Running head: A Study into the Recall of Basic Multiplication Facts

Memory, Multiplication and Mnemonics: A Study into the Recall of Basic Multiplication Facts

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Abstract

The purpose of this study is to examine what effects the mnemonic devices of pictures and stories have on the memorization and recall of multiplication facts. This study was conducted on a fourth grade classroom in which the students were divided into three groups. The first group was given standard flashcards, the second group was given a set of picture and story cards, and the third group was given both flashcards and picture/story cards. Students were initially assessed with a pre-test and subsequently given post-tests each Friday for five weeks. Results from the study suggest that students who received both the flashcards and the picture/story cards displayed the greatest success.

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Introduction

I have a distinct memory in my head. I'm just a young boy and I'm sitting in my room with mom across from me. Both of us are on the floor. About every three or four seconds, she takes a multi-colored card and flashes it up in front of my face. On it are two numbers with a big x next to them. My job is to multiply those two numbers as quickly as possible and spit the answer out while at the same time readying myself for the next card. Many of us have endured the same tortuous experience on numerous occasions, all for the point of memorizing our multiplication facts. The ability to quickly recall basic facts in multiplication is the very foundation of future math courses. Algebra, Trigonometry and calculus all require an in-depth knowledge of multiplication. Those courses are very difficult and any teacher would agree that brain energy spent on the process of solving the algebraic equation carries more benefit than figuring out what seven times eight is. Therefore, archiving multiplication facts in the brain with a quick ability for recall becomes the task of third, fourth and fifth grade teachers. The question emerges, though, of how to best accomplish such crucial objectives. This paper attempts to tackle that question.

I. Identifying the General Focus Area

The purpose of this study is to examine what effects the mnemonic devices of pictures and stories have on the memorization and recall of multiplication facts. Rote memorization has had many proponents and detractors in recent years. Alan Walker, on his multiplication website (Walker, n.d.), offers some insight into rote memorization, specifically outlining its benefits. An overwhelming majority of teachers have admitted to using this method simply because it works for most of their kids. Since most teachers use it, rote memory has had a profound impact on traditional education. It also requires very little in the purchase of resources. In an age of

increasing economic doom and gloom but lower educational dollars, many teachers find this advantageous. According to Walker, rote memory takes a large amount of time and commitment to be effective, giving it a downside. Rote memory takes practice and repetition. Since many students will not be able to practice multiplication at home, part of the instructional day is necessary to complete the task. Walker also states that "research has show(n) rote memory to be the least effective way of memorizing." (Walker, n.d.) However, he does not cite the research to which he is referring.

Daniel Cho (n.d.) reports on a brain imaging study by Yale University professor Sally Shaywitz. The research studied dyslexia as related to reading, but had some insight into rote memorization. Cho reports that Shaywitz found poor readers were attempting to identify words by rote memory rather than associating letters with sounds, as do most normal readers. Shaywitz concluded that these readers would do better with stronger phonics instruction rather than the common whole reading approach. In this study, rote memory proves ineffective for struggling readers, indicating some students may have the same difficulty with math.

Britiney Fife (2003) conducted an action research report on first graders assessing the use of flash cards versus active learning. Her report found no strong conclusions that active learning produced better results than flash cards. Dogged by many variables throughout the study, she did admit that her experimental group was small and time was limited. Due to these circumstances, Fife suggested further study for a solid answer.

Anita Zutaut (2002) performed an action research report on fourth graders. She assessed the use of mnemonic devices in multiplication facts, much as this researcher's project has undertaken. She too, had a number of uncontrolled variables, but had a slightly larger experimental group composed of students from her classroom. Over the course of several weeks,

she worked with two groups of students, one using flashcards, and the other mnemonic devices. Her results though showed no significant increase in the recall of multiplication facts when mnemonic devices are used.

