns, and above all, motivate and inspire them at work and to push for constant review and upgrading of the curriculum that would incorporate the relevant needs of the learners.

For the Curriculum Review Committee

It is very important to revisit regularly the provisions in the new curricular reform together with the principal and the teachers and representatives of all stakeholders like the student body, the parents, and the alumni to do review sessions and upgrade the curriculum based on the needs of the learners.

For the Parents

It is for them to make a follow-through of their children's undertaking in school in terms of making school requirements at home like assignments and practice exercises and for good study habits. Practice makes perfect in problem-solving situations, and this has theoretical basis; the long-term memory development in the child through rehearsal, maintenance or elaborative, and motivation and strategy.

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