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Growth Mindset in Mathematics among Ninth-Grade Students via 5Ps Learning Model

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Abstract

This paper determined the effects of implementing the Prepare, Perform, Process, Ponder, and Practice (5Ps) learning model in teaching ninth-grade students' growth mindset in mathematics. This study employed the quasi-experimental design and mixed-method research approach to answer the research questions with 60 ninth-grade students at a public secondary high school in the Philippines. The study administered a growth mindset questionnaire, informal interviews, learning journals, and Focus Group Discussions (FGD) on identifying learning experiences and mindsets of the students. Findings presented that employing the 5Ps learning model significantly influences students' mindset in mathematics. Meanwhile, traditional teaching does not significantly affect students' mindset in mathematics. The implementation of the 5Ps learning model has a significant positive effect on students' growth mindset in mathematics. The results of the study are limited merely to the participants included in the study; similar research utilizing the 5Ps learning model to other learning areas with a larger sample is recommended for more generalizable results.

Keywords: growth mindset in mathematics, 5Ps learning model

Introduction

Mathematics education begins in early education. Wherein progressive schools designed play a crucial role as center of curriculum to teach students about mathematical concepts through firsthand experiences and at the same time possess fun while learning. Its objective is to develop students' cognitive ability to identify shapes, patterns, and connections and help them understand the significance of mathematical applications to the real world.

However, the study of Mazana, Montero, and Casmir (2019) revealed that students exhibit a positive attitude towards mathematics, but their attitude is less positive when the students move to higher levels of education. It displays that as the students' grade level increases, their interest and positive attitude towards mathematics decreases, and it becomes a challenging subject to learn and appreciate as students also develop fixed mindsets.

The PISA 2018 results in the growth mindset. In the Philippines, only 31% of the students possessed a growth mindset, resulting in a score of 353 and ranked 76th, the second lowest ranking among participating countries. The data demonstrates that the students of the countries with higher growth mindsets conducted better than those with a lower growth mindset (OECD, 2018). With a growth mindset, intelligence and "smartness" can be learnt, and that one believes that the brain is able to grow from exercise (Boaler, 2013). Dweck (2016) further asserted that with a growth mindset, students will be able to work hard, perform more effort, and learn effectively, displaying a desire for challenge and resilience of

the failure. It frequently occurs in mathematics learning. In contrast, students with a fixed mindset believe that they are intelligent or not wise in mathematics.

Park et al. (2016) unveiled that student with a growth mindset possessed higher mathematics achievement levels and that the more the teachers are focused on classroom performance outcomes (learning outcomes), the more students develop fixed mindsets over the school year. They emphasized that concentrating on learning outcomes is similar to saying – "you need to know this by the end of the year". These words orient students toward performance but away from "learning". It is in accordance with Blackwell et al. (2007) who explained that fixed mindsets are associated with lower achievement as supported by many conclusive pieces of evidence.

Researchers have revealed that mistakes are significant opportunities for learning and growth (Heinze & Reiss, 2007; Moser, Schroder, Heeter, Moran, & Lee (2011); Sarwadi & Shahrill`, 2014), however, students generally regard mistakes as indicators of low ability (fixed mindset). Every time students produce mistakes in mathematics; new synapses are generated in their brains. The students and teachers should value mistakes and should not consider them as learning failures but as learning achievements. If students produce pages of correct work, their brains are not growing, and development opportunities are missed. Conley (2014) employed a growth mindset to provide feedback to students and discovered that students become more persistent and confident in attempting situations and possess happier outlooks.

Madden (2015) revealed that the students with low mindset scores definitely own low homework percentages but many other students with higher mindset scores do too. The study concluded that encouraging a growth mindset in students generates improved learning, motivation to learn, and standardized test scores. Menanix (2015), in his study, discovered that growth mindset instruction coupled with challenging mathematics and opportunities for students to share authority over their learning was significantly more effective at constructively influencing students' mindsets and performance. The study emphasized that when students were deprived of the opportunity to experience a growth mindset by solely working on procedural routine mathematics, they did not possess authority to develop their ideas. Their mindsets did not shift in productive ways for engagement learning.

