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# Content knowledge and pedagogy of science teachers' spiral progression approach in teaching in Magsaysay, Occidental Mindoro

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## *Abstract*

This study aimed to determine the content knowledge and pedagogy of science teachers' spiral progression approach in Magsaysay, Occidental Mindoro. The researcher used a descriptive correlational method and employed statistical treatments such as frequency, percentage, weighted means, and multiple regression analysis. The data were drawn from 23 science teachers and 1,064 junior high school students of the 10 secondary schools in Magsaysay, Occidental Mindoro. This study found that most science teacher-respondents were science majors and had units in Master's Degrees in Education. Most were Teacher III and have been in the service for 6-10 years. It was also revealed that the level of content knowledge and pedagogy of science teachers' spiral progression approach in teaching was high. Most students have a satisfactory academic performance in science, as revealed in their average grades of 80-84 in the school year 2022-2023. Furthermore, a significant connection was found when the science teachers' profile was linked to their content knowledge and pedagogy. Also, a significant relationship was found between the content knowledge and pedagogy of science teachers' spiral progression approach and students' academic performance in science. Therefore, it is recommended that school administrators continue addressing students' performance in science by providing various trainings and seminars that focus on enhancing the content knowledge and pedagogy of the science teachers to effectively use their spiral progression approach to support student learning and achievement in science education.

***Keywords:*** spiral progression approach, content knowledge and pedagogy, academic performance, science teachers, junior high school students

# Content knowledge and pedagogy of science teachers' spiral progression approach in teaching in Magsaysay, Occidental Mindoro

## 1. Introduction

In the Philippines, the Department of Education (DepEd) enacted the Enhanced Basic Education Law of 2013, Republic Act No. 10533, to initiate the new K to 12 Curriculum for the 2012–2013 school year. The new features of the K to 12 Basic Education Program are indicated in the DepEd Order No. 21 s. 2019 uses the spiral progression approach to ensure mastery of knowledge and skills after each level. The spiral progression approach will provide the learners with various concepts and disciplines and learn to master them by studying them in different complexities. The concept in science education (Earth Science, Biology, Chemistry, and Physics) is presented in a spiral progression, wherein the complexity of the content increases from each grade level; hence, the critical concepts attained easily by the learners in each grade level are implicit, and retention takes place (Gonzales, 2019).

It has been 11 years since the Philippines implemented the K to 12 curriculum. However, some teachers still need help to teach the concepts of the four areas of science using the spiral progression approach in one school year. Science concepts often build upon each other in intricate ways. Ensuring that students grasp foundational concepts before moving on to more complex ones can be challenging within the context of spiral progression. Science education typically involves multiple disciplines, such as biology, chemistry, physics, and earth science. Coordinating the spiral progression of topics across these disciplines while maintaining coherence can be difficult. There needs to be more teacher preparation in science as the Philippines moves toward implementing the K to 12 curriculum. Teachers must teach all the sciences in a spiral progression approach (Orbe et al., 2018). The study of Resurreccion and Adanza (2015) revealed that if teachers are not knowledgeable about the K to 12 curricula, they will be unable to implement it correctly and adequately in their teaching. Gonzales (2019) attested to these findings, revealing that seasoned science teachers had difficulty dealing with other specializations. The preparations they were doing in their specialization differed from those in another specialization. His study found that science instructors were still getting used to the new curriculum. They require more time and training to become experts in all subject areas and acquire new teaching techniques since it is challenging to instruct in a subject lacking the requisite expertise.

PISA is the Programme for International Student Assessment of the Organization for Economic Co-operation and Development (OECD), a triennial international test covering three foundational domains: Reading Literacy, Mathematical Literacy, and Scientific Literacy. Based on the PISA 2022 results, about 23% of Filipino students received a Level 2 or higher (OECD average: 76%) in science. These students, at the very least, can identify the proper explanation for well-known scientific phenomena and apply this knowledge in more straightforward situations to determine whether a conclusion is supported by the available data (OECD.org, 2023). The comparison to the OECD average of 76% indicates that Filipino students are performing significantly below the international average in science proficiency. This suggests areas where the education system may need improvement to prepare students for science literacy better. The relatively low proportion of students achieving Level 2 proficiency highlights potential challenges within the Filipino education system, such as curriculum effectiveness and teaching quality. These results highlight the need for concerted efforts to strengthen science education in the Philippines and improve student outcomes. The findings of previous studies and the PISA 2022 results reflect the urgency of improving the quality of primary education in the Philippines. Philippine National Agency (2023) reported that during the Basic Education Report (BER) 2023 in January, Vice President and Department of Education (DepEd) Secretary Sara Duterte vowed to revise the K to 12 curriculum to develop lifelong learners who are filled with 21st-century skills, discipline, and patriotism. This study aims to determine the content knowledge and pedagogy of science teachers, which is essential for ensuring the successful

implementation of the spiral progression approach and promoting meaningful learning experiences for students in science education. This will become beneficial to teachers in improving their performance in teaching science to their students. This study will give a clearer view of how the teachers teach as affected by the prediction.

***Statement of the Problem -*** This study sought to determine the content knowledge and pedagogy of science teachers' spiral progression approach in teaching in Magsaysay District, Division of Occidental Mindoro. Particularly, it aimed to answer the following questions: (1) What is the demographic profile of science teachers in terms of educational attainment, academic specialization, length of service, teaching position, and number of attended trainings and seminars related to science content knowledge and pedagogy? (2) What is the level of content knowledge and pedagogy of science teachers' spiral progression approach in teaching? (3) What is the academic performance of junior high school students in science? (4) Is there a significant relationship between the content knowledge and pedagogy of science teachers' spiral progression approach in teaching and their profile? (4) Is there a significant relationship between the content knowledge and pedagogy of science teachers' spiral progression approach in teaching and the academic performance of junior high school students in science? (6) In response to the findings of the study, what action plan can be recommended to improve the content knowledge and pedagogy of science teachers' spiral progression approach in teaching and the academic performance of their students?

