Level of Implementation of Spiral Progression Approach in Relation to Students' Performance in Algebra

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***Abstract*—** In the K to12 curriculum, teachers are required to teach using the Spiral Progression Approach. This study explored the level of implementation of the Spiral Progression Approach in relation to performance in Algebra of students in Tangub City National High School. The descriptive-correlational design was used in the study. Adapted and modified Spiral Progression Approach in Mathematics Questionnaire (L &Alegre, 2019) and the researcher-made Algebra Summative Test was used in gathering the data. The respondents of the study were 249 Grade 10 students selected through simple random sampling. Mean, Standard Deviation, Pearson Product-Moment Correlation Coefficient, and Regression Analysis were used as the statistical tools. Results revealed that the teachers highly implemented the Spiral Progression Approach, but the students' performance in Algebra was very poor. The use of a Spiral Progression Approach in teaching was significantly related to the students' performance in Algebra. Discussion is a common strategy for teachers in teaching the Spiral Progression Approach. Future researchers conduct researches focusing on the factors that affect students' academic performance in Mathematics.

***Keywords*—** Algebra, discussion, implementation, performance, Spiral Progression Approach.

I. INTRODUCTION

As the Philippines implemented the K to12 curriculum, there has been a mismatch in teacher preparation. Teachers used a discussion Spiral Progression Approach in teaching (Orbe, Espinosa, & Datukan, 2018). However, the new curriculum has varied activities like collaborative learning, peer tutoring, outcome-based performance, or performance task. Students are exposed to socializing, sharing thoughts and ideas, brainstorming, communicating, and expressing their multiple intelligences, abilities, and skills. Hence, the students will understand the concepts of a subject matter better if they participate in the activities conducted by the teacher, such as peer collaboration and problem-solving (Angeles, 2013).

Spiral Progression develops the same concepts from one grade level to the next in increasing complexity and sophistication (Corpuz, 2014). The Spiral Progression Approach repeating procedure reviews the previously learned concept, thus improving its retention and mastery of subjects and skills (Quijano & Curriculum Technical Working Group, 2012). There are a rich breadth and depth of knowledge achieved at the end. Hence, the topic may be progressively elaborated when reintroduced, leading to a broadened understanding and transfer (Mantiza, 2013).

Efforts to strengthen instruction also contributed to reform proposals being implemented and tested in the university Mathematics curriculum (Fukawa-Connelly, Johnson, & Keller, 2016). Endorsement of substitution definitions of the equals sign and completed an Algebra test plays a unique role in explaining secondary school students' Algebra performance above and beyond the school year and the other definitions (Simsek, Xenidou-Dervou, Karadeniz, & Jones, 2019). One factor in student success in Algebra is gender differences, which substantially narrowed as students were more driven to respond to homework assignments in a timely and consistent manner, meet deadlines, and achieve adequate academic achievement (Ndum, Allen, Way, & Casillas, 2018).

Direct assessments of instructional practice (e.g., classroom observations) are necessary to identify and eliminate opportunity gaps in students' learning of Mathematics. Instructional Quality Assessment identified high percentages of lessons featuring cognitively challenging tasks but declines in a cognitive challenge during implementation and discussions. The overall instructional quality exceeded results from studies with nationally representative samples and paralleled studies of instructional-focused urban middle schools (Boston & Wilhelm, 2017). Teachers need to equip students with critical and creative thinking skills. The principles of constructivism are emphasized as useful pedagogical considerations that may enhance critical and creative thinking skills in Mathematics

classrooms (Sanders, 2016). Identification of distinctive features of beliefs regarding different mathematical domains is followed by analyzing teachers' views on their classroom practice and professional development (Eichler & Erens, 2015).

Peer collaboration has identified both cognitive and social phenomena as essential components for success, though very little was known of the relationship between these factors. Students' rapport states may play a role in students' reasoning states, and thus calls for a more in-depth investigation within the CSCL community about the role of rapport in peer learning (Olsen & Finkelstein, 2017). Collaboration scripts and heuristic worked examples are useful means to scaffold university freshmen's mathematical argumentation skills. To encourage argumentation skills in Mathematics, learning environments should be designed to help learners display dialectical transactivity (Vogel et al., 2016).In the study conducted in Canada, most students, including newly-arrived immigrant students, reported benefiting from group work and working with others (Takeuchi, Bryan, Valera, & Dadkhahfard, 2019).

