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The Effect of Retention Interval Over a Three Year Period on the Elementary Algebra Performance of High School Students

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Abstract

This study provided empirical evidence on the effect of retention interval on the student's performance in elementary algebra mathematics among High School Students. The subjects were the grade 8, grade 9 and grade 10 students of the University Laboratory School, University of Southern Mindanao, Philippines for school year 2012-2013 who took their elementary algebra in their grade 7 in the school under the same instructor. The results of the respondents' grade 7 exam taken prior to the conduct of study was the initial test were used for comparison to their present retest result. Results revealed that there was a highly significant difference between the achievement during and after instruction of the participants according to their year level. Gain in performance across retention interval group were highly significant. Retention interval supplemented enough time for the students to practice what was previously learned as they engaged to new but highly related mathematics courses. Further, exposure to different academic trials facilitated development of expertise and mathematical academic maturity on the students contributed to the increase in gain with increasing retention interval. Thus, retention interval was found to be advantageous in mathematics if practiced and elaborated.

Keywords: achievement; after instruction; during instruction; gain score; test; retest; retention interval.

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1. Introduction

Mathematics is a cognitively challenging topic in school. It does not only require analytical skills but one should possess good memory in the concepts, formula and the definition of terms. As a language of Science, mathematics is an important components of the school curriculum in every country. They are seen as integral components of every student's educational program. As the role and impact of technology continue to increase in society and in the workplace, the concepts, processes, and skills of science and mathematics are likely to become even more highly valued and the importance of these subjects in school curricula to become even greater [1]. Through highly abstract symbol operations, students acquire skills such as conceptual understanding, procedural fluency, strategic competence and adaptive reasoning that serve them best in undertaking most career pathways. However, besides all these promising advantages of mathematics, the Philippines and the Filipino students in particular are still in the verge of an appalling academic performance on the subject. [2] Mentioned in their paper an alarming observation among Filipino students revealed that though Filipinos excelled in knowledge acquisition but fare considerably low in lessons that requires higher order thinking skills. Further they said that it cannot be denied that most of the prospective tertiary students are unprepared for learning mathematics with such low understanding level and poor achievements in Mathematics caused a great concern. This observation corroborates poor mathematical performance among Filipino pupils [1]. This poor performance does not only reflect and pose a problem to the teachers and students but to the entire Philippine educational system. Studies have been undertaken to assess the contributory factors to the problem, and such case includes the teacher and his or her mode of instruction; the student and his innate capabilities, self-concept and activities; and the classroom environment and curriculum. However, one cannot get away from the fact that overcoming mathematical difficulties requires good memory and recall on mathematical formula and procedures, thus one can simply assume that one cause of the matter relies upon memory and memory processing. In addition, the studies of [3,4] emphasized and substantiated the researcher's observations that problems in memory retention add to the effect, in which, working memory plays a significant role. More importantly, throughout arithmetic and math, even simple counting and estimation [5], algebra and complex problem solving [6] pervasively rely on good memory which was found to be a major predictor of the students' performance on number-based tasks [7]. These related studies emphasized that retention interval plays a significant role in the performance on some specific topics for basic mathematics. Furthermore, mathematics education in schools of all levels is arranged in such a way that each subject is highly related to the next making previously learned information rehearsed and integrated to new information in each year level. Thus, it might be tempting to assume that students can retain information across longer period of testing delay. Therefore, this study focused on the effect of retention interval to mathematics performance of students across different year levels. If it exists, then mathematics performance is strengthened over time and added experience. This in particular, to know first, if a significant difference exists between the achievement during and after instruction of the subjects according to their year level. Second, if a significant difference exists between the students' mathematics performance gained across different retention intervals. Lastly, to descriptively compare the average gains scores and retest scores over different retention intervals. The results of this study would be helpful in providing teachers a perspective on how students learn and retain information about mathematical concepts and procedures. It may give them ideas on appropriate actions to facilitate better retention of information. As centers and clients of educational endeavors, results can benefit students to have a better understanding on their mental processes, thereby, giving them ideas to what actions can be done to improve their performance and retain more information. Further, the results of this study may be used by school administrators in their decision-making concerning the arrangement of subjects in the school curriculum which should always be designed for the improvement of human capacity. This study also may provide insights for further research investigations of similar nature and will provide a new perspective and trends in educational researches.

