

# Algebraic Skills and Academic Achievement in Mathematics of Grade 7 Students in a Philippine Chinese School

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**ABSTRACT.** Mathematics achievement is an essential part of a student's academic achievement. However, teaching and learning mathematics is a significant concern in education, especially in distance learning. This paper described the algebraic skill level and academic achievement in mathematics of Grade 7 students of a Chinese high school. Also, it determined the difference in their level of algebraic skills according to learning modality. It determined whether a significant relationship exists between algebraic skills and academic achievement. Using the researcher-made questionnaire and students' secondary data (average grade from first quarter to fourth quarter in Mathematics), mean, standard deviation, Kruskal-Wallis, and Spearman's rho were used. Results reveal that the level of algebraic skills were average while academic achievement levels were approaching proficiency. No significant difference was found in their algebraic skills level according to learning modality. However, significant low

relationship was found between the students' level of algebraic skills and academic achievement.

## 1.0. Introduction

Mathematics is a field that involves a lot of knowledge and skills which individuals will need in their social life. Mathematics achievement is a necessary component of academic success in the modern era. It is essential for success in a variety of fields (Pandey, 2017). However, many students fall behind in mathematical achievement and lose interest in the subject, ultimately giving up learning mathematics (Yeh et al., 2019). In the most recent National Assessment of Educational Progress (NAEP) in mathematics, conducted in 2019 for grades 4, 8, and 12, for eighth-grade students, the 2019 mathematics score (282) was lower than the 2017 score (283) but higher than the score in 1990 score (263). Meanwhile, the students in 12<sup>th</sup> – grade scored lower in mathematics in 2015 (152) than in 2013 (153) (Hussar et al., 2020). Recently, because of the pandemic, virtual learning transitions have affected students' learning, particularly math. In 2020 – 2021, students could learn half or up to a full year less math than they would learn in a usual year (Sawchuk & Sparks, 2020). Furthermore, most teachers believe that students are less prepared for grade-level work than normal and are making less progress in math than before the pandemic. (Loewus, 2021).

Distance learning is still a polemic in the community (Ramadhan, 2021). However, according to Ahn and Edwin (2018), a better understanding of how students learn mathematics coupled with the successful use of mathematical e-learning will help the students learn mathematics more practically and make the subject more interesting. For instance, in distance learning education, the abstract nature of mathematics was not adequately discussed in the course material. The lack of accessible and supportive tutors for the subject made understanding abstract mathematics much more difficult (Reju & Jita, 2018). In addition, the thought process in learning mathematics cannot be obtained in distance learning (Widada et al., 2019).

In the Philippines, teaching and learning mathematics is a significant concern in any education system. In the 2016-2017 Global Competitiveness Report, the Philippines' mathematics performance needs to improve, which rated the Philippines 79th out of 138 nations in terms of Science and Math Education quality. As evidenced by the Department of Education (DepEd) report in the National Achievement Test (NAT) that the result for high school was low proficiency level, especially in Science and Math (Gonzales, 2019). The Trends have confirmed these results in International Mathematics and Science 2019 shows that the Philippines scored significantly lower than any other country in math



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and science assessment (Tadalan, 2021). The struggles in learning mathematics continue, especially during this new learning trend in pandemic times. The lack of in-person classes has significant effects, especially in learning mathematics. According to Cortez (2020), 76% of the students learned more when watching video tutorials. However, it is noticeable that 90% of the students still need validation from their math teachers in studying mathematics. The pandemic has exposed the gaps in the Philippine education system, and these gaps are evident in erroneous learning modules for distance learning (Magsambol, 2020).

In a Chinese high school in the division of Bacolod City, the implementation of distance learning significantly impacts students' performance, especially in mathematics. During the first quarter progress report, 35% of the grade 7 students could not comply completely with the assigned tasks. It is a challenge for a school to make the students comply with the tasks completely. This sudden pivot to distance learning has caused uncertainty to some mathematics educators regarding how the students will adapt and absorb the basic concepts in algebra. According to Garcia and Weiss (2020), students spent more time online doing social activities, surfing or seeking information, playing games, or checking email during the pandemic. Furthermore, students spend less time on educational activities, like schoolwork or talking with other students or teachers, and students are overwhelmed and overworked under the new way of learning (Adonis, 2020).