Efficiency improves with experience for most educators. The benefits of teaching experience are best realized when they are thoroughly chosen and well prepared and intensively mentored and rigorously evaluated over the years. They further reiterated that as teachers gain experience, their students learn more, as measured by standardized tests (Kini & Podolsky, 2016).

Results show no relationship between academic performance and the factors affecting the implementation of the spiral approach. However, there is a significant relationship between the academic performance between the first and second grading periods (Merza, Orge, Agatep, & Edaño, 2018).

Student success in Mathematics is a global concern, with many studies detailing the need for successful instruction to improve student achievement. However, the type of mathematics instruction most effectively raising students' performance remains debatable (Latif, 2016). Teaching Secondary and Middle School Mathematics blends the latest innovations in research and technology with a vibrant writing style to prepare teachers for secondary and secondary school mathematics challenges. With more than 60 realistic, classroom-tested teaching concepts, sample lessons, and activities, Secondary and Middle School Mathematics incorporates the best of theory and experience to provide clear examples of what is required to be a successful Mathematics teacher (Brahier, 2016).

Objectives of the Study

This study explored the implementation of a Spiral Progression Approach in relation to the students' performance in Algebra of students in Tangub City National High School, Tangub City. Specifically, this study:

1. Determine the implementation level of the Spiral Progression Approach in terms of discussion, peer collaboration, and problem-solving activities;
2. Assess the students' performance in Algebra;
3. Explore the significant relationship between the level of implementation of the Spiral Progression Approach and the students' performance in Algebra; and
4. Explore which among the Spiral Progression Approaches, singly or in combination, predicts students' performance in Algebra.

METHODS

Research Design

The study used the descriptive – correlational design. Descriptive research describes a phenomenon and its characteristics. The data may obtain qualitatively, but it is often analyzed quantitatively, using frequencies, percentages, averages, or other statistical analyses to determine relationships (Nassaji, 2015). On the other hand, correlational methods often rely on statistical control to rule out the effects of extraneous variables, provide more accurate estimates of relationships among variables, or produce conservative tests of hypotheses (Becker et al., 2016). Therefore, this design was considered suitable for the present study in determining the level of implementation of a Spiral Progression Approach in relation to the students' performance in Algebra.

Research Setting

The study was conducted at Tangub City National High School. The school is located at Mantic, Tangub City, Misamis Occidental. The school has a total population of 1,980 students from Grade 7 to Grade 10. The school is headed by a school principal with head teachers, a guidance coordinator, a guidance counselor, administrative personnel, and teachers. It has different curricula: Science Technology Engineering and Mathematics (STEM), Special Program in the Arts (SPA), Sports, and Regular Curriculum.

Respondents of the Study

There were 249 respondents out of 540 Grade 10 students of Tangub City National High School. In selecting the respondents, simple random sampling was used. Therefore, the students were from the

heterogeneous classes of Tangub City National High School for the School Year 2019 - 2020.

Instruments

The study used the following instruments:

A. Spiral Progression Approach in Mathematics Questionnaire. The Grade 10 students answered this adapted and modified questionnaire consisting of thirty statements used in determining the level of implementation of the Spiral Progression Approach in Mathematics (Appendix A). The questionnaire consists of thirty indicators with three constructs, namely: (a) discussion, (b) peer collaboration; and (c) problem-solving activities. The questionnaire had undergone validation through the research adviser and other Mathematics teachers. After the validation process, the instrument was subjected to a pilot test using students not included as the actual respondents of the study. The research instrument yielded the Cronbach's Alpha of 0.8297.

Table 1: In determining the extent of students' participation in Spiral Progression Approach in Mathematics, the following scale was used:

Responses	Continuum	Interpretation
5 – Always (A)	4.50 – 5.0	Very High (VH)
4 – Often (O)	3.50 – 4.49	High (H)
3 – Sometimes (S)	2.5 – 3.49	Moderate (M)
2 – Rarely (R)	1.50 – 2.49	Low (L)
1 – Never (N)	1.0 – 1.49	Very Low (VL)

B. Algebra Summative Test. This is a researcher-made test used in determining the students' performance in Algebra. The test is composed of the four-grade level topics in Algebra from Grade 7 to Grade 10. It is a multiple-choice test with forty items with four choices. A pilot test was conducted to students who were not included as the actual respondents. The instruments yielded the Cronbach's Alpha of 0.7076.

