Spiral Progression Approach in teaching science in selected private and public schools in Cavite

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Abstract – *This study aims to assess the implementation of the Spiral Progression approach in teaching sciences in both private and public high schools. The study utilized the mixed-method design (quantitative-qualitative research design), in which interviews, questionnaires, and observation were used to gather data. This was conducted in four private and two public schools. The data were processed, analyzed, and interpreted using the following statistical tools: frequency, percentage, means, "Goodness of Fit" test and Chi-Square. The study shows that a majority of private school science teachers have Biology as their specialization, while science teachers in public high schools specialized in Chemistry. However, for both private and public schools, Biology is the average specialization of teachers. Further, it was found out that at .05 level of significance there is no significant difference in the effectiveness of spiral progression in teaching Biology, Chemistry, Physics, and Earth Science between private and public schools. Consequently, both teachers of private ($x=3.3$) and public schools ($x=2.83$) see spiral progression as "sometimes" advantageous and disadvantageous to the students. Moreover, the study also revealed that, at .05 level of significance, discovery or inquiry learning ($\chi2=40.65$, $df=12$, $p<.05$), collaborative learning ($\chi2=32.69$, $df=12$, $p<.05$)), and experiential learning ($\chi2=25.60$, $df=12$, $p<.05$) are the three most preferred and effective teaching strategies in teaching science. In the qualitative part of the study, the responses of the respondents were categorized according to their themes. The study found out that the spiral progression approach had greatly influenced science curriculums, particularly the content and transitions of four areas of science, the secondary schools, the learners, and especially the science teachers. Based on the findings, science teachers were still adapting to the new curriculum, needed more time and training to master all the fields, and needed to learn new teaching strategies because it is difficult to teach something when one does not have the necessary mastery. They cannot teach other branches of science without the in-depth discussion because it is not their specialization.*

Keywords – *Spiral progression; science teaching; sciences; teaching approach; teaching methodology*

Introduction

Spiral Progression Revisited

The Spiral Progression Approach in curriculum is derived from Bruner's Spiral Curriculum Model (Lucas, 2011). Bruner stressed that teaching should always lead to boosting cognitive development. The student will not understand the concept if teachers plan to teach it using only the teacher's level of understanding. The curriculum should be organized in spiral manner so that the student continually builds upon what they have already learned. In congruence to Clark's (2010) findings, Bruner saw the role of the teacher as that of translating information into a format appropriate to each child's current state of understanding. Davis (2007) added that Hilda Taba also influenced the design of a spiral curriculum, organizing it around concepts, skills, or values in a horizontal integration of learning. Based on the given arguments, the effectiveness of the curriculum relies on the teacher's knowledge of the curriculum, his/her teaching strategies, and mastery of the subject matter (Duze, 2012).

The idea in the spiral progression approach is to expose the learners to a wide variety of concepts/topics and disciplines until they mastered it by studying the material over and over again, but with a differing depth of complexity. In relation to a secondary science curriculum, Sanchez (2014) explained that science is composed of four areas, namely, Integrated Science, Biology, Chemistry and Physics. In the old curriculum, Integrated Science was taught in first year, Biology in the second year, Chemistry in the third year, and Physics in the fourth year. However, in new secondary science curriculum implemented last 2012, all the concepts of those four major areas are taught at the same time. Each year, students are exposed to the spiral progression approach wherein the four areas are taught per grading period. Also, Integrated Science was changed into Earth Science.

Many problems in life involve scientific explanations and processes. For this reason, an understanding of science and the scientific approach is essential in making intelligent decisions (Realuyo, 2006). In relation to that, De Dios (2013) argued that Science subjects diverge into separate disciplines in secondary education, and require teachers to have a sufficient level of knowledge in all these areas.

