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 Spiral Progression approach in teaching sciences in both private and public high schools. This utilized the mixed-method design (quantitative-qualitative research design), in which interviews, questionnaires, and observation were used to gather data. This was conducted in 4 private and 2 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 majority of private school science teachers have biology as their specialization, while in public school, chemistry. However, for both private and public schools, Biology is the specialization of teachers. Further, it was also 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 or disadvantageous to the students. Moreover, the study also revealed that at .05 level of significance, 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), are the three most preferred used teaching strategies that are found effective in teaching science. In qualitative part of the study, the responses of the respondents were categorized according to their themes. The study found out that Spiral Progression approach had greatly influenced science curriculum 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, they needed more time and trainings to master all the fields and to learn new teaching strategies because it is difficult to teach something, in which one does not have the necessary mastery. They can 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.

I. Introduction

Spiral Progression Revisited

Spiral Progression approach in curriculum is derived from Bruner's Spiral curriculum model (Lucas, 2011). Bruner stressed that teaching should always lead boosting cognitive development. Student will not understand the concept if teachers plan to teach it using only the teacher's level of understanding. Curriculum should be organized in spiral manner so that the student continually builds upon what they have already learned. In congruence to Clark (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 spiral curriculum that organized around concepts, skills, or values in horizontal integration of learning. Based on the given arguments, the effectiveness of the curriculum relies on the teacher's knowledge about the curriculum, his/her teaching strategies and mastery of the subject matter (Duze, 2012).

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

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

Spiral Progression and Progressive Curriculum

Spiral progression approach follows 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 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 (2002) 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

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traditional practice of determining content by isolated topics. Given these descriptions, spiral curriculum can be understood as a design, a written plan, list of subjects and expected outcomes of the students in which one concept are 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 or projects that target the development of thinking skills and dispositions which do not stop at identification. It involves progression and continuity in learning science. *Progression* describes pupils' personal journeys through education and ways, in which they acquire, apply and develop their skills, knowledge and understanding in increasingly challenging situations. *Continuity* is concerned with ways in which the education system structures experience and provides sufficient challenge and progress for learners in a recognizable curricular landscape. Therefore, spiral progression approach is an approach or a way on how 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 (Mantiza, 2013).

Spiral Progression in the Philippines

This study focuses on the teaching of science subject using spiral progression approach in the Philippines. Review of related literature yields theoretical and philosophical underpinnings of spiral progression but few empirical studies are made in the area of science. Study on this topic in the Philippines is in scarcity, if not existent, because this approach was just fully implemented in 2012. It aims to determine how competent science teachers 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 existing condition. To produce positive changes, development should be purposeful, planned and progressive. It will take years to evaluate if the curriculum is effective and attuned to the needs of the learners and the society. One cannot really say that the spiral progression approach in teaching science is really effective in the Philippines. Evaluation of this approach is a must to determine, if like in other countries, in which this approach was abolished from their educational system after a certain period of time.

The Philippine basic education curriculum is congested. Therefore, President Benigno Aquino signed the Republic Act. 2013 also known as the K to 12 Program that mandated private and public schools to implement spiral progression approach in their curriculum.

The same with the researchers' study, De Dios (2005) noted that the spiral curriculum is in fact viewed as one of the problems of basic education in the United States. This is likewise emphasized in a study on curriculum coherence. The US curriculum is redundant while those of the top performing countries are coherent. Likewise, comparing the chemistry curriculum of the top performing countries against the Philippines' DepEd K+12 curriculum, it is clear that countries like Singapore are already teaching atoms, ions and molecules to Grade 7 students, which makes sense since these are the fundamental concepts of chemistry.

According to Kronthal (2012), the spiral curriculum could be regarded as an extreme design of mixing the sciences. However, De Dios (2013) argued that spiral curriculum can only devote one quarter of a year to each branch, so the topics student will be exposed per year in each branch of science are severely limited. The biggest disadvantage of a spiral curriculum is the lack opportunity to cover a variety of topics within one discipline in 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 is simply not enough time to cover enough to aid the student in another field. It is simply the nature of the subject. Therefore learner will require a year to take chemistry before taking biology.

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 with instructors who are specialized to teach 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 the required teaching abilities. A spiral curriculum that deals with a mile wide range of topics on various disciplines requires too much from any teacher. A spiral progression approach must consider the resources available. There is no point in introducing a curriculum that cannot be possibly implemented correctly.