Table 2: In determining the level of students' performance in Algebra, the following scale was utilized using the standard score equivalence by the Department of Education:

Scores	Equivalence	Descriptive Rating
34 – 40	90 – 100	Outstanding (O)
31 – 33	85 – 89	Very Satisfactory (VS)
28 – 30	80 – 84	Satisfactory (S)
24 –27	75 – 79	Fairly Satisfactory (FS)
23 and below	Below 75	Did Not Meet Expectations (DNME)

Data Collection

Before the data gathering, the researcher sought permission from the Dean of the Graduate School of Misamis University, Ozamiz City, to conduct the study. Moreover, permission was sought from the Schools Division Superintendent of Tangub City, school principal, and Grade 10 Curriculum Head of Tangub City National High School.

After approval was obtained, the Mathematics teachers were informed about the study. The class advisers were informed and asked of their participation, wherein their students served as the actual respondents.

Informed consent was observed before the respondents were asked to answer the research instruments.

The gathering of data lasted for four consecutive days. The researcher personally administered the instuments to the target respondents to ensure their full cooperation. The data gathered was tallied, computed, analyzed, and interpreted.

Ethical Considerations

This study complied with the ten principles of ethical considerations by Bryman and Bell (2007). First, the respondents were not subjected to harm by any means. Second, respect for the participants' dignity was prioritized. Third, clear consent was obtained from respondents before the study. Fourth, protection of the research respondents' privacy, adequate confidentiality of the research data, and the anonymity of participating individuals were ensured.

Moreover, deception and exaggeration about the aims and objectives of the study were avoided. Furthermore, affiliations in any form, sources of funding, and any possible conflicts of interest were declared. Lastly, any communication concerning the research was done with honesty and transparency, and any misleading information and the representation of primary data findings in a biased way were avoided.

Data Analysis

The researchers used thefollowing statistical tools in the study:

Mean and *Standard Deviation* were used in determining the level of implementation of the Spiral Progression Approach and the students' performance in Algebra.

Pearson Product - Moment of Correlation Coefficient was used to determine the significant relationship between the level of implementation in the Spiral Progression Approach and the students' performance in Algebra.

Regression Analysis was used in determining the predictor of students' performance in Algebra.

RESULTS AND DISCUSSION

Level of Implementation of Spiral Progression Approach in Mathematics

Table 1 shows the level of implementation of a Spiral Progression Approach in Mathematics in terms of discussion, peer collaboration, and problem-solving activities, which was high as perceived by the students (M = 3.92; SD = 0.69). Thus, it implies that the Mathematics teachers highly implemented the Spiral Progression Approach. Furthermore, it indicates that the students experienced the implementation of this approach in teaching.

The students indicated that their Mathematics teachers provided them with adequate support to work collaboratively during the discussion and problem-solving activities under the implementation of the Spiral Progression Approach. Thus, teachers taught different major topics/branches in Mathematics in every grading period. They recalled every lesson learned in Mathematics every school year with increasing complexity. Also, Mathematics teachers engaged the students in group/dyad activities that motivated them to listen to and let students discover some easy techniques of solving from the ideas of their group mates. They also provided problem-solving activities at an increasing difficulty level as the students progressed in the year level.

The teachers performed well in determining what misconceptions students might express in the given scenarios (Güler & Çelik, 2019). Furthermore, students feel more comfortable in environments with a Spiral Progression Approach, and therefore, the learning process becomes a more pleasant task (Garzón & Bautista, 2018). Thus, using this approach to instruction was equally effective in improving student Mathematics knowledge (Wilder & Berry, 2016). However, teachers' qualifications, resources, and training inadequacy are factors identified that prevent them from producing favorable outcomes in a Spiral Progression Approach (Orale & Uy, 2018).

With twenty-first century learners, teachers must be imbued with knowledge and skills that foster students' active learning process. There must be training and seminars about integrating a Spiral Progression Approach and technology in instructional strategies and activities that are suitable for achieving the learning competencies. It is necessary to provide students with real-life situations and experiences that will motivate students to gain long-term retention and mastery of concepts.

