Evaluating Grit Through the use of MathSpring in Individualistic and Collectivist Cultures

A Major Qualifying Project

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By

Luisa Perez Lacera

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Professor Ivon Arroyo, Advisor

Abstract

The purpose of this research is to analyze the relationship between learning technologies and affect, particularly in relation to students' grit, before and after using a software called MathSpring. This study also analyzes cross-cultural differences in grit between an individualistic culture (United States) and a collectivist culture (Argentina). The United States dataset consisted of students from different schools in Massachusetts. The Argentina dataset comes from a study conducted in three Argentine middle schools and MathSpring was tested in each school to see if grit was affected over a 5 week period. Grit was affected by the program as students had a higher post test score than their pretest score. The comparison between students from the United States and from Argentina after using the MathSpring software revealed that Argentina students had a higher post test grit than United States students. Predicting grit from problem solving behaviors gathered from MathSpring proved insufficient.

Keywords: Grit, Intelligent Tutoring System, Growth-Mindset, MathSpring, Individualist, Collectivist, Culture, Schools

1. Introduction

Institutions are becoming increasingly more accepting of technology and attempting to intertwine education with it. One school in Massachusetts has incorporated a 1:1 program, where one student has access to at least one device to use as a resource in their learning, and some states have implemented this policy for all the schools in their district ("Technology," n.d.). The state of Maine, for instance, has had a 1 laptop per child for the past 15 years; however, some recent articles have suggested that this policy has not made a difference in children's educational attainment (Morris, 2017). On the other hand, three teachers in a school in Texas have found that using an educational application, Quizalize, to prepare for a standardized assessment actually increased students' scores ("Test Scores up 10% with Edtech", 2017). While there may be a multitude of factors in how both areas dealt with technology, it can be surmised that technological devices alone will not help a student.

What students see on their screens matter, the kind and quality of software is key at impacting students in a positive manner. One software, MathSpring is a tool that was created to have a positive impact on students through the use of technology. Cognitively, students are solving math problems on various topics and, through their work, the software curates problems that are easier or more difficult for the student depending on how well they are doing. MathSpring can also leave a positive affective impact on students through its animated characters who offer encouragement or praise on each problem. Through the use of MathSpring, students have seen an increase in test scores in the United States (Arroyo, Woolf, Burelson, Muldner, Rai, & Tai, 2014).

As noted, much of the research with MathSpring has been done in the United States, an individualistic culture. What would happen if MathSpring is also used in a collectivist setting? This research broadens the scope by traveling to Argentina, a collectivist culture, and implementing the program in three different middle schools. Through these schools, I will also look at grit. Grit is a person's passion and incentive for achieving a long-term goal (Duckworth, Peterson, Matthews, & Kelly, 2007). It has been shown through studies that grit can be a predictive measure for future success (Eskreis-Winkler, Shulman, Beal, & Duckworth, 2014). While grit can suggest a certain future for an individual, is that characteristic something that is set in stone? Some may note that it is an unwavering trait, though it is not fact. Through the affective impact of MathSpring, can grit change? Moreover, grit has mostly been assessed with older participants and not those of a younger age. Since the students in Argentina will be of middle-school age, grit will be assessed and compared with United States students to see if one group is "grittier" than the other. Given all of this, my research project attempts to investigate:

RQ1. How do students display their grit and how can we effectively assess grit within Mathspring?

RQ2. Can grit be different between an individualist and collectivist culture? Between the US (individualistic) and Argentina (collectivist)?

RQ3. Can we affect grit by training growth-mindset in MathSpring? Can grit improve thanks to the messages delivered by characters who train their perseverance and effort?

2. Background

Prior to commencing the study, research needed to be completed. An elaboration of grit is explored. Differentiating and explaining why certain countries are either individualist or

collectivist are examined. A brief history of MathSpring is also included below, demonstrating how the program works the way it does.

2.1. Grit

Grit is defined as a "passion and perseverance for long-term goals" (Duckworth, & Eskreis-Winkler, 2015). It is a personality trait that encompasses the characteristics of people who do not let challenges stop them from achieving their goals. People who have grit can be seen working diligently towards their goals, not necessarily short-term goals, but long-term ones that can take years to complete. These people are usually found to be very successful not only in their work but their home lives as well. Although this does not necessarily mean that they have a high capacity for knowledge (Duckworth et al., 2015), grit can be seen as something potentially more important than intelligence itself. But people who have a high grit tend to be people who have a passion for what they do, exert huge amounts of effort when they want a goal completed, they will not back down whatsoever, and they have high diligence in what they do as illustrated in Figure 1. It is still under debate if GRIT is a trait that cannot be changed, or if GRIT is something

that can be taught. From an educational perspective, it would be ideal if GRIT could be trained.