1.1 Assumptions, Scope and Limitations of the Study

The study assumes that the subjects' mathematical performance is normally distributed across different retention intervals so as to satisfy the requirement for the use of it statistical procedures. The study only considers the responses of the retest of the grade 8, grade 9, and grade 10 students in the University Laboratory School of the University of Southern Mindanao, Kabacan, Cotabato, Philippines in the period of the school year 2012-2013 only assuming they have been given the same exam on their pre-test during their grade 7. These heterogeneous groups composed three year levels that each corresponds to the length of retention interval during that time. The subjects studied Advanced Algebra and Geometry during their grade 8, analytical Geometry and Statistics during their grade 9 and Calculus and Trigonometry in their grade 10. The retention interval covered one year, two years and three years. The study limits only on the topics covered in the instruments for the experiment that was obtained in the first and second grading period in their elementary Algebra particularly on the Real Number System, Percentage, Ratio and Proportion, Measurement, Algebraic Expressions, and Polynomials only. Subjects were assumed to have received same level of instruction in their grade 7 was only taught by the same instructor. However, in this study, we do not have control on the exposure to different academic trials facilitated development of expertise and mathematical academic maturity of the students that perhaps might later contribute to the increase of mathematical performance with increasing retention interval. Further, only subjects with complete data on pre-test and retest results were considered in the study. Non-completers are discarded in the analysis. In addition, no transferees were included in this study.

2. Materials and methods

2.1. Experimental Procedure

The research method employed a Test-Retest Comparative Design where three year levels represented the different retention intervals. The level treated under one-year retention interval were the grade 8 students who received their test on October 2011; those treated under two years' retention interval were grade 9 students who received their test on October 2010; and lastly those treated under three years' retention interval were grade 10 students who received their test on October 2009, using a teacher made validated test instrument. The same instrument was administered to the same three groups on February 2013. The performance was determined by their scores in the test-retest instrument consisting of 125 item multiple choice exam. Only the retest was carried out since test data were already available and the subjects took the test during their grade seven in high school as part of their quarterly examination. However, it is also customary to describe the events that took place prior to the retest. In the Philippines school year starts in June and ends in March in the following year but at present some schools are adapting school year from August to June.

2.2. Retention Interval

There were no interventions made by the researcher after the students finished their grade seven in high school. A normal curriculum was followed for their Mathematics. Their only source of rehearsal and elaboration was from discussions and activities conducted during their Mathematics class. The grade 10 students treated with 3-year retention interval, already took Elementary Algebra, Advanced Algebra, Geometry, Analytic Geometry, Statistics, Calculus and Trigonometry. The grade 9 students treated with 2-year retention interval already took Elementary Algebra, Advanced Algebra, and Geometry, Analytic Geometry, and Statistics. The grade 9 students treated with 1-year retention interval already took Elementary Algebra, Advanced Algebra and Geometry.

2.3. Present Retest Activities

With the retention interval, all three sections were all accounted that is to create a heterogeneous representation of each group. On February 2013, the retest was administered using the same material as with test in their grade 7. Papers were checked with anonymity to ensure protection against teacher-student bias. Data in the form of examination scores were gathered. Analyses included comparison between pre-test, retest and gain scores performance of students over different retention intervals.

2.4. Statistical Analysis

The results of the test and retest were compared using t-test for paired samples. To determine the difference on test and retest scores and the mathematics performances gained across retention intervals of the subjects, one-way Analysis of Variance (ANOVA) was used. If significant differences occurred among means, Post hoc mean multiple comparison test is applied.

3. Results and Discussion

3.1. Comparison of Achievements

In order to determine how the recall of information can be affected by the length of retention interval and the factors associated with time, three groups of students from University Laboratory Schools were studied. Each group came from different grade levels specifically grade 8 with 118 students, grade 9 with 90 students, and grade 10 with 87 students representing one, two, and three years of retention intervals, respectively.

