Evaluating Spiral Progression Approach (SPA) in Teaching Science and Mathematics for Junior High Curriculum

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ABSTRACT. The goal of the Spiral Progression Approach (SPA) is that the teaching process will lead to boosting cognitive improvement. This study aimed to evaluate SPA in teaching Science and Mathematics students using the modified post-test only design. The first batch of the K-12 program is the treatment group. In contrast, the last batch under the Basic Education Curriculum is the comparison group. The Wilcoxon rank-sum test was used to determine a significant impact on the students' academic performance. Results showed a significant impact in Biology and Chemistry but not in Integrated Science and Physics. There was also a significant impact in Trigonometry and Statistics but not in Elementary Algebra, Intermediate Algebra, and Plane Geometry. However, the student's academic performance remained below satisfactory in Biology, Chemistry, and Trigonometry, and Statistics. Hence, teachers must be experts in their respective fields and undergo rigorous training to improve their strategies and become globally competitive educators.

1.0. Introduction

Evaluation in educational systems and strategies serves as a guide or benchmark for diagnosis and improvement for an effective teaching-learning process (Casinillo & Guarte, 2018). The educational system is one of the focuses of the Philippine government regarding its issues and policies (Barrot, 2019). One of the main programs that establish, maintain, and support a complete, adequate, and integrated system of education relevant to the needs of every Filipino is the Republic Act 10533 (Ely, 2019). Republic Act 10533, or the "Enhanced Basic Education Act of 2013," was approved on July 23, 2013, by the Congress of the Philippines (Department of Education [DepEd], 2013; Official Gazette, 2013). This law enhances the Philippine Basic Education System by strengthening its curriculum and increasing the number of years for basic education, appropriating funds, and other purposes. Section 5 of this law is on Curriculum Development which states that "the Department of Education (DepEd) shall formulate the design and details of the enhanced basic education curriculum." Furthermore, the curriculum shall use the spiral progression approach to ensure mastery of knowledge and skills after increasing levels of complexity from one grade level to another (Igcasama, 2021).

In the previous curriculum, Secondary Education Curriculum (SEC) 2010, Science and Mathematics were taught using the discipline-based approach. The three stages of understanding by design, namely: identifying desired results, determining acceptable evidence, and planning the instruction, were considered in teaching all subjects (Southeast Asian Minister of Education, Organization, Innovation, and Technology [SEAMEO INNOTECH], 2012). On the contrary, Spiral Progression Approach (SPA) is used in teaching the subjects in the present K to 12 curriculum wherein students' learning improves based on their previously learned knowledge. Students are expected to have the mastery of the desired competencies by returning to the subject a few times and relate additional knowledge with the past but at a higher level of understanding and comprehension. Besides, the students are also anticipated to progress in their learning because it involves going from basic to more complex knowledge and skills. This approach promotes learner-centered rather than teacher-centered instruction (Tan et al., 2012). New circumstances give rise to a new learning experience, which is more student-centered, self-conscious, imaginative, and independent (Veselinovska et al., 2011). Veladat and Mohammadi (2011) view the spiral progression approach as not much different

from other methods. It is just trying to challenge students' minds in different ways by asking questions and answers and write what they have learned to reach the educational goal. Both agree that using this teaching method requires teachers' preparation before the class. McAleavy (2013) describes the spiral curriculum as a comprehensive educational program that guarantees continuous improvement through little and coherent steps aiming for the highest mastery in each year level. Instead of essentially revisiting the same learning materials until all students have them memorized, this spiral process permits for ceaseless development to challenge the top learners, while typical learners can review previous topics and lessons in Science and mathematics (Mangali et al., 2019).

In teaching Science using the disciplined-based approach, Integrated Science was taught in the first year, Biology in the second year, Chemistry in the third year, and Physics in the fourth year. Similarly, in teaching Mathematics using the same approach, Elementary Algebra was taught in the first year, Intermediate Algebra in the second year, Geometry in the third year, and Trigonometry and Statistics in the fourth year. In the spiral progression approach, the four stated areas in Science and Mathematics are taught per grading period each year (DepEd, 2013; Resurreccion & Adanza, 2015). At present, in the Philippines, few evaluations of the effectiveness of SPA have been done but not in the specific fields of Science and Mathematics in rural areas. Hence, this study was conducted to determine the impact of the said approach in a typical public high school in a rural area in teaching Science and mathematics. This study was done by comparing the academic performance in Science and mathematics between the batch taught using this approach and that which was not. The outcome of this study will guide the teaching strategies of science and mathematics teachers in light of the nature of the spiral progression approach. Furthermore, the study also contributes to the body of literature in science and mathematics education and aid as a benchmark for future studies.