Furthermore, the study of Amant (2017) uncovered that teacher who scored exhibiting growth mindset characteristics employed activities with higher levels of rigor more frequently, which implies that they plan more rigorous activities or ask more rigorous questions. Boaler (2013) also asserted that teachers' practices that contribute to fixed mindset thinking among students should be addressed. The researcher indicates that further research is required to determine the significance of the idea. Thus, future studies are more able to examine closely the relationship between student's academic achievement and teacher's mindset and practices (Sun, 2015).

With the significance of developing a growth mindset among students and considering the change of students' learning preferences and instruction modes, to the objective of this study is to investigate the effects of utilizing the 5Ps learning model in teaching to the students' growth mindset in mathematics. The 5Ps learning model (5Ps) was developed based on the learning principles and theories provided in the k-12 curriculum guide of the Education Department of the Philippines, comprising the five key steps (*italicized*): *prepare, perform,*

process, *ponder*, and *practice*. It was employed as a teaching methodology in designing lesson plans which encompasses three parts: the introduction to the lesson, lesson proper, and closure. The 5Ps learning model was explicitly designed for blended learning and possessed the advantage of emphasizing differentiated instruction particularly along with the key steps *prepare* and *process.* It also administered the key step *ponder* to provide students the avenue to develop a positive attitude and growth mindset in mathematics through reflective learning. Lastly, it also employed differentiated assessment along *practice,* which believes that the students should be provided equal opportunity to be assessed for and of learning.

The study results will be beneficial to the teachers and students in communicating growth mindsets and as a basis for utilizing the 5Ps learning model that suits different learning modalities compared to an existing lesson design because the 5Ps learning model supported the students to develop a growth mindset.

Methods

Research Design

This study administered the quasi-experimental design. The intervention (instructional materials) on the use of 5Ps lesson design and 5Ps-designed activity guide by the teacher and students was employed in the experimental group to determine its effect on students' mindset in mathematics. The controlled group was implemented to compare results without utilizing the intervention; instead, it was taught applying the traditional method following the Activity, Analysis, Abstraction, & Application (4As) lesson design with the assistance of the ninth-grade learners manual. The experimental and controlled groups equally consisted of 30 selected ninth-grade students randomly (n=60) from a secondary education institution in the Philippines. The quantitative research method was utilized to examine students' scores in pre-test and post-test mindset questionnaires employing frequency counts to determine the number of students in mindsets scales, paired t-test Cohen’s d to identify the difference between the pre-test and post-test scores of students, and effect size of the intervention to the students' mindset in mathematics. The qualitative research method was employed to demonstrate the students' learning experiences by applying informal interviews, journals, and FGD. During the implementation, the students' learning experiences were identified through triangulation in qualitative educational research exhibiting the students' learning journal, interview of the learners, and FGD while they were under the intervention.

Research Procedure

Before the study was conducted, the researcher sought written informed consent from school heads, teachers, parents, and the students. Ethical considerations encompass as informing the parents and participants about the benefits of the study, duration of the students’ involvement, the collected data, confidentiality, and that they can withdraw anytime. The researcher demanded a cooperating teacher (mathematics teacher) to implement the intervention and teacher-observers (selected teachers) to assist in observing and recording the learning experiences of the students. A week before implementing the intervention, the cooperating teacher, the actual teacher, decided the classes as a controlled group and

experimental group through toss coin. After the pre-test on the mindset survey, the intervention was performed, comprised of six lessons in the 4th quarter of the ninth-grade curriculum. The same cooperating mathematics teacher was teaching the experimental group and controlled group.