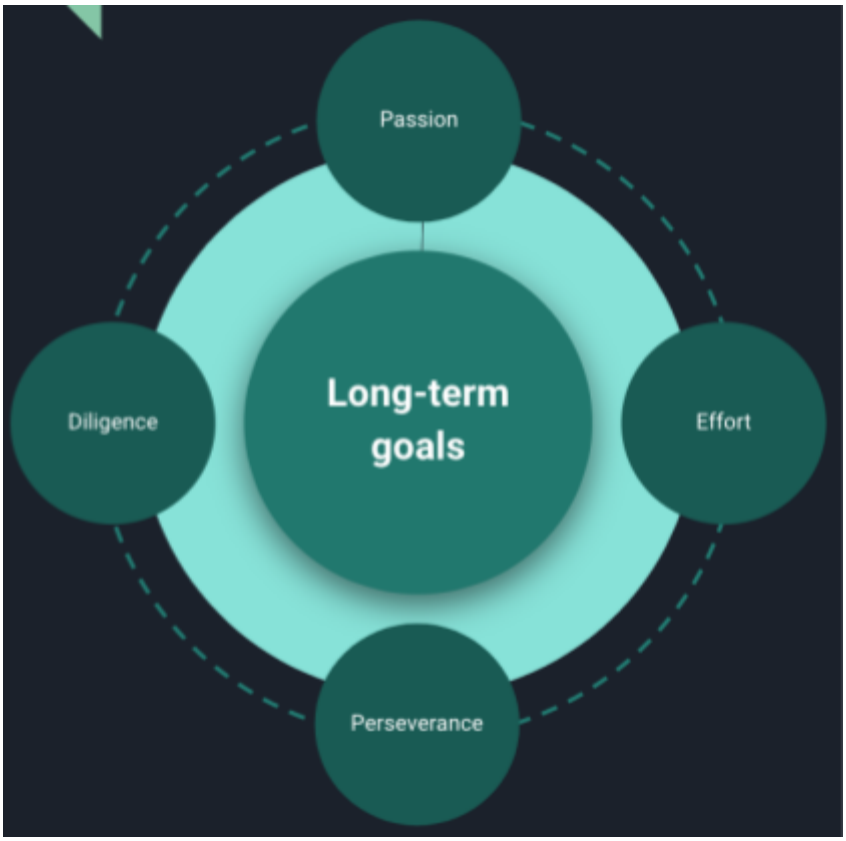

Figure 1*: Personality aspects that make up grit.*

There is a chance that grit can be affected. One possibility could be that growth mindset training could affect a student's grit assessment. Growth mindset implicitly believes that intelligence is malleable; it is not a static trait where if one cannot initially understand a topic, then it is improbable that they are to advance (Blackwell, Trzesniewski, & Dweck, 2007). This theory has been shown to have important impacts on behavior, which is an attribute loosely apart of the embodiment of grit.

Recently, a large longitudinal study was carried out, involving sixty-five schools all over the United States to test the benefits of training student's growth mindset (Yeager, Hanselman,

Walton, Murray, Crosnoe, Muller, & Dweck, 2019). Secondary education students in the experimental condition received a short, less than one hour, web-based online growth mindset intervention and it taught that intellectual abilities can be developed. Results showed that grades improved among lower-achieving students, and also increased overall enrollment to advanced mathematics courses. The intervention managed to change grades when peer norms at the school aligned with the message of the intervention.

If a short, long-term intervention of growth mindset was capable of increasing grades, then there is a chance that a similar intervention can affect grit. Previously mentioned and will be later explained, there are animated characters that are with the student as they are solving MathSpring problems. Those characters are sending positive messages similarly embodying the growth mindset theory. If the same results were to happen, a grit assessment would be higher because students will understand failure is a learning experience, not a setback, which would lessen discouragement of long term goals and encourage students to seek out those types of goals.

2.2 Individualistic and Collectivistic Cultures

An individualistic culture is where a person or a group of people primarily look to themselves. They focus more on their own goals and motivations rather than the benefits of a group (Triandis, 2018). Collectivist cultures more rather focus on the opposite. They focus on the goals of benefiting others or a group of people and emphasize their connectedness with that group. Typically, that group is most likely one's family and someone with a collectivist mindset will make sure they are providing and doing the best that they can for their family and will prioritize that over their own goals or ambitions.

It is commonly associated for the United States to be classified as an individualistic culture (Harms, 2007). Americans are less likely to touch each other during typical interactions with other people. There is more of an emphasis on personal space and therefore, there is less physical connections between family and friends (Rosenbaum, 2018). It has been shown that touch can increase bonds and positivity between people (Konnikova, 2015). If Americans are less likely to physically interact with others, then they are more isolated and look inwards. In many cases, depression becomes more prevalent the more individualistic a culture is (Alleyne, 2009). While Argentina has a blend of both European and Latin American traditions, the country still leans more collectivist. Family is still the main importance in society (Garza, McGregor, & Nguyen, 2018). Argentineans are more affectionate, greeting each other with kisses on the cheek, hands on shoulders.

In one article (Datu, 2017), it was found that people who connect with a collectivist culture have more to lose because of the connectedness they had with others, so if they fail in something, then by extension they also failed the family or group that person is a part of. Since those people had more connections to others, the article found that those people generally had a higher grit. If these results hold true then the Argentina participants should also have a higher grit than the United States participants.

2.3 MathSpring

The intelligent-tutoring system called MathSpring and originally named Wayang Outpost, is an adaptive tutoring system that allows students to practice different math problems based on the Massachusetts Comprehensive Assessment System (MCAS) and its Common Core standards (Arroyo et al., 2014), as seen in Figure 2.