2.0. Framework of the Study

There are numerous modern learning theories so as modern teaching theories. Veladat and Mohammadi (2011) view the SPA as not much different from other theories. Igcasama (2021) and McAleavy (2013) describe the spiral curriculum as a comprehensive program that ensures continual revision and progression through small and logical steps and key aims of mastery each year. In the Philippines, the K to 12 curriculum implementation has institutionalized a curricular framework anchored on spiral progression (de Ramos-Samala, 2018). It is a new perspective in the teaching and learning process in the educational system in the country as innovation (Montebon, 2014). Dunton (2019) stated that the Department of Education (DepEd) in the country sees the SPA as a solution to the current education problem. However, in the context of the Philippines, many influencing factors affect students' learning ability in the science and mathematics spiral progression curriculum (Garcia, 2021). Perhaps, Orbe et al. (2018) revealed that there had been a mismatch in teachers' preparation in Science and mathematics as the country implemented the SPA curriculum. Despite its merits, De Dios (2013) reveals that the spiral curriculum is one of the instruction problems in the United States due to curriculum incoherence. Resurreccion and Adanza (2015) point out that it requires years to evaluate the effectiveness of the spiral curriculum if there are improvements in the academic programs designed for the learners and the society. Authentic assessment is used in SPA rather than a traditional classroom assessment. An authentic assessment provides the students with learning tasks that are comparative tasks in the real world (Resurreccion & Adanza, 2015). Project-based learning, performance tasks, portfolio, collaborative works, and online examinations are examples of authentic assessment. Teachers can measure and evaluate the students' performance and learning based on these real-life learning activities by applying authentic assessment.

Capate and Lapinid (2015) believe that achievement scores, whether in local or international examinations, are means to measure learning performance. Gavin (2014) clarifies that there is a distinction between assessment and grading. Basically, the objective of grading is to evaluate the individual learning and performance of the students. Even though grades are treated as a representative measure for student learning, grades are not always dependable. Grades comprise criteria that include attendance, participation, and effort, meaning it is not a direct measure of student learning. However, he points out that assessment of learning can and should rely on or relate to grades, and so far as they do, grades can be a major source of data for assessment (Gray & Bunte, 2020; Ross & Kostuch, 2011). In this study, grades in junior high school are viewed as measures of learning outcomes. Hence, this study is generally an evaluation under quasi-experimental conditions of the spiral progression approach in teaching Science and Mathematics to junior high school

students using their final grades. Specifically, it sought to answer the following objectives: 1) to describe the baseline characteristics of junior high school students, 2) to determine the equivalence of treatment and comparison groups in terms of baseline characteristics, and 3) to determine the effectiveness of spiral progression approach as opposed to the traditional method of teaching.

3.0. Methods and Materials

The Research Design. White and Sabarwal (2014) recognize that quasi-experimental designs test causal hypotheses just like experimental designs. The program or policy is considered the "intervention" in which a treatment is evaluated for how well it accomplishes its targets relative to the indicators specified beforehand. They pointed out that a quasi-experimental design, by definition, lacks random assignment. Hence, a quasi-experimental design, specifically the modified post-test only design with a comparison group, was used in the study since the measurements on the comparison group were taken in the preceding period to that of the treatment group, in order to evaluate this new approach in teaching Science and Mathematics based on the expected outcomes. Establishing equivalence of the baseline characteristics between the comparison and treatment groups leads to a meaningful interpretation of the treatment effect of the spiral progression approach and having the same teachers.