The experimental group made use of the developed instructional materials. The cooperating teacher followed the 5Ps lesson design in which along *prepare (5Ps key steps italicized)*, the students prepared for lessons at home and along *perform,* the students conducted pre-class learning tasks. Along the *process,* there are three stations – a teacher's station, a collaborative station, and a computer station. The cooperating teacher grouped the students based on their learning needs, readiness, and interest, and guided them in rotating to the three stations. At the teacher's station, the students participated in the teacher's discussion, asked questions, verified concepts, received teacher feedback, and performed individualized assessments. At the collaborative stations, the students participated and worked collaboratively with their classmates to accomplish the assigned tasks. At the computer stations, the students reviewed the lecture videos to comprehend the concepts better (with their group) which were previously watched at home and discussed by the teacher. Along *ponder*, the students wrote their learning journals for reflective learning and proceeded to *practice*, in which they accomplished individual lesson assessments. In an instance that there were students who completed the lessons quickly or were performed in the stations, the teacher assigned them to help their classmates with their learning needs to avoid congestion in the stations. During the experiment implementation, some notable aspects were noted. One of the aspects is in terms of the student's interest to study the instructional materials, particularly during the key step *process*. Another aspect is the positive behavior in the intervention application reflected by their eagerness to learn the lessons, motivation to participate in the activities, and persistence to solve practice problems by the students, particularly in the process and practice of the 5Ps learning model key steps. Teacher-observers, teachers invited to observe, were present during the implementations.

In the controlled group, the teacher employed the traditional teaching method following the 4As lesson format and administered the Department of Education ninth-grade learners' manual. The students participated in the activity provided by the teacher at the beginning of each lesson. The teacher presented and discussed the lessons. After the discussions, the teacher equipped students with another activity associated with the topics, then analysis and abstraction, in which the teacher asked questions to solicit higher-order thinking among students. The students summarized the lesson learnt and completed the lesson assessments. After the implementation, the researcher administered a post-test mindset questionnaire, informal interviews, and FGD at each student's home, and the participant applied the minimum health protocol. The unique data gathered in the FGD was the students' statements displaying consensus about their significant learning experiences on the implementation of the 5Ps learning model, which became helpful in the thematic analysis.

Research Tool and Analysis

The effect of the intervention employing the 5Ps learning model on the students' mindset in mathematics was examined by utilizing the interview schedule by Dweck (2006)

questionnaire. In an interview schedule, the researcher inquired each student the question and checked their responses in the mindset questionnaire. The students responded, whether with a growth or fixed mindset, to each statement. A student with a growth mindset with some fixed ideas believed that his/her ability could be enhanced in mathematics, but still, he or she still possessed some fixed ideas that some of his or her mathematical ability could not be changed. On the other hand, a student with a fixed mindset believed that his/her ability in math could not be changed or improved; however, he/she had some ideas that his/her math ability could be changed in some ways. It encompassed 20 statements that reflect growth mindset (items 2, 3, 5, 6, 9, 10, 13, 15, 18 and 19) or fixed mindset (1, 4, 7, 8, 11, 12, 14, 16, 17, and 20). The statements were assigned with the following point values:

Table 1
Point Values of Mindset Questionnaire

Scale	Fixed mindset	Growth Mindset
Strongly Agree	0	3
Agree	1	2
Disagree	2	1
Strongly Disagree	3	0

To verify and obtain students' ideas not caught in the mindset questionnaire, informal interviews, learning journals, and FGD were conducted. Informal interviews were performed because the setting of the interviews was outside the students' homes, and they were instructed to share their learning experiences. After the interviews, the neighboring students were collected for an FGD, which also aims to corroborate their ideas and responses. Learning journals became the source of additional information which also helped in analyzing results.

Results and Discussion

Table 2 presents the summary of the pre-test and post-test frequency counts of the students' mindsets in the experimental and controlled group. There were eight students in the experimental group who possessed a fixed mindset with some growth ideas, while 20 students owned a growth mindset with some fixed ideas, and two students who possessed a strong growth mindset in the pre-test. During the post-test, eighteen (18) students owned a growth mindset, and twelve (12) students developed a strong growth mindset.

Table 2
Summary of the Pretest and Posttest Frequency Counts of Two Groups on Growth Mindset in Mathematics

Mindsets in Mathematics	Pretest		Posttest	
	Experimental Group	Controlled Group	Experimental Group	Controlled Group
Fixed mindset	0	0	0	0
Fixed mindset with some growth ideas	8	3	0	6
Growth mindset with some fixed ideas	20	24	18	21
Robust growth mindset	2	3	12	3
Total	30	30	30	30

It can be identified that both the students in the experimental and controlled group possessed fixed mindset with some growth ideas in the pre-test, in the post-test, the students of the experimental group developed a growth mindset which increased the numbers of students with robust growth mindset from two to 12 leaving no students with fixed mindsets. However, in the post-test of the controlled group, three students were included in the students with fixed mindsets with some growth ideas, resulting in the increase of students with fixed mindsets.