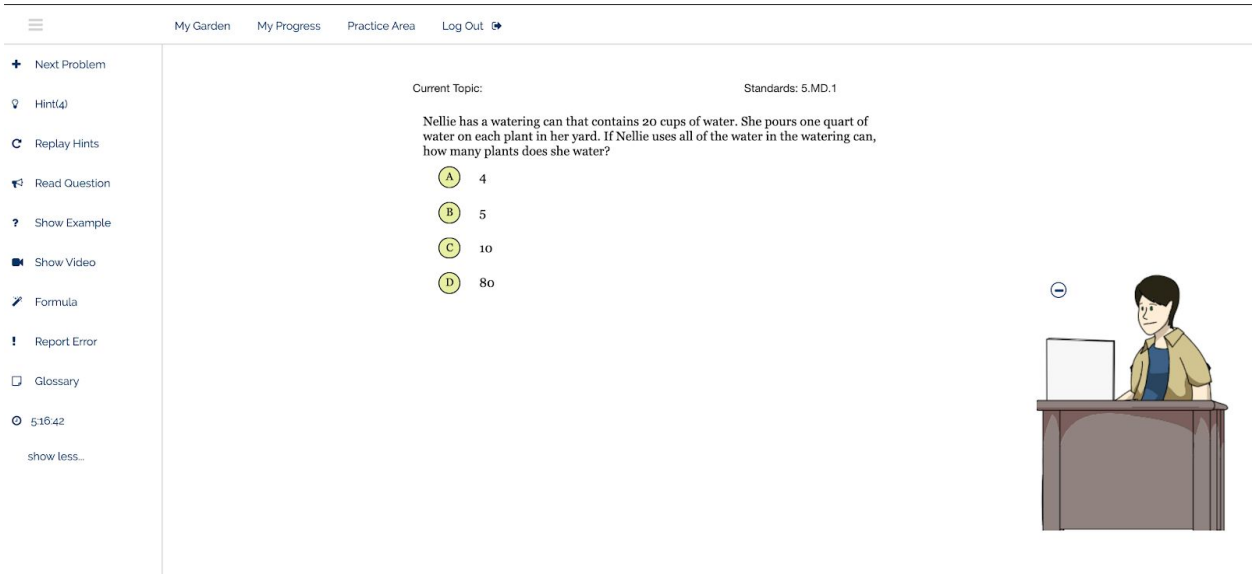

Figure 2: *Visual of what the student sees in MathSpring as they solve problems.*

MathSpring can create personalized instruction based on cognitive diagnostic assessment and effort-based tutoring. As individual mathematics difficulties vary within a class, it is challenging for teachers to meet the needs of every student. MathSpring maps student skills onto a fine-grained cognitive model of 214 mathematics topics and automatically assesses students' knowledge based on the model. An effort-based tutoring (EBT) algorithm considers a student's recent performance on each topic as well as level of effort exerted (e.g. is the student skipping, not reading, solving with hints) to provide adaptive selection of problems with increased/decreased difficulty. Each student has a garden where each plant represents a problem set and how well developed it is signifies the amount of effort put into the problems, as seen in Figure 3 (Arroyo et al., 2014). The tutor attempts to maintain students within a zone of proximal development by selecting problems that are neither too easy nor too hard (Vygotsky, 1978). A small randomized controlled study suggested that EBT improved learning, compared to a control

condition where problems were randomly selected for the same topic (Arroyo, Cooper, Burleson, & Woolf, 2010a).

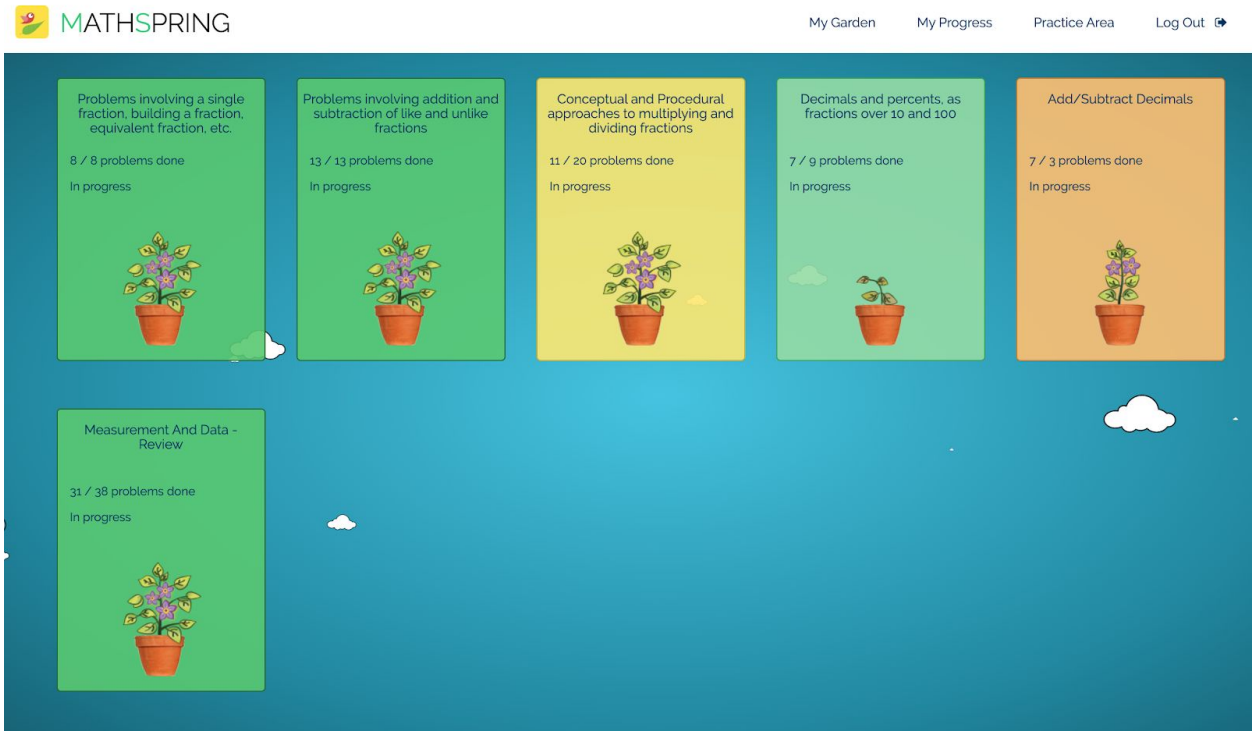

Figure 3: *The garden that students see with plants at various stages of development.*

The program also offers on-demand multimedia assistance. Rich multimedia help is available on-demand and offered when students make mistakes. MathSpring models problem solutions via worked-out examples with the use of sound and animations. MathSpring can read problems aloud and speak hints/help to the student, using auditory/visual channels, following multimedia-learning principles such as contiguity, modality, and animation (Mayer, 2009). Tutorial videos are also available to demonstrate strategies to approach problems more thoroughly. Like a human tutor, the system supports sustained engagement and structured practice required for students to become better learners and problem solvers.