***Significance of the Study -*** This study will benefit the following: The science teachers, the teachers themselves are to be the primary beneficiaries of this research. The result of this study will help the teachers better understand the needs and interests of their students to improve their performance in teaching science to them. This will also benefit understanding their learners and facilitate learning in science. The students are also seen to be the beneficiaries of this research. This study will be helpful to students; changes and improvements in the curriculum, enhancement in the teachers' content knowledge, and pedagogy will be made that will address their needs and interests in learning science concepts, thus enhancing their performance. To the DepEd Sub-Office, the government, as the prime mover of the K to 12 curriculum, will greatly benefit from the study. The findings of this research will provide solutions and help upgrade teachers' professional development and skills to improve their content knowledge and pedagogy on the spiral progression approach. To the respondent schools, this study will serve as a guide in planning interventions to improve the academic performance of their students in science. To the school heads, this study will serve as a guide in making interventions and planning for possible activities and training for the professional development of the teachers in knowledge and pedagogy in teaching science. The result of this study will also serve as a basis for improving the implementation of the K to 12 spiral progression approach. To the curriculum planners, it will guide understanding of the real situation of teaching science using the spiral progression approach. This study will guide revising the science curriculum so that the learning competencies will be organized following the principle of spiral sequencing. The parents, being the primary educators of their children, are also the beneficiaries of this study. Through this, they will be objectively informed of their children's academic performance in science and help establish their children's interest in learning science concepts. To the Magsaysay LGU, this will allow the Local Government Unit of Magsaysay to track the level of content knowledge and pedagogy of teachers as well as the academic performance of students. The research findings will provide a basis for developing an overall plan and budget for implementing the action plan. Future researchers can use this research work as a reference for their new research, and it can also be a basis for another exploration in the learning process.

***Scope and Delimitation of the Study -*** This study focused on determining the content knowledge and pedagogy of science teachers' spiral progression approach in teaching. Although other factors may correlate to the teachers' content knowledge and pedagogy in teaching science, the researcher only preferred five in this study (i.e., educational attainment, academic specialization, length of service, teaching position, number of attended training/seminars related to science content knowledge and pedagogy). The researcher also correlated the content knowledge and pedagogy of science teachers to the academic performance of students in science for the school year 2022-2023. This study was conducted among the junior high school teachers teaching science subjects and their students in the secondary schools in Magsaysay, Occidental Mindoro, for the school year

2022-2023. This study included the Magsaysay National High School- Bamban Extension, Magsaysay National High School- Caguray Extension, Magsaysay National High School- Calawag Extension, Magsaysay National High School- Lourdes Extension, Magsaysay National High School- Main Campus, Magsaysay National High School- Nicolas Extension, Magsaysay National High School- Alibog Annex, Magsaysay National High School- Purnaga Annex, Paclolo National High School and Sta. Teresa National High School.

## 2. Methodology

***Research Design -*** To see the general picture of the study on the correlates of science teachers' content knowledge and pedagogy in the spiral progression approach, the descriptive correlational method was used in this study. It provided how the predetermined factors correlating science teachers' knowledge and pedagogy in teaching science were described and compared as if the relationships among variables are significant. Descriptive research involves data collection to test the hypotheses or to answer questions concerning the study. The correlational study sought to measure the relationship among variables and indicated how one variable may predict another.

***Respondents of the Study -*** The study's respondents were teachers in secondary schools who taught science subjects. A complete enumeration sampling technique was used to get the science teacher population. There were 23 science teachers in the 10 selected schools in Magsaysay District. The students were categorized based on their grade level to determine their academic performance in science. A simple random sampling was used. Every unit in the sample has an equal chance of being included when using the simple random sampling method. From the total of junior high school students per secondary school, the population size of respondents per grade level was computed based on Raosoft at a 5 % margin of error, 95 % confidence level, and 50% response distribution. The calculated sample size was 258 grade 7 students, 270 grade 8 students, 270 grade 9 students, and 266 grade 10 students. The total number of respondents is 1,064 out of 3,446 junior high school students. To ensure that students in the different grade levels from each school were represented, sample sizes from the population of students in each grade level from other schools were computed. Moreover, simple random sampling was used to collect the students' academic performance per section in each school.

***Research Instrument -*** The main tool of this study was a researcher-made instrument. The questionnaire for the teachers had two parts. It consisted of items that assessed Part 1-Profile of the Respondents Part II-Content Knowledge and Pedagogy of Science Teachers. The science teachers and advisers collected the student's academic performance in science for the school year 2022-2023. A five-point Likert scale was used by the researcher to assess the respondents' attitudes toward the variable being investigated. In addition, weighted mean scores were interpreted accordingly. The researcher consulted the experts of DWCSJ graduate school to assess the instrument's validity. To ensure that the instrument was valid, comments and recommendations from experts were considered for the finalization of the questionnaire. To test the reliability, the researcher coordinated with other schools outside the municipality and asked permission to administer the researcher-constructed questionnaire. The items in the questionnaire that were tested included two areas: content knowledge and pedagogy in science, with 20 items each. The inter-item consistency of the instrument was tested using Cronbach's Alpha measure, and the result is given below.

**Table 1**

*Reliability Results of the Instruments*

| Components | Number of items | Reliability Coefficient* | Interpretation |
|---|---|---|---|
| A. Content Knowledge in Science | 20 | 0.959 | Very High Reliability |
| B. Pedagogy in Science | 220 | 0.973 | Very High Reliability |

*Cronbach's Alpha based on standardized items

The instrument was administered to 30 science teachers from the selected San Jose, Occidental Mindoro secondary schools. The coefficient of the reliability procedure was computed using the test and retest method. To measure the test and retest reliability, the researcher administered the same test to the same test respondents on two separate occasions, and the scores were then correlated. The reliability coefficients based on standardized items resulted in generally very high reliability, as shown by 0.959 and 0.973 coefficients of content knowledge and pedagogy, respectively. The reliability result confirms the acceptability of the instrument and can be given to the final group of science teachers.