Spiral Progression and Progressive Curriculum

The spiral progression approach follows a progressive type of curriculum. Progressive curriculum, anchored to John Dewey, is defined as the total learning experiences of the individual. Martin (2008) defined progression as a thing that describes the personal journeys of pupils through education, ways in which they acquire, apply, and develop their skills, and use their knowledge and understanding in increasingly challenging situations. On the other hand, Zulueta (2002) stated that this approach refers to the choosing and defining of the content of a certain discipline, which would be taught using prevalent ideas against the traditional practice of determining content by isolated topics. Given these descriptions, the spiral curriculum can be understood as a design, a written plan, a list of subjects, and a layout of expected outcomes from the students wherein one concept is presented repeatedly throughout the curriculum but with deepening layers of complexity.

According to Martin (2008), spiral curriculum is a design framework which will help science teachers construct lessons, activities, and projects that target the development of a student's thinking skills and disposition that does not stop at identification, but involves progression and continuity in learning science. As progression has already been described above, continuity is concerned with ways in which the education system structures a learner's experience and provides sufficient challenge and progress for them in a recognizable curricular landscape. Therefore, the spiral progression approach is a way to implement the spiral curriculum.

After the mastery of the initial topic, the student "spirals upwards" as the new knowledge is introduced in the next lesson, enabling him/her to reinforce what is already learned. In the end, a rich breadth and depth of knowledge is achieved. With this procedure the previously learned concept is reviewed, hence improving its retention. Also, the topic may be progressively elaborated when it is reintroduced, leading to a broadened understanding and transfer of knowledge (Mantiza, 2013).

Spiral Progression in the Philippines

This study focuses on the teaching of science subjects in the Philippines using the spiral progression approach. The review of related literature yields theoretical and philosophical underpinnings of spiral progression, but few empirical studies are made in the field of teaching science. Studies about the use of spiral progression are scarce because this approach was implemented recently in 2012. This study aims to determine how competent science teachers are in teaching science using the said approach.

Curriculum is a dynamic process. Development means changes which are systematic. A change for the better means any adjustment, revision, or improvement of the existing conditions. To produce positive changes, development should be purposeful, planned, and progressive. It will take years to evaluate whether or not the curriculum is effective and attuned to the needs of learners and society. One cannot say that the spiral progression approach in teaching science is effective in the Philippines. The use of this approach in the Philippines must be evaluated, since other countries had abolished spiral progression from their educational systems after a certain period of time from implementation.

The Philippines' basic education curriculum is congested. Therefore, President Benigno Aquino signed Republic Act 10533, also known as the K to 12 Program, which mandates private and public schools to implement the spiral progression approach in their curriculums.

De Dios (2005) stated that the spiral curriculum is viewed as one of the problems of basic education in the United States. This is also emphasized in another study on curriculum coherence. The US curriculum is redundant since those of the top performing countries are coherent. Comparing the Chemistry curriculums of top performing countries against the Philippines' DepEd K+12 curriculum, it is clear that the other countries are far more advanced. Countries like Singapore are already teaching atoms, ions, and molecules to Grade 7 students since these are fundamental concepts in Chemistry.

According to Kronthal (2012), spiral curriculum could be regarded as an extreme design of mixing the sciences. However, De Dios (2013) argued that spiral curriculum can only devote a quarter of a year to each branch, so the topics the student will be exposed to are severely limited due to the small amount of time allocated per branch. The biggest disadvantage of a spiral curriculum is the lack of opportunity to cover a variety of topics within a year. Each discipline requires steps. To get to intermolecular forces and a molecular understanding of solutions, there are prerequisites. The topics build on top of each other, and a quarter of a year is simply not enough time to cover enough concepts that will aid the student in another field. It is simply because of the nature of the subject. Therefore, the learner will require a year to take Chemistry before taking Biology.