The Subjects. The study focused on the last batch of the Basic Education Curriculum (comparison group) and the first batch of the K to 12 Curriculum (treatment group) of a public high school in Isabel, Leyte, Philippines. There were 220 and 198 graduates in the comparison group and treatment group, respectively. But the subjects included in this study were only those who studied from the first year until the fourth year (for comparison group) and from Grade 7 until Grade 10 (for treatment group), which means that transferees were excluded. The treatment group comprises 178 students; they were taught Science and Mathematics using the SPA from Grade 7 to Grade 10. The comparison group comprises 183 students; they were taught Science and Mathematics in the traditional method or the discipline-based approach from the first year (now Grade 7) to the fourth year (now Grade 10).

The Learning Domains for Science and Mathematics. Since the new curriculum has the different areas in Science and Mathematics distributed across quarters in each grade level based on the records of K to 12 Science Curriculum Guide and Learning Materials, the quarterly grades of the students in the Science subjects (Table 1) were used to compute their mean grades in every subject in Science. For example, in Chemistry, the quarterly grades of a student under the domain "Matter" across grade levels were considered in computing the mean grade in Chemistry of this student. The domains "Living Things and Their Environment," "Earth and Space," and "Force, Motion, and Energy" are the equivalent for Biology, Integrated Science, and Physics, respectively.

Table 1. Sequence of learning domains for Science

Period	Grade 7	Grade 8	Grade 9	Grade 10
1st Quarter	Matter	Force, Motion, and Energy	Living Things and Their Environment	Earth and Space
2nd Quarter	Living Things and Their Environment	Earth and Space	Matter	Force, Motion, and Energy
3rd Quarter	Force, Motion, and Energy	Matter	Earth and Space	Living Things and Their Environment
4th Quarter	Earth and Space	Living Things and Their Environment	Force, Motion, and Energy	Matter

In Mathematics, the different areas were not distributed across quarters in each grade level (Table 2). For a student's mean grade in a subject under Mathematics, his quarterly grades under the same domain were used. For instance, in computing his mean grade in Intermediate Algebra, his quarterly grades under the domain "Patterns and Algebra" were considered. The domain "Numbers and Number Sense" is the equivalent of Elementary Algebra, while "Geometry, Statistics and Probability" is the equivalent of Trigonometry and Statistics.

Table 2. Sequence of learning domains for Mathematics

Period	Grade 7	Grade 8	Grade 9	Grade 10
1st Quarter	Numbers and Number Sense	Patterns and Algebra	Patterns and Algebra	Patterns and Algebra
2nd Quarter	Measurement, Patterns, and Algebra	Patterns and Algebra, Geometry	Patterns and Algebra	Patterns and Algebra, Geometry
3rd Quarter	Geometry	Geometry	Geometry	Geometry, Statistics, and Probability
4th Quarter	Geometry, Statistics, and Probability	Geometry, Statistics, and Probability	Geometry	Statistics and Probability

Data Analysis. In the quasi-experimental design, four baseline characteristics were considered that may influence the impact of the SPA on the students' academic performance in Science and Mathematics. These were the age of entry to junior high school, the general average grade in elementary, the distribution of sex, and the elementary school (ES) graduated from. Hence, before comparing the two groups, these four baseline characteristics are assumed to be equivalent at a 5% level of significance to reduce the effects on the two curricula at different contexts and times. The Wilcoxon rank-sum test was used to test the equivalence of the two groups on the age of entry to junior high school and the general average grade in elementary.

The Chi-square test was used for the sex distribution, and the ES graduated from. In addition, to further account for the comparability of the two curricula, the two groups of students were taught with the same teacher. By Shapiro-Wilk test, it is found out that the grades for both treatment and comparison groups are not normal at a 5% level of significance. Hence, the study used a non-parametric method such as Wilcoxon rank-sum test since normality is not assumed.

The Wilcoxon rank-sum test was used to compare the difference in the academic performance in Science and Mathematics of the treatment and comparison groups in each level at the 5% level of significance. The data from the two groups were first combined then ranked, and the sum of the ranks for each group was generated. The observed test statistic is based on the normal approximation since there is a sufficient number of subjects (N=361). The significant result shows the positive impact of using the spiral progression approach on academic performance in a particular domain in Science and Mathematics. Estimation of the effect of the spiral progression approach in both subjects was also done to give more details on how large the treatment effect was. The estimated treatment effect in a particular domain was computed by determining the median of all the differences in the final grades of the treatment and comparison groups.