***Statistical Treatment of the Data -*** Descriptive statistics such as frequency, percentage, and weighted mean were used to describe the profile and academic performance of the respondents for content knowledge and pedagogy of science teachers' spiral progression approach in teaching. Regression analysis was used to answer the inferential problems and was computer-generated by WarpPLS version 7.0 using Partial Least Squares Structural Equation Modeling, and computations were all anchored at the 0.05 significance level.

***Ethical Considerations -*** The study complied with the research guidelines from the Graduate School of Divine Word College of San Jose. Before administering the survey, the study's purpose and the respondents' participation were explained first. The respondents' confidentiality of information and answers and anonymity were maintained throughout the data collection, analysis, and presentation of findings. It was ensured that all data and results collected were solely used for the study. In such cases that the respondents want to withdraw from their task, they can do so anytime. The American Psychological Association (APA) was used by the researcher to give credit to other research studies used as references. On the other hand, some studies and sources that were used as bases for this study were properly cited and acknowledged as well. This study only sought to contribute to the education sector and posed no risk to anyone involved in its conduct.

## 3. Results and Discussions

**Table 2**

*Descriptive statistics (n=23)*

| Educational Attainment | Frequency | Percent |
|---|---|---|
| Bachelor's Degree in Education | 7 | 30.4 |
| Other Bachelor's Degree Courses with 18 Professional Education Units | 3 | 13.0 |
| With Units in Master's Degree in Education | 12 | 52.2 |
| Graduate of Master's Degree in Education | 1 | 4.3 |
| Academic Specialization | | |
| General Science | 6 | 26.1 |
| Biology | 6 | 26.1 |
| Chemistry | 1 | 4.3 |
| Physical Science | 1 | 4.3 |
| General Science and Biology | 1 | 4.3 |
| Others | 8 | 34.8 |
| Length of Service (in years) | | |
| 0-5 | 6 | 26.1 |
| 6-10 | 10 | 43.5 |
| 11-15 | 3 | 13.0 |
| 16-20 | 1 | 4.3 |
| More than 20 | 3 | 13.0 |
| Position | | |
| Teacher I | 6 | 26.1 |
| Teacher II | 3 | 13.0 |
| Teacher III | 14 | 60.9 |

| | | |
|---|---|---|
| Number of Trainings and Seminars Attended | | |
| 0 | 8 | 34.8 |
| 1 | 8 | 34.8 |
| 2 | 3 | 13.0 |
| 3 | 3 | 13.0 |
| 4 | 1 | 4.3 |

Table 2 shows the demographic profile of the respondents in terms of educational attainment, academic specialization, length of service, teaching position, and number of training and seminars attended. It is revealed that most teachers have units in Master's Degree in Education as supported by the percentage of 52.2. Also, seven, or 30.4 %, of the science teachers are graduates of Education. Only one is a graduate of a Master's Degree in Education. These findings were supported by the study of Roberto & Madrigal (2018), which stated that the school must prioritize teacher quality maintenance by emphasizing the value of personal growth and development, which includes pursuing master's degrees and other professional courses and additional studies. Abarro (2018) revealed that teachers' performance depends on the highest educational attainment and scholastic rating the teachers obtain.

Among the 23 science teachers, the majority of them are science majors. Based on the results, 15 teachers are science majors and 8 teachers teaching science are non-majors. The study of Villena-Agreda (2020) revealed that non-science education majors must adapt to their teaching responsibilities, given that they were typically "forced" to teach science classes due to a shortage of qualified science educators in the area. The majority of the science teachers have academic specialization in General Science and Biology. The number of science teachers with academic specializations in biology conforms with the study of Bug-os et al. (2021), wherein it was found that high school teachers have the highest level of confidence in teaching biology. It is because of their educational background. Gonzales (2019) stated that teaching using the spiral progression is a significant advantage for the general science specialization. It is because they have a background in the different areas of science. Only one science teacher has an academic specialization in physical science. The study by Menon & Sadler (2016), which found that high school teachers had low levels of self-efficacy in teaching physics, corroborated these findings. They took fewer physics classes in their previous schooling, which could be one factor (Al Sultan, 2020). Based on the study conducted by Resurreccion & Adanza (2015), teachers are having difficulty adapting to the spiral progression approach, particularly those who have specializations and have been teaching for so many years. They also revealed that Biology makes up the majority of science specializations. More precisely, it's chemistry in public schools and biology in private ones.

Earth science specializations are the fewest in both public and private schools. This implies that although they are science teachers, most have yet to gain a background in other specializations. However, the study of Gonzales (2019) revealed that science teachers needed to become more familiar with the technical terms in another specialization. Mizzi (2013) also cited that teaching science outside of specialization faces considerable challenges in lesson preparation and science teaching. Based on the results, most respondents are teaching for 6-10 years. This implies that most science teachers are still new to the teaching profession. Only 1 teacher has been teaching for 16-20 years. Three teachers have stayed in the teaching service for more than 20 years. This implies that fewer science teachers are getting close to retirement. According to Manalo and Yazon's (2020) research, there is a notable variation in the teacher respondents' evaluation of the strategies used in the spiral progression approach when grouped by years of service. Maing et al. (2018) revealed that years in teaching correlate with the teacher's teaching approach. Also, the teacher's teaching experience affects the teacher's effectiveness and performance (Rashida Aini et al., 2018). This implies that years of teaching experience can significantly impact the effectiveness and expertise of science teachers. Based on the results, most respondents are Teacher III, which comprised 60.9 % of the total population of 23 teachers. This implies they had just started teaching but worked to attain their promotion.