Staci Bielsker (2001), along with a group of researchers, studied the effects of Touch Math, multiple intelligences and mnemonics on the recall of math facts for first and second graders. They found that first graders produced little extra while using mnemonic devices simply because they could not understand the concept. The transition from abstract to concrete seemed to bypass them thus making mnemonics a useless activity. Second graders, however, saw great success while using mnemonics. In fact, they preferred this method to any other because of the higher level thinking involved in relating the mnemonic to the concrete fact.

Overall, the literature concerning mnemonic devices such as rhymes, pictures, stories, etc. in aiding the recall of math facts is inconclusive. It almost seems as though research exists to support your favorite method. The trend in education, however, is moving away from traditional, rote memorization using flashcards. Although the literature mentioned in this report shows a certain level of confusion regarding the topic, mnemonic devices have shown past success. In addition, other research encourages their use.

II. Analysis of the Focus Area

This particular project offered a number of variables that proved uncontrollable. One of the most obvious involved absent students. Due to the setup of the day, absent students were unable to make-up the missed learning time with the instructional tools. Students who missed often showed a lower and slower learning curve. Another variable was cheating. All students were shown the goal time of 100% in five minutes or less and instructed how to reach it. Even though the researcher moved about the room during testing, students still had the opportunity to

look onto another classmate's test or remove a cheat sheet from within their desk. On several occasions, students displayed an unforeseen variable by simply making a copy mistake from the overhead onto their paper. By doing so, they limited the possible number of correct answers. The easy correction to this, though, was to simply supply a pre-made sheet with the multiplication problems already on it. Students also had variables of extra practice and study time. Although students did not take study tools home, controlling additional study was an unmanageable. Extra work in other classes or help from home was always a possibility. Finally, some students simply showed an uncaring attitude towards multiplication facts. They were uninterested in any competition or the achievement of goals. This resulted in low scores, unless they wanted to participate that day. The lack of consistency in a student's attitude could have skewed the results.

III. Generating Potential Solutions

Several options are available for instructors to use in teaching their students multiplication facts. The least expensive of these is flashcards simply because they can be homemade. Obviously, purchased flashcards are available, but even that solution is relatively inexpensive. Another solution relies on computer programs. Depending upon the chosen program, prices can quickly run into the hundreds of dollars, making the solution less conceivable. In order for this method to be effective, though, students in the classroom must have easy access to a computer. A less expensive computer option involves many websites that offer interactive practice on multiplication facts. Again, in order for this to be a viable option, all students must have access to a computer. Other purchase items include pre-made tools such as multiplication wraps. The benefit of these is their ease of use, quick feedback, and enjoyment they provide. The downside—cost. Each student requires on wrap, and several must be

purchased to have all of the multiplication facts. Another option is available online. Mulitplication.com has free solutions that involve the use of mnemonic devices to aid in the memorization and recall of multiplication facts.

IV. Developing the Action Research Plan

While reviewing the literature, several questions naturally emerged. Those questions formed the base of this action research project.

1. Do students learn multiplication facts better when they are associated with pictures and stories?
2. Would adding flashcards to the mnemonic devices of pictures and stories improve memorization and recall of the multiplication facts?
3. Will conducting an action research project in my classroom improve the overall recall of multiplication facts?
4. Do the mnemonic devices of pictures and stories motivate students to learn the multiplication facts quicker?

The answers to these questions will provide an excellent foundation for future action in the classroom. Perhaps the answers to these will assist other teachers as well.

A relatively straightforward model was setup in the classroom to find the research question answers. The researcher divided a fourth grade classroom as equally ass possible into three groups. In order to remove bias, random groupings proved best. The first group was the control group (Group A) and received the traditional flashcard approach. The second group (Group B^1) was the first experimental group and received a set of cards that contained the multiplication facts, a picture, and a story to go along with them. The third group (Group B^2)

was the second experimental group. They received both the flashcards and the picture/story cards.