There is also assessment of student emotion and engagement. Students are occasionally asked how they are feeling, with the ability to say how frustrated or confident they are feeling right now; this information is stored in the database of MathSpring for later retrieval and analysis, and also is presented to the teacher via visual charts.

MathSpring has also implemented affective learning companions and growth mindset interventions. MathSpring features a suite of animated learning companions (LCs) that are gendered animated characters sitting at the corner of the screen, who promise to be solving the problem together with the student. The characters are *empathetic* and use gestures to visually reflect the last emotion that the student has recently reported. The LCs demonstrate excitement when the system predicts that students have invested effort in problem solving activities and frustration when students seem to be stuck. The LCs act as study partners, offer advice and encouragement messages. Learning Companions train "Growth Mindset", expressing full sentences about the importance of *perseverance* and *effort* (e.g., praise students who exert effort even if the answers are incorrect) and the idea that intelligence is malleable (e.g., "You can grow your mental muscles through effort and work,") (Dweck, 2006). From previous studies, we know that characters can manage to alter the engagement behaviors of students within the software and improve feelings of frustration, confidence, interest and excitement (Arroyo et al., 2014).

3. Method

While only one study was conducted, three measures were produced to answer each research question.

3.1 Identifying and Assessing Grit

In the Argentina study, Duckworth's 8-point survey will be used to keep in line with the survey that was used for the United States data (Duckworth et al., 2015). In Table 1, each question can be seen.

Table 1 Grit-S items

Grit scale
1. New ideas and projects sometimes distract me from previous ones.*
2. Setbacks do not discourage me.
3. I have been obsessed with a certain idea or project for a short time but later lost interest.*
4. I am a hard worker.
5. I often set a goal but later choose to pursue a different one.*
6. I have difficulty maintaining my focus on projects that take more than a few months to complete.*
7. I finish whatever I begin.
8. I am diligent.

Note. Starred items are reverse coded. All items are rated by participants on a scale from 1 to 5 ranging from 1 = *Not like me at all* to 5 = *Very much like me*.

The survey looks at one's effort and passion and quantifies a score based on the response people give on a Likert scale ranging from 1 ("Not like me at all") to 5 ("Very much like me") to the eight statements (e.g. "I am a hard worker"). Four of the statements, which are starred will be reverse coded. While the survey has been tested, tried, and true there is still the potential of bias that can come into play. A common limitation to self-reported surveys is a social desirability bias

(Demetriou, & Özer, & Essau, 2015). In summation, this bias presents itself when a participant wants to be viewed in a socially acceptable way, which can true for most people. There is also the issue of people not answering truthfully or to the best of their ability because they do not see the "point" of the study. To avoid these biases, I want to focus on using another method that can calculate grit without just relying on a self-reported study.

3.1.1 Potential MathSpring Behaviors Related to Grit

MathSpring, as stated prior, has the capability to record certain efforts a student exhibits while using the program. The variables that will be focused on are: SKIP, NOTR, GIVEUP, SOF, ATT, GUESS, and SHINT. SKIP means that the student simply skipped a problem without doing anything to it. NOTR signifies that the student is not even reading the problem, they answered too quickly in under four seconds. GIVEUP means that the student started to work on the problem but they quit and moved on without solving correctly. SOF signifies that the student solved the problem correctly on the first attempt without any help. ATT means that the student tried to answer the problem, but got it wrong once, then answered correctly in the second attempt with no help. The GUESS variable means that the student clicked through three to five answers until they got the right one. SHINT means that the student solved the problem correctly after seeing one or more hints. How many hints and mistakes a student makes will also be considered along with time spent on a problem. Hints and mistakes will be aggregated to each student and each effort variable will be divided by the total number of problems each student has done to find a percentage that can be compared with the other students.

3.2 Differentiating Between Individualist and Collectivist Cultures

To see if there are any potential differences, a previously collected United States grit results will be compared against the Argentina student's grit results.

3.2.1 Existing US Data

Participants

In 2017-2018, data was collected from various schools around Massachusetts. 324 students in primarily 6th and 7th grade were obtained through completing math problems in MathSpring. The dataset has points regarding the student's location, which group they were in, grade, the score they inputted to answer the grit survey, and timestamp. Grit scores were collected from a post test after students have completed the duration of using MathSpring in their program.

3.2.2 Argentina Data

Participants

Three schools participated in this study. Each section participating are all in sixth grade. All schools originate near the northern center of Argentina. The first school is a middle Catholic school, which from now on will be referred to as school N. There were 43 students (17 males, 26 females) working with us. The students were split up by sex and met at alternating times on Friday; females worked with us for 55 minutes, while males worked with us for 50 minutes. In the next school, school B, we met with once a week on Tuesdays. There were two classes, each consisting of 38 students that we met for 45 minutes. School B did not have enough computers so the students had to work in pairs. The last school (school A), was a trilingual school, however,

we only worked with students focused on Spanish and English. Twice a week on Mondays and Wednesdays, in the morning, the students worked with the software in Spanish. There were three different sections, sections A and C had 21 students while B only had 18 students; they all worked with us for 50 minutes. In the afternoon, all A students worked on the study primarily in English for 40 minutes, once a week on Thursdays.

Measures

The grit 8-point survey was translated from English ("New ideas and projects sometimes distract me from previous ones.") to Spanish ("Las nuevas ideas y proyectos nuevos a veces me distraen de los que ya tenía de antes."), as seen in Table 2.