Additionally, Bogo & Aperocho (2023) stated that candidates for Teacher II and III vacancies must have

received a very satisfactory performance rating for the three rating periods immediately preceding their application. Meanwhile, six science teachers are ranked as Teacher I. This means that they need to work on their promotion. While adhering to the R.A. 9155, by DepEd Order No. 66 s.2007 "Updated Policies Regarding Appointment and Promotion," school heads and teachers' selection, promotion, and designation shall be based on merit, competence, fitness, and equality. Badur & Mardikyan (2011) showed that the significant dimensions of an instructor's teaching performance are the instructor's employment status, the course's workload, the student's attendance, and the percentage of the students filling out the form. Also, Dee & Wycoff (2015) found evidence that the performance of high-performing teachers is further improved by financial incentives. The result also showed that aside from age and tenure, the rank or position of the respondents is also correlated with the teaching strategies. The continuity of training is essential for teachers' educational excellence. They need regular training to adapt to the changes in the educative process. The study by Gamayao & Biňas (2021) showed that the teachers' high levels of instructional competency came from specialized training and seminars.

Table 2 shows the demographic profile regarding the number of trainings and seminars attended related to content knowledge and pedagogy in the spiral progression approach in 2018-2023, as well as the frequency and percentage of the teachers. Based on the findings, most respondents either had no training or attended only one training. This implies that administrators should train teachers to focus on the content knowledge and pedagogy of the spiral progression approach in teaching science. The study of Anderman et al. (2012) attests to the findings of this study, which stated that one of the challenges in the field of science education is the preparation and training of science teachers. Only one respondent attended four trainings about content knowledge and pedagogy from 2018 to 2023. Jalbani (2014) claimed that teachers who are willing for professional development in this area can deliver even complex and complicated content effectively, helping the students generate their interest and eagerness for more opportunities to learn in a conducive environment, making all the individuals feel that they are being taught in their unique way being unique themselves. The findings of Abarro (2018) revealed that civil status, highest educational attainment, scholastic rating, and local seminars significantly affect teachers' job performance. He also revealed that most of the seminars attended by the faculty members are school-based and division-wide in scope. Thus, administrators may provide school-based and division-based training and seminars on science content knowledge and pedagogy.

**Table 3**

*Mean Level of Content Knowledge of Science Teachers' Spiral Progression Approach in Teaching*

| Indicators | Weighted Mean | Verbal Description |
|---|---|---|
| 1. I apply knowledge of content within curriculum teaching areas. | 4.65 | Very Highly Applied |
| 2. I apply knowledge of content across curriculum teaching areas. | 4.39 | Highly Applied |
| 3. I have mastery of the subject matter in the areas of science which were not my field of specialization. | 3.91 | Highly Applied |
| 4. I have additional knowledge on prerequisite lessons to the current lesson I am teaching. | 3.78 | Highly Applied |
| 5. I have mastery of the concepts in earth science. | 3.91 | Highly Applied |
| 6. I have mastery of the concepts in chemistry. | 3.61 | Highly Applied |
| 7. I have mastery of the concepts in physics. | 3.57 | Highly Applied |
| 8. I have mastery of the concepts in biology. | 4.00 | Highly Applied |
| 9. I am able to connect the science concepts to real-life situations. | 4.48 | Highly Applied |
| 10. I apply knowledge of content that will develop the scientific literacy of my learners. | 4.17 | Highly Applied |
| 11. I apply knowledge of content that will promote the strong link between science and technology including indigenous technology. | 4.09 | Highly Applied |
| 12. I provide a more detailed discussion in science areas which are difficult. | 4.09 | Highly Applied |
| 13. I apply knowledge of content that will develop the inquiry skills and scientific attitudes of my learners. | 4.22 | Highly Applied |

| | | |
|---|---|---|
| 14. I incorporate previously learned science concepts to support the understanding of new topics within the curriculum. | 4.39 | Highly Applied |
| 15. I integrate concepts from other disciplines (e.g., mathematics, technology, engineering) to enhance my students' understanding of science concepts in the curriculum. | 4.35 | Highly Applied |
| 16. I provide real-world examples of how the science concepts taught in my grade level are applied in everyday life or various industries. | 4.30 | Highly Applied |
| 17. I guide my students to explore the depth of their understanding of a specific science concept. | 4.39 | Highly Applied |
| 18. I challenge my students to think critically. | 4.48 | Highly Applied |
| 19. I assess my students' comprehension of science concepts that reflect the spiral progression approach. | 4.13 | Highly Applied |
| 20. I provide examples of assessment tasks that require my students to apply their knowledge of previously learned concepts to solve more complex problems. | 4.22 | Highly Applied |
| Composite Mean | 4.16 | Highly Applied |

Scale: 4.50-5.00- Very Highly Applied; 3.50-4.49-Highly Applied; 2.50-3.49- Moderately Applied; 1.50-2.49 –Rarely Applied; 1.00-1.49-Least Applied

Table 3 shows that teachers very highly applied the integration of the various fields of science in their teaching. It can also be that science teachers have highly applied their mastery in biology, chemistry, earth science, and physics. This means they highly applied their mastery of the subject matter, even if it was not their academic specialization. However, the weighted mean showed that their application in physics is lower than that of other areas of science. The K to 12 spiral progression approach allowed teachers to acquire more knowledge in various science disciplines (De Ramos-Samala, 2018). The study's findings revealed that among the four science disciplines (Earth Science, Biology, Chemistry, and Physics), teachers have the highest mastery in biology with a weighted mean of 4.0, and their mastery in physics had the lowest with a 3.57 weighted mean. These results conform with the study of Bug-os, et al. (2021), wherein it was found that high school teachers have the highest confidence level in teaching biology. The study by Menon & Sadler (2016) also revealed that high school teachers had low levels of self-efficacy in teaching physics. The table also shows that science teachers provide real-world examples of how science concepts taught in their grade level are applied in everyday life and various industries, as supported by a weighted mean of 4.30. According to Ely's (2019) research, the spiral progression approach must prioritize students' mastery of learning competencies when teaching chemistry to enhance their academic performance. The findings revealed that the extent of science teachers' content knowledge on the K to 12 spiral progression approach was high, with a composite mean of 4.16. This result means that science teachers have a high level of content knowledge on the spiral progression approach in teaching. However, the study of Tirol (2021) revealed that regarding science process skills, the current curriculum lacks order in terms of sequencing from simple to complex and is not in line with the spiral progression approach of learning. Therefore, teachers should make necessary planning and consider a way of preparing learning competencies that target proper sequencing of science process skills aligned with the spiral approach that involves gradual sophistication of concepts and skills of learning science.

