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Spiral Progression Approach in Teaching Science: A Case Study

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Abstract

The K to 12 curriculum implementation has institutionalized a curricular framework anchored on spiral progression, and this calls for new perspectives in the implementation of the teaching and learning process. This research study aimed to describe: the students' perceptions on the vertical articulation of spiral progression approach (SPA); teachers' perceptions in terms of vertical/horizontal articulation on learning competencies, mastery of subject matter, teaching strategies, and availability of instructional materials; positive experiences and problems encountered upon the implementation of SPA; and possible solutions for the identified problems.

This study used the Modified Model of Comprehensive Assessment of an Educational Program in order to assess the students and teachers' perceptions in SPA. Three research instruments were used in this study namely: structured interview, focus group discussion (FGD) and, interview/FGD questionnaires to support the respondents' responses. The data gathered were assessed through open and axial coding system that led to the gathering of themes for easier evaluation.

The findings revealed that vertical articulation of spiral progression provides deep understanding of science concepts through a thorough review conducted by the teachers. Furthermore, vertical and horizontal articulations in spiral progression are achieved through cooperative learning in consideration of the students' propensity to easily forget what they have learned from the previous grade levels. Moreover, the use of instructional materials that fit the interests of the students and the mastery of the subject matter of the teachers helped in the retention of science concepts.

Keywords: formative assessment, horizontal articulation, spiral progression approach, teaching science, vertical articulation

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1. Introduction

The Philippine Educational System has undergone several developmental stages before it reached the current educational system today. For a very long time, the Philippine government worked hard in the revisions of the educational curriculum to

make it suitable in giving quality education for every Filipino. Its objective of improving the educational system has a fitting instrument for the achievement of national goals which can be realized through proper reforms in the educational program. As a matter of practice, the curriculum in the Philippines is revised every ten years, but the rapid change in education and the fast obsolescence of knowledge necessitate continual revisiting and updating to make it responsive to the emerging needs of the learners and the society.

The K to 12 Basic Education came in 2011. Republic Act No. 10533, otherwise known as the *"Enhanced Basic Education Act of 201",*Rule 2. Curriculum, Section 10.2.g. Standards and Principles, "The curriculum shall use the spiral progression approach to ensure mastery of knowledge and skills after each level". Enclosure No. 1 to Department of Health (DepEd) Order No. 31, s 2012 is the "Implementing Guidelines of Grades 1 to 10 to Enhanced Basic Education Curriculum", which states that "the overall design of Grades 1 to 10 curriculum follows the spiral approach across subjects by building on the same concepts developed in increasing complexity and sophistication starting from grade school. Teachers are expected to use the spiral progression approach in teaching competencies." Furthermore, the spiral progression of topics in the said subject reveals how lessons are intertwined in every year level.

There is now "vertical articulation" or a "seamless progression" and "horizontal articulation" of competencies. Vertical articulation serves as a bridge of knowledge from one lesson to the next, across a program of study. It develops skills and knowledge which are reinforced as other elements are used in the study. While, horizontal articulation integrates the skills and knowledge across different disciplines. It means that what has been studied in one specific course or area is in line with the other.

Spiral progression approach follows the progressive type of curriculum anchored on John Dewey's idea about the total learning experiences of the individual. According to Martin [1], progression as a thing that describes pupils' personal journeys through education, and ways in which they acquire, apply, develop their skills, knowledge, and understanding in increasingly challenging situations. On the other hand, Zulueta [2], stated that this approach refers to the choosing and defining of the content of a certain discipline to be taught using prevalent ideas against the traditional practice of determining content by isolated topics. Cabansag [3], concluded that students find the topics easy at first and gradually become hard, but there is mastery of the topics because they are discussed in their own pace and longer years to study. On the contrary, some students did not agree that K-12 program is more interesting, effective and enjoyable because the topics are too difficult, and they need to stay longer in

school for two years on senior high school.De Dios [4], stated that when DepEd's K to 12 treatment of chemistry was compared with the basic education curriculum in other countries, it can be said that one can combine Grades 7 to 10. Each of these grades in DepEd's K to 12 assigns one quarter of the year to chemistry. Adding these across the first four years of high school could sum up to one year of instruction in chemistry.The flow of concepts covered can be managed more easily in a year-long subject than in a spiral curriculum.Tapang [5], on the other hand stated that the decision of DepEd in dropping science from the subjects being taught at the grade 1 level is based on the design of the K-12 curriculum and the department's efforts to decongest the Basic Education curriculum. Hence, science will be introduced as a subject only at Grade 3. This move to limit the contact hours for science is worrisome, especially since the purported target of the shift to 12 years of basic education curriculum is to improve student's competencies in English, Math and Science and prepare them for college.

