How Do Breaks Affect Learning?

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Abstract

This research consists of a high school testing as well as a college testing. Seventh and eighth grade students were tested in their math abilities before and after spring and summer break. College students were tested at the end of the semester. The college students consisted of students who were currently finishing an algebra class and those who had not had algebra in years. The results from these studies show that short breaks do not affect achievement, while longer breaks affect achievement in different ways. More research needs to be conducted in this area due to the lack of recent data.

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Chapter One

Introduction

Much of a person's childhood is spent in the classroom. This is a crucial part of development and where a great amount of learning will occur for many individuals. The education system of the country goes back centuries but has been under constant change. A norm that Americans have grown accustomed to is the long summer breaks that we currently have. However, the school system has not always had the standard summer, winter, and spring breaks that have been adopted by many schools.

History of the School Calendar

There is a common misconception about where the breaks came from and why schools have them. The summer and winter breaks have not always been what we know them as today and are not necessarily solely based on a farming calendar (De Melker, 2014). The long summer break that we have grown accustomed to has been a development starting around 1900. Before this, schools were in session in various amounts of time. In some places, school calendars were much longer than they are now. Large cities had school on average for 260 days a year, at the same time, rural schools only attended for about 180 days a year. This created an 80 day difference for students in school. (Pederson, 2012).

Schools based their calendars off of the needs of the community and until the past century were not normalized. "Prior to 1890, students in major urban areas were in school for 11 months a year" (Pederson , 2012, p. 57). Many states even had schools that went off of a twelve month calendar, with only two weeks of break in the summer.

According to Pederson (2012), this two week break that some schools had, extended to four weeks due to high absenteeism in the summer. The summer had high truancy rates among students and disease spread more rapidly with the heat. The heat also made classrooms uncomfortable environments to learn in (De Melker 2014). Even though there is no national standard for a calendar, the majority of schools now average 180 days, have a long three month summer break, a winter break, and a spring break (Cooper, 2003).

Raised Concerns

The long summer break has raised some concern in the academic community as early as 1894. U.S Commissioner of Education, William T. Harris, stated in his annual report that, “it was a great mistake to abandon the custom of keeping urban schools open nearly the entire year” (A Prisoner of Time, p. 8). When Harris gave this report, the average days only decreased from 193.5 days to 191 days of instruction. The Commissioner was concerned with the disappearance of Saturday morning sessions, longer summer vacations, less morning and afternoon sessions, as well as more days off for holidays and teacher development. (A Prisoner of Time).

“A Nation at Risk” was released to the public in 1983. President Ronald Regan addressed it to the country publicly, calling for reform in public schools. The content of the classroom, expectations of students, time spent in school instructing, as well as the teaching methods that were being used, were all under attack at this time. Along with addressing the problems that “A Nation at Risk” reported, recommendations for these issues were also included. Concerning time in school, three major recommendations were made. School days should be at least seven hours long and the amount of days in schools should increase. The extended time recommended was 200-220 days of school compared to the 180 days that is the norm. Also, the time in the classroom spent on instruction should increase. All of these recommendations were to help extend time spent on teaching “the basics” as well as creating more “rigor” in the classroom. (Editorial Projects in Education Research Center, 2004). These recommendations were also made to be able to compete with other countries. The U.S was starting to fall behind the achievement level of other students around the world, and the concern to compete was elevating. In 2005, statistics showed that the U.S spent 1460 hours in core academics compared to 3170 in Japan, 3260 in France, and 3528 in Germany. Statistics like these caused for reconsideration for the time spent in school in America (A Prisoner of Time, 2005).

In 1994 and again in 2005 a push for a different school calendar was made by the National Commission on Time and Learning. They published an article in 1994, “A Prisoner of Time”, and reprinted it again in 2005 with up-to-date data. The updated data showed no change in the educational calendar or the time spent on academics. Current statistics in their 2005 reprint shows that students spend seven hours a day in school, with 5.6 hours of classroom time, and nine months or 180 days out of the year in the classroom. Regardless of the difficulty of content, 51 minutes per day is spent on a subject. In their report, they also recognized that there was a shift in American society and that students needed different attention for their learning, this included a different time frame. Eight recommendations were made in the article regarding time, the fourth specifically noting the length of days and calendar days of school titled, “Keep Schools

Open Longer to Meet the Needs of Children and Communities". (A Prisoner of Time, 2005).

The Debate: Reasons For and Against the Extended Calendar

The topic of the educational calendar has been an issue that has been raised time and time again with reason from educators as well as parents. The first reason is clear, a long summer break is thought to disrupt student learning. Many believe that learning is best done at a continuous rate and that the summer breaks this cycle. The summer gives enough time for students to forget material which requires extensive time to review in the fall. This time spent reviewing is time that is not being spent on new material for that academic year's standards. (Cooper, 2003).

Also, the new standards that have been arising are making the education system more rigorous and this type of rigor requires more time. More content needs to be covered in each grade and the standards in each grade force teachers to teach faster and make children understand at a faster pace. It is argued that more time will help lessen the stress and give more time for educators to fully teach lessons and more time for the students to fully comprehend what is being taught.

Another reason that the long summer break is under fire is that it disrupts the education of students with special educational needs. Students with learning disabilities and non-native English speakers need continuous education to reinforce learning. English may or may not be a focus at home for some students. Not hearing English for an entire summer may be detrimental to their education and understanding of material after a long break.

Low social economic students (SES) are also another concern when it comes to the long summer breaks. These students may not have the resources that a high SES student would have. They may not have the money to spend on educational activities over the summer or the encouragement to join free ones. (Cooper 2003).

There is also a negative concern when it comes to switching the school calendar and extending the hours as well as days of school. The first is that the extension of school hours and days requires more money. Money would have to be spent on increasing teachers' salaries as well as the extra programs that would be created. Money is also an issue when funding the professional development of teachers and the technology that will be used in the classrooms. Another item that will cost money is the building itself, the air-conditioning and heat for the extra days of school the students will have, as well as the electricity for these days.