**Table 4**

*Mean Level of Pedagogy of Science Teachers' Spiral Progression Approach in Teaching*

| Indicators | Weighted Mean | Verbal Description |
|---|---|---|
| 1. I use a range of teaching strategies that enhance learner achievement in science. | 4.35 | Highly Applied |
| 2. I apply a range of teaching strategies to develop critical thinking of learners. | 4.35 | Highly Applied |

| | | |
|---|---|---|
| 3. I apply a range of teaching strategies to develop the higher-order thinking skills of learners. | 4.26 | Highly Applied |
| 4. I let my learners perform group activities that provide applications of science concepts in everyday lives. | 4.26 | Highly Applied |
| 5. I ensure that my learners have acquired the pre-skills before introducing difficult skills in different areas in science. | 4.13 | Highly Applied |
| 6. I use problem-based activities to master the important concepts in science. | 4.04 | Highly Applied |
| 7. I am able to scaffold learning experiences that build upon prior knowledge. | 4.17 | Highly Applied |
| 8. I employ effective teaching strategies that are suitable for the developmental levels of my students. | 4.26 | Highly Applied |
| 9. I assess my students' understanding and modify my lecture as necessary. | 4.48 | Highly Applied |
| 10. I use a variety of instructional methods such as hands-on experiments, discussions, group activities, and technology integration. | 4.30 | Highly Applied |
| 11. I ensure that the science concepts I teach are appropriately scaffolded across grade levels. | 4.22 | Highly Applied |
| 12. I plan lessons to deepen previously introduced science concepts. | 4.39 | Highly Applied |
| 13. I engage students with varying levels of prior knowledge in science. | 4.26 | Highly Applied |
| 14. I incorporate hands-on experiments, interactive activities, and discussions to enhance students' understanding of science concepts. | 4.04 | Highly Applied |
| 15. I assess my students' understanding of science concepts. | 4.39 | Highly Applied |
| 16. I provide feedback to my students to help them build on their prior knowledge. | 4.35 | Highly Applied |
| 17. I use differentiated instructions to accommodate the diverse learning needs of students in a spiral progression science classroom. | 4.04 | Highly Applied |
| 18. I integrate concepts from other subjects to provide a holistic understanding of scientific principles. | 4.17 | Highly Applied |
| 19. I provide examples of how my students connect science concepts to real-world applications. | 4.48 | Highly Applied |
| 20. I share my strategies to ensure that my students with diverse learning needs can engage with the science concepts. | 4.22 | Highly Applied |
| Composite Mean | 4.26 | Highly Applied |

**Scale**: 4.50-5.00- Very Highly Applied; 3.50-4.49-Highly Applied; 2.50-3.49- Moderately Applied; 1.50-2.49 –Rarely Applied; 1.00-1.49-Least Applied

Table 4 shows the mean level of pedagogy of science teachers' spiral progression approach in teaching. The spiral progression approach follows the progressive type of curriculum anchored on John Dewey's theory on the total learning experiences of an individual. Dewey's concept of education puts importance on meaningful activity in learning and participation in classroom democracy (Mangali et al., 2019). The study by Gonzales (2019) stated that the success of the pedagogy also relies upon the instructional materials and the strategies teachers employ. The findings revealed that teachers highly employed effective teaching strategies suitable to their needs, supported by the weighted mean of 4.26. The teaching strategies used in the context of the spiral curriculum are experiential learning, collaborative/cooperative learning, and inquiry-based learning (Perez, 2020). The K to-12 curriculum in the Philippines has pushed educators to incorporate technology into their lessons to prepare students for the new era of 21st-century skills. The results showed that teachers highly applied technology integration. This finding conforms to the study of Bibon (2022), wherein it has been suggested that ICT use in the classroom may be included in various curricula on various educational platforms, covering all grade levels. The table also shows that science teachers highly incorporate learner-centered strategies like hands-on experiments and interactive activities, with a weighted mean of 4.04. These results conform to the

study of Mangali et al. (2019), which stated that the spiral progression approach in science is learner-centered; teachers employ varied teaching strategies that will cater to students' different learning abilities, capabilities, interests, and nature. Montebon (2014) also supported these results, for it revealed that the K to 12 curriculum uses learner-centered approaches such as inquiry-based learning pedagogy – concepts and skills are taught by providing pedagogy that enables students to enhance their cognitive, affective, and psychomotor domains. According to Orbe et al. (2018), the new science curriculum program incorporates numerous modernizations in learning pedagogies, mode of instruction, planning competencies, and integration of every branch of science in every grade level. These statements were supported by the composite mean of 4.26 in science teachers' pedagogy, which means a high extent. This implies that science teachers highly applied the science content knowledge and pedagogy on the spiral progression approach.

**Table 5**

*Academic Performance of Junior High School Students in Science (n=1,064)*

| Academic Performance (Grade 7) *n=258* | Frequency | Percent |
|---|---|---|
| Below 75 | 0 | 0.0 |
| 75 - 79 | 61 | 23.6 |
| 80 - 84 | 110 | 42.6 |
| 85 - 89 | 57 | 22.1 |
| 90 - 100 | 30 | 11.6 |
| Academic Performance (Grade 8) *n=270* | | |
| Below 75 | 0 | 0.0 |
| 75 - 79 | 56 | 20.7 |
| 80 - 84 | 89 | 33.0 |
| 85 - 89 | 65 | 24.1 |
| 90 - 100 | 60 | 22.2 |
| Academic Performance (Grade 9) *n=270* | | |
| Below 75 | 6 | 2.2 |
| 75 - 79 | 55 | 20.4 |
| 80 - 84 | 97 | 35.9 |
| 85 - 89 | 62 | 23.0 |
| 90 - 100 | 50 | 18.5 |
| Academic Performance (Grade 10) *n=266* | | |
| Below 75 | 1 | 0.4 |
| 75 - 79 | 64 | 24.1 |
| 80 - 84 | 91 | 34.2 |
| 85 - 89 | 54 | 20.3 |
| 90 - 100 | 56 | 21 |