2. Objectives of the Study

This study aimed to conduct a formative assessment on the implementation of the spiral progression approach (SPA) in teaching science in Polytechnic University of the Philippines Laboratory High School (PUPLHS). This particularly sought answers to the following: the students' perceptions on vertical articulation of spiral approach in terms of the continuity of concepts learned in Grade 9 and Grade 10 science; the teachers' perceptions on SPA in terms of horizontal and vertical articulation, mastery of the subject matter, teaching strategies and availability of instructional materials and laboratory equipment; positive experiences and problems encountered in the implementation of spiral approach by the students and teachers; and the possible solutions for the identified problems as perceived by the students and teachers.

3. Materials and Methods

This research is a qualitative research case study that aimed to gather the necessary data and information regarding the formative assessment of the implementation of the SPA in teaching science in PUPLHS Academic Year 2016-2017.

The sampling technique used in this study was the heterogeneous purposive sampling which is also known as the maximum variation. One hundred thirty-three (133) students, regardless of their academic standing and level of understanding were chosen in order to provide wide range of data to be assessed in this study. While all science

teachers (with part-time, temporary or permanent status) with an experience in teaching the Grade 9 and 10 students of PUPLHS were considered teacher-respondents of this study.

3.1. Research instruments

There are three (3) instruments used for data collection in this study, namely: structured interview which aimed to gather the students' perceptions on the implementation of the SPA; focus group discussion (FGD) which was guided by the developed and validated questionnaire; and interview/FGD questionnaire which was designed to guide the respondents on the conduct of the structured interview and FGD.

3.2. Data gathering procedure

The researcher conducted 133 individual structured interviews from both Grade 9 and 10 student-respondents. A random schedule of interview was done since the student-respondents came from six (6) different classes. The FGD was conducted during the dismissal time of the teachers that lasted for twenty (20) minutes.

Two (2) levels of coding were used in this study namely: open coding, which was done by examining the interview questionnaires and by selecting key words or phrases used; and the axial coding, that involves linking of categories and codes, followed by interconnecting them with main concepts. The researcher mind-mapped the themes uncovered during the open coding to show how the student-respondents' ideas were interconnected with regard the spiral progression approach in science.

4. Results and Discussion

The data gathered from the students and teacher-respondents were focused on their perceptions in terms of understanding of the concept of SPA. Also, the mastery of the subject matter, the instructional materials appropriate in the implementation of the said approach, and the teaching strategies used were explained. The positive experiences and problems encountered, and the solutions to the identified problems by both respondents.

Most of the student-respondents' understanding of the spiral progression in science is focused on the continuity of lessons in the same area of science in all grade levels. This concept of vertical articulation got the highest frequency as indicated in Table 1.

Table 1: Students' Perceptions on Vertical Articulation of Spiral Progression Approach.

Students' Perceptions	Frequency
There is continuity of lessons in the same area of science in all grade levels	42
The topics discussed in the previous years are needed in the present year.	33
Same areas of science are discussed in all grade levels.	26
The lessons are easier to understand because the same topics are offered in all grade levels.	19
There is a different level of difficulty in one area of science in different grade levels.	10

Hence, most of the student-respondents understood vertical articulation as continuation of discussions of the same areas of science in all grade levels. The need of the knowledge gained in the previous grade level to the discussion in the present grade. Based on the student-respondents' responses, the continuity of the lessons learned and the consistency in the discussion of the topics laid in the science curriculum guides from Grade 7 to Grade 10 were noticeably seen in spiral progression approach.

On the other hand, the teacher-respondents agreed that both vertical and horizontal articulation of the SPA were hard to trace in the learning competencies. Based on the data gathered, 2 teacher-respondents, with Chemistry and General Science as their fields of specialization, said that vertical articulation was hard to trace in all the areas of science, for the reason that the students tended to forget what they have learned from the previous grade level. However, one teacher-participant, with Biology as her field of specialization, said that vertical articulation was hard to trace in other areas of science except for her own field of specialization.