Spending money on more school is difficult in the sense that it is hard to prove that more educational days will lead to higher achievement scores for all students. It is also hard to say that money in other areas of education will not reproduce the same results as extending the calendar year. If money can be spent on improving instruction or reducing class size with the result being the same achievement, then that option is more efficient. If extending the number of days does lead to higher achievement compared to spending the money on other areas, then the next question will be, is the achievement significant enough to spend millions or even billions of dollars on? Will this achievement lead the U.S to go beyond what other countries are achieving? If these questions were answered, then the money would become less of a problem in the argument against extending school. (Cooper, 2003).

Some of the population also claims that students, as well as teachers, will become burnt out on academics without the long breaks. It is argued that teachers need the summers to prepare for the next year and need a break from having students constantly (Cooper, 2003). Also some are concerned that students will not have time for other activities outside of school. Many summers are spent on family vacations and summer jobs. Family time is a concern when extending the school day, even if it gives parents the opportunity to work longer. Some parents would rather have time with their children than to be at work. Students will have a harder time finding a place in their schedule for family activities, jobs, as well as sports outside of school. Not all schools support the activities that children enjoy and summer is a time for students to be involved in them.

A final argument is that tradition is hard to break. Especially when reforms have been recommended and change has still yet to arrive. The summer break has been a luxury for both students and teachers and adjusting will take some time. Some schools have begun to extend days, but how long it will take for every state to change, if they ever change, is unknown. (Cooper, 2003)

Possible Changes to the Calendar

Three popular suggestions for a calendar change have been made. These include: extending the school year, providing summer school, and modifying the school calendar. Extending the calendar would simply put students in class longer into the summer and would cut their summers shorter. This suggestion came from looking at other country's school calendars. Our average of 180 days is significantly less than the average in Japan of 240 days. (Cooper, 2003).

Providing summer school is also a possible suggestion for the school calendar. Summer school typically has been for remedial purposes only but providing this in the summer for all students including, remedial, accelerated, and enriched students is an option that schools can take. Research by Cooper (2003) showed that these programs had a positive impact on the knowledge and skills of the students who participated.

Lastly, modifying the calendar would entail getting rid of the long summer break and replacing the calendar with cycles. These cycles can either make students attend the same amount of days or more depending on how the school implements this type of calendar. Research done by Cooper was ambiguous and not reliable so the effectiveness of getting rid of the break is unknown based off of his data. (Cooper, 2003)

Purpose

The purpose of this project is to examine how the school calendar is affecting students' learning. Specifically, in math over summer and spring breaks. Looking into the summer break will give evidence to how math skills decline over a long three month break for high school students. Analyzing the spring break time frame will give a comparison for how math skills decline between a shorter break and a longer one. This project is beneficial not only in a math class but can be translated to other subject areas as well to help educators as a whole. It will help teachers better understand the knowledge of their students coming back from different types of breaks. They can use this information to help plan and instruct their students better.

There are standards in most states for each grade level. An example of new standards includes the Common Core standards that many states have recently adopted.

These standards lay out what each student must be able to do after each grade level. Also, the ideas in the Common Core build off one another and the previous concepts need to be mastered before students can move on in that subject area. The lessons that teachers are planning will be based off what the students should have learned in the previous grades. However, these plans do not always take into consideration that the students may not remember everything after a long break. Teachers may be planning to build off of knowledge that may have been lost over the summer break. This creates more confusion and frustration from the students at the beginning of the year and may even affect their learning throughout the course. On the other hand, teachers may be over planning for forgotten material. They may be planning a month of reviewed material when the students may not need all of the extra review. My study is important because it will inform teachers of how much knowledge and the types of skills that are being lost and how much they need to plan for review at the beginning of the year. This will help create a better base of knowledge for the students to build off throughout their academic year and will prevent unnecessary review time.

We have already discussed the history of the school calendar, different times in history where it was brought to the public's attention, the reasons for debate as well as the possible changes that could be made. The rest of the paper will look at different theories of how memory works and how we forget. It will then go into a review of the literature on summer learning loss and the research that has been done. One particular study in 1996 will be broken down and looked at specifically due to its importance in the research of summer learning loss. The complications with this study and other studies will also be discussed. Chapter three will begin with the explanation of the high school testing that took place for this research. It will describe the methods and the results of the summer break testing first and then go into the two spring break testing sessions that were done. After the high school testing is explained, the college testing that occurred will be described. Once again the methods and results of the testing will be explained. The paper will conclude with a discussion of these tests and the implications and conclusions that can be made from them.

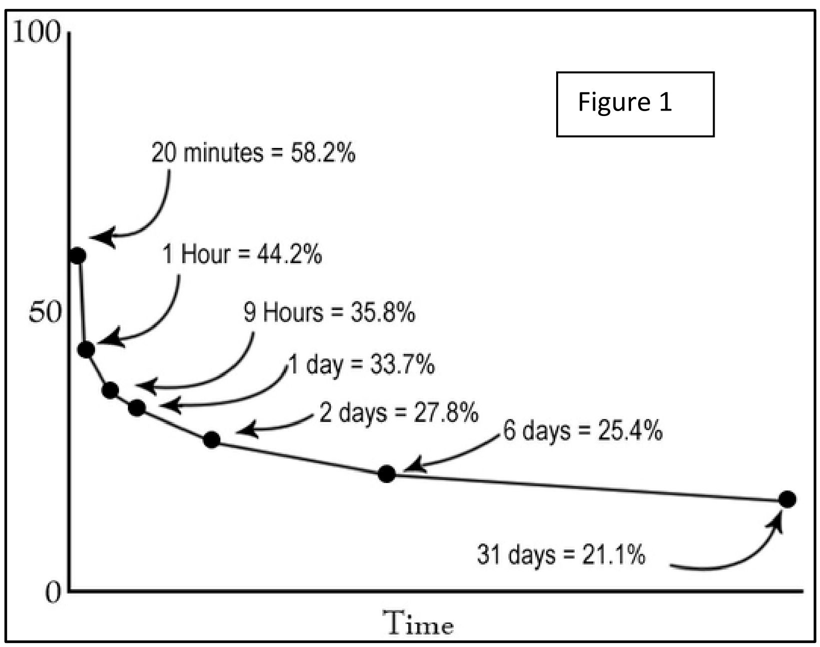
Chapter Two

Literature Review

Memory Theories

The Ebbinghaus Forgetting Curve

One of the first researchers in the area of forgetting was Hermann Ebbinghaus in 1885. He used himself as the subject for his experiment testing memory. He tested his memory of nonsense words and how time affected his memory of remembering these words. The shortest amount of time in his study was 20 minutes and he continued up to 31 days. His study has led to what we now know as the Ebbinghaus forgetting curve.