Assessing students' academic performance provides valuable feedback on the effectiveness of science teachers' content knowledge and pedagogy. Teachers can use this information to revise and improve teaching methods, materials, and curriculum content to meet students' needs better. Students' academic performance was determined by their final rating in science for the school year 2022-2023. The students are categorized according to their grade level from different secondary schools in Magsaysay District since teachers follow the same curriculum guide and competencies in teaching the students. Table 5 shows that most grade 7 students got the 80-84 academic performance in science for the school year 2022-2023. Their academic performance can be described as satisfactory. This means that most junior high school students demonstrate acceptable understanding, competence, and achievement in their science classes. This implies the significance of their accomplishments and highlights the need for continued support and encouragement to nurture their talents and potential. The study by Dunton & Co (2019) also revealed that the science students' academic performance in

grade 7 at various study schools is very satisfactory. However, they stated that most countries implementing the spiral progression approach in their educational system share that it does not apply to their learners' needs. The study by Manalo & Yazon (2020) stated that teachers' teaching strategies to put spiral progression into practice approach and students' academic achievement in science are significantly correlated. This suggests that teachers must focus on their strategy in delivering the lessons well so that the students can understand the topics easily.

Moreover, 24.1 % of the grade 8 students have an academic performance of 85-89, which is very satisfactory. Also, Dunton & Co (2019) revealed that the science students' academic performance in grade 8 at various schools of their study is very satisfactory. The lowest percentage of 20.7 was for the grade 8 students with an academic performance of 75-79, which is fairly satisfactory. These results show that most students have a satisfactory academic performance in science. In K to 12 Education, teaching science subjects is minimized to 4 hours per week compared to the Secondary 2002 BEC, wherein the hours per week in science subjects were six. Many topics are covered but only briefly. Many students fail to master important concepts because on average, teachers devote less than 30 minutes of instructional time across an entire year to 70% of the topics they cover, the result of teaching for exposure (Resurreccion & Adanza, 2015). The study by Torio & Cabrillas-Torio (2016) stated that the instructional method is only one of the numerous elements that can potentially raise students' performance levels.

Based on the findings, most grade 9 students have an academic performance of 80-84, with 35.9 percent of the total respondents. 23% of the grade 8 students achieved very satisfactory academic performance in science. The study by Dunton & Co (2019) also revealed that the science students' academic performance in grade 9 at various study schools is very satisfactory. The concepts in science education (earth science, biology, chemistry, and physics) are presented in a spiral progression, wherein the complexity of the content increases from each grade level; hence, the key concepts attained easily by the learners in each grade level are implicit, and retention takes place (Gonzales, 2019). However, Bibon (2022) revealed that the academic performance of science students was found to fall short of the policy's expectations, which further suggests that the instructional strategies used needed more effective to produce the desired learning outcomes. The table discloses that six students have the lowest academic performance below 75 in science for the school year 2022-2023. This implies that each of these students may need help understanding or engaging with the subject matter. Determining academic achievement in science using spiral progression allows educators to identify learning gaps early on. By monitoring student progress as they revisit concepts, educators can pinpoint areas where students may struggle and provide targeted support and intervention.

Lastly, most grade 10 students have an academic performance of 80-84, with 34.2 percent. It implies that though a significant portion of students are performing well, there's still room for improvement for those scoring within this range and those scoring below it. It could be an area of focus for science teachers to enhance students' academic performance further. The table discloses that the lowest percentage of 0.4 was for the grade 8 students with an academic performance below 75. This implies that there is a need to reflect on the effectiveness of teaching methods and the ability of educators to engage students in the subject matter. It may indicate a need for professional development or training to support student learning better. The study by Gamayao & Biňas (2021) showed that the teachers' high levels of instructional competency came from specialized training and seminars. The findings revealed that 20.3% of the grade 8 students had very satisfactory academic performance. Dunton & Co (2019) showed that the academic performance of science students in grade 10 at various study schools is very satisfactory. In general, the academic performance of junior high students in science was satisfactory. The Spiral Progression Approach is influenced by theories of cognitive development, such as those proposed by Jean Piaget.

Piaget's theory of cognitive development highlights the importance of learners' active exploration and interaction with their environment in constructing knowledge (Thompson, 2017). In the Spiral Progression Approach context, educators scaffold learning experiences to support students in advancing through increasingly complex levels of understanding. The concepts in science education (earth science, biology, chemistry, and

physics) are presented in a spiral progression, wherein the complexity of the content increases from each grade level; hence, the key concepts attained easily by the learners in each grade level are implicit, and retention takes place (Gonzales, 2019). According to a study by Yunzal and Casinillo (2020), physics is a subject where students' interest and motivation are significantly lower because of its complexity and difficulty. According to De Ramos-Samala's (2018) study, the spiral progression approach in physics employs discovery and cooperative learning as effective teaching strategies to help students catch up with challenging lessons. Furthermore, Dioneda (2019) highlighted that to raise student performance and motivation, biology teachers should incorporate localization and contextualization into their lessons. According to Ely's (2019) research, the spiral progression approach must prioritize students' mastery of learning competencies when teaching chemistry to enhance their academic performance.