As perceived by the teacher-respondents of the study, vertical and horizontal articulation of spiral progression were not easy to be traced based on learning competencies. Having students with different level of understanding, not everyone is able of remembering their past lessons that led to the need of review before the start of the new lesson especially in the areas of Physics and Chemistry. Though at lower grade levels, the topics are simple, the students find it hard to connect to the more complex topics in higher-grade levels. The teachers had the mastery of the subject matter in their own area of specialization because they are very much aware of the lessons. In times that they are about to teach other areas of science, the teachers study and ask the help of their colleagues in order to have enough knowledge of the topic that they are about to teach. They agreed that cooperative learning is appropriate and

effective in teaching science as all of them gave this response during the FGD. This shows that cooperative learning could be used in all areas of science regardless of the area of specialization of the teachers. Thus, the students, if were given a chance to work collaboratively they discover learning on their own. With proper guidance of teachers, it is easy for the students to remember the lessons. For these strategies to be effective, the teachers need mastery of the lesson and are aware of what concepts the students need to master. Working collaboratively with other science teachers through sharing of techniques and team teaching helped them in gaining mastery of the subject matter.

Table 2: Instructional Materials used by Teachers as perceived by the Students.

Students' Perceptions	Frequency
Multimedia (videos, PowerPoint presentations, movies and the use of laptop and projector)	112
Group activities	101
Reference books/laboratory manuals	93
Laboratory equipment	81
Use of models/pictures/illustrations/drawings	42
Use of mind-map/concept map/flow chart	40
Interactive games	27

Based on table 2, the use of multimedia was the most used instructional material by the teacher in their science classes. This addressed the kind of learners today – 21st century learners who are technology-oriented. Group activities during the cooperative learning are also effective. This enhanced the students' capability of working with their classmates to think critically and understand better the science concepts discussed by their teachers. On the other hand, reference books and laboratory manuals are still important teaching materials despite the technology that the students are using in their studies. Laboratory experiments develop the minds of the students to discover science concepts, think critically, and apply what they have learned during the class discussions.

Although the teacher-respondents revealed that there is shortage in the supply of the laboratory equipment and only the basic equipment like beakers, test tubes, and the like are present in the laboratory, they still managed to do some laboratory activities. The data gathered also showed that using models such as DNA models, organ system, planets and cells, pictures and drawings enhance the imagination of the students in order to understand better the science concepts. These materials helped

them grasp difficult lessons specifically in Chemistry and Physics. It was also the same in the case of mind-maps, concept maps and flow charts. On the other hand, some students preferred to have interactive games during science lessons. This helped the students become motivated specially in learning difficult areas of science and aid in the success of the goal of SPA in science education.

Table 3: Students' Positive Experiences in the Implementation of Spiral Progression Approach.

Students' Positive Experiences	Frequency
Going back to the previous lesson through review made me understand the new lesson.	121
Connecting the past lessons to the current one made me understand the complex lessons in science.	117
Having the same concepts in a specific area of science to be discussed and continued in the next grade levels made me become familiar with science lessons.	105
Basic to complex lessons in science allowed me to think critically.	98

The most-cited positive experiences of the student-respondents in spiral progression shown in table 3 reflects that the students were able to understand the new lessons in science in their current grade level because of the review done during class discussions. Majority of the students stated that going back to their lessons in the past years before the start of the new lesson in their current grade level made them understand the latter. On the other hand, the students were able to understand the complex lessons by connecting their previous lessons to the new ones. Familiarity of the science lessons was gained by having the same concepts in a specific area in all grade levels attributed to the nature of spiral progression.

As perceived by the teacher-respondents, having four areas of science to be taught in one school year allowed them to gain mastery of the subject matter not only on their area of specialization but in other areas of science as well. This became possible by the further study and research that they have done in order to teach these properly to their students. Through cooperative learning and discovery approach as effective strategies for teaching science, the teachers' role then relegated to facilitate the discussion and monitor the learning and progress of their students. Since the teachers have different areas of specialization, SPA in science allowed them to collaborate with other science teachers, who in turn taught them other teaching techniques they can use for when the time comes that they need to teach the science concepts which are not in their areas of specialization.

Table 4: Teachers' Positive Experiences in the Implementation of Spiral Progression Approach.

Teachers' Positive Experiences	Frequency
Mastery of the subject matter/ Additional knowledge in the areas of science which were not our field of specialization.	3
Lessened the tasks of the science teachers because spiral progression as part of K to 12 is student centered.	3
The teachers were able to collaborate with other science teachers and exchange techniques and strategies in teaching the different areas of science.	2
The teacher was able to be familiar with the science concepts which are difficult for her students, and perform intervention to address the problem immediately.	1

On the other hand, the teacher-participant who specialized in Chemistry stated that SPA helped her monitor her students in terms of the difficult science concepts as perceived by her students. Through this, she was able to address and make interventions so that the students might catch up with difficult lessons especially in Physics and Chemistry. Thus, SPA allowed teachers to gain more knowledge in different areas and gave them the chance to discover and learn other teaching strategies that would help them teach the areas of science assigned to them.