Moreover, in a study, the science teachers in the US have agreed to abandon the spiral approach and adopt a field-focus approach to teaching science. Ironically, while the Philippines moves to Spiral Approach, Missouri does the opposite. School districts in the state of Missouri are changing their science curriculum 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 goes 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 an education reform leads to failure even if the change is the correct prescription. A major part of the implementation is the transition stage, which is crucial for the success of the reform. It is therefore necessary to pay close attention to the transition process as this stage can easily 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". It is therefore very important that teachers during this stage are heard and supported. With these in mind, one can evaluate how DepEd in the Philippines is implementing its K to 12. One should understand and appreciate the crucial role of teachers in education reform.

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

II. Methodology

This utilized the mixed-method design (quantitative-qualitative design). This was conducted in 4 private and 2 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 from private schools were recruited within randomly chosen districts of Cavite province. A validated, researcher-made, Likert scale type of questionnaire was used (Cronbach α=.821). On the qualitative part of the study, the participants preferred to answer by writing the three open-ended questions asked by researchers.

III. 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 majority of private school science teachers have biology as their specialization (40%), while in public school, chemistry (40%). However, for both private and public schools, biology is the most common specialization of teachers (33%). The least specialized areas for private school teachers are chemistry (6%) and earth science (7%), while in public, the least 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
X^2 = 4.76; Tabulated value= 9.88
Decision= Accept H_0

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

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
X^2 = 5.56; Tabulated value= 9.88
Decision= Accept H_0

Table 2.2, which is a contingency table, shows "often" and "sometimes" having the highest frequency of all the answers when participants were asked about effectiveness of spiral progression in teaching biology for both private and public schools. Testing the result's statistical significance, response from private and public schools are undifferentiated (x^2=5.56, p>.05). Therefore, the null hypothesis is retained, that indeed there is no significant difference on the perception of teachers about spiral progression's effectiveness in teaching biology, when they are grouped according to whether they are working in a private or public school.

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

X^2 = 0.86; Tabulated value= 9.88

Decision= Accept H_0

Table 2.2, which is a contingency table, shows "often" and "sometimes" having the highest frequency of all the answers when participants were asked about effectiveness of spiral progression in teaching biology for both private and public schools. Testing the result's statistical significance, response from private and public schools are undifferentiated (x^2=0.86, p>.05). Therefore, the null hypothesis is retained, that indeed there is no significant difference on the perception of teachers about spiral progression's effectiveness in teaching physics, when they are grouped according to whether they are working in a private or public school.

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

Table 2.4, which is a contingency table, shows "often" and "sometimes" having the highest frequency of all the answers when participants were asked about effectiveness of spiral progression in teaching earth science for both private and public schools. Testing the result's statistical significance, response from private and public schools are undifferentiated (x^2=4.14, p>.05). Therefore, the null hypothesis is retained, that indeed there is no significant difference on the perception of teachers about spiral progression's effectiveness in teaching physics, when they are grouped according to whether they are working in a private or public school.

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 spiral progression approach. It can be seen in the data that private schools participants rated the advantages of spiral progression approach as "*Sometimes"* with a composite mean of 3.3 while Public Schools respondent's also rate the advantages as "*Sometimes"* with a composite mean of 2.83. The result also shows that the overall composite mean of the advantages of spiral progression approach was 3.06 which are interpreted as "Sometimes." This implies that teachers perceive spiral progression to be sometimes an advantage but not always. In simpler terms, it is a case by case, depending upon a situation or context.

Moreover, it is interesting to note that in advantage number 1 which states that spiral progression avoids disjunction between stages of schooling, there is a big 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, much more for 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 spiral progression approach. It can be seen in the data that private schools respondents rated the disadvantages of spiral progression approach as "*Sometimes*" with a composite mean of 3.04 while public schools respondents also rate the disadvantages as "*Sometimes*" with a composite mean of 3.37. The data also shows that the overall composite mean in the disadvantages of spiral progression approach was 3.21 which is interpreted as sometimes. This reveals that respondents perceive the disadvantages of spiral progression as "*Sometimes.*" Comparing private schools and public schools, although they both perceive sometimes the disadvantages, still figures suggest that public school teachers look at spiral progression more as a disadvantage than an advantage, as compared to private school teachers. This corroborates their perception of the advantages of spiral progression, in which public school teachers has a lower level of perception that spiral progression in advantageous, as compared than that of the private 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, majority of teachers have been using the discovery/inquiry learning, which has a total of 12 or 13%. Collaborative learning has a total of 11 or 12%. This is followed by experiential learning (10 or 10%); cooperative and group investigation (9 or 9%); jigsaw puzzle (8 or 8%) and buzz session, child-centered, round robin that got 7 or 7% has a total of 7 or 7%. Portfolio's and Journal has a total of 6 or 6%. Think-pair-share and role play has a total of 5 or 5%. Testing of independence or preference through "Goodness of Fit" test, reveals that among the strategies, there are only three preferred strategies. They are 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, $p<.05$). It was also revealed that at .05 level of significance, 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, $p<.05$), are the three most preferred used teaching strategies that are found effective in teaching science. The rest are not statistically significant.