According to De Dios (2013), human learning requires steps; we learn to walk before we run. Coherence in curriculum is therefore a must. Coherence in a curriculum can be a given by instructors who specialize in teaching a particular subject. A teacher who has an education degree specializing in Chemistry, with or without a curriculum, would know what to teach first. This, in fact, is one major difference between teachers in Singapore and those in the United States. Teachers in Singapore, even in the elementary years, are subject experts. Teaching science in an integrated approach requires specific training. Drawing a curriculum that recognizes the hierarchical nature of topics within a discipline not only provides the conditions helpful to learning, but also facilitates procurement of the required teaching abilities. A spiral curriculum that deals with a mile-wide range of topics on various disciplines requires too much from one teacher, therefore the approach must consider the resources available. There is no point in introducing a curriculum that cannot be implemented correctly.

While the Philippines moves to use spiral approach, Missouri is doing the opposite. In a study, science teachers in the US had agreed to abandon the spiral approach and adopt a field-focus approach to teaching science. School districts in the state of Missouri are changing their science curriculums for Grades 6 to 8. The reform primarily changes science instruction from a spiral approach to a field-focus curriculum. The Philippines, on the other hand, with DepEd's K to 12 program, is going in the opposite direction. Without debating which direction is the correct one to take, both need to face the challenge of a major transition. Poor implementation of education reform leads to failure, even if the change is the correct prescription. The transition stage is a major part of the implementation since it is crucial for the success of the reform. Therefore, it is necessary to pay close attention to the transition process as this stage can lead to failure if not implemented correctly. As Alwardt (2012) emphasizes, "Transitions are inherently difficult for teachers." While trying to adjust to the change, teachers still have the obligation to give the very best instruction to the students. There are no "dress rehearsals", so it is very important that teachers during this stage are heard and supported. With this in mind, one can evaluate how DepEd in the Philippines is implementing the K to 12 program. One should understand and appreciate the crucial role of teachers in educational reform.

It is the aim of this study to determine how secondary science teachers in selected secondary schools within the Cavite area assess and implement the spiral progression approach in their science curriculums. It specifically aims to answer the question of whether teachers who graduated in a specific specialization in science can teach a branch beyond their specialization.

Methodology

The study utilized the mixed-method design (quantitative-qualitative design), and was conducted in four private and two public schools. The data were processed, analyzed, and interpreted using the following statistical tools: frequency, percentage, means, “Goodness of Fit” test, and Chi-Square. Using the judgmental sampling approach, 15 secondary science teachers from public schools and 15 secondary science teachers from private schools were recruited within randomly chosen districts of Cavite province. A validated, researcher-made Likert scale questionnaire was used (Cronbach α=.821). Regarding the qualitative part of the study, the participants answered three open-ended questions asked by the researchers.

Results and Discussion

On Science Specialization

Table 1. Science Specialization of Teachers

Areas	Private	Public	Total
Biology	6-40%	4-27%	10-33%
Chemistry	1-6%	6-40%	7-23%
Physics	4-27%	2-13%	6-20%
Earth Science	1-7%	1-7%	2-7%
Others	3-20%	2-13%	5-17%
Total	15-100%	15-100%	30-100%

Table 1 shows that a majority of private school science teachers have Biology as their specialization (40%), while public school science teachers have Chemistry as their specialization (40%). However, for both private and public school science teachers, Biology is the most common specialization (33%). The least specialized areas for private school teachers are Chemistry (6%) and Earth Science (7%), while the least specialized areas for public school teachers are Earth Science (7%) and Physics (13%).

On the Perceived Effectiveness of Spiral Progression in Teaching Chemistry

Table 2. 1 Effectiveness of Spiral Progression Approach in Teaching Chemistry from Private and Public Schools

	Private f		Public f		Total
	O	E	O	E	
E1	1	1	1	1	2
E2	6	5.5	5	5.5	11
E3	6	5.5	5	5.5	11
E4	2	3	4	3	6
E5	0	0	0	0	0
TOTAL	15		15		30

Legend: E1-always, E2-often, E3-sometimes, E4-rarely, E5-not at all

X2 = 4.76; Tabulated value= 9.