To establish equivalence of each group in terms of their grade 7 mathematics ability in terms of score performance, their grade 7 first and second grading Mathematics examination results were summed up, used, and compared. Moreover, to determine the effects of retention interval, the same examination was given and compared.

Table 1: Test of difference between the total score of math examination during and after instruction. ULS-USM, Kabacan, Cotabato. SY 2012-2013.

Student Group	Test	n	Mean Score	SD	t	df	p-value	Mean Difference
8	*During*	118	65.04	15.377	8.763	117	0.000**	13.87
	After	118	78.92	24.044				
9	*During*	90	66.61	18.384	10.179	89	0.000**	15.033
	After	90	81.64	17.472				
10	*During*	87	68.89	15.067	12.89	86	0.000**	21.00
	After	87	89.89	18.976				

***–highly significant; p<0.01 (paired t test)*

Table 1 shows the mean scores of each group during instruction. It shows that the present grade 10 students obtained the highest mean score of 68.89 while the current grade 8 students obtained the lowest mean score of 65.04 and grade 9 students ranked in between the two (66.61). Meanwhile, it can also be seen from the table that the scores of the third year students were more dispersed (18.384) than the scores of the grade 8 and grade 10 students (15.377 and 15. 067, respectively). On the other hand, the hierarchy of scores existed between the groups, the scores were not considered to be significantly different due to the relative closeness of the values. This implies that the three groups of students were to be more or less equivalent in terms of their grade 7 mathematics skills and abilities, and were comparable in terms of the knowledge obtained when they took their examination.

After the retention interval specified for each group, the same examination was given to the same students and results were compared. Results revealed that students from each group significantly gained scores even after retention intervals. Comparison of the previous and recent scores, using t-test for paired samples, revealed that the gain of an average of 21 more points was observed for the grade 10 students and was highly significant. Also, there was gain of an average of 15.033 more points on the previous scores of the grade 9 students which was highly significant. Further, for grade 8 there was a gain score 13.87 more points from previous scores and was also highly significant. In the three results, a highly significant difference existed between the achievement during and after instruction of the participants according to their grade year level These results contradicted the studies of [8,9,10,11] which stated that the ability to recall information decreases with increasing retention interval. This decrease is maybe due to memory loss or perhaps have lesser interest to remember or even cause by a disease that affects the brain. However, in this study, it was found out that achievement of students seemed to increase with the retention interval. Based on the result of this study, it was also evident that retention intervals significantly affected the achievement of students in Mathematics for it yielded a significant increase in the scores of students as the length or degree of retention interval increased. However, we do not know yet how this retention interval causes the significant increase of scores, is it due to the students' ability to retained previous information? Or other exposures that made him more mature on dealing with the given problems to solve. Retention interval may possess in itself a myriad of activities that may enhance and relearn the previously learned material; information and events that may strengthen the bond between prior and recent knowledge and skills; and especially the increased attention span, reasoning skills, and memory storage that come along with maturity. In a similar sense, Reference [12] implicitly revealed some properties of retention interval such as exposure to increasingly multifaceted mathematics courses as students move from one level to the next. Such exposure, according to them build new knowledge that should be integrated with prior knowledge. With the theory of elaboration, basic knowledge is strengthened when it forms a connection with new but highly related ideas, and the more connections are formed, the easier it is for the person to recall information. What might had happened during the retention interval in this study was that as students move from grade 7 to the next level, they encountered new mathematical concepts using the basics learned from their grade 7 Mathematics. In addition, the consistency and frequency of application of the basic mathematics provided the student the chance for rehearsal and elaboration, thereby, strengthening the retention of the basic information.

