SPIRAL PROGRESSION APPROACH IN THE K TO 12 SCIENCE CURRICULUM: A LITERATURE REVIEW

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ABSTRACT

This review highlights the relevance of the Spiral Progression in the K to 12 Science curriculum in order to address the current issues and concerns of the spiral approach. The advantages and disadvantages of the spiral curriculum was reviewed with some researches among foreign counterparts. The nature of science teaching and the current researches of the K to 12 in both local and international context was also emphasized to highlight the science curriculum framework in the Philippines made up of an intertwined science content and science processes. Science process skills in the basic education of the K to 12 are utilized in context through learning the science content. The curriculum is organized on problems and situations that challenge and arouse the curiosity of students to motivate them in learning as well as appreciating science as useful and relevant. Findings showed the spiral curriculum as learner-centered, smart, and advanced rather than extensive and concentrated.

KEYWORDS

Spiral Progression Approach, Science Curriculum, K to 12, science process, science content

1. INTRODUCTION

Our idea as to how people learn has undergone a significant change, which has major implications for science education. A constructivist approach to learning, which posits that learning is constructing one's own knowledge and understanding and involves teaching students how to do so, has emerged from traditional approaches that acknowledge learning as obtaining or emulating knowledge from credible sources and learning science through the transfer of information from the teachers to students. This emerging view of learning science still remain to receive controversies nowadays, yet such developments in educational as well as social and philosophical spheres have call for reforms in science education globally [1].

Spiral Progression Approach is a strategy whereby basic concept are first presented in the first grade and then rediscovered in more complex forms in the following grades. Concepts are first introduced at a young age and then reinforced in progressively more sophisticated ways over the years [2]. In this study, the term refers to the compulsory pedagogical technique to be applied in all subjects, including Science, as mandated in the newly-implemented curriculum that introduces the gist of every given subject matter as it becomes complex as the grade level progresses.

One of the most popular methods for content organization, commonly referred to as spiral curriculum, is spiral content organization [3]. The key premise of the spiral curriculum was whether mastering topics that are vital in a child's early development provides a solid foundation for later learning [4]. A spiral curriculum has subjects that go from tangible to abstract, simple to complicated, and from fundamental concepts to strong comprehension [5].

In order to identify any gaps in the spiral structure of processes and concepts without sacrificing cooperation and connection or focusing on pointless repetition of learning experiences, it is important to take into consideration how science is structured in elementary schooling and how connectivity of content is organized to facilitate transfer to secondary schooling in the K to 12 science. The researcher can determine the nature of the spiral progression of learning science with in Philippine basic education by looking at the science curriculum from the third grade to the 12th grade with an emphasis on content organization and science process skills.

2. REVIEW OF RELATED LITERATURE

The review begins with a discussion of the current paradigms of science education followed by the presentation of the overview of the theoretical underpinnings behind the use of spiral progression. Literature related to the underlying approaches on the study of spiral curriculum contexts is also presented followed by a discussion of spiral progression models which then connects to the sequence of curriculum content and the scope of curriculum in science with focus on the organization of content using learning progressions.

2.1. Science Education and its Current Paradigm.

Paradigm of science education is defined as a set of basic postulates, strategies, approaches, contents, instruments and objectives that influence and lead the transformation of science knowledge into science education. First science courses in school use descriptive method of teaching simple knowledge mainly for future work where students were not used to uncover natural phenomenon. This approach at the end of the nineteenth century changed with the advent of science, technology and the industry applications such as gasoline engines and electrification.
More modern approaches replaced the paradigm of simple practice for life into a broader content and increased theoretical knowledge with the teaching of science remaining to be descriptive and practically oriented [6]. From the second half of the nineteenth century, emerged several major paradigms in science teaching described as being pragmatic and from the beginning of the twentieth century, the study of nature began to sprout out along with simple science way of teaching. Technological approach was developed from the end of the World War II while humanistic and scientistic methods came about from the nineteen seventies. From the 1900's, the paradigm shift into multidisciplinary approach of teaching science. Current science education are influenced by the foregoing paradigms with the humanistic, scientistic and multidisciplinary approaches being presently affecting science teaching [6].

Such calls echoed in countries around the world such as the case of Turkey when latest reforms in secondary education took place in 2007 targeting the structure and content as well as the philosophy of secondary education. In this reform, the secondary science curriculum adapted have the new biology, chemistry and physics introduced with new curriculum materials having new aims, approaches in teaching and learning and assessment methods for teaching secondary science. Using the framework of Thomas Khun (1970) called The Structure of Scientific Revolutions as a lens, the researches analyze the nature and complexity of such large-scale educational reforms in Turkey in a study entitled "Educational reforms as paradigm shifts: Utilizing khunian lenses for a better understanding of the meaning of, and resistance to, educational change" [7]. The aim of the study was to assess the change between the former and the new biology curricula in terms of its nature and scale. The method used in the study was qualitative oriented approach using Ethnographic Content Analysis (ECA) as a methodological framework to provide a systematic and analytical approach to content analysis. Results of the study revealed that the former and the new biology curricula possess radical difference in perspectives in terms of the nature of scientific knowledge. The former biology curriculum has taken the nature of knowledge from a perspective of a positivist-realist while the new biology curriculum embraces the constructivist perspective. The main paradigm in the previous curriculum represents the heritage of a positivist-behaviorist, which claims that there is an independent reality that can be discovered by science in a methodical manner. The new biology curriculum on the other hand, dominantly presents aspects of the constructivist tradition where learning involves a process of actively constructing personal knowledge and teaching promotes knowledge construction through learning by conceptual change and the assessment as a process of evaluating and promoting personal development [7].