Table 5: Students' Difficulties/Challenges Experienced in the Implementation of Spiral Progression Approach.

Students' Difficulties	Frequency
Retention and mastery of subject matter in difficult science concepts	118
Repetition of topics in all grade levels.	110
It was hard to adjust in the changes in the area of science to be discussed every grading period.	91
Review is time consuming.	87
There was a confusion on the complex lessons in different areas of science.	73
There was a limited time allotted to some science concepts.	52

Based on table 5, the students had a hard time in remembering all the lessons learned in the past, since these acted as pre-requisites in the current lessons. Several factors could be causing such difficulty, like the lack of full discussion in difficult science concepts such as Chemistry and Physics; time allotment for each lesson in

every grading period is not enough to cover all the lessons in science per area; and the failure to remember all the lessons taught to the students.

Some students stated that since there were concepts in science that were revisited each year, it seemed that the teacher was just repeating the discussions. Unfortunately, because there are some of their classmates who cannot relate their present lessons to the previous ones, their teachers tend to go back to their past lessons so everyone will be able to cope up. Thus, the students find the discussion sometimes repetitive.

Apparently, the students had a hard time to focus on four (4) areas in a year as spiral approach when compared to one subject of focus like he design of the disciplinal approach. Since the four areas of science were to be taught in one year, the division of topics for each area was seen as a difficulty of the students. They find it hard to adjust in shifting lessons from each quarter or grading period perhaps due also to the limited time in each quarter, which somehow affects their academic standing.

Review done by the teachers before the start of each lesson helped them remember their previous ones which are needed to understand their current topics in science. Students who are slow learners benefited on this matter. However, for some students, reviewing is also time-consuming. Students stated that if most of the class failed to remember their previous lessons, it take much of the teacher's effort to review in order for the students to cope up with the current lessons and seemed that they are just repeating the discussions they had in their previous years. Thus, the discussion of the new lesson is shortened. In case the teacher did not conduct a review before the new lesson, it is difficult for the students to comprehend. It was clear that SPA helped the students improve their retention in science first by revisiting their previous lessons in their lower grade levels and through the review done by their teachers. However, the data collected also showed some conflict particularly in the concept of review. It was shown that review played an important role in the retention process of the students and at the same time stated as one of the difficulties experienced by them and was considered as time consuming.

The researcher was able to clarify this matter of conflict to the students who gave those perceptions and found out that review is indeed a tool to help the students remember what they have learned in the previous years. It helped the students to have retention of the subject matter. The problem arose when review became the lesson itself during class discussion because some of their classmates would ask their teachers to re-discuss what they studied before. In effect, their discussion on the new lesson suffered. In order to verify this matter, the researcher asked the teachers on their point of view. In order to address this problem, the teachers had to re-discuss

their previous lessons through review. Because the students were grouped heterogeneously, some students are able to move to their new lessons while some still need to review.

It was seen that one grading period is not enough to fully grasp the lessons included in one area of science in a particular grade level. There were also times that there were unfinished lessons in one grading period. There were also instances that in order to cover all the concepts in one area of science, rushed discussion was done. This led to confusion in the next grade level because the students were not able to discuss and understand the basics in the previous year.

Table 6: Teachers' Difficulties/Challenges Experienced in the Implementation of Spiral Progression Approach.

Teachers' Difficulties	Frequency
Teaching areas of science which are not areas of specialization	3
Short time for review part in the lesson	3
Lack of laboratory equipment	3
Inconsistent academic grades of the students	2

The teacher-respondents find it hard to teach areas of science which are not their field of specialization. This means that the teachers might teach based only on their level of understanding. Moreover, the other two teacher-respondents who specialized in Chemistry and General Science agreed on this matter.

In order to attain vertical articulation in SPA, the students need to connect their previous lessons in the past grade level to the present. One way of doing this is to conduct review before the start of the class; however, the teachers find it hard to limit the review to 5 minutes that was the recommended time for it in a regular setting. Tendency is, the teachers seem to re-discuss the lessons that students learned in the previous year to connect it to the current lesson.

The data shows that the students still prefer to have a review before the start of the new lesson for all of them, regardless of the type of learners are present in the classroom to cope up with the new lesson. Reviewing while introducing the new lesson or review as the need arises was suggested to address the conflict. The researcher found out that this is much of the teachers' technique for all his/her students be allowed to cope up with the lesson.

Moreover, the students believe that they will learn more if they are engaged in different science activities, even as their teachers serve as facilitators. Through this,

Table 7: Students' Suggestions to Improve the Implementation of Spiral Progression Approach.