Table 3 shows the student's median final grade and its corresponding description.

Table 3. Median final grade and its corresponding description.

Range of Median Final Grade	Description
60.00 - 75.00	Poor
75.01 – 81.00	Unsatisfactory
81.01 – 87.00	Satisfactory
87.01 – 93.00	Very Satisfactory
93.01– 100.00	Outstanding

4.0. Results and Discussion

Baseline characteristics of treatment and comparison groups

Table 4 shows that the treatment group, Batch 2018, comprises 178 students with 101 (56.74%) females and 77 (43.26%) males. The comparison group, Batch 2015, comprises 183 students with 104 (56.83%) females and 79 (43.17%) males. The age of entry of the subjects in the treatment group ranges from 11 to 16 years old with the mean age of 12.9 (SD=0.85), while in the comparison group, it ranges from 12 to 18 years old with a mean age of 13.2 (SD=1.17). About 63% and 60% of the treatment and comparison group participants came from Matlang Elementary School (MES), while the rest came from outside MES. The general average grades in elementary for the treatment and comparison groups are 82.7 (SD=4.16) and 81.8 (SD=3.66), respectively. This implies that both groups obtain a satisfactory grade in their elementary (See Table 3).

Table 4. Descriptive statistics for Baseline Characteristics

Baseline Characteristic	Treatment Group		Comparison Group		Total	%
	n	%	n	%		
Sex distribution						
Female	101	56.74	104	56.83	205	56.79
Male	77	43.26	79	43.17	156	43.21
Age of entry to junior high school						
11 years old	2	1.1	0	0.0	2	0.6
12 years old	60	33.7	53	29.0	113	31.3
13 years old	82	46.1	84	45.9	166	45.98
14 years old	28	15.7	26	14.2	54	14.96
15 years old	4	2.2	10	5.5	14	3.88
16 years old	2	1.1	5	2.7	7	1.94
17 years old	0	0.0	4	2.2	4	1.1
18 years old	0	0.0	1	0.5	1	0.28
Elementary school (ES) graduated from						
Apale ES	4	2.19	10	5.62	14	3.89
Bilwang ES	24	13.11	30	16.85	54	14.96
Binog ES	7	3.83	6	3.37	13	3.60
Honan ES	21	11.48	8	4.49	29	8.03
Libertad ES	30	16.39	30	16.85	60	16.62
Matlang ES	63	34.43	60	33.71	123	34.07
Tolingon ES	10	5.46	10	5.62	20	5.54
Tubod ES	11	6.01	8	4.49	19	5.26
Others	13	7.10	16	8.99	29	8.03
General average (Mean) grade in elementary	82.7 (SD=4.16)		81.80 (SD=3.66)			

Equivalence of the treatment and comparison groups

Aside from having the same teachers in Science and Mathematics, the treatment and comparison groups are also similar on four (4) baseline characteristics that can influence their response to learning Science and Mathematics subjects under the spiral progression approach. The two groups can be taken to be equivalent in terms of age (years) of entry in junior high school and general average grade in elementary based on the results of the Wilcoxon rank-sum test (Table 5). It implies that the treatment and comparison groups are not significantly different (p-value>0.05). In the study of Gray and Bunte (2020), the previous grade can affect students' performance. Hence, the result of the Wilcoxon rank-sum test in terms of general average grade follows to be a good variable in quasi-experimental design if it is equivalent. Results of the chi-square test for two independent samples also showed that the two groups do not differ significantly (p-value>0.05) on sex distribution and in the elementary school graduated from (Table 5). According to White and Sabarwal (2014) and Ming et al. (2019), in quasi-experimental designs, it is necessary to use a comparison group that is comparable or equivalent to the treatment group in terms of baseline characteristics.