(Cherry, n.d.a). His findings show that information is quickly lost once it is learned, but forgetting levels off at some point (see figure 1) (Cherry, n.d.b). The question remains, does this curve apply to the breaks of summer, winter, and spring that school calendars currently have and how closely is it related?

Decay theory

Ebbinghaus' theory relates very closely with the decay theory of forgetting. Short term memory is suggested to only last up to 30 seconds if it is not rehearsed.

This theory also suggests that time is the only factor that leads people to forget and that the events in-between do not affect our memory. This is difficult to prove because of all the factors that we cannot control. Many events happen between the time something is learned and the time that they are asked to recall the information. Also, this theory does not show why some memories fade quickly, while others slowly fade. (Cherry, n.d.b)

Retrieval failure theory

The retrieval failure theory suggests that some information that is taught never truly becomes stored in long-term memory. Someone may remember hearing about it, but the details or the exact answer slips their mind because they never encoded the data to their memory. This is apparent in a demonstration by Nickerson and Adams. Try to draw the details of a penny. This is an object that is seen almost daily, but yet most people can only recall the color and shape of the penny and not the actual details on it. This is because people never focus on the details that are not needed to differentiate it from other coins. Knowing the color and the size of the coin is enough to tell it apart from the other coins that are used. Applying this to the classroom, students may be remembering the information that they see in their everyday lives, but not the math that they do not encounter often and do not need to get through a typical day. (Cherry, n.d.b; Cherry, n.d.a)

Interference theory

The interference theory stated by Psychology expert Kendra Cheery (n.d.a) is "the result of memories interfering with one another. It is difficult to remember what happened on an average school day two months ago because so many other days have occurred since then." Important "stand-out" days, like graduation, are more memorable because they are different than a typical day. This theory can be applied to material that is learned at the beginning of a grade. In-between this material and the next year's starting material, the students have had an entire year of information as well as a long break that may cause them to forget. Also, math lessons typically follow the same pattern: lecture, homework, review of homework. According to this theory, unless a lesson is different from others, it will be easier to forget because so many other lessons that were similar had been taught. (Cherry, n.d.b; Cherry, n.d.a)

Previous Research in Summer Learning Loss

There are many articles that give solutions to the "summer slump" that educators see in their students. The majority of these articles have no research studies of their own to show the loss that they are trying to fix. One study that is cited in research papers and non-researched articles alike is the meta-analysis by Cooper, Nye, Charlton, Lindsay, and Greathouse in 1996. This study includes data from the ERIC and PsycLIT computerized reference databases with search terms of: summer loss, summer vacation, summer break, summer intersession, summer school, and summer variations. These search terms also included related terms like "learning" to help produce results. The relevant research was used and the researchers were contacted to give the most recent papers. This method produced 39 relevant research reports. (Cooper et al, 1996)

Cooper et al states that "We found that few studies published more than 20 years ago (prior to 1975) contained enough information to provide data suitable for inclusion in a meta-analysis" (p. 233). They also pointed out that because of the date, the information may not be relevant to the students currently in the education system.

This made their decision to break their analysis up, looking at studies before 1975 and then looking at the thirteen studies after 1975. (Cooper et al, 1996)

Cooper and his co-authors were skeptical to use data that was twenty years old to date from the time of their research, saying that it may not be relevant for the children of their day. Their entire study now dates nineteen years old. The data that they were hesitant to call relevant now dates almost forty years from now in 2015. Educators and writers are still using this study in their reports, despite its aged research. The study is a good reference, but the data may not be completely relevant to today's education system. If more research was done and similar results occurred, then the data could be added to help prove a better case for a change in the school calendar and system in general. Because there is limited recent research in summer slump, a valid case for changing time spent in school is difficult to make.

Recent research only on math decline over the summer was not found. One article focusing on math and reading was very recently published in October of 2015 by Berding, Fink, Luttenberger, Macher, Paechter, Papousek, and Weiss. This research was done in Australia with a nine-week summer vacation. Research in reading, special education students, as well as family income was found within the past decade, but was slim in results as well. Using the search term "summer learning loss" produced minimal results in the ERIC database and no results were found on math research and summer breaks. Variations of the terms "math summer slump" and "math summer learning loss" also produced no results. Searching in Google Scholar had the same outcome. The majority of the results are articles on how to fix the summer slump; when adding the term "math" in the search, it produced summer school research and summer programs to help solve the summer slump.

The majority of the articles that were produced using these search terms used the meta-analysis done by Cooper et al in 1996. Also, the only math reference in these articles is the data that Cooper and his colleagues collected during their research. Because Cooper et al.'s data is one of the most recent data that could be found dealing with math, it is important to look at the studies and research that they used dealing with math skills. His meta-analysis included reading as well as math but the next section will only describe the math research that was found and used in the analysis. The purpose of this section is to describe previous studies that have been done, but also to show the outdatedness and the lack of consistency within the studies. After the description, problems with this analysis will be discussed and the recent research by Berding (2015) will also be addressed.