2.2. Spiral Progression and its Theoretical Underpinnings.

Rooted around the constructivist perspectives, spiral progression approach developed by Jerome Bruner [8] involves learning in an active and dynamic process where learners build new concepts constructed from their present or previous knowledge. As a purposive participant in the knowledge acquisition process, learner chooses structures, remembers and transforms information. Insight, concept attainment and rational mental process rely on imaginative process of structuring own knowledge [9].

Behaviorism is another learning theory that underpins spiral progression that attest the idea that all behaviors are learned through conditioning. Through the behaviorist's perspectives, conditioning happens through environment interaction and that behaviors are shaped by our responses to environmental stimuli [9].

Another approach to learning in which spiral progression is anchored on include progressivism in line with discovery-based technique or inquiry method and problem-solving learning method. The teacher facilitates students' learning as they explore and discover [10]. Inquiry-method emphasizes pro-active activities, no schoolbooks and little or no directions from the teacher giving students responsibility of their personal learning [11].

Authentic assessment used to evaluate how learners apply what they learned through real-life activities becomes the theme used in a spiral progression approach. The tasks given to students under authentic assessment are similar to the tasks they might encounter in real life which includes Project-based learning, Performance Tasks, Portfolios and Collaborative Works and using On-line tests. In connection to spiral progression approach in science, authentic assessment becomes commonly used in science laboratory experiments which focus more on certain areas compared to the old curriculum approach [9]. Such kind of assessment mimics real-world circumstances which is essentially better because students gain effective experiences. Traditional assessment is content-oriented in which vigorous students with complex and advance understanding may perform poorly in this type of assessment.

Spiral progression is also aligned with progressive curriculum anchored to John Dewey that describes the total learning experience of people. Progression describes an individual's journey through learning and means in which they obtain, relate, and improve their skills, knowledge and understanding in a progressively more stimulating situation. Spiral progression is a design including a printed plan, a list of topics and projected outcomes of the students in which concepts in the curriculum are repeatedly presented but with deepening complexity. It can also be described as a framework designed to help teachers make programs, activities or tasks that aimed at the improvement of intellectual skills and outlooks that do not end at identification. Progression and continuity became the themes in science learning. Progression involves own journey of individuals through learning and methods in which they gain, develop and apply their skills, awareness and understanding in gradually challenging conditions. Continuity describes ways in which the educational system configures experience and offers adequate task and growth for learners in a familiar curricular landscape [12].

Further, it can be emphasized that once initial topic is mastered, the learner spirals upwards as a new topic is presented in the next lesson reinforcing what is already learned. As a result, a rich breadth and depth of understanding is attained. Through this method, the formerly learned lesson is reviewed therefore increasing its retention. The lesson may be increasingly expounded when it is reinstated resulting to an increased understanding and learning transfer. Therefore, a way of implementing the spiral curriculum is through the use of spiral progression approach [13].

Spiral sequence in the curriculum involves arrangement of topics under a certain learning domain based on spiral progression approach that involves iterative revisiting and gradual sophistication of concepts and process skills. The three key features of spiral sequence were described [3], [14] as constant revisiting of topics, themes or subjects many times throughout the school career of learners; increasing complexity of subject matter with each concept revisit and; old knowledge as the base for new knowledge or concept.

2.3. Spiral Progression and Continuity in Learning Science.

"Progression and Continuity in Learning Science" describes two areas of knowledge and understanding of science being linked by a model that explains continuity and progression as part of spiral curriculum [7]. Conceptual and procedural knowledge as wells as understanding in science are built upon continuity and progression of learning experiences. As an analogy, continuity provide individual learners a safe and recognizable map that they make use across their personal journeys. Similar to this, curriculum disciplines like science, math, and English might be viewed as landmarks, and the study and work plans as villages and cities or communities of information and experiences that can be visited, with optional routes connecting them. To include progression in the analogy, these journeys can be forwards representing progression or backwards as the setbacks of regression. Two interrelated areas are identified in considering progression in learning science, i. e., procedural and conceptual understanding as shown in Gott and Duggan's model.

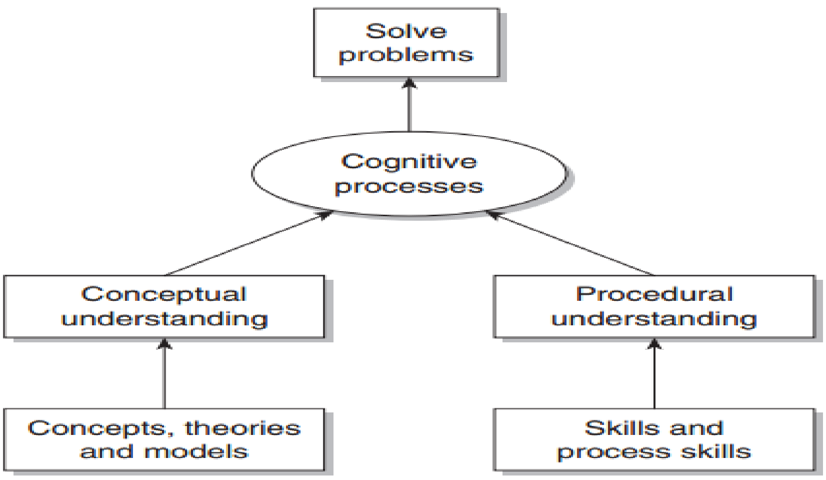

Figure 1. A model for school science [15].