3.2 Comparison of Achievement Across Retention Intervals

Table 1 illustrated the mean total score of each group during and after retention interval. It did give an implication how the mean score of a group differed from the other in both times of test administration, that is during and after instruction, as well as the difference that existed between the scores obtained during instruction and the scores obtained after the specified retention interval for the group. Though the latter implications were justified by statistical procedures (t-test for paired samples), it did not on the former implication. The former implication required statistical procedures (One-Way Analysis of Variance) in order to validate the following claims that there was no significant difference between the mean score of each group during instruction that is students were equivalent and comparable in terms of their knowledge in mathematics when they took their grade 7 math exam; there existed a significant difference between the mean scores of each group after retention interval that is to establish that different retention intervals can cause variation in student achievement; in terms of the average score gained, each group differed significantly that is to further corroborate the variations brought by different degrees of retention interval. In a concise manner, such justification aimed to reject or accept the second null hypothesis stating that there was no significant difference between the students' mathematics performance gained across different retention intervals.

The scores obtained by the students when they took their grade 7 exam (during instruction) were used to determine if the groups have equivalent mathematical knowledge and skills. Using One-way Analysis of Variance, there was no significant differences (F=1.398, p-value=0.249) among the three grade level on their average overall scores obtained during their mathematics examination taken in their grade 7 in high school. These results suggested that in terms of the grade 7 mathematics knowledge and skills, the three groups were said to be equivalent and comparable, the skills and the fact that they were all grade 7 when they took the test, their exposure to the same mathematical experience was facilitated by the same instructor who probably gave the same amount of instruction and contributed to such comparability.

Analysis of the data of the achievement scores for the three groups in the second administration of the same test yields a highly significant differences in their average scores (F=7.265, p-value=0.001). It would be more evident and substantial, if not customary, if gain in achievement be taken into account.

Scores of each student during and after instruction were compared to obtain the score gained by each. The averages gained scores of each group were then compared shows that there was a highly significant differences on the gain scores among the three retention interval (F =5.603, p-value=0.004).

To summarizes the performances of the students during instruction, after retention interval, and the difference or gain of scores by each group. It can be noted that during instruction, that is when the students took their grade 7 mathematics examination, the current grade 10 students obtained the most average of scores, followed by the grade 9 and then the grade 8 students who got the least average score. Though difference existed between the mean scores, it did not qualify to be significant. This leads to the implication that the students were comparable in terms of their grade 7 mathematics achievement. Each group of student, even if weighed against their mathematics knowledge and ability when they were grade 7 students were compared (see table 2).

Table 2: Summary of performance during and after instruction, and the gain in performance. ULS-USM, Kabacan, Cotabato. SY 2012-2013.

Grade	Retention Interval (years)	During	After	Gain
8	1	65.04	78.92^{a}	13.87^{a} *(21.33%)*
9	2	66.61	81.64^{a}	15.03^{a} *(22.56 %)*
10	3	68.89	89.89^{b}	21.00^{b} *(30.48 %)*
p-value		0.249^{ns}	0.001**	0.004**

ns – not significant at 5% level

***– Highly Significant (p<0.01)*

Column mean with similar letter superscripts are not significantly different (Tukey's HSD)

The examination score during instruction were all considered and assumed having the same mathematical ability, skills and amount of knowledge during their grade 7. Factors about this occurrence perhaps can be attributed to the same amount of exposure to the same mathematical activities (assignment, quizzes, examinations, board-work, and pedagogical methods) as facilitated by the same instructor who probably rendered the same amount of instruction. These results imply that the test-retest and respondent selection methods used in this study contradicted with studies by [8,11,13,14] in which their results showed that the ability to recall information decreases with increasing interval retention. Intricately, retesting group of students with different age and competency level at present may be as efficient, valid, and reliable as its methodological predecessor, that is retesting similar subjects over different retention intervals. The different groups retested were found to have the same ability and amount of knowledge in Mathematics when their grade 7 exam scores in mathematics were compared. In Table 2, the group performance varied with large differences in mean total score when the effects of retention interval were tested on each group of students considering that such variation in the mean total score resulted from substantial gain in score. It can be observed that the current grade 8 students obtained a mean total score of 65.04 during their first time they took the exam. After one-year retention interval, the results of retake gain of 13.87 points, leading to a mean total score of 78.92. The gain consequently ensued to a test and retest results with high degree of significant difference. Similarly, the present grade 9 students obtained a retest result averaging to 81.64 after gaining an average of 15.03 more points to their first year test score that averages to 66.61, these group retook the exam after two years and resulted a high significant difference in their gain scores. It also showed on the three-year retention interval which gave the present grade 10 students an average gain of 21.00 points to their grade 7 test score that averages to 68.89. Such gain leads the group to a retest mean score of 89.89. It can be noted the performance gain increases with retention interval. The test and retest score on this group proved to have a high significant difference. The comparative analysis of the retest results between each group proved that the variations observed in the mean total score of each group's retest exam generally possessed a high significant difference ($F = 7.265$; p-value = 0.001). Further analyses for the multiple mean total score comparison using Tukey's test showed that the grade 8 and grade 9 groups were not significantly different. Significant differences only occurred when either of the two groups mentioned were compared to the grade 10 group. Additional analysis proved that the discrepancies in the mean total score gained by each group were, in general, significantly different ($F = 5.603$; p-value = 0.004). However, it can be noted that only when the mean score gained by either grade 8 group or grade 9 group was compared with mean score gained by the grade 10 group that significant difference occurred.