More specifically, 10 students who were placed into group of students with strong growth mindset during post-test in the experimental group, 9 of them were from Growth Mindset with some fixed ideas, and one of whom originated from fixed mindset with some growth ideas to possessing a strong growth mindset. In contrast, the three students in the controlled who were involved in to possess a fixed mindset with growth ideas in the post-test had a growth mindset with some fixed ideas in the pre-test.

The results revealed that students in the experimental group demonstrated a comprehension of growth mindset role in their learning. Considering the student's statement coming from having a fixed mindset with some growth ideas to a robust growth mindset, she stated in an informal interview:

> *"Dakula po ang naitabang sakuya kang* instructional materials *na gamit ang* 5Ps learning model *ta dahil* guided *na po ako sa gigibuhon ko sa harong sa pagadal ko, mas nakakaprepare ako sa mga* lesson *saka sa tabang kang mga kaklase ko narealize ko na maiimprove man talaga ang kakayanan ko sa math kapag nagaadal ako tapos naghihigos sa pagparticipate sa mga* activities (The instructional materials that feature the implementation of 5Ps learning model helped me a lot because I am guided on what I am going to apply at home in studying. I can prepare better for the lessons and with the help of my classmates, I realized that my math ability could really be improved if I am studying and being hardworking in participating the activities)*".*

Based on the student's statements as previously discussed in their learning experiences, the student's growth mindset development could possibly be attributed to the implementation of the instructional materials, which promotes growth mindset through self-learning that emphasizes efforts in learning mathematics.

In the controlled group, the increase of students having fixed mindset could be attributed to the pressure which the students may experience at a provided time and might be having lesser motivation for self-learning because the teacher reluctantly performed with the classroom discussion only, which also resulted to less one-on-one feedbacking.

To determine if the implementation of the instructional materials along the experimental group impacts students' pre-test and post-test on mindset in mathematics, the mindset scores for each component were subjected to t-test and Cohen's index (Table 3).

Table 3
Pre-test and Post-test mindset scores t-test and Cohen's Index on Mindset in Mathematics of the Two Groups

Groups	t-value	p-value	Interpretation	Cohen's Index (d)	Interpretation
Experimental	5.058	0.000	Significant	0.92	large
Controlled	-1.264	0.216	Not Significant	-	-

The mindset scores of the pre-test and post-test of the experimental group were highly significant, with a t-value of 5.058 and p-value of 0.000 examined at a 95% confidence level. Analysis of the effect employing Cohen's index presented a large effect with d=0.92. On the other hand, the pre-test and post-test of the controlled group were not significant, with a t-value of -1.264 and a p-value of 0.216. It is indicated that the computed effect size of this skill is negative. A negative size implies that the effect decreases the mindset scores. To determine if there is a significant difference in the mindset scores of the students between the experimental and controlled groups, a t-test for independent sample was administered. The results revealed a significant difference between mindset scores of the two groups displayed by the t-value of 4.395 and p-value of 0.000, which was significant at a 95% confidence level.

The findings from the study presented that the implementation of intervention significantly affects students' mindset in mathematics, while traditional teaching does not significantly affect students' mindset in mathematics. It implies that the conduct of intervention enhanced students' mindset in mathematics in the experimental group. On the other hand, other factors may affect students' mindset during the implementation of the study due to the delayed post-test of the mindset survey caused by health restrictions. However, based on the data gathered by the study, it was strongly possible that the growth mindset development and robust growth mindset among students in the experimental group could be attributed to the application of the instructional materials.