Table 2: *Grit Survey in English and Translated to Spanish.*

English	Spanish Translation
1. New ideas and projects sometimes distract me from previous ones.*	1. Las nuevas ideas y proyectos nuevos a veces me distraen de los que ya tenía de antes.*
2. Setbacks do not discourage me.	2. Los contratiempos no me desaniman.
3. I have been obsessed with a certain idea or project for a short time but later lost interest.*	3. He estado obsesionado con una cierta idea o proyecto por un corto tiempo, pero luego perdí el interés.*
4. I am a hard worker.	4. Soy muy trabajador/trabajadora.
5. I often set a goal but later choose to pursue a different one. *	5. A menudo me he fijado un objetivo pero después decidí perseguir otro.*
6. I have difficulty maintaining my focus on projects that take more than a few months to complete. *	6. Tengo dificultad para mantenerme enfocada/enfocado en proyectos que tardan más de unos meses para completarse.*
7. I finish whatever I begin.	7. Termino todo lo que empiezo.
8. I am diligent.	8. Pongo esmero en todo lo que hago.

The ratings of the grit 8-point survey were also translated from 1 (“Not like me at all”) to 1 (“Esto NO es PARA NADA como soy yo.”). The rest can be seen in Table 3.

Table 3: *Grit Survey Rating in English and Translated to Spanish*

English	Spanish Translation
This is VERY much like me.	Esto es MUY TIPICO de como soy yo.
This is MOSTLY like me.	Esto es BASTANTE como soy yo.
This is SOMEWHAT like me.	Esto es MAS O MENOS como soy yo.
This is NOT MUCH like me.	Esto NO es TIPICO de como soy yo.
This is NOT like me AT ALL.	Esto NO es PARA NADA como soy yo.

Procedure

As the study will be seven weeks long, six of those weeks will be spent collecting data. Prior to the study, teachers were given consent forms to distribute to the parents of the students participating (Appendix A). Parents did not need to sign to allow their child to use MathSpring since the teachers decided the program would be apart of the school curriculum. However, parents still needed to sign whether they allowed students to be in film or photography. Since each school participating has a different schedule, the timeline will be based on the days we will meet with them. For school A, each section meets twice a week, once in Spanish and once in English. Since they are switching between languages each week, they are given the same problem set for that week just in a different language. On Day 1, students are introduced to the study and will take the pretest that will consist of math problems and the grit survey in Spanish (Appendix B). They will also log in for the first time into their respective accounts on MathSpring to make sure everything works smoothly and to troubleshoot if anything went

wrong. If students were to finish early, they could begin using the MathSpring software. Since the typical math problems in MathSpring were in English and were fitted into the Massachusetts standards, special problems sets were created for each week, in Spanish, with different math themes that coincide with the standards the Argentinian students were learning during the study. The first week students will work on conversion of fractions and operations with fractions. Second week students will work on conversion between fractions and decimals as well as using the order of operations with decimals. The third week will have a problem set related to unit conversion based on the Metric system in base ten as well as conversions of time. Week four will touch upon angles and order of magnitude. On the final week, students will be tested with the same test that was administered the first week as their post test (Appendix C).

3.3 Change in Grit

To measure growth-mindset, the Argentinian post test and pretest will be compared.

3.3.1 Training Growth-Mindset

As the participants will be working with Mathspring at least once a week for 40 minutes, they will be exposed to their Learning Companion. As stated before, the Learning Companion act as study partners, offering advice and encouraging messages. To keep consistency, the gender of the companion will be male for all the participants. They will encourage students to seek help if they need it, and praise them even if their answers are incorrect.

4. Results

4.1 United States Post Test Data Results

Of the 324 students post test results obtained, 67 results were omitted due to some participants who completed the grit survey were adults and inconsistent with the age range present in this study. An overall histogram was produced to view the bell curve of the data points, M = 3.30, SD = 0.62, as seen in Figure 4.