Cooper et al.'s Used Studies From 1975-1995

A small study with math was done in 1906 by William White and was the earliest study that was found. This study only included seven participants, but did find summer learning loss for speed, but not for accuracy. In 1919, math was once again looked at by Garfinkel. A total of 747 participants between fifth and seventh grade were used in a June and September study that produced results that showed a loss in speed and accuracy in math. This study also looked at the primary summer activity of students and found that students who primarily worked instead of playing or studying (summer school) showed less loss in skills. Jumping another six years brings the research to 1925 with Patterson and Rensselaer. Fourth through eighth grade students were tested for a total of 149 participants. A general loss in math was found across all grades, but inconsistencies were found when specifically looking at IQ's. Surprisingly, the students in fourth and sixth grade with the highest IQ showed the greatest loss in computation skills, while the seventh and eighth graders with the highest IQ showed an increase over summer. (Cooper et al. 1996)

Cooper et al. also briefly mention five other studies that occurred during the 1920's including: Noonan (1926), Kramer (1927), Nelson (1928), Bruene (1928) and Morgan (1929). These studies focused on fourth through seventh grade students and a loss for math was found in all five studies. In Noonan's study the loss was "so small that it may be ignored for practical purposes" as quoted by Cooper et al (1996). In the other research it was found that summer affected the "brighter students" negatively in certain grades more than others. They also found that reviewing took two to six weeks to recoup the losses, and that math computation and problem solving skills decreased over summer. (Cooper et al, 1996)

The 1930's and 40's produced three studies that looked at intelligence, only one included math. Schrepel found in 1936 that eighth and ninth graders alike showed a loss for math computation. His research also showed an inconsistency with eighth and ninth graders with eighth grade showing a gain in math reasoning and the ninth graders showing a loss. Overall, he came to the conclusion that the majority of the time people with a higher mental age, showed less loss in learning. This time frame also produced three more studies, one showing loss in math in general (Keys and Lawson, 1937), another showing a loss in math fundamentals and a gain in problem solving (Lahey, 1941), and lastly one showing a loss in math fundamentals again, but a gain in math reasoning (Bender 1944). Note that the 1941 study by Lahey contradicts research in the 1920's that showed a gain in problem solving. (Cooper et al, 1996)

Another gap of time, spanning almost twenty years, passed before more research was done on summer learning loss. The group of writers of the meta-analysis point out that during this gap of time, measurement instruments were dramatically improved, sample sizes were considerably larger, and the use of inferential testing was commonplace" (Cooper et al, 1996, p. 234). Despite all of this, the questions of summer learning loss stayed the same and were far from being answered. (Cooper et al, 1996)

The next study that was mentioned occurred in 1962. The research done by Parsely and Powell at this time focused on second through seventh graders, consistently showing a decline in math fundamentals but a gain in math reasoning. This is the first study that mentions using "achievement based testing". Botwin in 1965 found similar results to the 1962 study with the same focus on grades with a decline in math fundamentals and a gain in math reasoning. The 1967 study done by Scott was deemed unreliable but found a decline in math skills as well. (Cooper et al, 1996)

Another math study in 1968 by Beggs and Hieronymus used the Iowa Test of Basic Skills with participants in the fifth and sixth grades. These grades showed a summer learning loss in math concepts as well as problem solving which contradicts the study done in 1969 by Soar. Soar's results showed that for sixth graders over the summer they gained math concepts and problem skills. The results may not be reliable because the students had months of instruction between testing. This included a fall review which will affect the tests to show more gain over a summer. Soar's study was the last research on math learning loss that was found prior to 1975. A summary of the data before 1975 shows that, "All 17 comparisons of math computation before and after summer break indicated a loss in math skills, $p < .0001$. Tests involving math concepts, reasoning, or applications showed relatively equal instances of summer gains or losses". (Cooper et al, 1996, p. 236)

In 1975, Grenier made an interesting contribution to the research that had already been done. Her testing included retests after two weeks to see how the math skills improved over time. The study started in late August and followed the trend of the previous studies showing a loss in math computation skills. Problem solving and math concepts were areas of gain for these 763 seventh grade students. The loss in math computation skills, surprisingly, was recovered in two weeks. It is not known whether the first test was on the first day of school so this two week recovery may not be completely valid. (Cooper et al, 1996)

Pelavin in 1977 and NIE in 1978 focused on students in compensatory education programs. These two studies contradict each other and the second of the two was done in response to the testing in 1977. Pelavin found that for seventh and eighth graders, math skills declined over time. NIE on the other hand, found a gain for first and second graders and a loss in third and fourth graders. Both studies used CE students and both used the Comprehensive Test of Basic Skills (CTSB). However, the results may be varying from the different grade levels or the difference in sample size. (Cooper et al, 1996)

Two studies in 1981 dealt with math skills declining and these included Hawn and Klibanoff. Hawn focused on genders but was not necessarily focusing on the effects of summer according to Cooper (1996). However, he found that genders did not matter in loss over summer and that three fourths of the students experienced a loss in math skills. Klibanoff's testing was not described in Cooper's article but was included in table 3 of the article. From the table it shows that the study consisted of first through fifth graders with a sample size of 39,000, he used the CTBS testing, and that there was a gain in math knowledge over the summer. Another study in the 80's was done by Shaw in 1982. This study focused on special education and regular education students. The special education students were grouped in either a regular classroom or a resource room. The three groups all showed a loss in math skills over the summer vacation. (Cooper et al, 1996)

The 1986 study done by Wintre was done in Canada; this is the first mentioned study in a different country other than the USA that was used in the meta-analysis by Cooper et al (1996). This study produced the common result of a loss in mathematical computations and a gain in math concepts. Allinder and Entwistle both produced studies in 1992 showing a loss in math computation in elementary grades. Entwistle looked specifically at African Americans versus Caucasians in gains and losses for math and found that both races had losses, but the gap of achievement grew larger over the summer. (Cooper et al, 1996)

The last study that was used in the meta-analysis was the Sustaining Effects Study. This large study found no evidence of absolute or relative loss over summer but also had problems dealing with instruction time in-between testing. Math had little to no gain and had much less gain than reading overall. (Cooper et al, 1996)

Having a nine week instruction time, with five weeks before summer and three weeks after summer, makes the data hard to use effectively. We can compare this study with the previously mentioned study in 1975 by Grenier and the study by Noonan in 1926. Grenier claimed that it took two weeks to recoup the knowledge lost over summer and Noonan claimed that it took anywhere from two to six weeks to recover this knowledge. The three week instruction time in the Sustaining Effects study shows that there was no loss or gain in skills. A conclusion can be drawn that at this point the students gained the knowledge that they lost. (Cooper et al, 1996)

The meta-analysis by Cooper et al. in 1996 came to a few conclusions that are still used today. First, the most common statistic used is that students lose one standard deviation of knowledge over summer. This is equivalent to one month of school for students. This data includes both the reading and math related areas. When broken into two different areas, math showed a greater loss than compared to reading and related subjects. Another finding that came from this analysis is that as the length of summer break increased in studies, the lower the scores tended to be. These scores were equally as low in math for students with middle or low income households, suggesting that math skills are not being used by many students over the summer regardless of social economic status. (Cooper et al, 1996)

There are some issues with this study other than the age of it. Looking at the research in the analysis, very few studies use the same methods and replicate each other. For studies to be reliable and valid, they need to be tested more than once with the same methods. Testing once leaves more room for error and for other factors affecting it. Also, the time frame was nearly 75 years and included only 39 studies.