Several pieces of research looked into the challenges that junior high school students had with algebra (Sugiarti & Retnawati, 2019; Jupri, 2016; Pramesti & Retnawati, 2019). Some research focused on secondary school students' algebraic skills in grade seven (Kaya et al., 2016; Erdem & Aktas, 2018; Lim, 2015); however, these studies did not provide enough evidence to support the students' algebraic skills in distance learning education.

Hence, the study assessed the algebraic skills of Grade 7 students in a Chinese high school in the areas of signed numbers, arithmetic, fractions, exponents, and factors, as well as their academic achievement in Mathematics. The results of this study served as a basis for making instructional materials of the researcher to enhance the students' algebraic skills and the school's curriculum.

## **2.0. Framework of the Study**

The study theorizes that adequate algebraic skills in signed numbers, arithmetic, fractions, exponents, and factors positively influence academic achievement according to the Cognitivist and Constructivist Learning Theories; hence, this study is anchored on the Theories of Cognitivism and Constructivism.

Piaget's cognitivist theory (1972), cited in Dennis (2020), perceived human cognition as a constant struggle of a very complex organism to adapt and survive in a very complex environment. In addition, the development of human intellect proceeds through adaptation and organization. The organization indicates that all cognitive structures are interconnected, and new must be incorporated into the existing system (Yelich Biniecki & Conceição, 2000).

Furthermore, adaptation is an organism's ability to cope with the environment to survive and is composed of two terms: assimilation and accommodation. Assimilation is getting a good grasp or making sense of present experience through existing knowledge, while accommodation occurs when new knowledge is too complex to be absorbed into the old structure. As a result, cognitive structures change in response to new experiences.

Likewise, the algebraic skill is considered a gateway to many scientific and technological fields; thus, Piaget's cognitivist theory is exceedingly relevant. Appropriate for the student to become proficient in algebra, a meaningful connection between the prior and present knowledge should be crafted.

This study was aligned correspondingly to Bruner's constructivist theory (1960) cited in Mcleod (2019), which proposed that the idea of a spiral curriculum where a more complex idea can be taught at a simplified level first and a more complex level later.

Moreover, according to Zuliana et al., 2019, the framework of Bruner's constructivist theory is a general basis for instruction in which the study of cognition is related. The theory emphasizes three principles: readiness, in which instruction must be concerned with the experiences and contexts that motivate students to learn; spiral organization, in which instruction must be designed in such a way that students can absorb it readily; and going beyond the information, wherein instruction must be designed to facilitate extrapolation and or fill in the gaps (Stapleton & Stefaniak, 2019).

In relation to this study, Bruner's constructivist theory implies that students' readiness, spiral

organization, and going beyond the information will help students develop and enhance their algebraic skills and mathematical achievement. Through spiraling, students learn the concept gradually and repeatedly. Also, reinforcing the concepts presented to the students improves their level of knowledge and skills in Algebra.

The conceptual paradigm of the study involves the Grade 7 students of a Chinese high school in Bacolod City. The respondents were grouped according to learning modality: synchronous, asynchronous, and learning packet. The independent variable, algebraic skills (signed numbers, arithmetic, fractions, exponents, and factors), was linked to the dependent variable, academic achievement in mathematics. The results of these data were interpreted and used as the basis for making instructional material for the grade seven students of a Chinese high school.