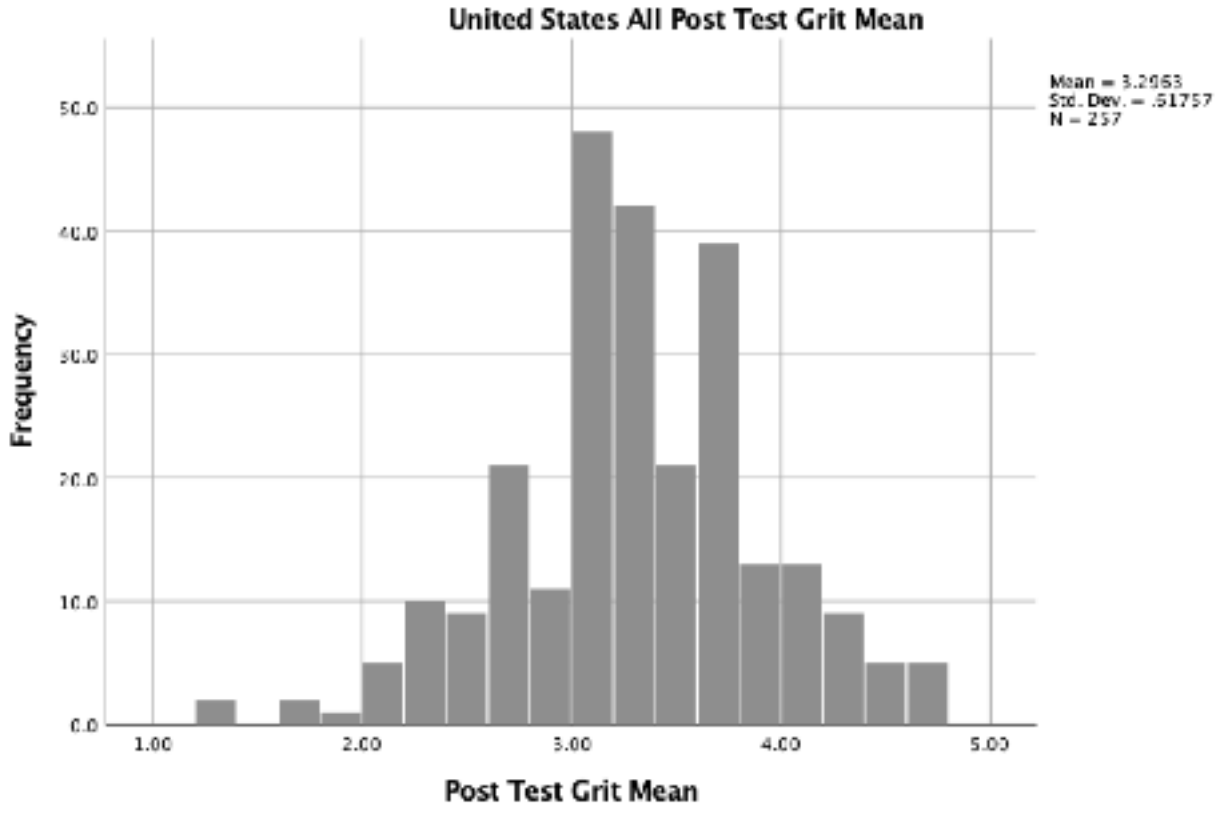

Figure 4: *The spread of grit scores from the post test in United States data.*

Grouping the grit scores by school, there was no significant difference between them. In table 4, School 1 had a sample of eighteen participants, M = 3.24, SD = 0.86. School 2 had a sample of

nineteen participants, M = 3.02, SD = 0.86. School 3 had a large sample of 56 participants, M = 3.41, SD = 0.71. School 4 had a sample of 12 participants, M = 3.17, SD = 0.51. School 5 had a sample of 19 participants, M = 3.18, SD = 0.82. School 6 had a sample of 37 participants, M = 3.35, SD = 0.82. School 7 had a sample of 21 participants, M = 3.30, SD = 0.55. School 8 had a sample of 33 participants, M = 3.19, SD = 0.51. School 9 had a sample of 38 participants, M = 3.39, SD = 0.59. School 10 had a small sample of 4 participants, M = 3.63, SD = 0.53. Figure 5 visualizes the spread of grit means by school groups. Given that the largest possible score is 5 and the smallest possible score is 1, we can see that schools scored very similarly, with an average score that ranges between 3.02 and 3.63, most schools scoring slightly under the neutral grit level of 3.5, with a grand mean of 3.30 across all schools.

Table 4: *United States means and standard deviations grouped by school.*

School	N	M	SD
School 1	18	3.24	0.86
School 2	19	3.02	0.43
School 3	56	3.41	0.71
School 4	12	3.17	0.51
School 5	19	3.18	0.82
School 6	37	3.35	0.45
School 7	21	3.30	0.55
School 8	33	3.19	0.51
School 9	38	3.39	0.59
School 10	4	3.63	0.53

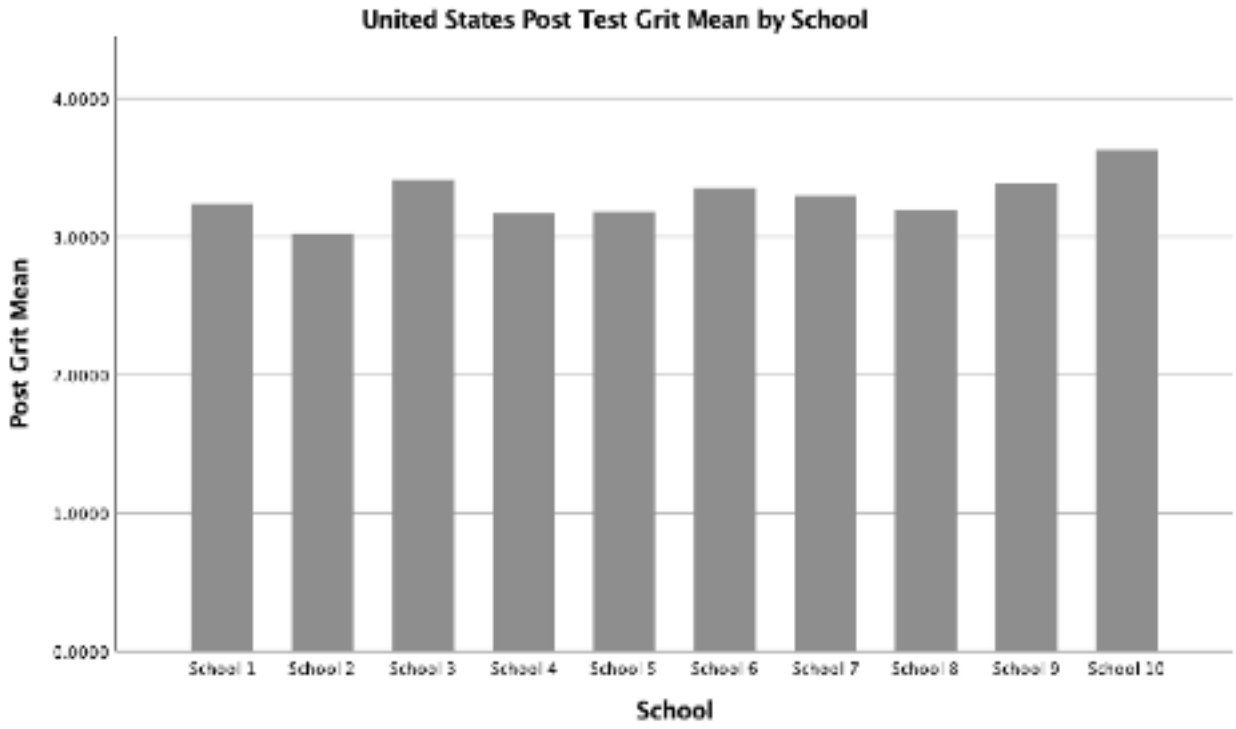

Figure 5: *The spread of grit scores by United States schools.*

4.2 Argentina Pretest Results

One hundred and sixty five (165) pretest results were obtained from the participating students. Eight results were omitted due to the students not fully completing all the answers so grit could be calculated. The grit average was calculated through SPSS of each student. Looking through the spread of all the Argentinian students, M = 3.24, SD = 0.54, as seen in Figure 6.