These studies showed contradictions in some areas, making it difficult to draw a conclusion for the sub-areas of content. On the other hand, consistent results, like a decline in math computation skills, make it easier to make a correlation between summer and declination of skills. The studies used different sub-areas of content, especially in math. Having these different areas is helpful, but, the studies may have viewed the same problem differently. For example, if one study viewed a math problem as a conceptual thing, but another categorized it as an application question, the data is mixed and the sub-areas may not be as reliable. Knowing the definitions that the studies used in each of these areas is important but unknown.

The studies that were mentioned mainly discussed the elementary and middle schools years of education for students. Only once was ninth grade mentioned and no research on higher grades was included at all. Research that is spread across grades can be misleading. Each grade may be different and research on elementary, middle, and high school years should be done separately as well as together. Students in the elementary grades live a much different lifestyle in the summer compared to an older student in high school. Because of the difference in summer activities, these grades should not be completely generalized together.

Lastly, none of these studies tested on the last day of school before summer or on the first day of school. Cooper et al (1996) states, "…it seems reasonable to assume that the typical study of summer effects has included at least five weeks of instructional time" (p. 259). Having this large amount of instructional time can have misleading results. If teachers spent this time reviewing the material, then the results will be skewed in the more positive direction. Cooper et al (1996) found that "…as the length of the summer interval increased, the amount of loss in test scores decreased". This indicates that the students were recuperating knowledge that they lost over the summer. The studies that were found also only included summer testing. A summer break is much longer than a winter break, spring break, and a Thanksgiving break. Each break may be affecting students differently and research should be done on these as well. A short Thanksgiving break may be helping the students by giving them more time to digest the lessons that they have learned. It also may be a time in which students cram before the break and lose all knowledge after the break due to the holiday activities.

Berding et al. Study

The Berding et al study was the first research in Australia that was done on summer learning loss. The authors also mention the lack of studies done in Europe and Asia. This left their literature review with the research that has been done in America. Dealing with math, one of their claims in their review says that "Altogether, previous surveys suggest that summer vacations do not lead to losses in knowledge and skills per se, but that their effects are instead moderated by other variables" (Berding et al. 2015, p. 1400), one of these variables was the socio-economic status of the household. Other variables included education levels of parents and summer activities like television use. They also mentioned in their review that studies found that math skills decline more than reading or spelling and decline in all grades 1-8. No other higher grades were mentioned. In the few European studies that Berding et al found, interestingly, the socio-economic status of the parents had no affect on the students' achievement contrary to many American studies. (Berding et al, 2015)

The Berding et al study included 182 participants of students between the ages of 10 and 12. "Arithmetic problem solving was measured using the respective subtest of the HAWIK IV intelligence test…" (Berding, 2015, p.1404). This test did not allow for pencil or paper during it and was administered orally. The test was given immediately after school ended for the year, during the first days of school starting, as well as nine-weeks into the school year. A control group that only took the test at the beginning of the year and nine weeks later was created to see if taking the test previously had any affect in scores. They repeated this testing three times. Their results showed that "Achievements deteriorated significantly over the summer vacation…" (Berding et al. 2015, p.1406). They also found that this decline over the summer was not significantly different between social classes, which are much different findings when compared to American studies. They also found that after nine-weeks of instruction, students surpassed the achievement that they lost over the summer.

Three variables were looked into when analyzing achievement after nine weeks: mother's education, gender, and prior achievement. They found that only achievement on the test at the beginning of school had a significant affect in whether or not the students' regained their knowledge in the first nine-weeks. The mother's educational background had a significant effect on arithmetic losses over the summer, but not for spelling or reading. (Berding et al, 2015) This recent research in Australia is one of the only tests found that tested without weeks of instruction between the summer testing, this results in what Cooper et al calls for in his 1996 meta-analysis, a more "pure" effect of summer.

Chapter Three

High School Testing

Methods

Participants

Participants for the summer testing were students in an eighth grade enriched math course at Rittman Middle School that were going into their freshman year of high school. The school is located in a rural area in Rittman, Ohio. The study consisted of nine males and six females for a total of fifteen participants ($n = 15$) that took both parts of the summer testing. There were five students who took the second portion but not the first and there were three students who took the first portion but not the second.

The participants for the eighth grade spring testing included a majority of the same students from this class, but due to absentees only fourteen participants ($n = 14$) were included in the spring data. These participants were made up of seven males and seven females. Four students took only one portion or no portions of this test and are not included.

Another set of participants included a seventh grade math class by a different teacher from Rittman Middle School. These participants were made up of eighty-four students in total. Their genders are unknown. Only fifty-seven students took both the pre-spring break and post-spring break test which the results are based off. Their genders are unknown. These participants took a quiz before and after the same spring break as the eighth grade students above. No demographics were asked of any student and are unknown.

Testing method

The eighth grade students took a final exam that is required in each subject at the end of the academic year. This final exam covered material that was taught throughout the year. These same fifteen students took this exam during the first week of school in geometry their freshman year of high school. This class, as well at the seventh grade math class, also took a quiz over material they were learning before they left for spring break and when they returned from spring break. The spring break was shorter than normal because of make-up snow days that occurred during this time. No known instruction on the material occurred between the pre and post-tests for summer or in-between the tests for spring. The students were not informed of any post-test that would occur after any break.