Cognitive processes needed for solving problems draw on two interacting and distinct sets of knowledge that needs to be taught [15], [7]. Conceptual knowledge allows students to produce known facts, hypotheses, and frameworks aimed at explaining those two aspects in order to progressively advance to more sophisticated levels of understanding how the world functions. On the other hand, procedural understanding is linked to practical science skills, also known as process skills, which are essential for developing understanding of a particular phenomenon or concept as well as testing theories. Figure 1 shows the model for school science [15], [7].

The relationship between procedural knowledge, or "Exploration of Science," and conceptual knowledge, or "Knowledge and Understanding of Science," is depicted in another model. According to this framework, each major step includes a review of related procedures and ideas (Figure 2). It can be seen from Qualter et almodel, .'s known as the double spiral model, that "experiential blobs" represented by the letters "p" and "c" refer to the fact that each investigation's concept level and the processes to carry it out advance in consonance with trend and sophistication related to the program's content at each primary grades [16], [7]. The model by Qualter et al. depicts four rounds of a double spiral with solid and dashed lines to represent two aspects of science learning.

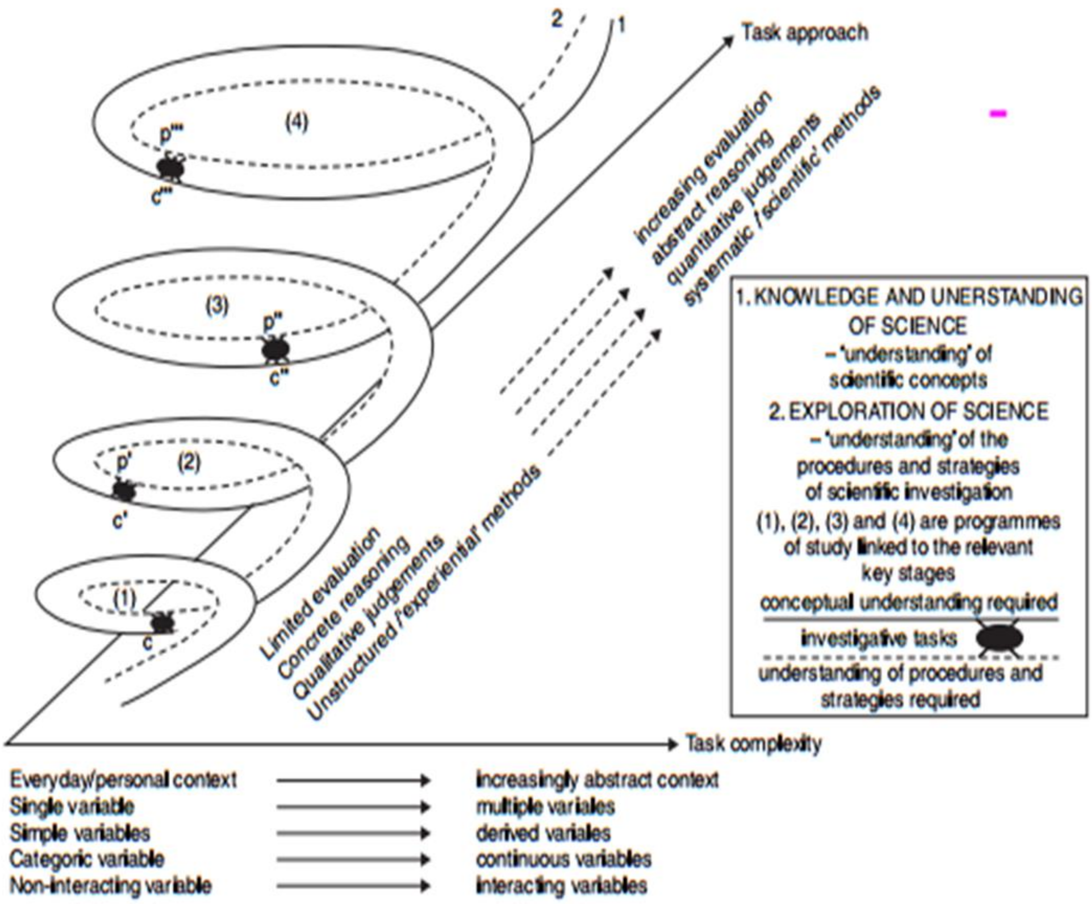

Figure 2. An integrated model of progression in science [16].

Science is both substance and a method. Science process and content are interwoven. Science processes are vital since they enhance the collection of knowledge or the content. Students will fail to use basic science process skills in the absence of information. Processes in science cannot operate in a vacuum. They are taught in relation to context. Understanding continuity and consistency in science learning is a requirement for making decisions about whether or not students are able or unable to go on in their knowledge at transitions. The science education system should be developed to enhance not just two but three having to learn domains of the students because it is the goal of the science education to produce scientifically minded citizens who are well-informed and engaged members of society, responsible decision-makers, and apply scientific information that will greatly impact the environment and society. These include using scientific methods and techniques, comprehending and using scientific information, and adopting science attitudes and values.