3.3. Courses and Trends on the Results

Based on the preceding analyses, two important courses and trends were deduced and were considered for the foundation of the conclusion. The students manifested gain in retest score after the retention intervals and resulted to significantly higher scores. Gains and retest score increased with retention intervals. The foremost goal of this study was to determine the effects of retention interval to the students' performance in Mathematics as manifested by students' scores in an examination conducted when they were grade 7 students and the retake of the same material after a specified length of retention intervals. Under uncertainties, two possibilities were expected at the beginning of the study: First, one can expect that the amount of information recalled decreases after the specified length of retention interval. Such anticipation can be affirmed by mere observation of the everyday activities and through the experiments conducted by [8] when he discovered that the forgetting increases as retention intervals increase; Moreover, Reference [13] found out that as retention interval increase, participants' performance on extensively practiced single-digit multiplication problems deteriorates, and [14] also found that difficulty encountered by participants on complex mathematical problems increased over the long retention intervals however in our study it is not the case since over long retention intervals subject's mathematical performance increased. . Even though this was the most plausible event that may result from the experiment, this was the least expected for reasons dealt in the succeeding discussions. Lastly and the most expected was that the test and retest scores of each group did not differ significantly. It was highly expected due to the fact the mathematics curriculum in secondary schools is organized and sequenced in which the present subjects – unlike sciences and other course – are interrelated with the former as well as the subsequent subjects to be taken up. This well-known fact provides an avenue for the grade 7 mathematics that is Elementary Algebra to be practiced by the students as they are learning higher or more advanced branches of mathematics. Conversely, what can be noted from Table 1 and Table 2 were far from both expected outcomes. It showed that not only that the students in each group recalled the information required by the exam but, surprisingly, were able to surpass their previous performance. Analyses revealed that such gain resulted to a significantly higher score. Even though the students were now in different ages and year levels, analyses found that their abilities when they were in grade 7 were comparable and equivalent that is, they possessed similar amount of mathematical knowledge and abilities. For this reason, it is customary to consider factors (other than their initial abilities) that may influence the outcome of the experiment. These factors are in terms of the properties of retention interval: exposure to substantial amount of practice or rehearsal, elaboration by related branches of mathematics, and expertise brought by maturity and exposure. To further understand how practice resulted to improved retention of information, consider the study conducted by [14]. Eleven consecutive daily sessions of single digit multiplication problems were given to the two participants. After the training, their retention was measured on regular intervals ranging up to 14 months. After which, they found out that the participants experienced a decrease in difficulty on complex mathematical problems with increased practice. More importantly, it was revealed that when practices were given to respondents, retention of information increased over the long retention intervals. This implies that practice contributes to the durability of retention of information over long periods of time. Such result was consistent with the views of [15,16,17] that explicated the amount of practice acquired through increasing the number of academic avenues led to improved retention of newly learned items. These comments coincided with the results of this study. Practice, as one of the properties of retention interval in this study had been extensively experienced by the students throughout the entire length of retention interval even though the students may not be rehearsing the exact materials as with their grade 8 subject. Apparently, this became possible since elementary algebra was so basic that it was one of the requirements and tools in understanding many advanced branches of mathematics particularly those that followed after the Elementary Algebra in the locale of the study namely, Geometry, Advanced Algebra, Geometry, Analytic Geometry, Trigonometry, and Calculus. As the students undertook new subjects, they encountered new concepts and problems. Thus, in order to understand the concept and solve the problem, the students considered to a much more basic concept. For example, in order to understand the concept of the derivative, a student would recall the concepts of functions, exponents, slope of the line, et cetera. In this case, not only that the new material came into meaning and solved, but also the prior knowledge and skills were reviewed, rehearsed, and activated that is maybe explain to their exposure to much advance topic that provided recall of previous learnings. As this happens frequently, as it always does in mathematics, more and more information is recalled and practiced, thereby, strengthening the retention of the previous material. This explanation corroborated with the idea of [18] that the strength of knowledge and were influenced by regular practice experienced through repeated academic trials. Therefore, home-works, quizzes, examinations, group discussions and other similar activities can serve as best examples of academic processes since these require the students to practice or re-experience the situation or information over time [18,19]. In addition, higher levels of strength can be achieved when skills, facts, or procedures practiced regularly through similar processes. And more importantly, newly learned materials were retained better when they were associated with prior knowledge [20]. The aforementioned accounts explained why and how information can be recalled in similar situation as in this study. However, it did only a little to explain why retention interval and its underlying properties not only allow the material to be recalled but also to significantly outperform the student's previous records. Forgetting occurs when information underwent a period of inactivity information was neither elaborated nor rehearsed, interference or overlapping of other memories and decay happened when neurochemical memory trace created during encoding disintegrated as time passed [21]. Apparently forgetting occurs most of the time regardless of age. What had happen explained that the gain in scores way back the students' first year (grade 8) in high school and the interval between instruction and test were considered to be relatively small amount of time – one grading period or two months. This limited time may not give enough time for all the students to be exposed to related materials that may strengthen the retention of information can limit the frequency of rehearsal, and may not allow relearning and rehearsing forgotten materials. As compared to the length of time specified for the retention interval, a grading period was relatively not enough for the students to gain an average score obtained after a specified retention interval. Moreover, Reference [12] suggested that new knowledge and skills must build on, and be integrated with, prior knowledge as students move through different levels of school and take increasingly comprehensive math courses. In a concise manner, gains of score occur due to relearning of forgotten materials, consistent rehearsal of information and elaboration of new knowledge to prior knowledge. In this study, perhaps more exposure to different activities of students related to mathematics they have passed since their grade 7 until grade 10, contributed to much recall of previous topics that possibly explained the increased gain in mathematical performance of the students.