Table 3: Level of Implementation of Spiral Progression Approach in Mathematics
(n = 249)

Constructs	*Mean*	*StDev*	*Remarks*
Discussion	4.01	0.64	High
Peer Collaboration	3.83	0.73	High
Problem-solving Activities	3.92	0.67	High
Overall	3.92	0.69	High

Note: Scale: 4.20 – 5.0 (Very High); 3.20 – 4.19 (High); 2.61 – 3.19 (Moderate); 1.81 – 2.60 (Low); 1.0 – 1.80 (Very Low)

Students' Performance in Algebra

The students' performance in Algebra is presented in Table 2. It is shown that the students' performance in Algebra belongs to the category of "Did Not Meet Expectations" (M = 11.47), where a majority or 98.80 percent of the respondents got a score below 24. Also, only 1.20 percent of the respondents have fairly satisfactory results, and none of them scored higher than 27.

This finding implies that students have forgotten their knowledge of basic to complex Algebra topics from Grade 7 to Grade 10. Furthermore, it shows that the respondents do not have retention and mastery on the issues since the test was given without prior notice.

Retention and mastery of the topics in Algebra are some of the factors that affect students' performance. Students only remember that their Mathematics teachers taught particular issues, but they forgot the process. One cannot solve the complex if the basic principles are ignored. Furthermore, lessons can be difficult to bring back if students lack mastery and retention.

Learning to solve Algebraic problems is mainly influenced by domain-specific factors, though domain-

general capacities are still associated with performances on a cross-sectional basis. The importance of domain-general abilities varies greatly depending on the domain of Mathematics and perhaps how they are measured (Lee, Ng, & Bull, 2017).

For example, student understanding of the variables within a problem context played a central role in developing the conceptual knowledge of expressions and equations (Moss & Lamberg, 2019). Furthermore, working on assignments led to improved grade outcomes (O'Connell, Wostl, Crosslin, Berry, & Grover, 2018).

Benefits from mastery-style over conventional homework, particularly for weaker students who are less familiar with the material being studied and questions more closely linked to study materials (Evans & Selen, 2017).

Teachers must provide differentiated instruction based on knowledge of individual students' emotional and cognitive needs and abilities. Administrators who require teachers to provide differentiated instruction and content knowledge must support teachers with tangible, practical, and tailored professional development (Meadows, 2016).

The teacher needs to ensure the students' mastery in Algebra to enhance the retention and performance of the students.

Appropriate instructional strategies and proper motivation may be undertaken to support the students in improving their scores. There must be constant drills about the basics up to the complex concepts of Algebra.

Table 4: Students' Performance in Algebra (n = 249)

Performance	Frequency	Percent
Outstanding (34 – 40)	-	-
Very Satisfactory (31 –33)	-	-
Satisfactory (28 – 30)	-	-
Fairly Satisfactory (24 – 27)	3	1.20
Did Not Meet Expectations (below 24)	246	98.80
Mean Performance	11.47 – Did Not Meet Expectations	

Note: Scale: 34 – 40 (Outstanding); 31 – 33 (Very Satisfactory); 28 – 30 (Satisfactory); 24 – 27 (Fairly Satisfactory); 23 and below (Did Not Meet Expectations)

Significant Relationship between the Level of Implementation of Spiral Progression Approach and Students' Performance in Algebra

Pearson Product-Moment Correlation Coefficient was used in determining the significant relationship between the level of implementation of the Spiral Progression Approach and students' performance in Algebra (Table 5). Discussion (r = 0.14; p= 0.03), peer collaboration (r = 0.13; p = 0.03) and problem-solving activities (r = 0.14; p = 0.03) have significant relationship to the students' performance in Algebra. This finding means that the three constructs in the Spiral Progression Approach can greatly contribute to the students' performance in Algebra.

The data show that if Mathematics teachers highly implement the Spiral Progression Approach, the students' performance in Algebra may increase. However, in this study, though the approach's implementation level was high, the student's performance in the subject was unsatisfactory. Therefore, the students' performance in Algebra belongs to the level of not meeting expectations despite the high level of implementation of the Spiral Progression Approach by the Mathematics teachers.

The students' performance in Algebra may become satisfactory if students are appropriately motivated and engaged in the active learning process. Teaching Algebra requires teachers to apply appropriate instructional strategies to improve students' interest, learning, and enjoyment. Teachers have to merge the use of discussion and collaborative learning in teaching Mathematics lessons.