When participants were asked about the effectiveness of spiral progression in teaching Chemistry for both private and public secondary schools, Table 2, a contingency table, shows “often” and “sometimes” having the highest frequency of all the answers. Testing the result’s statistical significance, responses from private and public secondary school science teachers are undifferentiated (x^2=4.76, p>.05). Therefore, the null hypothesis is retained—when they are grouped according to whether they are working in a private or public secondary school, there is no significant difference in the teachers’ perception of spiral progression’s effectiveness in teaching Chemistry.

On the Perceived Effectiveness of Spiral Progression in Teaching Biology

Table 2. 2 Effectiveness of Spiral Progression Approach in Teaching Biology from Private and Public Schools

	Private f		Public f		Total
	O	E	O	E	
E1	1	1.5	2	1.5	3
E2	6	5	4	5	10
E3	7	5.5	4	5.5	11
E4	0	2	4	2	4
E5	1	1	1	1	2
TOTAL	*15*		*15*		*30*

Legend: E1-always, E2-often, E3-sometimes, E4-rarely, E5-not at all
X2 = 5.56; Tabulated value= 9.88
Decision= Accept H0

When participants were asked about effectiveness of spiral progression in teaching Biology for both private and public schools, Table 2.2, a contingency table, shows "often" and "sometimes" having the highest frequency of all the answers. Testing the result's statistical significance, response from private and public schools are undifferentiated (x2=5.56, p>.05). Therefore, the null hypothesis is retained—when they are grouped according to whether they are working in a private or public secondary school, there is no significant difference in the teachers' perception of spiral progression's effectiveness in teaching Biology.

On the Perceived Effectiveness of Spiral Progression in Teaching Physics

Table 2.3 Effectiveness of Spiral Progression Approach in Teaching Physics from Private and Public Schools

	Private f		Public f		Total
	O	E	O	E	
E1	1	1	1	1	2
E2	6	5.5	5	5.5	11
E3	6	5.5	5	5.5	11
E4	2	3	4	3	6
E5	0	0	0	0	0
TOTAL	15		15		30

Legend: E1-always, E2-often, E3-sometimes, E4-rarely, E5-not at all
X2 = 0.86; Tabulated value= 9.88
Decision= Accept H0

When participants were asked about effectiveness of spiral progression in teaching Biology for both private and public schools, Table 2.3, a contingency table, shows "often" and "sometimes" having the highest frequency of all the answers. Testing the result's statistical significance, response from private and public schools are undifferentiated (x2=0.86, p>.05). Therefore, the null hypothesis is retained— when they are grouped according to whether they are working in a private or secondary public school, there is no significant difference in the teachers' perception of spiral progression's effectiveness in teaching Physics.

On the Perceived Effectiveness of Spiral Progression in Teaching Earth Science

Table 2.4 Effectiveness of Spiral Progression Approach in Teaching Earth Science from Private and Public Schools

	Private f		Public f		Total
	O	E	O	E	
E1	1	.5	0	.5	1
E2	6	5.5	5	5.5	11
E3	7	6	5	6	12
E4	1	2.5	4	2.5	5
E5	0	.5	0	.5	1
TOTAL	15		15		30

Legend: E1-always, E2-often, E3-sometimes, E4-rarely, E5-not at all

X^2 = 4.14; Tabulated value= 9.88

Decision= Accept H_0

When participants were asked about effectiveness of spiral progression in teaching Earth Science for both private and public secondary schools, Table 2.4, a contingency table, shows "often" and "sometimes" having the highest frequency of all the answers. Testing the result's statistical significance, response from private and public schools are undifferentiated (x2=4.14, p>.05). Therefore, the null hypothesis is retained—when they are grouped according to whether they are working in a private or public secondary school, there is no significant difference in the teachers' perception of spiral progression's effectiveness in teaching Earth Science.