The tools used for study were flashcards and picture/story cards. The flashcards were single-digit multiplication facts printed on one side of a card approximately 3" x 2". The backside of the cards had the same multiplication fact with the answer beneath it. The picture and story cards were printed length-wise on an 8 ½" x 11" sheet of paper and contained three parts to aid the student in recall. At the top of the paper, the multiplication fact was listed—for example 2x3=6. Beneath the fact three pictures were drawn. The first picture was associated with the two. The second picture was associated with the three. The third picture was associated with the six. Each of the pictures contained an object that rhymed with the number they represented—for example a shoe, a tree, and sticks. Beneath the pictures was a paragraph. The paragraph explained through a story the relationship of the three pictures—for example: how a shoe times a tree would equal sticks. See Appendix A for an example.

Three times a week students worked with their group of cards. Each session lasted approximately 20 minutes. Students had a partner within each group who they would work with to memorize the facts (In retrospect, this grouping needed more control. Such a setup allowed another variable of non-participation). The flashcard teams would take turns holding up the cards and stating the answers. The picture/story teams would read the fact, study the pictures, read the story, and attempt to reproduce the story. Each Friday students received a post-test to assess learning (See Appendix B for a copy of the test).

V. Analysis of Data

The researcher used two data collection methods during the experimentation period. The first was the post-test given each week. Each post-test recorded the number of correct answers

and the amount of time to complete the test. The researcher then made calculations to determine how many seconds were required to record a correct answer called the SFC (Seconds for Completion). Over a series of several weeks, students received five tests. All underwent comparison to previous tests. Averaging each group's score allowed for easy comparison of changes. Finally, averaging all scores enabled a comparison from week to week to note improvement or decline.

The second method used for collection was an anecdotal journal kept by the researcher. The hopes were to capture general emotions and thoughts that pre and post-tests would not reveal. The journal would add some depth to the numbers shown in the pre and post-tests.

The data needs interpretation in relation to the research questions previously stated. The first question dealt with better learning when pictures and stories are associated with multiplication facts. In order to evaluate the data for this question, examining the control group must come first. Group A, made up of six students from various ability levels, showed a pretest score of 56%. Their time for completion was 16 minutes and 17 seconds. This gave them an SFC (Seconds For Completion) of 17.6. After five post-tests and nearly 15 specific study times Group A had a final score of 98%. The completion time was 11 minutes and 36 seconds giving them an SFC of 7.1. Their percentage correct increased by 42% and the SFC improved by 10.4 seconds.

Group B^1 began with 35% of their answers being correct. The time for completion was 17 minutes and 38 seconds giving them an SFC of 30.7. Five post-tests later, Group B^1 had a score of 85% and completed their tests in 12 minutes and 6 seconds giving them an SFC of 8.6. This results in a percentage correct increase of 50% and an SFC improvement of 22.1 seconds.

See Table 1 for a graph of these SFC scores. Also, see Appendix C for a complete listing of scores.

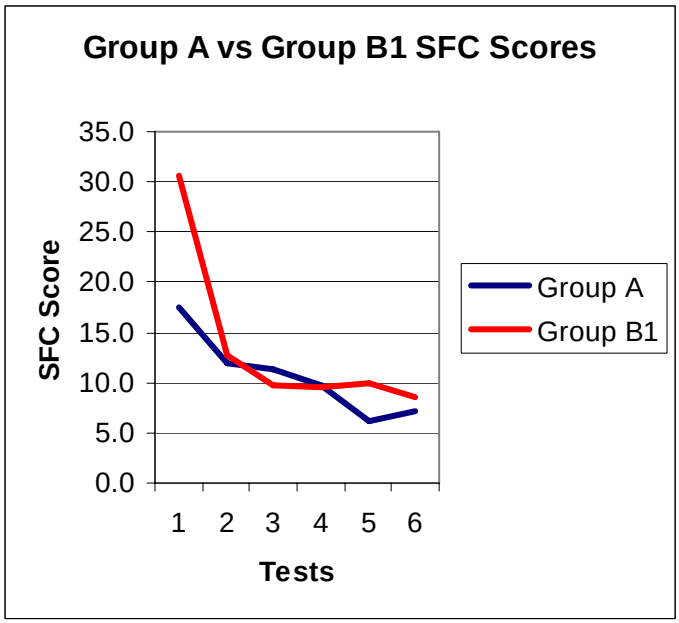

Table 1

The results of these scores indicate that, though Group A began with a higher SFC, Group B^1 showed a greater improvement in percentage correct answers, time to complete, and SFC scores. This seems to imply that learning multiplication facts with the mnemonic devices of pictures and stories aides better in memorization and recall.