Table 5. Equivalence on the baseline characteristics

Baseline Characteristics	Test Statistic	p-value
Age of entry to junior high school[a]	1.823[ns]	0.068
General average grade in elementary[a]	1.865[ns]	0.062
Sex distribution[b]	0.0003[ns]	0.986
Elementary school graduated from[b]	9.7236[ns]	0.285

Note: a – Wilcoxon rank-sum test; b – Chi-square test; ns – not significant

Impact of the spiral progression approach on the students' academic performance

According to Cabansag (2014), students think that learning is more interesting and more enjoyable in the new curriculum since they learn all four components of Science in a year, and there are varied learning activities as well. However, the impact of the SPA in teaching Science on the students' academic performance is not the same in the different domains. Results showed that this approach is highly significant (p-value<0.01) effective in improving the academic performance in Biology and in Chemistry (Table 6). The estimated effect of this new way of teaching Biology is 2.25 significantly higher compared to the discipline-based approach. An average difference of 0.75 on the students' academic performance was also observed in the treatment group in Chemistry which implies that SPA is significantly (p-value<0.01) effective. However, the improved academic performance is still below the target in both subjects (at least 85, on average), with median final grades of 81.0 in Biology and 81.25 in Chemistry.

Table 6. Comparison of the academic performance in Science

Domain	Median Final Grade		Treatment Effect Estimate	Test Statistic	p-value
	Treatment Group (n=178)	Comparison Group (n=183)			
Integrated Science	80.25	80.50	-0.00002	-0.188[ns]	0.4256
Biology	81.00	78.88	2.24996	5.434[***]	<0.0010
Chemistry	81.25	80.25	0.75004	2.417[***]	0.0078
Physics	79.75	79.25	0.49992	1.424[ns]	0.0773

Note: ns - not significant; *** - significant at 1% level

Moreover, Dioneda (2019) emphasized that Biology teachers should integrate localization and contextualization in teaching to improve the performance and motivation of students. In the

study of Ely (2019), it is very important that in the spiral progression approach, mastery in learning competencies must be focused on teaching Chemistry to improve students' academic performance. For Integrated Science, there is no significant impact on the academic performance of the students. The estimated effect of this new approach is almost nil.

Furthermore, Dunton (2019) mentioned that implementing the spiral progression approach is not well planned considering a lack of qualified teachers. Some teachers are incompetent since time spent on teachers' training is not enough in teaching Science. Although the sample median academic performance of the treatment group was relatively higher in Physics, it shows no significant difference with the comparison group but an estimated average difference on the academic performance was 0.50 in favor of the treatment group. Also, the median final grades in these subjects remain far from satisfactory. Yunzal and Casinillo (2020) stated that Physics is a subject where students' interest and motivation are profoundly less due to its complexity and difficulty. It is stated in the study of de Ramos-Samala (2018) that the discovery approach and cooperative learning are the effective teaching strategies used in the spiral progression approach in Physics so that the students might catch up with difficult lessons.

In Mathematics, using the SPA significantly helps only one subject—Trigonometry and Statistics (Table 7). Results showed an average difference of 1.50 in the treatment group compared to the comparison group, which indicates that SPA is significantly (p-value<0.01) effective. However, the improved academic performance remains below satisfactory (See Table 3), with a median final grade of 81. It has been found out that the remaining three domains are much better taught using the discipline-based approach than this new approach. The comparison group performs significantly better in Elementary Algebra and Plane Geometry than the treatment group. Although the sample median for Intermediate Algebra is relatively higher in the comparison group, it does not show a significant average difference in the academic performance for those in the treatment group. It is revealed in the study of Orale and Uy (2018) that about 71% of students who are about to move to Grade 11 are still beginners of Grade 10 Mathematics. This suggests that the spiral progression is ineffective, as teachers seem to proceed to the next higher mathematical concepts without the mastery required. Hence, in the study of Ferrer (2018), it is suggested that Mathematics teachers should examine how to align the progression of mathematical knowledge and skills of the learners through the spiral approach. Mathematics teachers must regularly assess the learners' academic performance as they level-up in the prior mathematics and explore strategic problem solving approaches. It is also worth noting that low academic performance in mathematics is derived from different factors affecting to students' interests (Casinillo & Aure, 2018).