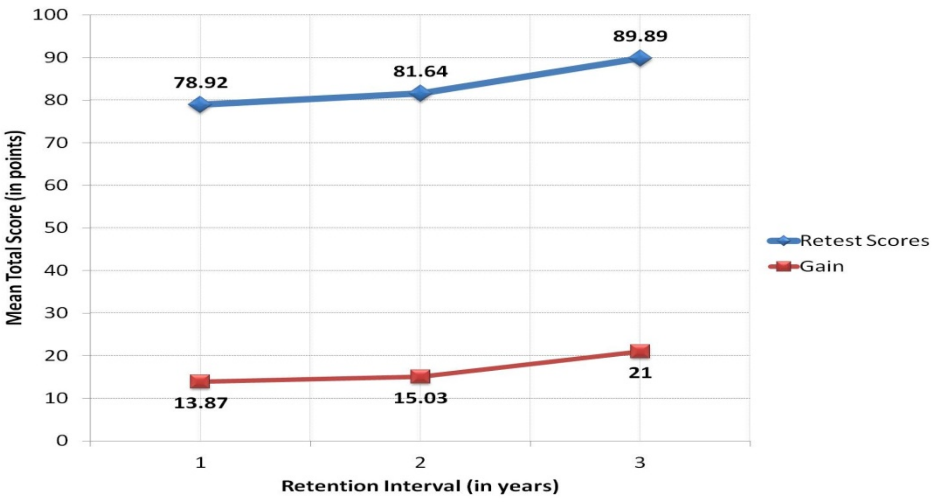

Figure 1: Comparison Between Retention Interval and Gain, Retest Score. ULS-USM, Kabacan, Cotabato. SY 2012-2013.