In order to fully grasp spiral progression knowledge acquisition, it is crucial to consider both procedural and conceptual comprehension. Students should be introduced to science in the early grades as a "hands-on, minds-on" approach and should be encouraged to investigate and pose questions about their surroundings. As pupils progress through the grades, they should have the ability to plan and carry out investigations that involve identifying and controlling variables, answering both teacher- and student-generated questions. Students should gain the skills necessary to convey investigations, present data in an organized manner, and build interpretations or theories based on the results of investigations as they progress through the grades.

2.4. Organization and Scope of Content in a Spiral Curriculum.

Iterative revisiting and gradual sophistication of topics in Spiral Progression Approach were assessed. A study conducted [4] entitled “An Analysis of Science Curricula in Turkey with Respect to Spiral Curriculum Approach” aims to analyze the implemented Science curricula with respect to spiral curriculum approach in Turkey. A document analysis using qualitative research method is used in the study. Curricular documents of 3rd, 4th, 5th, 6th, 7th and 8th grade science programs in 2013 are analyzed to determine the iterative visiting and gradual sophistication of topics across differing grade levels. Findings show that iteration of topics based on spiral progression principle is evident in which previous learning becomes the foundation for future knowledge. Further, it is apparent that certain topics appear to be repeatedly covered in different grade levels or being given more emphasis compared to other topics particularly on Physical phenomena such as ‘force’, light, sound and electricity. For other topics such as ‘earth and universe’, the ‘structure of earth’ is the only one being covered in every grade except for the 7th grade. On the other hand, other topics are covered at a time in different grade levels. In terms of gradual sophistication of topics, different facts and concepts are presented in each class level from simple to complex way showing progressive level of difficulty and sophistication only in certain learning areas such as electricity, states of matter, its properties as well as light and heat. Some topics do not appear to be represented in certain grade levels such as living beings and life [4].

Although the spiral curriculum's theoretical foundations are strong and logical, there is sadly a paucity of actual evidence to back up the curriculum's overall success. It is frequently very challenging to evaluate the outcomes of the curriculum rather than the implementation of that curriculum since the spiral curriculum is frequently braided with investigation and constructivist learning methodologies. The study on the “Analysis of Science Curricula in Turkey with Respect to Spiral Progression Approach” had focus on how the topics are arranged based on the spiral progression principle. Examining the Philippines' present spiral curriculum using the study's method would be very beneficial.

2.5. Sequencing and Integrating Science Content Across Grade Levels.

Another study on the spiral curriculum, named "Investigation of Matter and Change using Spiral Curriculum Model: Turkey Sample," was carried out [17]. The study aimed at investigating how content of “Matter and Change” is spiraled from 5th to 8th grade Science and Technology curriculum arranged in 2004 by the Ministry of National Education. Descriptive survey model within a qualitative research scope was used to evaluate the curriculum by looking at program draft. Since the study aimed at asserting a case existing in the study as it was, qualitative survey method was employed. Collection of data happened through document review that included analysis of written materials containing information of target case focus on “Matter and Change” learning area as they appeared in the 2006 Science and Technology curriculum and guide [17].

Results of the cited study above asserts how the topic on “Atoms” in “Matter and Change” learning area is spiraled based on grades. In the 4th and 5th grade, topics on basic concepts of substances, states of matter and phase changes, mass and volume concepts and distinctive substance characteristics becomes apparent. In the 6th grade, concepts of the “Atom” and “structure of matter” are given focus. Accordingly, topic on “nucleus of an atom” and basic particles are provided in the 7th grade while in the 8th grade, information about “isotopes” and “protons” are introduced. Apparently, topics on “atoms” are arranged in a spiral manner [17].

Findings from the same study revealed spirality of the topic on “elements” based on grades. In the 4th to 5th grade, the concepts of atoms and elements is not introduced while from 6th to 8th grade, concepts of atoms are provided in details. Students in the 6th grade learn about the “atom” as the smallest unit of matter that forms the atomic and molecular structures of an element. In the 7th grade, students learn that elements combine to form compounds and so on. Students categorize elements in the eighth grade using their characteristics and their placement in the chemical elements. Overall, the concepts of “elements” follows the spiral form [17].

Another significant finding from the study stated above is that as the students build on the concepts of “atoms and elements”, they are introduced into the topic on “chemical bonding” in the 7th and 8th grade. However, this concept is not handled in the 6th grade. Further, the topics on “compounds and molecules” are also found to be in a spiral design from the 6th, 7th and 8th grade. Conversely, the concept of “mixtures” in “matter and change” is seen as deficient in its spirality since it appeared to be covered in the 6th and 7th grade but not in the 5th and 8th grade. Moreover, topics of “physical and chemical changes” also shows deficiency in spiral progression as they are handled in the 6th grade and 8th but not in the 7th grade. Likewise, the concepts of “heat” and “states of matter” are also found to be lacking on certain grade levels [17].

A similar study conducted [5] which explored the intended junior high school science curriculum in Bangladesh in terms of organization of content. The research aims to determine the sequencing of science content and integrating it in the intended curriculum. The method used in the study involves qualitative approach through document analysis. Data collection process use existing curriculum documents and textbooks. The National Curriculum and Textbook Board (NCTB) of Bangladesh produces published textbooks one for each of the subjects thus considered as a de facto curriculum. The sequence of content is analyzed using the four principles of sequencing content as a lens [18] which composed of simple to complex, prerequisite learning, whole to part, and chronology as bases for the evaluating content sequence. In terms of the status of spiral sequencing of content, the researchers developed the four key questions (KQ) anchored on Spiral Progression Approach [3], [19]. Spiral sequencing is determined by the decisions based on the responses against the KQs. A rubric [2], [20] wasused to explore the integration of science content within the disciplines and with other fields of discipline. While for summing up the current condition of integration in the science curriculum in the junior secondary level, a continuum is used having “discrete factual content” and “completely integrated content” as the two ends [5].