Table 5: Test of Significant Relationship between the Level of Implementation of Spiral Progression Approach and the Students' Performance in Algebra

Variables	r-value	p-value	Remarks
Discussion and Performance	0.14*	0.03	Significant
Peer Collaboration and Performance	0.13*	0.03	Significant
Problem-solving Activities and Performance	0.14*	0.03	Significant

*Note: * means p-value ≤ 0.05; significant at 5% level*

Predictors of Students' Performance in Algebra

The data revealed that the discussion is the predictor of students' performance in Algebra using the Spiral Progression Approach among the three constructs (= 1.04; t = 2.33; p = 0.02). Thus, the finding shows that teachers' focus on the Spiral Progression Approach can significantly affect the students' performance in Algebra.

The regression equation (Students' Performance in Algebra = 7.35 + 1.037 Discussion) indicates that when teachers use discussion in implementing the Spiral Progression Approach increases by a unit, the student's academic performance will also increase by 1.037. The variation of students' performance in Algebra is explained by discussion for only 43 percent (r2 = 43.0 %). It means that only 43 percent of the students' academic performance is attributed to the teachers' use of discussion in teaching. In comparison, the remaining 57 percent is attributed to other constructs not significantly related to students' performance, such as peer collaboration, problem-solving activities, and other factors not included in the study.

The result specifies that discussion is still an effective strategy for teachers in using the Spiral Progression Approach. It is supported that majority of the students appear quite content to lecture, and among those who have suggested willingness to make a shift in the pedagogical strategy change. There is minimal usage of existing reform materials or interaction with educational research results (Fukawa-Connelly, Johnson, & Keller, 2016).

The finding of this study conflicts with the concepts related to student factors rather than teacher factors. Students' domain-specific capacity to self-concept emerged as the best predictor of students' mathematics and German grades. However, combined effects analysis found that having classmates with comparatively high intelligence positively predicted students' standardized test success in both subjects, accounting for common skills, but did not significantly predict students' grades (Lauermann, Meißner, & Steinmayr, 2019). Student's position and role in information relay in online case discussions, combined with the strength of that student's network, can be used as predictors of performance in relevant settings (Saqr, Fors, & Tedre, 2018).

A study that the teachers' presence and cognition were associated with students' academic performance (Galikyan & Admiraal, 2019). The substitution of equal signs plays a unique role in explaining secondary school students' Algebra performance above and beyond the school year and the other definitions (Simsek, Xenidou-Dervou, Karadeniz, & Jones, 2019).

Students have different learning styles and study habits. Thus they need varied instructional strategies and activities. However, the role of a traditional teacher plays a vital role in students' performance using the Spiral Progression Approach. Students' performance in Algebra can be enhanced through discussion, peer collaboration, problem-solving activities, and other teaching approaches.

Table 6: Predictors of Student's Performance in Algebra

Predictors	**Coef (β)**	**SE Coef**		**t-value**	**p-value**
(Constant)	7.35	1.80		4.08	0.00
1. Discussion	1.037	0.45		2.33*	0.02
R^2 = 43.0 % **Dependent Variable: Performance in Algebra**					
Students' Performance in Algebra = 7.35 + 1.037 Discussion					

*Note: * means p-value < 0.05 (Highly Significant) at 0.05level*

CONCLUSION AND RECOMMENDATIONS

Though the Mathematics teachers highly apply the Spiral Progression Approach in the K-12 curriculum, the student's performance in Algebra is still poor. Thus, the said approach does not address the needs of the learners in the subject. The low performance in Algebra signifies the lack of retention and mastery of the students. The students' performance in Algebra may improve if the basic concepts are mastered starting lower grade levels. The traditional way of teaching, like lecture method/discussion, a common strategy used by Mathematics teachers, can contribute to the students' performance in Algebra.

Based on the findings and conclusion of the study, it is recommended that the school authorities provide training related to the Spiral Progression Approach. Mathematics teachers have to attend seminars and workshops related to implementing the approach in teaching to ensure that they do the right thing in the classroom. They may use interactive teaching strategies, aside from the commonly practiced strategy, and discussion to cater to the diverse learners' needs in mathematics. Teachers in Mathematics continue to use discussion and drills to strengthen the students' foundation of basic concepts in Algebra. Future researchers conduct researches focusing on the factors

that affect students' academic performance in Mathematics.

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