The second research question dealt with improved memorization when mnemonic devices include flashcards. Again, Group B^1 began with 35% of their answers being correct. The time for completion was 17 minutes and 38 seconds giving them an SFC of 30.7. Five post-tests later Group B^1 had a score of 85% and completed their tests in 12 minutes and 6 seconds giving them an SFC of 8.6. This results in a percentage correct increase of 50% and SFC improvement of 22.1 seconds.

Group B^2 began with 72% of their answers being correct. Their initial time for completion was 20 minutes giving them an SFC of 16.8. The final scores for Group B^2 show 84% of their answers being correct. They completed their tests in an average of 8 minutes and 46 seconds giving them an SFC of 6.3. This results in a percentage correct increase of only 12%, but an SFC improvement of 10.5 seconds.

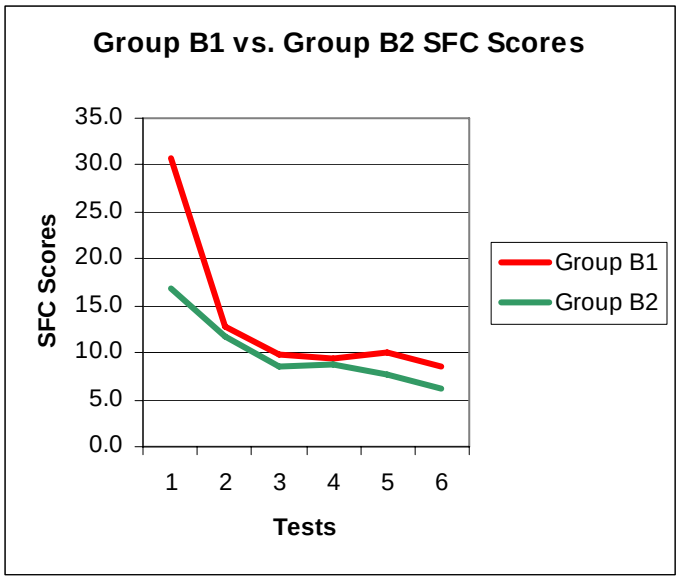

Table 2

Group B^2 began with a much higher percentage correct (See Table 2). Due to this fact, they had the lowest percentage improvement of correct answers. However, their final SFC score was the lowest, meaning they had a quicker rate of getting correct answers. Group B^2 also had a nearly identical SFC improvement to Group A (See Table 3). The results of these scores seem to indicate that adding flashcards to mnemonic devices will aid in the memorization and recall of multiplication facts.

The third research questions deals with the overall effect of action research in the classroom. The researcher wondered whether such activities would offer any comprehensive improvement of multiplication facts across the classroom. On the first pre-test, the whole class averaged 52% correct (see Table 4). Their time averaged to 17 minutes and 43 seconds (see Table 5), giving the class an SFC of 20.6 (see table 6). On the last post-test, the class averaged 83% correct and completed the test in 10 minutes and 55 seconds. This resulted in a class average SFC of 7.9; again, meaning every 7.9 seconds the average