For the summer testing, the time allowed for the pre-summer test was longer than the post testing due to it being during final exam week. The students had 65 minutes to complete the test during finals week compared to 42 minutes after summer. The after summer test was taken during a normal classroom instructional period and not during an exam week.

Materials and conditions

The summer test included forty-five algebra questions and the eighth grade spring test included ten questions over varies types of factoring. Factoring skills that were needed by the students included: taking a GCF, factoring trinomials as binomials, taking the difference of two squares, and taking the sum or difference of two cubes. These skills were on the summer test as well and this test also included skills in: simplifying, exponent rules, solving equations, equation sentences, finding slope, writing in slope-intercept form, system of equations, percentages, variations, proportions, as well as inequalities. The seventh grade spring math test included material over reading data tables and the five relative frequencies. Formulas were not provided for the students on any of the quizzes. Each test will be provided in the appendix. The tests were taken in a normal classroom setting; no variables were controlled during the testing. No calculators were allowed for the eighth grade spring break test or the pre-summer test.

Confidentiality and safety

The identity of each student was unknown but their work and scores were provided for the pre and post-summer testing. The work for the eighth grade spring tests were also provided, however, only the raw scores of the seventh grade spring break testing were provided. All grades for these students and their personal information were not shared with me or my advisor. The Malone Human Research Committee reviewed the planned testing before it was implemented and was approved.

Results

Seventh grade spring break testing

Having no work shown from the seventh grade students makes it difficult to draw conclusions as to the concepts missed by the students on the tests, but the raw scores can give clues as to how a short break may be affecting student learning. The results show a slight increase over the break with student increasing on average .25 points. Out of the 57 students, 9 of them had no increase or decrease in scores. Whether or not they missed the same questions before and after the break is unknown. 20 students increased in score compared to 28 students who decreased. Despite the fact that more students decreased in score, the average increase in score was higher than the average decrease. Students improved by 3.55 points on average between the spring break days while the average decrease was only 2.04 points. 12 students improved between 1-3 points while the remaining 8 improved between 4-8 points with the median increase being 3 points. With the average increase of .25 points, one can claim that the shorter break had little gain or no affect in achievement of the students. Seeing the test previously may have had a slight affect but is not a significant figure.

Eighth grade spring break testing

Another test was given to these eighth graders before and after their spring break. They were not informed that there was going to be a test after the spring break. The test was out of 20 points total. The results showed that there was a slight decline in achievement. Six people decreased with a range of 1-8 points, 8 points considered as an outlier. The average decrease with the outlier was 2.9 points. Without the outlier, the decrease was only 1.9 points. Three students scored the same on the pre and post-test, while five increased for an average of 1.6 points. Combing all of the scores resulted in a small loss of .9 points with the outlier and .3 without it, making it not significant.

Looking at the work of the students gives more detail on the loss. The students all missed the same exact problems as they did before spring break. This indicates that students either did not learn from their mistakes, or they did not look into why they missed these problems, leading to them answering incorrectly a second time. Overall there was no significant gain or loss in achievement.

Eighth grade summer break testing

Due to the time difference in the pre-summer and post-summer tests, the data was difficult to analyze and can be interpreted in different ways. If we look at raw scores and do not take into consideration the time difference, there is a massive decline in math skills over the summer break. The pre-summer average test score was $\frac{79}{90}$ or about an 87.8%. The range was 26 points, the lowest score being a $\frac{64}{90}$, or about a 71%, while the highest was a $\frac{90}{90}$, or 100%. The median score was an 83.25%. If we compare this to the post-summer test scores, the decline is apparent. The lowest score was a 35% with the highest being an 80%. The highest score is close to the previous median, but almost a full 8% lower than the mean of the tests before summer. The lowest score is 36% lower than the lowest score of the previous tests. The average of the post-test was about a 59.5%, making it approximately a 28.3% decrease. This decrease in letter grades is the difference between a B+ and a D+, equaling a full two letter grades for students. Looking at solely raw scores, one can come to the conclusion that a long break is harmful to student achievement.

There are a few interesting pieces of data that can be looked at with these raw scores. The biggest decline was 40.5 points or a 45%. This person had the sixth highest math score before summer, and the fourth lowest score after. This information pieced with the fact that the highest scoring student before summer had the second lowest score after summer makes it interesting. A question here can be asked, why did these two students drop so greatly compared to the others? Was time the factor or did the fact that they did not study for the second test play a bigger role? The second lowest score before summer turned into the sixth highest score after and had the smallest difference in points, with only a 9.5 point difference. This student did have a smaller chance to drop in score, but are there other factors involved with this data? The range of decreases in scores is also interesting to look at. The smallest difference in scores was 9.5 while the highest difference in score was a 40.5. This massive range in points leads to the idea that there may be underlying factors when it comes to declining skills over the summer.

Taking the points out of the number that the students attempted on the test gives a different perspective on the tests. Looking at the student who scored a perfect score before summer shows that time may have been the factor in their loss. The person attempted 56 points out of 90 and answered 54 points correctly. Whether or not the student would have finished the test given the same amount of time is unknown. Also, it is unknown how long the test took each student to finish the first time. Skills may not exactly be declining, but instead the speed of the students in math may have declined. There was only one student who attempted all of the questions after summer break. This student scored a 90% pre-summer and 80% post-summer, showing that skills declined but speed did not. Not every student attempted the same amount of points on the post-test, but the average when looking at the scores this way was a 77%. Comparing this to the pre-summer test gives almost an 11% difference in scores. This indicates some decline over the summer.

Time difference is a big issue within this test. Taking the test out of 58 points (29 questions), instead of the full 90 points (45 questions) gives another perspective of the data. This would give the students the same amount of time per question as the pre-summer test. Interestingly, by looking at the scores this way, the average was a 92%, a full 4% higher than the pre-summer test. This would encourage the claim that if the students continued with the test, their scores would not have decreased in the staggering amount that they did when not taking time into consideration.

Discussion

There are issues with the testing of the high school students, first the sample size of the eighth grade spring break and summer break test was small. The seventh grade had an adequate size, but it showed no significant gain or loss. One can claim that a short spring break does not affect students from these results. Also, the tests were all the same before and after. This may have led to some students remembering answers. It also may have led to the gains that were seen in the sense that students were learning from their mistakes.