### 3.0. Methods

The present study used the descriptive research design to determine the level of algebraic skills in the areas of signed numbers, arithmetic, fractions, exponents, and factors and academic achievement in mathematics of the Grade 7 students of a Chinese high school. Comparative analysis was used through Kruskal-Wallis to determine the difference in the level of algebraic skills of Grade 7 students when grouped according to learning modality: synchronous, asynchronous, and learning packet (the teachers prepare instructional materials, weekly study guides, and tasks and to be accomplished by the learner for the week). Moreover, correlational analysis was used through Spearman's Rho correlation to determine the significant relationship between algebraic skills and academic achievement in mathematics.

The respondents were 94 grade 7 students out of the 121 enrolled in a Chinese high school during the school year 2020 – 2021. Stratified random sampling was applied wherein the whole population was divided into strata. In the study, the strata were the learning modalities, and the lottery technique was used to select the respondents: Synchronous (70 or 74.5%), Asynchronous (12 or 12.8%), Learning packet (12 or 12.8%).

The 40 items researcher-made questionnaire was used to determine the level of algebraic skills in the areas of signed numbers, arithmetic, fractions, exponents, and factors based on the Most Essential Learning Competencies (MELC) of the Department of Education for the school year 2020-2021. It was validated using Lawshe's content validity ratio (greater than or equal to 0.79), reliability tested ( $KR_{20} = 0.886$ ). The level of academic achievement was determined using the respondents' secondary data (average grade from the first quarter to the fourth quarter in Mathematics). The statistician was consulted in the scoring range and interpretation to ensure that the data covered the problems of this study.

To gather the data, the researcher sought the approval of the school principal of a Chinese high school to conduct the survey and obtained the students' average grades in mathematics from first grading to fourth grading. The researcher-made test, the Algebraic Skills Test, was conducted online through the Learning Management System of a Chinese high school. The participants were given one attempt with a time limit of 50 minutes to answer the test. After the data collection process, these data were encoded and analyzed using statistical tools with statistical software.

To assure the study's ethical soundness, the researcher addressed the general ethical principles of respect for persons, beneficence, and justice. The researcher obtained informed consent from the parents of grade 7 students, ensured their voluntary involvement, and advised them of their right to withdraw at any moment throughout the study if they felt uncomfortable or inconvenient. The researcher assured the respondents that the data they provided would be kept completely confidential and that their identity as respondents would remain anonymous.

### 4.0. Results and Discussion

#### Level of algebraic skills

Table 1 presents data on the level of algebraic skills based on the researcher-made questionnaires in the areas of signed numbers, arithmetic, fractions, exponents, and factors. As presented in the table, the level of algebraic skills of the students is "average" ( $M=22.68$ ,  $SD=9.60$ ). Moreover, students have an "average" level of algebraic skills in the areas of signed numbers ( $M=3.30$ ,  $SD=1.62$ ), fractions ( $M=7.11$ ,  $SD=3.11$ ), and factors ( $M=4.93$ ,  $SD=2.72$ ). Meanwhile, in the areas of arithmetic ( $M=3.24$ ,  $SD=1.43$ ) and exponent ( $M=4.11$ ,  $SD=2.22$ ), students have a "high" level of algebraic skills.

Arithmetic and exponents scored a high interpretation among the five areas, while the remaining areas got an average interpretation. This concludes that the students have developed the fundamental algebraic skills with little guidance from the teacher and/or assistance from peers to apply these understanding. Moreover, none of the areas was classified as low-level skills. This shows that students in a Chinese high school have developed the fundamental skills needed for algebra regardless of the new trend of learning brought by the pandemic.

This can be paralleled to research results revealed by Macion (2015) that algebraic skills of the grade 7 students, which was determined through algebraic performance tests, were average. However, this study is in discordance with Angriani et al. (2020), indicating that the Grade 7 students' algebraic literacy skills are low.