Findings of the study previously cited revealed that there is no principle of sequencing contents within a chapter found in most cases. Only few cases follow and partially follows the principles of sequencing [18]. There are existing chapters though that follows explicitly the sequence of “whole to part” in which a concept is introduced as a whole which then later on discussed in detail. Another important finding show that there exists no pattern of sequencing content among the chapters within a grade in the textbook. Most chapters are discrete from each other. Only a certain pattern is found to exist in the curriculum and textbooks. Biological science chapters are located at the beginning chapters, physical sciences in the middle including physics and chemistry with earth and space and environmental science placed in the end. These chapters are found to be discrete even those belonging to the same sub-discipline of science. Such as the case of Biology wherein five chapters examined are not even linked to each other nor do they present holistic view of the living world with each chapter having different focus. Thus, no pattern of sequencing among chapters exists in this case. In terms of vertical sequencing of contents from one grade to another, there exist an inconsistency in following the principles of sequencing in the intergrade vertical sequence. As for spiral sequencing of content where key concepts are revisited multiple times and using concepts learned previously as the foundation for further concept development, it was also revealed to be followed and partially followed only in few cases. None of the parts explored follows a truly spiraled sequence as none of the items received affirmative responses against spiral sequencing found in KQs. Meanwhile, integration of science among several sub-disciplines has been examined but is found inadequate and very low. The level of integration with other field of discipline is not also found in any of the chapters. From the integration continuum, the current curriculum in secondary science is placed almost in the middle closer to the discrete factual content part since it reflects no complete integration [5].

2.6. Spiral Progression: its Advantages and Disadvantages.

Spiral progression enables learners to acquire knowledge and skills suitable for their developmental and cognitive levels for it eludes disjunctions between phases of schooling and strengthens retention and mastery of skills and concepts as they are revisited and associated. However, certain problems exist in the spiral design such as the degree in which new topics are introduced either too fast or too slow. All topics either easy or difficult to master are allotted equal amount of time. Approximately, units are of the same length, and each topic within a unit is covered in a lesson for a day. There are other days that there will not be sufficient time to introduce. Since a whole class period must devote to one concept, sequencing instruction would be difficult in ensuring that learners attain essential pre-skills before presenting a tougher skill. Also, many topics are covered but only shortly and teachers on the average, allocate only 30 minutes time of instruction through the whole year to 70 percent of the covered topics resulting to students not being able to master important concepts. Further, there is no enough sufficient review promoted once units are finished in the spiral curriculum. A review might be encountered in a chapter but earlier concepts may not be seen again once students proceed on to the succeeding chapter until they are covered the next year [9].

The spiral curriculum could also be regarded according to a study [21], as an extreme design in merging the sciences. On the other hand, another author [16] contended that spiral curriculum could only allocate one quarter of a year to each branch thus, in each area of science the topics in which students will be exposed per year are severely limited. The inability of a spiral curriculum to cover a range of subjects in one discipline over the course of a year is one of its main drawbacks. Each field requires prerequisites because it entails steps. The themes were built upon one another, and a quarter was not long enough to cover everything that might be useful to the learner in another field. It's just how the topic works. The learner thus need a year to take up chemistry before taking up biology. Since human learning involves steps, consistency in a curriculum becomes a necessity. We learn to walk before we run. Thus, coherence can be achieved in curriculum with instructors that are specialized to teach a specific subject. A specialized teacher in chemistry with an education degree would know what to teach with or without a curriculum. Singaporean teachers are subject specialists, which is one significant way in which they differ from their American counterparts. Training is required for teachers in science to teach in an integrated approach. Having a curriculum that identifies hierarchical nature of topics within a discipline not only entails conditions supportive to learning but also enables the necessary teaching capacities. With a mile wide array of topics on different disciplines in a spiral curriculum wants too much from a teacher. Spiral progression approach must assure consideration of the resources available [9].

While Philippine basic education had adopted the spiral curriculum, other countries had otherwise shifted on to another direction. According to a study [16], one of the basic problems faced by the United States in basic education is in terms of the spiral curriculum. Another study conducted that investigated the process of transition from a spiral curriculum alignment to a field-focus curriculum alignment in science at middle school districts in Missouri. Teachers of middle school districts in the state of Missouri agreed to shift to a field-focus curriculum alignment in science from a spiral curriculum alignment. The reform involved changing the Grade 6 to Grade 8 science curriculum [9].

Reformative changes in curriculum also took place in Turkey. In 2004, curriculum reforms in elementary and middle education introduced the constructivist program. Centered on activities and organized on spiral approach, science and technology designed for 4th and 5th grade and many subjects were covered in a content arranged by grade level progressively in increasing depth. This would reinforce what was learned through iterative revisiting of concepts in appropriate frequency. In 2012, education programs were further amended in a transition to a 12-year mandatory educational system. In 2013, the amended programs were introduced to having still the spiral structure but not as much as how it used to be [4].