On Advantages and Disadvantages of Spiral Progression in Private and Public Schools

Table 3.1 Advantages of Spiral Progression in Private Schools

Advantages	Mean	Q.I.
1. Avoids disjunction between stages of schooling	3	Sometimes
2. Allows learners to learn topics and skills appropriate to their development/ cognitive stages.	3.67	Often
3. Allows learners to learn topics and skills as they are revisited and consolidated.	3.6	Often
4. It strengthens retention and mastery of topics and skills as they revisited and consolidated.	2.87	Sometimes
5. It allows learners to gain valid experiences.	3.32	Sometimes
Composite Mean	3.3	Sometimes

Table 3.2 Advantages of Spiral Progression in Public Schools

Advantages	Mean	Q.I.
1. Avoids disjunction between stages of schooling	1	Rarely
2. Allows learners to learn topics and skills appropriate to their development/ cognitive stages.	3.6	Often
3. Allows learners to learn topics and skills as they are revisited and consolidated.	3.27	Sometimes
4. It strengthens retention and mastery of topics and skills as they revisited and consolidated.	3.06	Sometimes
5. It allows learners to gain valid experiences.	3.26	Sometimes
Composite Mean	2.83	Sometimes

Tables 3.1 and 3.2 reveal how the participants perceived the advantages of the spiral progression approach. Respondents from private schools rated the advantages of the spiral progression approach as "Sometimes" with a composite mean of 3.3, while respondents from public schools also rated the advantages as "Sometimes" with a composite mean of 2.83. The overall composite mean of the advantages of the spiral progression approach was 3.06, interpreted as "Sometimes." This implies that teachers perceive spiral progression to be sometimes an advantage but not always. In simpler terms, it is on a case-to-case basis depending on a certain situation or context.

It is interesting to note that in advantage number 1, which states that spiral progression avoids disjunction between stages of schooling, there is a difference of two units between private (x=3, sometimes) and public schools (x=1, rarely). Not all teachers believe that avoiding disjunction is an advantage of this approach, especially public school teachers, who gave this advantage the lowest rate.

Table 4.1 Disadvantages of Spiral Progression in Private Schools

Disadvantages	Mean	Q.I.
1. Does not promote sufficient review once units are completed.	3	Sometimes
2. The rate of introducing new concept is often either too fast or too slow.	2.99	Sometimes
3. All concepts are allotted the same amount of time whether they are easy or difficult to master.	2.86	Sometimes
4. It is difficult to sequence instruction to ensure that students acquire necessary pre-skills before introducing difficult skills.	3.13	Sometimes
5. Many students fail to master important concepts	3.26	Sometimes
Composite Mean	3.04	Sometimes

Table 4.2 Disadvantages of Spiral Progression in Public Schools

Disadvantages	Mean	Q.I.
1. Does not promote sufficient review once units are completed.	3.13	Sometimes
2. The rate of introducing new concept is often either too fast or too slow.	3.46	Often
3. All concepts are allotted the same amount of time whether they are easy or difficult to master.	3.26	Sometimes
4. It is difficult to sequence instruction to ensure that students acquire necessary pre-skills before introducing a difficult skills.	3.59	Often
5. Many students fail to master important concepts	3.4	Sometimes
Composite Mean	3.37	Sometimes

Tables 4.1 and 4.2 reveal how the participants perceived the disadvantages of the spiral progression approach. It can be seen in the data that respondents from private schools rated the disadvantages of the spiral progression approach as "*Sometimes*", with a composite mean of 3.04, while respondents from public schools also rated the disadvantages as "*Sometimes*", with a composite mean of 3.37. The data also shows that the overall composite mean in the disadvantages of the spiral progression approach was 3.21, which is interpreted as *"Sometimes"*.