**Table 1.** Level of Algebraic Skills

Variables	M	SD	Interpretation
Signed Numbers	3.30	1.62	Average
Arithmetic	3.24	1.43	High
Fractions	7.11	3.11	Average
Exponents	4.11	2.22	High
Factors	4.93	2.72	Average
As a whole	22.68	9.60	Average

**Level of academic achievement in Mathematics**

Table 2 presents the level of academic achievement in mathematics based on the average grade of the students in mathematics from first to fourth grading. As shown in the table, the level of academic achievement in mathematics of the Grade 7 students is "approaching proficient" (M=84.69, SD = 4.96). This implies that the students have established fundamental knowledge, abilities, and core understandings and can transfer these understandings through authentic performance tasks with little help from the teacher and/or with little aid from peers.

The result implies that the students of a Chinese high school perform well academically in mathematics. The student's academic achievement in mathematics may be due to the mastery of the concepts needed in learning algebra. Furthermore, it may be due to the high commitment of the teachers in this school, and the Chinese private teaching has lifted to a better quality of classroom instruction. However, the result also shows that they still have a chance to improve their academic achievement from approaching proficient to proficient. The strongest possibility in improving students' academic performance in mathematics is to implement multiple changes in the teaching and learning activities affecting the daily life of the students. Thus, gearing up the instructional materials and strategies in teaching may bring students' academic achievement to a higher level of achievement.

The result is parallel to the claim of Andamon and Tan (2018) that the Grade 7 students' performance in mathematics belongs to the range of approaching proficiency, which implies they have a moderate or average level of learning. Also, Simbulas (2014) revealed that students' level of academic performance in algebra is satisfactory.

**Table 2.** Level of Academic Achievement in Mathematics

Variables	M	SD	Interpretation
Academic Achievement	84.69	4.96	Approaching proficiency

**Difference in the level of algebraic skills of Grade 7 students**

Employing the Kruskal – Wallis to analyze the data which are not normal, Table 3 presents the difference in the level of algebraic skills of grade 7 students. As reflected in the table, there is no significant difference in the level of algebraic skills of Grade 7 students in the areas of signed numbers [ $X^2(2)=0.865$ ,  $p=0.649$ ], arithmetic [ $X^2(2)=5.607$ ,  $p=0.061$ ], fractions [ $X^2(2)=0.180$ ,  $p=0.913$ ], factors [ $X^2(2)=0.378$ ,  $p=0.828$ ], and exponents [ $X^2(2)=0.225$ ,  $p=0.894$ ] when they are grouped according to learning modality at 0.05 level of significance. From the result, the null hypothesis was, therefore, not rejected.

**Table 3.** Difference in the Level of Algebraic Skills of Grade 7 Students

Areas	Learning Modality	N	Mean Rank	$\chi^2$	df	p
Signed Numbers	Synchronous	70	46.59	0.865	2	0.649
	Asynchronous	12	46.13			
	Learning packet	12	54.21			
Arithmetic	Synchronous	70	46.79	5.607	2	0.061
	Asynchronous	12	36.96			
	Learning packet	12	62.21			
Fractions	Synchronous	70	46.86	0.180	2	0.913
	Asynchronous	12	48.46			
	Learning packet	12	50.29			
Exponents	Synchronous	70	46.89	0.225	2	0.894
	Asynchronous	12	50.88			
	Learning packet	12	47.71			
Factors	Synchronous	70	47.66	0.378	2	0.828
	Asynchronous	12	43.67			
	Learning packet	12	50.38			

Note:  $p > 0.05$  not significant

It implies that regardless of learning modality, students perform equally when it comes to the level of algebraic skills in the areas of signed numbers, arithmetic, fractions, exponent, and factors. This also suggests that students are comfortable with the different modalities of learning. Moreover, the study results show that students in a Chinese high school easily grasped the sudden change of learning modality, and they were flexible learners.

The result of this study adheres to the claim of Berry (2017) that there is no difference between synchronous and asynchronous formats in students' perceptions of the Algebra 1 course. However, the result of this study negates the claims of Adamiak and Sauls (2017) that online intervention can affect students' success rates, of Ramadhan (2021) that students who used distance learning had better mathematical learning results than students who used conventional direct methods, and of Murphy et al. (2016) that flipped class (students watched short video lectures made by the instructor and complete a short online quiz before each class attendance) performed better in overall content in linear algebra with a 21% improvement in the median final exam grade. Also, the notion stated in the study of Melad (2016) and Torrefranca (2017) that the students' algebraic skills can be promoted effectively by students themselves using well-designed instructional modules is contradictory to the result of this study.