**Table 6**

*Path Coefficients and p-values for Ho*

| Paths | Beta (β) Coefficients | p-values* | Interpretation |
|---|---|---|---|
| CONTENT→PERF-7 | -0.101 | 0.047 | Significant |
| CONTENT→PERF-8 | -0.090 | 0.068 | Not Significant |
| CONTENT→PERF-9 | -0.054 | 0.185 | Not Significant |
| CONTENT→PERF-10 | -0.217 | <0.001 | Highly Significant |
| PEDAGOGY→PERF-7 | 0.075 | 0.108 | Not Significant |
| PEDAGOGY→PERF-8 | 0.013 | 0.416 | Not Significant |
| PEDAGOGY→PERF-9 | 0.143 | 0.008 | Significant |
| PEDAGOGY→PERF-10 | -0.053 | 0.189 | Not Significant |

*Significant at p<0.05

The results in the table above registered low Beta coefficients ranging from 0.013 to -0.217. These values were generated when content and pedagogy variables were hypothesized to link to students' academic performance from grade 7 to grade 10. While coefficient values of -0.101, -0.217, and 0.143 appear to be low, the corresponding p-values of 0.047, <0.001, and 0.008 can confirm the significance of the connection between the variables. No significant relationship is found between the content and performance of students from grades 8 and 9. The same holds true for the connection between pedagogy and students from grades 7, 8, and 10. There may be areas for improvement in the science teachers' content knowledge and instructional practices or other factors that influence student learning and achievement. The results revealed that teachers' content knowledge affects the performance of grade 7 and grade 10. And the science teachers' pedagogy affects the performance of grade 10. These findings emphasize the critical role of teachers in shaping student achievement and highlight opportunities for targeted interventions to improve teaching quality and enhance student learning outcomes in grades 7 and 10, particularly in the context of content knowledge and pedagogical approaches. The study of Kleickmann et al. (2013) claimed that pedagogical content knowledge (PCK) and content knowledge (CK) are key components of teacher competence that affect student progress. Also, Gamayao & Biňas (2021) revealed that the high instructional competence of the science teachers suggests that they are proficient in the material and have employed various instructional techniques, excellent communication abilities, and classroom administration. This indicates that educators possess the necessary skills to instruct students and their peers effectively.

Figure 1 shows the emerging model of the variables used in this study. The standardized estimates of the two hypotheses are presented with values ranging from 0.153 to -0.455. The result leads to the rejection of the first null hypothesis of no significant relationship between the teachers' profile and their content knowledge in science. This finding ascertains that the teachers' profile moderately contributes from a small to medium effect (0.098, 0.207) on the teachers' level of content knowledge and pedagogy in science. A highly significant and inverse relationship between these variables can be attested by the *p*-value less than 0.001. A small effect is revealed as content knowledge is related to students' academic performance from grades 7 and 10, with effect

sizes from 0.023 to 0.033. For grade 7 students, a positive coefficient of 0.153 is recorded, while a negative coefficient of -0.169 for grade 10 students. Pedagogy in science registers a 0.180 coefficient for grade 9 academic performance.

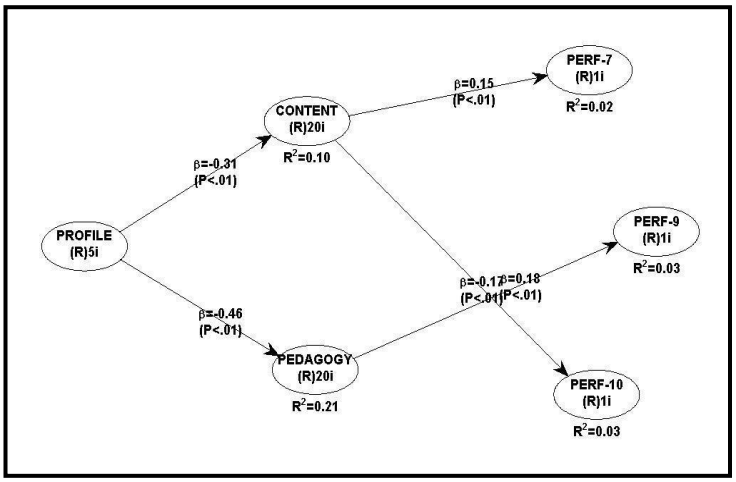


**Figure 1.** Emerging Model of Content Knowledge and Pedagogy of Science Teachers' Spiral Progression Approach in Teaching, their Profile and the Academic Performance of JHS Students

Moreover, standard error values are very low, which suggests the accuracy of the samples concerning the conclusions drawn about the overall population. These results mean that the profile of the teachers correlates with their content knowledge and pedagogy in teaching science using the spiral progression approach. This finding is consistent with a study by Gamayao & Biňas (2021), who revealed that the high instructional competence of the science teachers suggests that they are proficient in the material and have employed various instructional techniques, excellent communication abilities, and classroom administration. This indicates that educators possess the necessary skills to instruct students and their peers effectively. Moreover, Garcia (2021) revealed that the student's learning progress in the science spiral progression curriculum might be influenced by many factors. Based on the study of Rufugio et al. (2020), teachers' educational background, teaching experience, and the number and quality of seminars and training attended are predictors of students' performance in science. This finding also conforms to the study of Gumayao & Biňas (2021), which found that for students to perform well, teachers must be competent and possess the necessary knowledge and skills to teach effectively and efficiently.

**Table 7**

*Proposed Action Plan for Science Teachers and Their Students*

| Objectives | Program/ Activities | Persons Involved | Time Frame | Resources Needed | Expected Outcomes | Success Indicator |
|---|---|---|---|---|---|---|
| To enhance the content knowledge and pedagogy of science teachers' Spiral Progression Approach in Teaching | Assessment of Current Knowledge and Skills | Science teachers | Monthly | Laptop | Identified areas of strengths and weaknesses in their understanding of the Spiral Progression Approach and content knowledge | Reinforced areas of strengths and decreased areas of weaknesses in their understanding of the Spiral Progression Approach and content knowledge |
| | Co-teaching | Department Heads/ Science teachers | Monthly | Laptop | Created a schedule of mentorship and coaching sessions to provide | Facilitated mentorship and coaching sessions to provide personalized |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | personalized support, guidance, and feedback to mentees as they implement the approach in their teaching practice | support, guidance, and feedback to mentees as they implement the approach in their teaching practice |
| To address the lack of training of science teachers on content knowledge and pedagogy | Professional Development Training and Seminars | Science teachers/ Training Facilitators | Quarterly | Fund | Learned more content knowledge and pedagogy in the spiral progression approach | Mastered the content knowledge and pedagogy in the spiral progression approach |
| To improve the academic performance of junior high school students in science | Assessment of Academic Performance | Students and Science Teachers | Quarterly | Laptop | Identified specific areas of strength and weakness among students | Addressed specific areas of strength and weakness among students |
| | Peer Teaching and Collaborative Learning | Students and Science Teachers | Monthly | Laptop | Assigned opportunities for peer teaching, where students work in pairs or small groups to teach a concept or explain an experiment to their classmates | Implemented opportunities for peer teaching, where students work in pairs or small groups to teach a concept or explain an experiment to their classmates |
| | Monitor Progress and Provide Feedback | Students and Science Teachers | Quarterly | Laptop | Implemented formative assessment techniques to track students' progress regularly | Provided timely feedback to students on their performance and areas for improvement |