This reveals that respondents perceive the disadvantages of spiral progression as "*Sometimes.*" Comparing teachers from private secondary schools and public secondary schools, although they both perceive the disadvantages sometimes the figures suggest that public secondary school teachers look at spiral progression more as a disadvantage than an advantage, more so than private school teachers. This corroborates their perception of the advantages of spiral progression, wherein public secondary school teachers have a lower level of perception that spiral progression is advantageous compared to the perception of private secondary school teachers.

On the Common Teaching Strategies Used

Table 5. Common Strategies Used by Both Private and Public School Teachers

Strategies	Frequency	Percentage
Discovery/Inquiry Learning	12	13%
Collaborative Learning	11	12%
Experiential Learning	10	10%
Cooperative	9	9%
Jig-Saw Puzzle	8	8%
Buzz Session	7	7%
Child-Centered Approach	7	7%
Round-robin	7	7%
Think-pair-share	5	5%
Role play	5	5%
Portfolio's and Journal	6	6%
Whole Brain Teaching	2	2%
Group Investigation	9	9%

Table 5 shows the frequency and percentage of respondents from private and public schools. Out of 30 respondents from private and public schools, a majority of teachers have been using the discovery/inquiry learning approach, totaling at 12 or 13%. Teachers who make use of collaborative learning (11 or 12%), followed by teachers who make use of experiential learning (10%), teachers who make use of cooperative and group investigation (9%), teachers who make use of jigsaw puzzle approaches (8%), teachers who make use of buzz session and child-centered round robin (7%), teachers who make use of portfolios and journals (6%), and finally teachers who make use of think-pair-share and roleplay (5%).

Testing of independence or preference through "Goodness of Fit" reveals that among the strategies, only three are widely preferred: discovery/inquiry learning (X^2=40.65, df=12, $p<.05$), collaborative learning (X^2=32.69, df=12, $p<.05$), and experiential learning (X^2=25.60, df=12, $p<.05$). A .05 level of significance reveals that the three most preferred used teaching strategies that are found effective in teaching science are discovery or inquiry learning (χ^2=40.65, df=12, $p<.05$)), collaborative learning (χ^2=32.69, df=12, $p<.05$)), and experiential learning (χ^2=25.60, df=12, $p<.05$).

On the Influence of Spiral Progression in Teaching Science

The data gathered showed the following themes based on the responses of respondents from both public and private schools: "Responsibility and Role of Teachers", "Secondary Science Teachers should be given more time, seminars, and training because it is hard to implement", and, "Teachers need to change/improve their way of teaching and learning to adapt the spiral progression approach".

Moreover, based on the findings, public secondary school teachers find it hard to easily adapt to the new curriculum, particularly teachers who have had long years in service in teaching within a certain specialization. However, they are doing their best to adapt to it by using new technologies, reading more books and resources, attending seminars, and collaborating with their fellow teachers. According to the respondents, when they first heard that there will be a reform in the educational system, they were shocked because they were not yet ready for it and were still coping with the past problems encountered in the former curriculum. On the other hand, some respondents said that the spiral progression approach can create globally competitive and dynamic learners and citizens.

Conclusion

The following are the conclusions of this study:

1. A general majority of science specialization is in Biology. Specifically, it is Biology in private schools and Chemistry in public schools. Both private and public schools have the lowest number of specialization in Earth Science.

2. Both private and public school teachers observed that sometimes and often spiral progression is effective in teaching science courses. Their perception is not differentiated statistically.

3. Both private and public school teachers sometimes perceive that spiral progression in science has both advantages and disadvantages. However, when compared as to how they perceive spiral progression, it is suggested that private school teachers are more inclined to perceive that spiral progression as more advantageous than disadvantageous.

4. As they are statistically significant, discovery/inquiry learning, collaborative learning, and experiential learning are the most commonly used and most effective teaching strategies of private and public school teachers under the context of the spiral progression program.

5. Teachers are having a hard time adapting to the new approach, particularly those who have specializations and have been teaching for many years. However they also believe that through this, globally competitive and dynamic learners and citizens can be created.

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