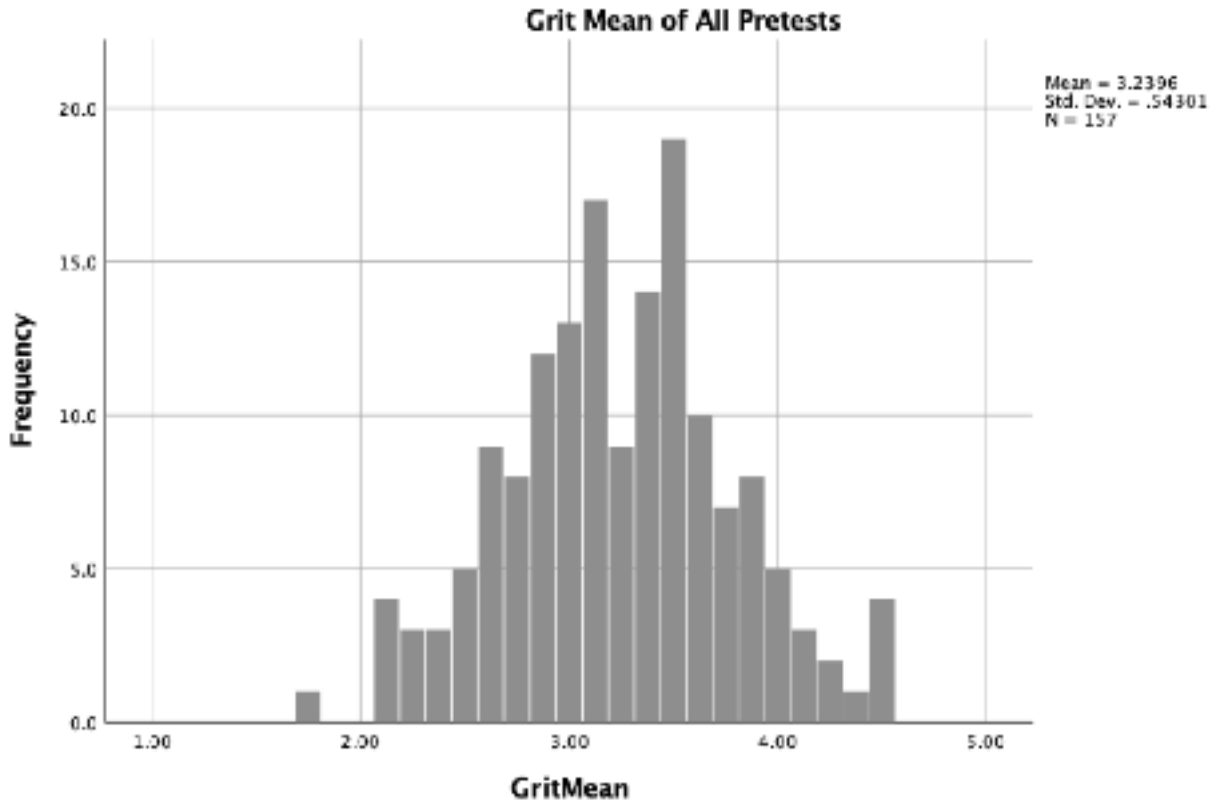

Figure 6: *The spread of grit scores from the pretests in all Argentinian schools.*

There was no significant difference when grouping grit by school. As seen in Table 5, School A had a grit mean of 3.11 (SD = 0.46, N = 52). School B had a grit mean of 3.32 (SD = 0.62, N = 69). School N had a grit mean of 3.27 (SD = 0.47, N = 36). Figure 7 visualizes the means in a graph. Again, given that the largest possible score is 5 and the smallest possible score is 1, we can see that schools scored very similarly, with an average score that ranges between 3.11 and 3.32, all schools scoring somewhat under the neutral grit level of 3.5, with a grand mean of 3.24 across all the schools that were part of the Argentina study.