The activities planned in the action plan will help the science teachers. This study revealed high content knowledge and pedagogy of science teachers' spiral progression approach. With this, science teachers should reinforce their areas of strength and decrease their areas of weakness through monthly assessments, co-teaching, and attending training and workshops. As stated in the study of Roberto & Madrigal (2018), wherein the teachers can assist them in achieving the necessary competency to enhance their teaching performance, they should constantly assess their advancement to the teaching standards. Rahman (2014) stated that enhancing a science teacher's pedagogical aspect can lead to better science teacher performance. Their lack of training must be addressed to ensure educators are equipped with the knowledge, skills, and resources to effectively facilitate student learning and development using the spiral progression approach. This can be done by offering them professional development training and workshops. The need for these activities was also supported by the conclusions of Bibon's (2022) study, wherein it stated the necessity of participating in DepEd pedagogy-related seminars and training programs to enhance instructional practices and demonstrate parallelism among planning, delivery, and assessment measures to improve academic achievement outcomes in science. Improving science

teachers' teaching qualities can improve their students' science performance. According to Ulmer et al. (2013), teachers with high science self-efficacy believe they can teach science and will continue to engage unmotivated students. The activities in the action plan will also help the junior high school students. These planned activities are essential for promoting effective teaching and learning practices, fostering student engagement and motivation, and preparing students for academic success in science using the spiral progression approach.

In general, the academic performance of junior high students in science was satisfactory. Quarterly assessments of students' academic performance in science provide a way to measure students' progress over time. By comparing performance on different assessments, science teachers can track how students develop their scientific knowledge and skills and adjust instruction accordingly. Assessments can also be used to evaluate the effectiveness of teaching methods and curriculum materials. By analyzing assessment results, teachers can identify which instructional approaches most successfully promote student learning and make adjustments as needed. Students will be given more opportunities to learn science effectively through peer teaching and collaborative learning. The teaching strategies used in the context of the spiral curriculum are experiential learning, collaborative/cooperative learning, and inquiry-based learning (Perez, 2020). Feedback provides students with valuable information about their progress and achievements in science. It also encourages students to reflect on their learning process and develop metacognitive skills such as self-assessment and self-regulation. When students receive feedback on their performance, they learn to evaluate their work critically and make adjustments to improve their learning strategies and study habits.

## 4. Conclusions

The following conclusions were drawn based on the summary of the findings presented. Most of the science teachers have units in Master's Degree in Education. This indicates that they are well aware of pursuing their graduate studies and are science majors. This implies that DepEd is hiring teachers suited to their subject majors. Also, most science teachers are in the service for 6-10 years. This means that most science teachers are still new in the teaching profession. The majority of the science teachers are Teacher III. This implies they had just started teaching but worked to attain their promotion. Science teachers need training on content knowledge and pedagogy on the spiral progression approach since most of them have no training attended and have just attended one training in this area. This implies that administrators should train teachers to focus on the content knowledge and pedagogy of the spiral progression approach in teaching science. The content knowledge and pedagogy level of science teachers' spiral progression approach in teaching was high. This implies that science teachers highly applied the science content knowledge and pedagogy on the spiral progression approach. For the school year 2022-2023, most junior high school students have a satisfactory academic performance in science. This means that most junior high school students demonstrate acceptable understanding, competence, and achievement in their science classes. A significant relationship existed between the content knowledge and pedagogy of science teachers' spiral progression approach in teaching and their profile. A significant relationship existed between the content knowledge and pedagogy of science teachers' spiral progression approach in teaching and the academic performance of junior high school students in science. An action plan was developed in response to the study findings.

***Recommendations*** **-** Based on the study's findings, the following recommendations are suggested: Administrators may provide support and incentives for science teachers to pursue advanced degrees or specialized certifications in science education, allowing them to broaden their expertise in science subjects in and outside their areas of specialization. Administrators may keep hiring science major teachers to teach science subjects. Administrators may advocate for policies and initiatives prioritizing education funding, teacher support, and professional development in science education. The administrators may continue sending science teachers to training to enhance and improve their teaching strategies. The administration of each public junior high school may establish school-based training or cluster-based training programs on content knowledge and pedagogy to enhance the science teachers' capabilities and skills to use the spiral progression approach in teaching effectively. Science teachers may use a spiral progression approach to reinforce their content knowledge and pedagogy. This

will be done by attending more trainings and workshops on using the spiral progression approach in teaching the four areas of science with effective teaching strategies. Administrators may facilitate mentorship programs and encourage collaboration among science educators to share resources, lesson plans, and instructional strategies. Administrators and science teachers may plan and implement intervention activities to improve the academic performance of junior high school students in science. Teachers may provide feedback to students on their progress and performance, highlighting strengths and areas for improvement. They also encourage students to reflect on their learning and set further growth and development goals. The developed action plan is recommended in response to the study's findings. Future researchers may conduct a parallel study considering a greater number of respondents and more expansive geographical areas and different variables to further determine the relationship between content knowledge and pedagogy of science teachers' spiral progression approach in teaching, their profile, and the academic performance of their students.

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