In Bangladesh, a new curriculum was finalized in 2012 followed by its implementation in 2013. Science curriculum in the junior high school at 6th to 8th grade aimed at making students familiarize with modern science concepts and scientific process to teach them with advanced education in science and become scientifically literate. The new science curriculum follows a spiral curriculum sequencing of content [5].

2.7. Teaching Science in the K to 12 Curriculum.

Science teaching becomes continuously considered to be a tough job. The nature of teaching science not only involves teaching scientific knowledge and developing science skills but also includes fostering scientific attitudes and conveying messages of the nature of science and of scientists' work. According to the authors [22], science teaching includes 9 hours with 4 hours lecture and 5 hours for laboratory. In the previous secondary basic education 2002 BEC, the time spent for science subject composes only 6 hours per week while in the new K to 12 system, the time for science subject is reduced to 4 hours per week. Science subject comprises lectures, laboratory and tutorials with lectures providing students understanding of the context covered in the lesson considered to be an hour of active study. To be effective, given materials should be read by the students ahead of time and teachers should identify topics considered as obstacles of learning. Effective lectures rely on how the teacher identify the topics that could promote doubts or questions whether in written or oral form. The spiral progression technique exposes students to a wide range of ideas, subjects, and activities till they have understood them by going over them grade-by-grade but with varying levels of difficulty [9].

The Department of the Education and SEAMEO INNOTECH have developed a new K to 12 science curriculum framework that aims to teach students how to find technological and scientific information about issues around the world from a variety of sources that have an impact on the nation, how to innovate and make products that are very useful to the community or the nation, how to process information to find crucial data for a problem at hand, how to make plans related to their own interests, and more. In science teaching, varied approaches were identified including interdisciplinary approach used to achieve the K to 12 science education goals. Using interdisciplinary approach, two or more areas of discipline are being put together to interact and have an effect on the perspectives of one another. K to 12 curricular reforms in the Philippines known as “Enhanced Basic Education” are designed to globally respond and compete against the standards set by regional or international organizations like the ASEAN Economic Community (AEC). The reform is a strategy to prepare the country in parallel assessment along with competitors on our quality of graduates in regional or international economic communities like the AEC [23].

In other foreign counterparts like the U.S., traditional science teaching has been generally direct but inquiry through the K to 12 education becomes the advocate of recent national and state science education. Though inquiry-based has an advantage of demonstrating features of scientific inquiry, there exist little known comparative research of the two modes of instruction cited above regarding their effectiveness and efficiency for increasing science conceptual understanding [11].

Furthermore, issues with disjunction in students' learning when they transition from elementary to secondary school education have been noted in the U.K. for more than 50 years [7]. A spiral-arranged curriculum that presupposes learning in continuity and development but doesn't take into account the substance of the primary school program or the previous experiences and accomplishments of the students has inconsistent teaching provisions on either side of transfer. In their secondary education, primary school students eagerly anticipate studying science, but their enthusiasm is frequently dampened by needless repetition of material without a new experience, an environment that does not honor their work, and a setting that does not seem to be connected to their everyday lives [7]. Furthermore, according to yet another expert [24], continuity must persist into children's early years. This suggests that curriculum methods ought to be structured and carried over from one educational setting to the next.

2.8. The Philippine K to 12 Science Basic Education Framework.

The Grade 1 to 10 approach, which offers a structure for understanding science's big ideas over time and allows students to develop through the grade levels smoothly while maintaining continuity and consistency, was adopted by the latest Philippine science curriculum framework, according to the authors [25]. While science is technically taught in third grade, it is covered in kindergarten and grade children in other disciplines like health, languages, and math. The three subject areas—life science, physical science, and earth and space science—as a whole are included in each grade level using a spiral progression [25].