In the 5Ps key step, *perform*, the students were trained not to be afraid to attempt things and produce wrong answers which results the students are reluctant to perform harder in learning. Along the *process*, the station rotation model encouraged students to learn autonomously and that their knowledge will grow through study and engaged in the activities through stations. At the same time, along *ponder*, the students were expected to reflect on their learning growth and opportunities. Finally, along with the *practice*, the students' patience, perseverance, diligence, eagerness, and other traits were reinforced because they require to strive harder to learn and pass the lesson examination and eventually developed a growth mindset with the assistance of the teacher's encouragement and growth mindset messages. With growth mindsets, students are expected to be more motivated to learn, work harder, are less discouraged by difficulty, and employ more effective strategies for learning.

The result in the controlled group was associated with the finding of Menanix (2015) which revealed that when students were deprived of the opportunity to experience a growth mindset by only working on procedural routine mathematics in which they did not possess

authority to present with their ideas, their mindsets did not shift in ways that were productive for engagement or learning.

In the study of Boaler (2013), she asserted that teachers and schools are better to constantly communicate messages to students about their ability and learning through instructional and classroom practices (i.e., instructional materials). She then argued that if one possesses a true commitment to the communication and teaching of a growth mindset, a thorough examination of all aspects of teaching is necessary. She emphasized that mindset messages were communicated through questions asked, task, grading and feedback, mistakes, grouping, and norm-setting.

To identify students' learning experiences and mindsets, informal interviews, learning journals, and focus group discussions were conducted. After thematic analysis, the following themes emerged:

Students' Attitude and Mindset about Mathematics Affected Their Learning

Since the 5Ps learning model corroborated mind setting, the students understand the value of attempting and failing to succeed. For this reason, the students comfortably participated during the activities and discussion without being afraid to fail. Furthermore, the students become more motivated to try and learn. In an informal interview, one of the students who developed a robust growth mindset at the end of the quarter shared as follows:

> *"In my own belief, the students who get smarter understand the topic with more efforts to get the higher achievement. Meaning to say, if you exert an effort to perform things to enhance your knowledge, your life will change, but if you do not do something, you will never find relief in life (Student 18)".*

In an informal interview, a student (student 20) shared his experience in trying his best to study at home and at school:

> *"Dati po sir dae ako nakaka-adal sa harong pero kang naintindihan ko ang* importance *kang pag-adal lalo na sa math, nagaadal na ako sir. Nagngagalas na ngani sakuya si mama ta nag-aadal na ako ngunian. Nagcocompute ako sir sa harong, uni ang notebook ko sir oh, si mga pigkorompute ko* (Before I could not study at home, but when I understood the importance of studying, particularly in math, I am now studying. My mom is wondering because I am now studying. I do computations at home, sir, here is my notebook, the ones that I have been computed)".

The students' statements corroborated the argument of Dweck (2006) that better learning occurs when students comprehend the advantage of trying, failure, and success during the learning process.

Based on the students' statements, the learning process by implementing the 5Ps learning model had upheld students understand the significance of efforts, trying, experiencing failure and success, and untiring "practice" to master the mathematical concepts and possess a full grasp of the learning competences. These lead the students to own a positive attitude on

learning mathematics and a growth mindset affecting their learning performances. This learning principle confirmed one of the learning principles on Mathematics Framework for Philippine Basic Education, which similarly explained *"*Students' attitudes and beliefs about mathematics affect their learning*"* (Science Education Institute - Department of Science and Technology [SEI-DOST] & Philippine Council of Mathematics Teacher Education, Inc. [MATHTED], 2011).

Mathematics Teaching Requires Positive Attitude and Growth Mindset to Perform More Teaching-Learning Efforts.

Boaler (2013) explained that mindset involves "knowing that math is a subject of growth and [the math user's] role is to learn and think about new ideas." She also stated that "Many teach mathematics with their fear of the subject."

A teacher's mindset manipulates many aspects of his/her teaching and students' learning, encompassing the learning tasks he provides, how classroom discourse is orchestrated, his response to mistakes, and the assessment practices he employs. When teachers learn about the research behind mathematical mindsets and identify their own current mindsets, they are able to reset their approach to learning and teaching math. They will believe that all students are able to understand and enjoy it and set them all up for success (Chapman & Mitchell, 2018).