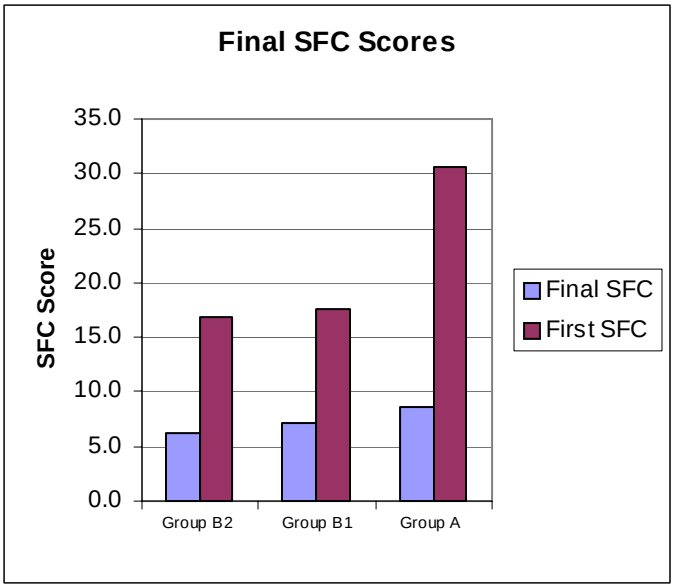

Table 3

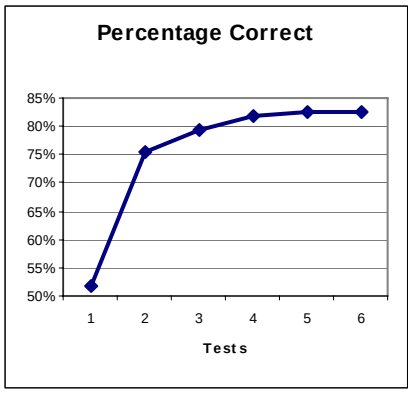

Table 4

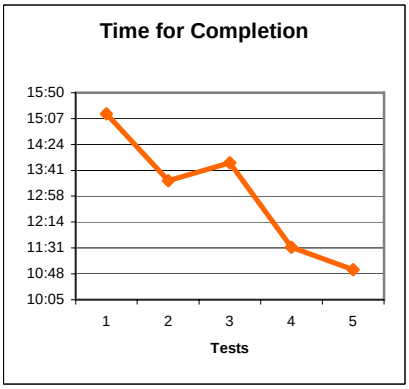

Table 5

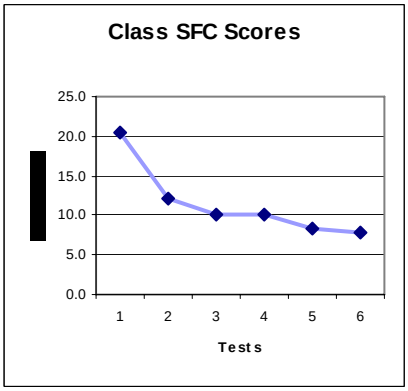

Table 6

student answered one multiplication fact correctly. Despite the uncontrollable variables hurdled throughout the experimentation process and regular frustration of careless mistakes made by students, there is a delightful surprise to see that the class as a whole greatly improved their multiplication facts. Therefore, the third research question had a positive answer regarding the effect of action research on the classroom.

The fourth question dealt with general feelings of motivation concerning the mnemonic devices. In the journal, the researcher notes that a considerable amount of excitement was the initial response of the students, regardless of group. As time wore on, several students began to describe frustration with their partner, though this deals with more of a personality issue than a motivational one. Around the fourth post-test many of the Group A students began to get bored with the flashcards. They would regularly ask the teacher if they could use the picture and story cards instead of the flashcards. By the last post-test, all students seemed to be weary of everything. One note of interest was the observations of Group B^2 who received both types of learning devices. Initially, they used both sets of cards, but by the end, they focused mainly on the flashcards. It seems they felt as though they had already learned the facts and were using the flashcards to improve their speed, which the data describes as what happened.

VI. Drawing Conclusions

The steps this particular research presents are simple and straightforward. The group that received both mnemonic devices and flashcards showed the greatest jumps in success. It is this researcher's opinion, therefore, that the classroom should have a large number of mnemonic devices to begin with and finish off with flashcards for speed and accuracy development. Short spurts describe a more effective method rather than day-after-day, week-after-week pressure. Perhaps an exploration of five to six two week bursts is in order.