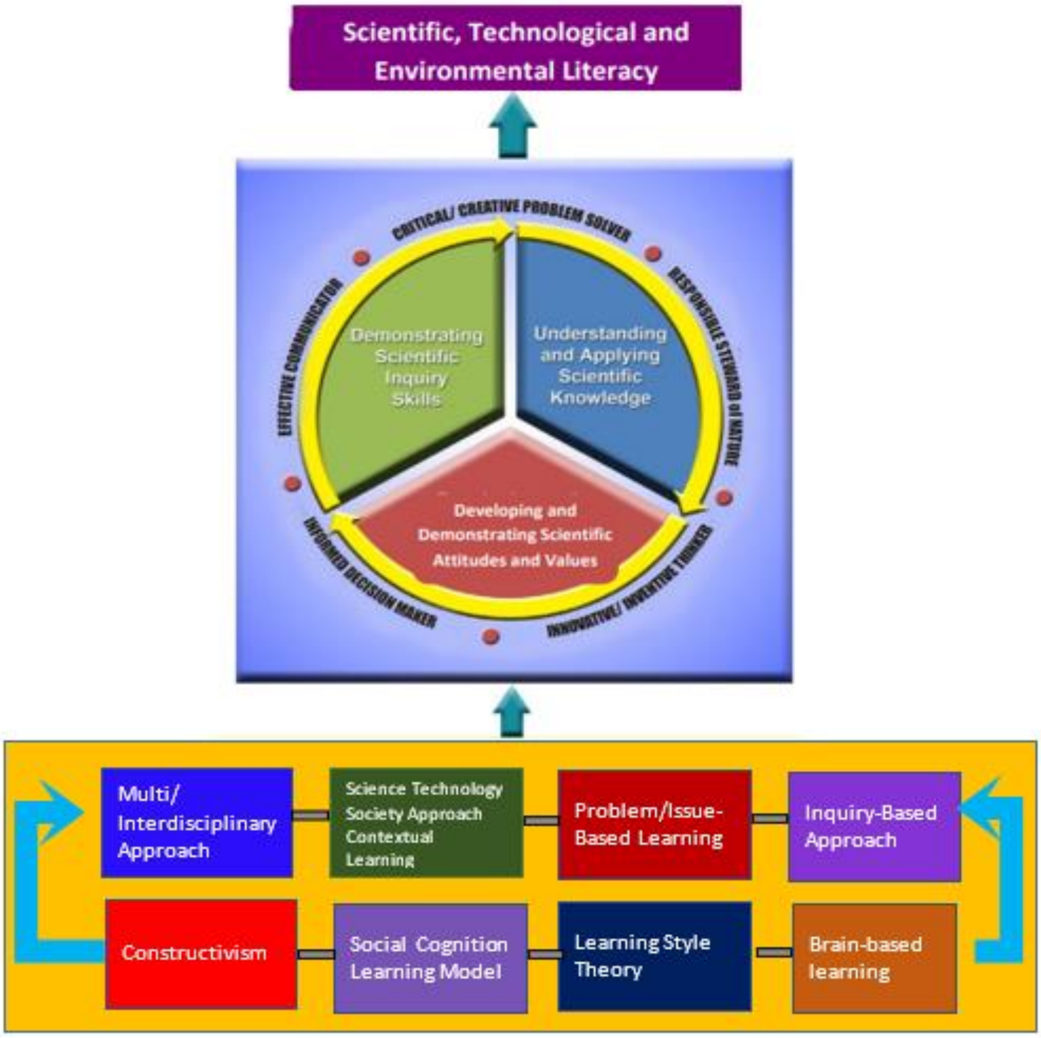

Figure 3. The K to 12 Philippine Basic Science Education Conceptual Framework (DepEd, 2016)

Science education in the K to 12 curriculum serves as the framework of the new Philippine basic education science curriculum. The aims of the new science education is to develop among learners scientific literacy to make them informed and participative citizens and be able to make judgments or decisions of applying scientific knowledge which have impacts on social, health and environmental aspects. Recognizing the place of science and technology in human daily affairs becomes the focus of the new science curriculum. Integrating science and technology in the aspects of social, economic and ethical phases of life is also of great concern. Preserving the cultural heritage of the country through promoting strong links in science and technology including indigenous technology is another feature of the new science curriculum [18].

Further, learners in the K to 12 science curriculum are provided with a repertoire of competencies needed in the actual world of work grounded on a knowledge-based society. A scientifically, technologically and environmentally inclined individual and a productive society member developed to be critical problem-solvers as responsible stewards of nature are expected of the K to 12 learners who are innovative, creative and well informed decision-makers with effective communication skills. Three domains of science learning are incorporated in the curriculum design which includes understanding and applying knowledge of science in both local and global context, performing process and skills in science and lastly, developing and demonstrating attitudes and values in science. The approaches used to attain the science domains involve multi/interdisciplinary, science-technology-society and inquiry-based approach in a contextual and problem/issue- based learning. Constructivism, the social cognition model, learning style theory, and brain-based learning are only a few of the comprehensive educational pedagogies on which the methods are founded [18]. Figure 3 shows the K to 12 Philippine science basic education curriculum framework.

To develop the interest of students, the use of varied activities that are hands-on, minds-on and hearts-on in nature rather than the use of textbooks alone have been employed for the students to become active learners. Taken as a whole, the K to 12 science curriculum emphasize the use of evidence in building up explanations in a learner-centered and inquiry-based method. Presented with increasing level of complexity, concepts and skills in Biology, Physics, Chemistry and Earth Sciences are arranged in spiral progression from one grade level to another for a deeper understanding of core concepts. Integration across different science topics and other disciplines are also used to provide meaningful understanding and application of concepts to real-life conditions [18].

2.9. Spiral Progression: A Phenomenon of the Philippine K to 12.

Studies on spiral progression of the K to 12 science curriculum in the Philippines emphasized on the experiences of students and teachers on the implementation of the new curriculum. Students perceived that the curriculum has been positively implemented based on the three domains of learning namely: scientific skills acquisition, concept formation and values and attitude development through a survey conducted to 216 grade 8 students from selected schools in Metro Manila [26]. It was found out that teachers in science have misconceptions and misinterpretations about the spiral progression approach in a study conducted to secondary science teachers in selected private and public schools in Tagum City [3]. Based on real interviews performed, it has been said that the teachers' lived experiences during the adoption of the K–12 curriculum were beneficial despite the challenges they faced [3]. Further, another study have assessed the implementation process of the spiral progression approach in science teaching to both public and private schools in Cavite. Using a mixed-method design through interviews, observations and survey questionnaires, the researchers found out that teachers perceived the new science curriculum to have advantages and disadvantages to students. Also, it was found out that the most preferred strategies found to be effective by teachers include, discovery or inquiry learning, collaborative and experiential learning. Conversely, teachers have pointed out that they need more time and more trainings to effectively carry out the new curriculum [9].