With the assistance of instructional materials, the teacher was able to communicate a positive attitude and growth mindset, which was tremendously advantageous in providing an equal learning opportunity for all because the teacher believed that everybody could learn mathematics and that the students just require to possess the right attitude and mindset.

It also substantiated the teaching principle of SEI-DOST and MATHTED (2011) in Mathematics Framework for Philippine Basic Education that "Mathematics can never be learnt in an instant, but rather requires lots of work and the right attitude*."* It indicates that teaching mathematics by communicating a positive attitude and growth mindset in mathematics encourages students to conduct more effort into learning. The students are also able to understand the significance of trying, failure, and success during the learning process that eventually will lead to successful enhanced mathematics learning.

Overcoming Challenges in Studying

There are challenges that the students experienced during the implementation of the lessons and activities. One of the challenges was on studying and learning autonomously. From an informal interview, student 10 commented on how the instructional materials helped her, and she stated,

> *"Kaya ko nang maintindihan ang* lesson *kahit hindi ito itinuturo dahil nagse-* self-study *ako na dati na di ko magawa-gawa* (I can now understand the lesson even if not taught because I do self-study that I could never perform before)".

Student 11 also argued, *"I develop myself being always in the mood to whatever task it has, to easily understand."*

The statement of student 10 obviously proves that the student's study habit has been changed for a good while student 11 adjusts her mood (attitude in learning mathematics) so that she is able to understand and learn the lessons. Student 30 also experienced difficulties in performing self-study. However, she also managed to continue studying at home. She reflected, "*I experienced how hard to study by myself because there's no one to teach me, so I needed to study it and see that my answer was correct when my teacher checked the prepare*."

The students' journal entries also present evidence that they have overcome challenges in studying while answering the question, which is does the use of the instructional materials helped you learn? The students answered:

*Student 4: "*Yes because *noong gumamit ako ng* activity guide, *nadagdagan yung kaalaman ko at lalo ko pang tinibayan para marami pa akong maencountered* (Yes because when I used the activity guide, my knowledge increased and so I conducted more effort so that I might learn more)"

*Student 9: "*Yes, because it helps students in learning. It has self-assessment to comprehend the student's knowledge employing their own understanding in the lesson. It helps to study hard.*"*

*Student 20: "*Yes, *dahil mas madali itong matutunan at dahil nagkukusa kami para matutunan* and *isang bagay na walang nag-gaguide* (Yes, because it was easy to learn, and we initiated so we can learn things even nobody is guiding)".

Student 22: Yes, *dahil nalalaman ko kung ano-ano ang pagsunod sunod para malaman mo ang tamang sagot at natulungan ako nito para mapalago ang aking kaisipan. Nagustuhan ko ang paggamit ng* activity guide *dahil mas madali na pag-aaralan kahit nasa bahay lang ako* (Yes, because I learnt the steps and corrected answer, hence, it helped me to improve my mind. I liked the application of the activity guide because it was easy to be studied, even I was just at home)".

*Student 30: "*Yes, because of that, I learnt on how to study by myself.*"*

On a focus group discussion, the students approved that one of their significant learning experiences was overcoming challenges to study. The students' statements in studying indicate that the students also encountered challenges and were able to study autonomously, resulting in a more meaningful mathematics learning experience.

In general, the study results recommended the necessity for instructional materials, learning model, teaching approach, and methods that communicate growth mindset messages. Findings of the study propose that the application of the 5Ps learning model provided the students with necessary learning experiences that develop a growth mindset in mathematics. However, the study is limited solely to the participants included in the study; a larger sample is required for more generalizable results.

Conclusion

The implementation of the 5Ps learning model in teaching mathematics significantly affects students' mindset in mathematics, while conventional teaching does not significantly affect students' mindset in mathematics based on the findings of this study. Specifically, the application of the 5Ps learning model possesses a significant large effect on enhancing students' growth mindset in mathematics. The students manifest a growth mindset in mathematics by presenting courage in overcoming challenges in learning. There was an emphasis on the teaching and learning efforts that require the teacher's positive attitude and growth mindset in mathematics. Researchers could examine using the 5Ps learning model in teaching other learning areas and with larger samples to develop students' growth mindset.

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