Table 7. Comparison of the academic performance in Mathematics

Domain	Median Final Grade		Treatment Effect Estimate	Test Statistic	p-value
	Treatment Group (n=178)	Comparison Group (n=183)			
Elementary Algebra	78.25	80.75	-1.49999	-3.809***	<0.0010
Intermediate Algebra	80.25	81.25	-0.25002	-0.910ns	0.1815
Plane Geometry	80.50	80.75	-0.75003	-2.325***	0.0100
Trigonometry & Statistics	81.00	79.25	1.49995	3.463***	0.0003

Note: ns - not significant; *** - significant at 1% level

5.0. Conclusion

The study was conducted to evaluate the initial impact of SPA in teaching Science and Mathematics to the first batch of students in the K to 12 programs at Matlang NHS, representing a typical rural public high school in the Philippines. The treatment group and the comparison group are similar to the teachers teaching Science and Mathematics, the average age of entry in high school, the general average grade in elementary, sex ratio, and the elementary school graduated. The

spiral progression approach is favorable in teaching Science (two out of the four domains showed significant improvement on academic performance) but not so in teaching Mathematics (only one of the four domains showed significant impact) compared to the old approach. The spiral progression approach can improve students' academic performance in Biology, Chemistry, and Trigonometry, and Statistics at Matlang NHS. The academic performance of the students, however, remains below satisfactory. Given more time, this approach also promises to improve the students' academic performance in the other domains in Science and Mathematics at Matlang NHS. Stakeholders should then provide relevant training to the Science and Mathematics teachers, especially those teaching Integrated Science, Physics, Elementary Algebra, Intermediate Algebra, and Geometry to statistically improve the students' academic performance of the K to 12 curriculum. Teachers in Biology, Chemistry, Trigonometry, and Statistics should sustain their efforts and aim to attain their students' very satisfactory academic performance. Employing suitable and highly competent Science and Mathematics teachers will help greatly raise the students' academic performance to greater levels.

6.0. Recommendations

Evaluation of the SPA should be done on the next batches to determine improvements over time. For future studies, the perceptions of the students and teachers may be sought. Comparison of the impact of the spiral progression approach can also be done in rural and urban settings, public and private, and small and big high schools.

REFERENCES

Barrot, J. S. (2019). English curriculum reform in the Philippines: Issues and challenges from a 21st-century learning perspective. *Journal of Language, Identity & Education*, *18*(3), 145-160. https://doi.org/10.1080/15348458.2018.1528547

Cabansag, M. S. (2014). Impact statements on the K-12 science program in the enhanced basic education curriculum in provincial schools. *Journal of Arts, Science & Commerce*, 5(2), 29-39.

Capate, R. N., and Lapinid, M. R. (2015). *Assessing the mathematics performance of grade 8 students as basis for enhancing instruction and aligning with k to 12 curriculum*. Research paper, De La Salle University, Manila.

Casinillo, L., & Aure, M. R. K. (2018). Econometric evidence on academic performance in basic calculus of Science, technology, engineering, and mathematics (STEM) senior high students. *Journal of Educational and Human Resource Development*, *6*, 238-249.

Casinillo, L. F., & Guarte, J. M. (2018). Evaluating the effectiveness of teaching strategies: The case of a national vocational school in Hilongos, Leyte. *Review of Socio-Economic Research and Development Studies*, *2*(1), 64-79.

Department of Education (DepEd). (2013). *Republic Act No. 10533*. An act enhancing the Philippine basic education system. Republic of the Philippines. https://www.officialgazette.gov.ph/2013/05/15/republic-act-no-10533/

De Dios, A. (2013). *Spiral Curriculum: When and How? Redundant versus Progressive?* http://www.philippinesbasiceducation.us/2013/05/spiral-curriculum-when-and-how.html?m=1

de Ramos-Samala, H. (2018). Spiral progression approach in teaching Science: A case study. *KnE Social Sciences*, 555-567. https://doi.org/10.18502/kss.v3i6.2404

Dioneda Jr, I. P. (2019). Localization and contextualization in teaching biology for grade 7 students of Paliparan National High School for the school year 2018–2019. *IOER International Multidisciplinary Research Journal*, *1*(3).

Dunton, J. B. (2019). Spiral progression approach in teaching Science and the performance of learners in District I, Capiz. In *Journal of Physics: Conference Series* 1254(1), 012045. https://doi.org/10.1088/1742-6596/1254/1/012045

Ely, L. L. *(2019).* Mastery learning of chemistry competencies through the spiral progression approach in curriculum. *International Journal of Educational Science and Research (IJESR), 9(5),* 9-*28*.