**Relationship between algebraic skills and academic achievement in Mathematics**

Employing Spearman's Rho, Table 4 presents the computed data on the test of the relationship between the algebraic skills and academic achievement in mathematics of the Grade 7 students. The result shows that the students' algebraic skills have a positively low correlation with academic achievement in mathematics [ $r_{sr}(92) = 0.471, p = 0.000$ ] at a 0.05 level of significance. Hence, the null hypothesis is rejected.

This result implies that the algebraic skills of the grade 7 students have a significant bearing on their academic achievement in mathematics. Therefore, a lack of mastery of their algebraic skills may lead to poor academic performance. In contrast, the amplitude of these skills has positive outcomes such as good grades and better performance in mathematics, especially in algebra. Since algebraic skills significantly affect the student's academic achievement in mathematics, there is a hope that improving strategies and instructions in teaching algebra to the students will bring qualitative changes in their academic achievement in mathematics.

The result of this study is in accordance with the notion of the study of Bayat and Maemar (2016) that there is a positive, moderate, and significant relationship between algebra performance and mathematical achievement. Also, Preciado (2016) noted that the single most effective indicator of future mathematical proficiency is knowledge of fractions, which is one of the areas of the algebraic skills in this study.

**Table 4.** Relationship between Algebraic Skills and Academic Achievement in Mathematics

Variables	$r_{sr}$	df	p
Algebraic Skills *	0.471**	92	0.000
Academic Achievement			

Note:  $p < 0.05$  significant

Overall, the study's findings signified that cognitivist theory was reflected in the algebraic skills where students got an average level because of mastery in five areas: signed numbers, arithmetic, fractions, exponents, and factors. Students got a high interpretation in arithmetic and exponents and an average interpretation in the remaining areas. The acquisition of knowledge or mastery of skills in the areas of signed numbers, arithmetic, fractions, exponents, and factors leads to a higher level of algebraic skills of the students. A meaningful connection of prior knowledge is very helpful in learning algebra for Grade 7 students. The level of algebraic skills of the students in a Chinese high school can still be geared up to a higher level by enhancing the teacher's instruction and materials needed during distance learning education.

The constructivist theory was observed in the study where students have approaching proficiency in their academic achievement in mathematics since they got an average level of algebraic skills. Students' acquisition of algebraic skills brought them to have good grades or good academic achievement in mathematics. This means that in order for students to have high academic achievement, mastery of the prior knowledge on the basic skills must be considered. Teachers may also make use of the teaching approach suggested by the constructivist theory, which is spiraling. Teaching the basics is very important before teaching complex. In this study, constructions of the students' learning in the basic areas of algebra (signed numbers, arithmetic, fractions, exponents, and factors) will bring the students to a higher level of algebraic skills, which in the end will also bring the students to quality and a higher level of academic achievement in mathematics.

## 5.0. Conclusion

The average level of algebraic skills of the Grade 7 students of a Chinese high school implies that students acquired knowledge of signed numbers, arithmetic, fractions, exponents, and factors and with little guidance from the teacher and/or assistance from peers to apply these understanding.

Regardless of the learning modality of the students, which are synchronous, asynchronous, and learning packets, these learning modalities are not factors in developing the algebraic skills of the students. Therefore, it implies that students could cope with different challenges brought by the new trend of learning. Moreover, the students' algebraic skills have a significant bearing on students' academic achievements in mathematics. This means that lack of mastery in algebra or low level of algebraic skills may lead to poor academic achievement in mathematics, while adequate knowledge and skills in algebra or acquiring high-level skills in algebra yields good grades or academic achievements in mathematics.

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