Students' Suggestions	Frequency
Allot more time for review in order for the students to comprehend with the new lesson.	128
Assign at least one (1) laboratory activity or science experimentation in each lesson in science.	101
Provide a more detailed discussion especially in areas of which are difficult, such as: Chemistry and Physics.	82
Continue the use of multimedia, models, mind-maps and other teachings aids that help the students understand the science lessons.	81
Perform interactive activities and group activities that provide applications of science lessons in everyday lives.	75

the students will be able to enhance their scientific skills and attitudes and will be able to discover science concepts on their own. Thus, proper guidance of the teachers is still necessary for a clear discussion and understanding of the science lessons.

A more detailed discussion specifically in the areas of science such as Chemistry and Physics would be of help to the retention and mastery of the subject matter of the students. Thus, a fast-paced discussion may only be applied in discussing the basic science concepts.

The use of multimedia and other teaching materials appropriate to the level of understanding of the students was an important factor in transferring knowledge. Hence, these sufficient instructional materials present in PUPLHS science laboratories may be continuously used in order for the students to understand the science lessons even as they are simultaneously motivated in all science classes. Thus, the student-respondents believed that the suggestions they offered would enable them to comprehend the science lessons in all areas.

Table 8: Teachers' Suggestions to Improve the Implementation of Spiral Progression Approach.

Teachers' Suggestions	Frequency
The teachers should practice time management in preparing themselves in teaching the different areas of science.	3
The teachers should be allowed by the school administration to attend seminars and trainings that will enhance their knowledge in the subject matter and enhance their teaching skills.	3
Add another one hour per week for science classes.	3

Mastery of the subject matter and retention of knowledge gained by the students were the top problems identified by the teachers. To be equipped in teaching science, teachers must first have the mastery of the subject matter by allowing them attend to workshops and trainings that will enhance their knowledge and skills in different areas of science and strategies to be used in class. As per mandated by DepEd, science subject must be taught four (4) hours a week in Grades 7 to 10 (DepEd Order No. 31, Series 2012, Policy Guidelines on the Implementation of K to 12, section 2, e. Time Allotment). A proposal of bringing it back to five (5) hours a week would benefit both students and teachers in order to grasp all the lessons that should be tackled in the whole year. Improvement of laboratory facilities will help the students experience and apply the lessons they have learned, and practice their scientific skills as well as attitudes in conducting experiments.

5. Conclusion and Recommendation

In conclusion, SPA in science through vertical articulation provides better understanding and deepens the learning capacity of the students. Vertical and horizontal articulations were traced by the students through a thorough review done by the science teachers before the start of each lesson. Thus, review is essential in order to gain mastery of the subject matter. As for the teaching strategy, discovery approach and cooperative learning are the effective teaching strategies used in spiral progression approach in science. The use of multimedia and laboratory activities play vital roles for the students to better understand science concepts and its application to their everyday lives under spiral progression approach. Lastly, in order to provide excellence in teaching science through vertical articulation, teachers must be equipped and updated in terms of the new strategies, pedagogical content, and must have mastery in other areas of science.

Among the recommendations of this study are: the teachers must perform a review as need arises during class discussions so as not to become time consuming. In terms of strategies, collaborative learning and discovery approach were seen as helpful in the discussion of science lessons thus, the researcher recommends considering it in the selection of strategies to be used in teaching science. As for instructional materials, the researcher recommends that one (1) laboratory activity shall be conducted for each science lesson for the benefit of the students. Also, the use of multimedia in their class discussions is encouraged so that the students can easily adapt in the discussion of science lessons under SPA. For future researchers, it is recommended to look at the

possibility of measuring students' mastery of the subject matter in spiral progression through summative test or standardized test in each grade level at the end of the school.

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References

[1] Martin, B.(2008). Obstacles to Academic Integrity. Proceedings of the 3rd Asia-Pacific Conference of Educational Integrity: Creating a Culture of Integrity. University of South Australia

[2] Zulueta, A. (2002). As cited by Resurreccion J. & Adanza J. (2015). Spiral Progression Approach in Teaching Science in Selected Private and Public Schools in Cavite. DLSU, Manila, Philippines

[3] Cabansag, M. 92014). Impact Statements on the K-12 Science Program in the Enhanced Basic Education Curriculum in Provincial School. PNU Isabela, Philippines

[4] De Dios, A. (2012). Philippines' Basic Education. Department of Health's Curriculum II. Discovery Learning Scaffolding. http://kadriyeportfolio77.weebly.com/jerome-bruner-1715.html

[5] Tapang, G. (2012). Science and K+12. Retrieved: http://opinion.inquirer.net/22527/science-and-k12.Teachersshouldknow.