Another issue is the length of time for the summer test after the break. Doing this study with the same time would show a more accurate result. Looking at the results indicates that there was a loss in speed, but not accuracy for most students. This also may attribute to the fact that the sample consisted of honors algebra students. This can lead to the claim that these students decrease less over the summer compared to “normal track” students. More research in this area should be studied. The characteristics of an honors class should be looked at to see if these characteristics were to be implemented in “normal track” classrooms, if students would remember more and decline less over the summer. All of the tests were graded by the instructor of the classroom. It is hoped that the grading was equally as challenging in the pre and post-test, however, there is no way to determine this.

This study is one of the only studies done that was on the last day of school and during the first week of the school year, showing the full effect of a summer vacation. It focused on the upper middle grades which is also another area that has very little research in. This study included a short break and a long break. Short break studies have not been found when dealing with math achievement over time. From this research, review time after a shorter time may not be needed. After a long break, like the summer, review may need to be different time lengths for the different tracks of students. From this study one can see that the summer affected skills slightly, but not as greatly as one would think. Also, it still affected this small group very differently as seen by the range of scores. The underlying factors causing this could be another research project for the future.

Chapter Four

College Testing

Methods

Participants

The participants are students at Malone University in Canton, Ohio. The University is a small private college consisting of 2,400 undergraduate and graduate students. It is religiously affiliated with the Evangelical Friends Church. Forty percent of the campus consists of males with sixty percent being female. The college testing included a total of forty-eight participants. The ages typically ranged between 18-23 years of age. Exceptions included: 1 aging 26 years, 1 aging 33 years, and 1 person aging 66 years old. Twenty-seven participants were female and twenty-one were male. These people were recruited via email, professors on campus, as well as posters around campus. For some math classes, extra credit was offered to the participants in the study.

Twelve students were either in Intro to Algebra or Intermediate Algebra. Intro to Algebra had some skills that were included in the test and Intermediate Algebra covered all of the skills on the test. The other participants were in math classes that included: intro to statistics, pre-calculus, discrete, probability and statistics I and II, and calculus II. Some of these courses use skills that were on the test, however, none of these classes specifically instructed on the material. Eight students specified taking an algebra class within a year of the testing. Only the students' major, age, and dates of their math classes are known, no other demographics were asked of the participants.

Testing method

The testing was broken into two dates. The participants were told that they were allowed thirty minutes to take the test, however, after thirty minutes no student that arrived on time was still in the room. One participant showed up late, however, this student also took less than thirty minutes to take the test. No calculators were allowed on the test and students had to complete the test on their own. Questions about the directions were allowed, however no student asked any questions.

Materials and conditions

The test consisted of standards between seventh grade and high school algebra which is typically taken in the first year of high school. The first section dealt with the concept of negative numbers. This involved adding, subtracting, multiplying, and dividing negative numbers with positives and the different combinations. The next section included the distributive property and the concept of "adding like terms". One question was asked in solving for a variable. A section on fractions was also added to the test. One problem had a common denominator and two problems did not. The second of the two problems that did not have a denominator included a variable in the denominator. One question involved solving a system of equations. No method was specified for solving this problem. This ensured that the participants had to remember the methods and gave them the freedom to solve how they understood the problem. Three questions dealt with rules with exponents. The last portion of the test reflected the eighth grade spring break test in factoring. The college test included five questions on factoring that dealt with: taking a GCF, factoring trinomials as binomials, taking the difference of two squares, and taking the sum or difference of two cubes.

Confidentiality and safety

Before the testing began, the students were asked to sign “a statement of informed consent to participate” form. This sheet was handed in with the completion of the test. This statement informed the students about the study that they were participating in; it also informed them that the test was voluntary and that they may leave at any time. Contact information for my advisor and The Malone Human research Committee was also given on this sheet. The identities of the students were kept confidential by numbering the tests. My advisor had access to the tests with their names and demographics on them. He then put this information into an excel sheet for me to view.

Results

The results can be looked at in many different perspectives. This next section of results will be looking at different groups of students including grouping them by when their last algebra class was taken or if they were a mathematics major or not. The average score was $\frac{13.4}{20}$ points possible or about 67%. The range was between seven points to a perfect score of twenty. Only two scores were a perfect twenty, one of these students being a female mathematics major while the other was a non-traditional male student at the age of 66. The non-traditional student was currently in an intermediate algebra class, making his score non-reliable.

There were ten mathematics majors that took this test. These students were in math classes above the content on the test however, they may not have used some of the skills or concepts continually in any of the classes that they were currently taking. Their average was surprisingly low with an average score of $\frac{15.3}{20}$ or a 76.5%. These scores ranged from nine to a perfect twenty. The nine was an outlier, without this score the average was still only $\frac{16}{20}$ or 80%.

Sixteen students were either currently in an algebra class or had taken one within the past year. The data here may have underlying factors affecting their scores. The students in an algebra class in college could be students who have average or high math skills and did well in the course or students who have low math skills and still did not have high skills after taking the class. Looking at the data, the latter of the two seems to be the case. There average was $\frac{11.6}{20}$ or 58%. This average is considerably lower than the total average. Taking these students out and only considering students who had not had an algebra class in over a year increases the average to $\frac{14.7}{20}$ or 73.5%.

Looking at the different questions separately we can see what types of problems students are having after not seeing a concept for a longer period of time. Nine students missed the first question dealing with adding two negative numbers together (-5 + -7). Students most commonly subtracted 5 from 7 for an answer of two. Four of these students had an algebra class within the past year. Only five students answered the second question incorrectly (10 – (-6)). Mistakes included: multiplying the two numbers, using the 10 as a negative and using the 6 as a positive. Four students answered number three (-14/7) incorrectly and one student missed number four (-1)(-25). Only one student missed number 5 as well. The majority of the questions missed in this section, dealing with negatives, were students in an algebra class or who had algebra in the past year.