Consistent with the tables 1 and 2 discussed previously, Figure 1 does only show the retest score and the average gain but also the two results graph against retention interval. Generally speaking, it can be observed that as the retention interval increases, so as the gain of score resulting to a retest score that behaves in similar aspect. Previous analyses revealed that the gains and retest scores were significantly different. It was an atypical result since a less peculiar event would lead to a negative response in every increase in retention interval. As mentioned earlier, the retention intervals in this study possess some properties that would explain this phenomenon. The aforementioned statements left the remaining pages allotted for elucidating the function of expertise that brought by maturity and exposure to material. Reference [22] mentioned that a person’s ability to recall a certain material depends heavily on the amount of his or her prior knowledge. This may be possible his exposure to previous knowledge related to Mathematics. Reference [23] also found that amount of prior knowledge was positively correlated to the tendency of the material to be recalled where those who have prior knowledge (experts) had the highest tendency of recalling the material while those who possess the least (novices) behaved otherwise. Experts who tend to detect features and meaningful patterns of information can adapt to new situations, retrieve important aspects of knowledge with little effort and most importantly, accumulate more content knowledge and organize it in a manner that shows understanding of the topic [24]. Reference [21] added that children remember less than adults since they are far less expert in different areas. Apparently experts’ knowledge is organized around many ideas and concepts. Moreover, they tend to have deeper understanding of knowledge than novices [25]. Expertise, as implied from the mentioned accounts is a function that involves length of exposure to a subject matter to which an individual can master the subject and the amount of material to which he or she was exposed to. Thus, in relation to this study, one good reason why performance of students increases as retention interval increases is apparently when student stayed longer in school, he or she is much exposed to a more advanced mathematics subject, received longer amount of time to practice, received substantial amount of rehearsals and more importantly learned more new concepts where his or her prior knowledge is linked and in turn strengthens the retention of the basic information. Even though the three groups had equivalent abilities when they were in first year, it was still expected that the current grade 10 students performed better, followed by the grade 9 and grade 8 group, since the said group represented and was retested after the longest retention interval (three years) which entails a longer time to receive enough practice and more information.

This was theoretically and empirically true due to the fact that the grade 10 students attained a certain level of maturity and expertise greater than the other group. It was also true for similar reason as to why the grade 9 group would fall next to the grade 10 group. This idea was supported by [21,26] stating that having many and organized knowledge results to sophisticated system of information, more interconnections and better organization in an area that allows individual to retrieve more information with greater fluency. Moreover, in terms of organization of knowledge, the fourth year group ranked first, followed by the third year and the second year group. This would still hold true since the variation in the length of retention interval before they were retested affected the level and amount of study training they received. Finally, the results are reasonable since the mathematics curriculum is carefully arranged in such a way that it is easier for students to organize the knowledge and skills in a more meaningful way. Concisely, gain in score was a result of longer and frequent practice throughout the retention interval.

4. Conclusion

The following conclusions were drawn from these study. Firstly, the retention interval promoted a significant increase in the performance of the same examination. An increase in score significantly differs with varying retention interval were observed and recall of information is strengthened as retention interval increases. Secondly, subjects' exposure to related academic trials such as meaningful and organized knowledge as well as maturity may have contributed to the increase of mathematical performance across retention intervals.

5. Recommendations

The authors recommend that first; a similar study shall be conducted to compare mathematical performance that consider using shorter range of retention intervals but with over long periods of time. Perhaps a different result might occur and subject exposure to related academic trials and other organized knowledge might not be a factor for increased performance but rather due to good memory recall of shorter range of retention intervals. Second, this study might be replicated considering different subjects such as elementary pupils or college students as to determine if it yield the same results and not only due to prior knowledge. Lastly, to conduct a similar study which shall consider single group of subjects being taught over 3 years in their grade 8, 9 and 10 and evaluated every year with the same test given in their grade 7.

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