Using a mixed-method design, a study [9] conducted on “Impact statements on the K-12 science program in the enhanced basic education curriculum in provincial schools” through qualitative method in gathering and documenting of data and quantitative data consolidation into themes and treated statistically using frequency endorsement count and percentage. Thematic content analysis was the primary method used to code the written responses. In K–12, all four of the component science subjects are covered in one school year, and there are a variety of learning activities, according to some students, making learning more engaging, efficient, and fun. Students also initially find the topics simple and then find them difficult, but because they are covered at their own speed and take longer to study, they are mastered. On the other hand, some people think the subjects are excessively complex. The impact statements recommend thorough monitoring of the program's execution along with ongoing professional development for teachers to eliminate any potential for misunderstandings [9].

Meanwhile, a study [26] conducted with Grade 8 students in public schools determined the perceptions of students regarding the implementation of the K to 12 Science Program in the

Philippines. Based on the overarching objectives of the domains of learning as specified in the K to 12 curriculum standards, a qualitative survey method using a questionnaire was used. The K to 12 Science program's increasing level of complexity in terms of how science abilities are organized received the highest amount of neutral impression from respondents [26].

The study carried out in the Philippines employed a hybrid methodology (quantitative-qualitative design), where data were processed, evaluated, and analyzed with statistical tools: frequencies, percentage, means, "Goodness of Fit" test, and Chisquare. Teachers have noted that spiral progression can be useful for teaching science courses, both sometimes and frequently. The spiral process in science can occasionally have benefits and drawbacks, according to both public and private school teachers. The study does indicate, however, that when instructors from schools were compared with regard to how they view step involved, private-school teachers were more likely to believe that spiralling progression was preferable. Under the framework of a spiral progression curriculum, teachers in private and public schools most frequently and most successfully used the teaching techniques of discovery/inquiry learning, collaborative learning, and experiential learning [9].

Moreover, through a study population of 66 participants, using qualitative, literature review, interviews and assessment in qualitative form was conducted to determine student performance in mathematics. According to the report, 71% of pupils entering Grade 11 still are learning the basics of math from Grade 10. The spiral progression method is severely disadvantageous to students who advanced to upper year levels without taking the necessary remedial classes. Making remedial sessions for slow learners more engaging for both teachers and learners may aid in achieving the necessary mastery of subjects needed for the following level [27].

Further, another study was conducted using a population of 12 informants through qualitative data using interview conducted as the data collection approach entitled "*Teaching Chemistry in a Spiral Progression Approach: Lesson from Science Teachers in the Philippines*." They discovered that the content's spiral curriculum is learner-centered, advanced, and sophisticated rather than extensive and concentrated. Chemistry instruction in grades K–12 is engaging, practical, and effective, but it also needs skilled teachers and adequate resources [28].

Through qualitative research case study, 133 (students) and all science teachers in PUPLHS were made to participate to determine how the spiral progression approach was implemented in teaching science. It was discovered that vertical spiral growth provides a thorough knowledge of scientific subjects. Discovery approach and cooperative learning were the effective teaching strategies used. Multimedia and laboratory activities play vital role. Teachers suggested adding an extra hour each week for science classes, encouraging students to practice time management, and attending training seminars and workshops. More review time, a lab activity in each and every course, in-depth dialogues, especially on large number of diverse, continued use of audiovisual and other teaching aids, and interactive activities were all suggested by the students. The option of testing students' knowledge of the subject using summative tests or standardized tests in each grade level was lastly urged for future studies to consider [29].

Another study was conducted [26] using qualitative type of research through document analysis. It is advised that educators take into account the following: (1) carefully consider how to align the learners' progression of numerical knowledge and skills through the circular pattern approach; (2) conduct regular assessments of the learners' performance as they advance in the fundamentals; (3) strengthen students' capacity to adopt contemporary technological advancements in mathematics learning; (4) explore strategic teaching approaches; and (5) increase engagement.

In their study on the factors that influence the use of spiral progression method in relation to students' academic performance in mathematics, the authors [30] used a study population of 74 participants and a descriptive research design with qualitative and quantitative survey questionnaire and documentation. Quantitative data showed the average academic performance of the students in spiral approach. The teacher answers concurred that the spiral Approach's application was impacted by the curriculum, teachers, students, and schools. During the first and second marking periods, the students' academic achievement was deemed to be "approaching proficient." They discovered that the perceived elements influencing the execution of the spiraling approach differ significantly, with respondents giving the instructor aspect affecting the spiral approach a higher grade [30].

3. CONCLUSION

Based on literature, while other countries focus their study on the organization of content and how topics are arranged based on the spiral progression approach, little is known about how content is spiraled in the science curriculum in the Philippines. Consequently, the need to assess the new curriculum based on how it is organized must be explored to improve delivery and content learning. The review's findings showed that the spiral curriculum for the subject matter is learner-centered, complex, and advanced rather than extensive and concentrated. The most popular approaches that teachers believe to be successful are experiential learning, collaborative learning, and discovery learning. Teachers, on the other hand, have emphasized that in order to implement the new curriculum successfully, they need more time and training. Students who promoted to upper year levels without taking the requisite remedial coursework suffer greatly under the spiral progression technique. Making remedial classes for slow learners more interesting for both teachers and students may help them get the requisite topic mastery for the next level. Teachers recommended encouraging students to practice time management, adding an extra hour of scientific instruction each week, and going to training sessions and workshops. The students recommended more review time, lab activities in every course, in-depth discussions, particularly on a wide range of diverse topics, ongoing use of multimedia and other teaching aids, and interactive activities. Last but not least, it was recommended that future research take into account the possibility of evaluating students' topic knowledge via summative assessments or standardized tests at each grade level.

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