Only two students answered number six (2(x +5)) incorrectly. One in an algebra class distributed only to the variable x and not the 5; this student also missed number seven which dealt with distribution and combing “like terms”. The other student who missed number six simply rewrote the question down. This student also missed the next distribution question (number seven). Two additional students had an error when answering number 7. One, distributed correctly but added incorrectly. The other, in an algebra class, distributed correctly but did not combine “like terms”. Number eight dealt with solving an equation for a variable. Ten students missed this question, six of them either currently in algebra class or had an algebra class within the past year.

Numbers nine, ten, and eleven dealt with combining fractions. Number nine had a common denominator already and only three people missed this question. These three students were in algebra or had an algebra class within the year. Ten students answered number ten incorrectly, four students with the common mistake of adding the numerators and the denominators of the fraction without getting a common denominator first. Seven out of the ten students had math within the year. Number eleven dealt with adding fractions with a variable in the denominator. Some students in a lower algebra class may not have had this concept in class yet. This was the third most missed question on the test with 32 students. The most common answer involved multiplying the numerators with many variations of the denominators. Twelve students fell into this category. Two students added the numerators together. Ten students gave no answer or answered without any work. Five students had the concept of multiplying to get a common denominator, but had a simple mistake in their work while three had the numerator correct without a denominator.

Solving a system of equations was also a heavily missed question with eighteen incorrect answers. Eight of these students had a math class within the year. Five of these answers however only had an operation mistake and had the concept of solving the problem. Nine other students had an answer with no work shown.

The next section involving exponent rules went fairly well with numbers thirteen and fifteen on the test. Four missed number thirteen while three answered fifteen incorrectly. Number fourteen on the other hand was the second most missed question on the test at 35 students. Twelve of these students had math within the past year. Twenty five of these students understood the idea of an exponent, but did not understand negative exponents, commonly making the answer a negative number instead of putting the answer in the denominator.

Factoring concluded the test and was easily the most missed section of the test. 28, 27, 21, 28, and 43 students missed numbers 16-20 consecutively. Looking at these numbers tells us that only two students answered the last question correctly. This question dealt with factoring using the difference of two cubes method. Twenty students missed every single problem in this section with only five getting them all correct. Number 18 was the most correctly answered question of the section with twenty six students understanding the concept of factoring a trinomial into two binomials. Interesting, only one math major answered number 20 correctly.

Discussion

Looking at the college results gives light to common misconceptions in math. It is difficult to tell if these skills were never learned of if they were forgotten without a pretest. Also, the students who were currently in a math class or had math within the year, had a lower average than the other students. This may indicate that students with lower math skills in high school forget mathematical rules and concepts more easily than other students.

Looking at the data above, one can draw that more difficult ideas are forgotten faster. Simple concepts, like solving for variables, were easily recalled by students who had not had math for over a year. Solving for variables does not happen in everyday life very often, but was still easily remembered. This can be compared to the concept of factoring, which was most heavily missed on the test. Factoring tends to be a more difficult concept in high school for students and takes time. There are many different rules to remember and tricks that can be used to solve these types of problems. Remembering them all is difficult; especially when they may not have been fully comprehended the first time they were learned.

Having a pre-test in math classes, like the ones used in this test, in high school or college, can help educators see what concepts students may not have learned or have forgotten over the summer. It will reduce review time on the ideas that the majority of the students know, and will help educators' better use the review time on ideas that the students struggled with before. A conclusion that can be drawn from this testing is that math skills may not necessarily declining heavily, but students in high school are not fully understanding concepts before they are tested on it and move on to something new. Having more time in the classroom and a longer school calendar may help in giving the students the adequate time to learn something. Different instructional strategies also could be the answer to help students learn things and remember them better after time has passed. Both ideas are research questions that could be studied in the future.

Conclusion

The results from these tests show that even after years of not having math, people can still remember how to solve certain types of questions. This is true even with math that is not used in everyday life and if it had not been used for years. In high school, short breaks seem to have no effect on the overall achievement in math skills. For a longer summer break, from these results it is difficult to come to an overall conclusion about achievement. More research should be done, specifically looking at honors track students compared with the traditional tracks. Teachers should be evaluating their students at the end of the year to predict the loss that may occur over the summer. Teachers should also be testing their students at the beginning of the year to indicate how much review time should be done for that group of students. Review time may vary greatly by class and not all classes will need an extensive review. By doing this teachers will be more effective with the time in their classroom and extend the achievement that their students will have.

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Answer all questions to the best of your ability without a calculator. Show work in the blank space next to the problem or on another sheet of paper. You may leave when you have completed the test. Thank You!

Simplify.

1) -5 + (-7) = ___________ 2) 10 – (-6) = ___________

3) -14/7 = ___________ 4) (-1)(-25) = ___________

5) (5)(-2) = ___________

Distribute and combine like terms when possible.

6) $2\,(x + 5)$ = ____________

7) 3 (5 + x) + 4(5 + 7x) = _____________

Solve for x.

8) 5x + 9 = 6 x = _____________

Combine the fractions and simplify.

9) $\frac{1}{3} + \frac{1}{3}$ = ______________ 10) $\frac{1}{3} + \frac{3}{4}$ =______________

11) $\frac{2}{x-1} + \frac{x}{x+1}$ = ___________________________________

Solve the system for x and y.

12) 2x + y = 7 x= _____ y = _________

x – y = -1

Solve.

13) 5^3 = ___________

14) $3^2 \cdot 3^{-5}$ = ____________

15) $(2^2)^2$ = ____________

Factor Completely.

16) $36x^2$ - 49 = ________________

17) $2x^2$ - 6x = ________________

18) $x^2 - 6x + 8$ = ________________

19) $3x^2 + 9x + 4x + 12$ = ________________

20) $y^3 - 8$ = ________________

Name ________________________________

Age: ____________ Gender: ______________

Major________________ Date: ____________

Are you in a math class currently? If so, what class?

____

What was the name of your last math class? (If statistics, name statistics as well as the last previous math class) ______________________________________

____

When did your last math class end? If currently enrolled in one, date the last math class before the one you are currently taking. Month __________ Year____________

(Statistics, if applicable)

Month ___________ Year ___________ (Other math class)