Overall, the length of time for research and experimentation was limited and needs further development. More research is necessary to confirm the results of this report. In particular, an examination of the effects of the two-week burst mentioned above is in order. Consideration on the limitations of variables is necessary and different grouping techniques are advisable.

This particular research was enjoyable and offered a great deal of insight into the students of this classroom. Certainly, the students who struggle with multiplication have been pegged and potential help for them has been exposed. Furthermore, the entire classroom showed a considerable level of improvement from the day experimentation began. Perhaps after a short break the students will be eager to begin again, and maybe, with a little blessing, the multiplication facts can be fully internalized.

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Appendix A

Picture and Story Card

FACT 4 x 4 = 16

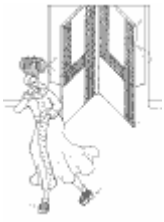
Door x Door = Sick Queen

DOOR (4)

X

DOOR (4)

=



SICK QUEEN (16)

Story:

One evening, there was a party for a queen at a big hotel. The hotel had revolving doors. When the queen got to the hotel, she was amazed to see the revolving doors. She had never seen such interesting doors. She pushed the doors and went around and around and

Appendix B

Post-Test

Facts Master

Time _____

Score _____

Appendix C

List of Scores

	10/19		seconds for correct	10/22			seconds for correct	Chng	10/29			seconds for correct	Chng
Group A													
Student 1	**25%**	**20:00**	**48.0**	**37%**	12%	**20:00**	**32.4**	15.6%	**15%**	-22%	**19:47**	**79.1**	-46.7%
Student 2	**37%**	**15:00**	**24.3**	**89%**	52%	**15:00**	**10.1**	14.2%	**92%**	3%	**20:00**	**13.0**	-2.9%
Student 3	**16%**	**15:07**	**56.7**	**1%**	-15%	**9:45**	**585.0**	-528.3%			**Absent**		
Student 4	**93%**	**20:00**	**12.9**	**96%**	3%	**13:00**	**8.1**	4.8%	**100%**	4%	**9:27**	**5.7**	2.5%
Student 5	**68%**	**20:00**	**17.6**	**85%**	17%	**17:27**	**12.3**	5.3%	**84%**	-1%	**20:00**	**14.3**	-2.0%
Student 6	**95%**	**7:34**	**4.8**	**100%**	5%	**6:16**	**3.8**	1.0%	**100%**	0%	**5:15**	**3.2**	0.6%
	56%	**16:17**	**17.6**	**68%**	**12%**	**13:35**	**12.0**	5.6%	**78%**	10%	**14:54**	**11.4**	0.6%
Group B[1]													
Student 7	**30%**	**18:30**	**37.0**			**Absent**			**58%**	28%	**18:53**	**19.5**	-19.5%
Student 8	**1%**	**20:00**	**1200.0**	**51%**	50%	**20:00**	**23.5**	1176.5%	**76%**	25%	**20:00**	**15.8**	7.7%
Student 9	**53%**	**20:00**	**22.6**	**92%**	39%	**18:00**	**11.7**	10.9%	**91%**	-1%	**11:00**	**7.3**	4.5%
Student 10	**24%**	**15:39**	**39.1**	**69%**	45%	**20:00**	**17.4**	21.7%	**65%**	-4%	**8:06**	**7.5**	9.9%
Student 11	**20%**	**20:00**	**60.0**			**Absent**					**Absent**		
Student 12	**79%**	**11:40**	**8.9**	**100%**	21%	**8:03**	**4.8**	4.0%	**81%**	-19%	**6:13**	**4.6**	0.2%
	35%	**17:38**	**30.7**	**78%**	**44%**	**16:31**	**12.7**	18.0%	**78%**	0%	**12:50**	**9.8**	2.9%
Group B[2]													
Student 13	**50%**	**20:00**	**24.0**	**73%**	23%	**16:00**	**13.2**	10.8%	**71%**	-2%	**9:36**	**8.1**	5.0%
Student 14	**65%**	**20:00**	**18.5**	**68%**	3%	**20:00**	**17.6**	0.8%	**89%**	21%	**19:10**	**12.9**	4.7%
Student 15	**83%**	**20:00**	**14.5**	**94%**	11%	**14:58**	**9.6**	4.9%	**92%**	-2%	**10:00**	**6.5**	3.0%
Student 16	**88%**	**20:00**	**13.6**	**99%**	11%	**14:00**	**8.5**	5.2%	**99%**	0%	**11:00**	**6.7**	1.8%
	72%	**20:00**	**16.8**	**84%**	**12%**	**16:15**	**11.7**	5.1%	**88%**	4%	**12:27**	**8.5**	3.2%
Class Total	**52%**	**17:43**	**20.6**	**75%**	**24%**	**15:15**	**12.2**	8.4%	**80%**	4%	**13:24**	**10.1**	2.0%