Ferrer, F.P. (2018). Reforms in the Philippine secondary education mathematics curriculum. *International Journal of Multidisciplinary Research and Modern Education, (4)*2, 15-18.

Garcia, R. E. (2021). Factors that influence students' learning progress in the science spiral progression curriculum. *Journal of Curriculum Studies Research*. https://doi.org/10.46303/jcsr.2020.5

Gavin, J. (2014). *Teaching and grading assessment*. http://www.cmu.edu/teaching/assessment/howto/basics/grading-assessment.html

Gray, T., & Bunte, J. (2020). The effect of grades on student performance: Evidence from a quasi-experiment. *College Teaching*, 1-14. https://doi.org/10.1080/87567555.2020.1865865

Igcasama, R. M. (2021). Teachers and students' perceptions on the implementation of the K-12 spiral progression approach. *International Journal of Indonesian Education and Teaching (IJIET)*, *5*(1), 116-124.

Mangali, G. R., Tongco, C., Aguinaldo, K. P., & Calvadores, C. J. (2019). Stories of students toward spiral progression approach in Science: A phenomenological study. *International Journal of Multidisciplinary Research and Publications*, *2*(2), 27-48.

McAleavy, T. (2013). *Exploring different approaches to teaching primary maths*. http://www.theguardian.com/teacher-network/2012/jul/20/primary-maths-programme

Ming, J. L., Huang, H. M., Hung, S. P., Chang, C. I., Hsu, Y. S., Tzeng, Y. M., ... & Hsu, T. F. (2019). Using simulation training to promote nurses' effective handling of workplace violence: A quasi-experimental study. *International Journal of Environmental Research and Public Health*, *16*(19), 3648. https://doi.org/10.3390/ijerph16193648

Montebon, D. T. (2014). K12 science program in the Philippines: Student perception on its implementation. *International Journal of Education and Research*, *2*(12), 153-164.

Official Gazette (2013). *Republic Act 10533: Enhanced basic education act of 2013*. https://www.officialgazette.gov.ph/2013/05/15/republic-act-no-10533/

Orale, R. L., & Uy, M. E. A. (2018). When the spiral is broken: Problem analysis in the implementation of the spiral approach in teaching Mathematics. *Journal of Academic Research, 3*(3), 14-24.

Orbe, J. R., Espinosa, A. A., & Datukan, J. T. (2018). Teaching chemistry in a spiral progression approach: Lessons from science teachers in the Philippines. *Australian Journal of Teacher Education (Online)*, *43*(4), 17-30.

Resurreccion, J. A., & Adanza, J. (2015). *Spiral progression approach in teaching Science in selected private and public schools in Cavite*. St. Dominic College of Asia.

Ross, J. A., & Kostuch, L. (2011). Consistency of report card grades and external assessments in a Canadian province. *Educational Assessment, Evaluation, and Accountability*, *23*(2), 159-180. https://doi.org/10.1007/s11092-011-9117-3

Southeast Asian Minister of Education, Organization, Innovation, and Technology (SEAMEO INNOTECH). (2012). *K to 12 Toolkit: Reference guide for teacher educators, school administrators, and teachers.* Quezon City, Philippines.

Tan, M. C., Philippines, D., & City, Q. (2012). *Spiral progression approach to teaching and learning*. In CEAP National Convention, SMX Convention Center, Pasay City, Philippines.

Veladat, F., & Mohammadi, F. (2011). *Spiral learning teaching method: Stair stepped to promote learning.* Elsevier Ltd., Islamic Azad University, Tehran, Iran.

Veselinovska, S. S., Gudeva, L. K., & Djokic, M. (2011). The effect of teaching methods on cognitive achievement in biology studying. *Procedia-Social and Behavioral Sciences*, 15, 2521-2527. https://doi.org/10.1016/j.sbspro.2011.04.138

White, H., & Sabarwal, S. (2014). Quasi-experimental design and methods. *Methodological Briefs: Impact Evaluation*, *8*, 1-16.

Yunzal Jr, A. N., & Casinillo, L. F. (2020). Effect of Physics Education Technology (PhET) simulations: Evidence from STEM students' performance. *Journal of Education Research and Evaluation*, *4*(3), 221-226. http://dx.doi.org/10.23887/jere.v4i3.27450

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