On the Influence of Spiral Progression in Science Teaching

The data gathered 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 trainings because it is hard to implement," and "Teachers need to change/improve their way of teaching and learning to adapt spiral progression approach."

Moreover, based on the findings, public school teachers find it hard to easily adapt to the new curriculum, particularly teachers who had long years in service in teaching with 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 by collaborating with their fellow teachers. According to the respondents, when they first heard that there will be a reform in educational system, they became shocked, because we are not yet ready for it. We are still coping with the past problem we have encountered in the former curriculum. On the other hand, some respondents, said that, spiral progression approach can create a globally competitive and dynamic learners and citizens.

IV. CONCLUSIONS

The following are the conclusions of this study:

1. Majority of science specialization is in Biology. However, specifically, it is biology in private schools and chemistry in public schools. Both private and public schools have the lowest number of earth science specialization.
2. Both private and public school teachers observe that sometimes and often, spiral progression is effective in teaching science courses. Moreover, their perception is not differentiated statistically.
3. Both private and public school teachers perceive that sometimes spiral progression in science has advantages and disadvantages. However, the study also suggests that when private and public schools are compared as to how they perceive spiral progression, private school teachers are more inclined to perceive that spiral progression is more advantageous than disadvantageous.

4. Significant statistically, 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 spiral progression program.
5. Teachers are having hard time adapting to the new approach, particularly those who have specializations and have been teaching for so many years. However, they also believe that through this we can create a globally competitive and dynamic learners and citizens.

References

[1] Alonzo, AC. Evaluation of a model for supporting the development of elementary school teachers' science content knowledge. Proceedings of the Annual International Conference of the Association for the Education of Teachers in Science; Charlotte, NC. 2002.

[2] Bilbao, Puritan., Paz Lucida, PhD, Tomas a C. Iringan, Ph.D. Rodrigo B. Javier, Ph D. Curriculum Development. Mandaluyong: Lorimar publishing.2008.

[3] Brown, R., Pressly, M., Van Meter, P., and Schuder, T., A quasi-experimental validation of Transactional strategies instruction with low-achieving second-grade teachers. New York: International reading Association.2004.

[4] Corpuz, Brenda B.,Ph.D., and Gloria G. Salandanan, Ph.D. Principles of Teaching 1 -2nd Edition. Quezon City: Lorimar Publishing, Inc., c2011.

[5] Crawford, B. A. Learning to teach science as inquiry in the rough and table of practice. Journal of Research in Teaching (2007).

[6] Cruz, Gloria L. Standard-Based Assessment and Grading in the K to 12 Program (October 9, 2013).

[7] Davis, Edith G. A Study of the Effects of an Experimental Spiral Physics Curriculum Taught to Sixth Grade Girls and Boys (2007).

[8] Fang, Zhihui, Linda L., Lame and Roes M. Pringle. Language and Literacy in Inquiry-Based Science Classrooms, Grade 3-8. United States: Corwin Sage Company., c2010.

[9] Frando, Milagros F., Ph, D. General Psychology. Mandaluyong City: Books Atbp. Publishing Corp. c.2009.

[10] Greenstein, Laura. Assessing 21st century skills. A Guide to Evaluating Mastery and and Brookway, D. (2006). The Nations Report Card: Science 2005

[11] Haeusler, Carole. Examining the curriculum and assessment framework of the Australian Curriculum: Science. Volume 33 Number 1, 2013; Pages 15–30.

[12] Houtz, Barbara. Teaching Science Today. Huntington Beach CA: Shell Education, 2010.

[13] Ilarde, Isabelinadel Pan. Science and you in the 21st Century Science and Technology:Third year Chemistry Textbook. Quezon City: JMC Press, Inc. 388. , c2003.

[14] Makhila, Aggrey Sonny. Teachers Perceptions Toward Subject Specialization by Primary School Teachers(2008). University of Botsawanna.