Appendix C (continued)

	11/5			seconds for correct	Chng	11/12			seconds for correct	Chng	11/19			seconds for correct	Chng
Group A															
Student 1	9%	-6%	20:00	133.3	-54.2%	18%	9%	15:50	52.8	80.6%	47%	29%	13:01	16.6	36.2%
Student 2	97%	5%	20:00	12.4	0.7%	97%	0%	15:10	9.4	3.0%	96%	-1%	14:10	8.9	0.5%
Student 3	93%	92%	17:38	11.4	573.6%	86%	-7%	10:14	7.1	4.2%			Absent		
Student 4	98%	-2%	9:50	6.0	-0.4%	100%	2%	5:15	3.2	2.9%	100%	0%	9:15	5.6	-2.4%
Student 5	95%	11%	20:00	12.6	1.7%	83%	-12%	6:00	4.3	8.3%	98%	15%	9:57	6.1	-1.8%
Student 6	99%	-1%	6:39	4.0	-0.9%	99%	0%	5:14	3.2	0.9%			Absent		
	96%	18%	15:41	9.8	1.7%	93%	-3%	9:37	6.2	3.6%	98%	5%	11:36	7.1	-0.9%
Group B[1]															
Student 7	66%	8%	16:59	15.4	4.1%	60%	-6%	12:42	12.7	2.7%	49%	-11%	11:50	14.5	-1.8%
Student 8	80%	4%	20:00	15.0	0.8%	74%	-6%	20:00	16.2	-1.2%			Absent		
Student 9	90%	-1%	7:50	5.2	2.0%	99%	9%	11:41	7.1	-1.9%	100%	1%	9:10	5.5	1.6%
Student 10	64%	-1%	5:40	5.3	2.2%	90%	26%	18:50	12.6	-7.2%	91%	1%	14:28	9.2	3.3%
Student 11	71%	51%	20:00	16.9	43.1%	81%	10%	20:00	14.8	2.1%	80%	-1%	20:00	15.0	-0.2%
Student 12	100%	19%	6:14	3.7	0.9%	100%	0%	4:59	3.0	0.8%	68%	-32%	5:01	4.4	-1.4%
	81%	3%	12:47	9.5	0.4%	89%	8%	14:42	9.9	-0.5%	85%	-4%	12:06	8.6	1.4%
Group B[2]															
Student 13	81%	10%	8:36	6.4	1.7%	76%	-5%	8:56	7.1	-0.7%	73%	-3%	9:17	7.6	-0.6%
Student 14	85%	-4%	19:58	14.1	-1.2%	65%	-20%	14:15	13.2	0.9%			Absent		
Student 15	99%	7%	10:00	6.1	0.5%	97%	-2%	7:30	4.6	1.4%	95%	-2%	8:00	5.1	-0.4%
Student 16			Absent			95%	-4%	9:30	6.0	-6.0%	93%	-2%	9:00	5.8	0.2%
	88%	1%	12:51	8.7	-0.2%	79%	-9%	10:03	7.6	1.1%	84%	5%	8:46	6.3	1.3%
Class Total	82%	2%	13:53	10.2	-0.1%	83%	1%	11:32	8.4	1.8%	83%	0%	10:55	7.9	0.4%