Table 5: *Means and standard deviations of Argentina data grouped by school.*

School	N	M	SD
School A	52	3.11	0.46
School B	69	3.32	0.62
School N	36	3.27	0.47

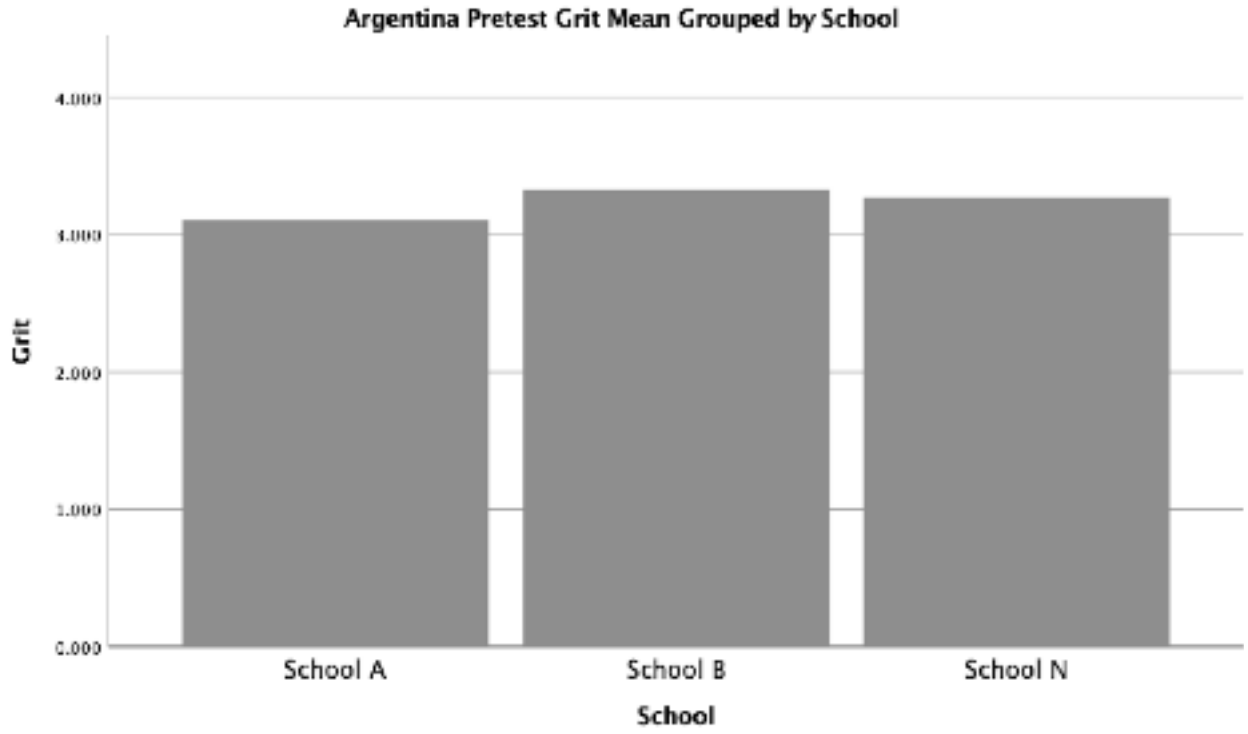

Figure 7: *Graph of Argentina grit distribution by school.*

4.3 Argentina Post Test Results

One hundred and fifty four post tests were collected from the participating students. Four were omitted due to students not fully completing the grit section. Standard deviations and means were produced. A bell curve of all the grit means (M = 3.44, SD = 0.56) can be seen in Figure 8.

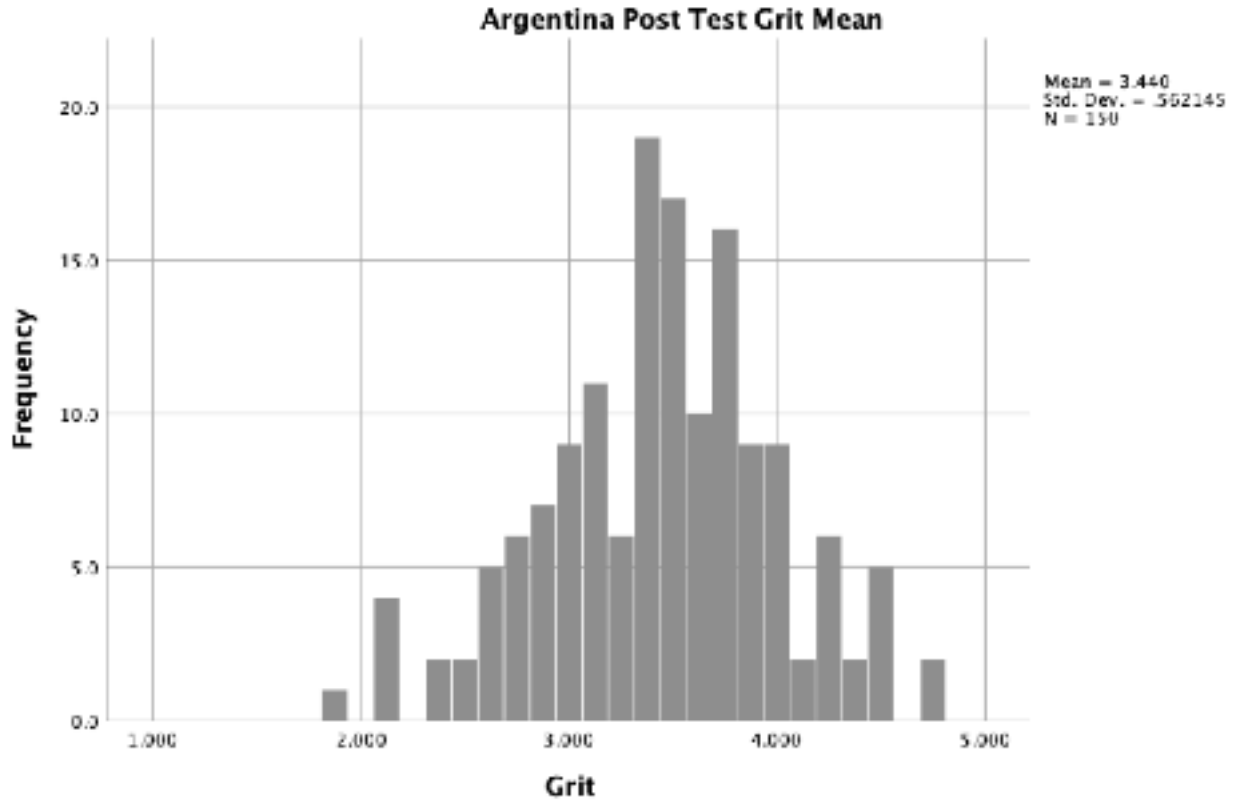

Figure 8: *Argentina post test grit spread of mean and standard deviation of all participants.*

There was no significant difference when grouping the post test grit by school. As seen in Table 6, School A had a grit mean of 3.35 (SD = 0.56, N = 53). School B had a grit mean of 3.44 (SD = 0.57, N = 67). School N had a grit mean of 3.61 (SD = 0.54, N = 30). Figure 9 visualizes the means in a graph. Considering that the largest possible score is 5 and the smallest possible score is 1, we can see that schools scored similarly, with an average score that ranges between 3.35 and 3.61, all schools scoring somewhat around the neutral grit level of 3.5, with a grand mean of 3.44 across all the schools that were part of the Argentina study.

Table 6: *Argentina means and standard deviations grouped by school.*

School	N	M	SD
School A	53	3.35	0.56
School B	67	3.44	0.57
School N	30	3.61	0.54

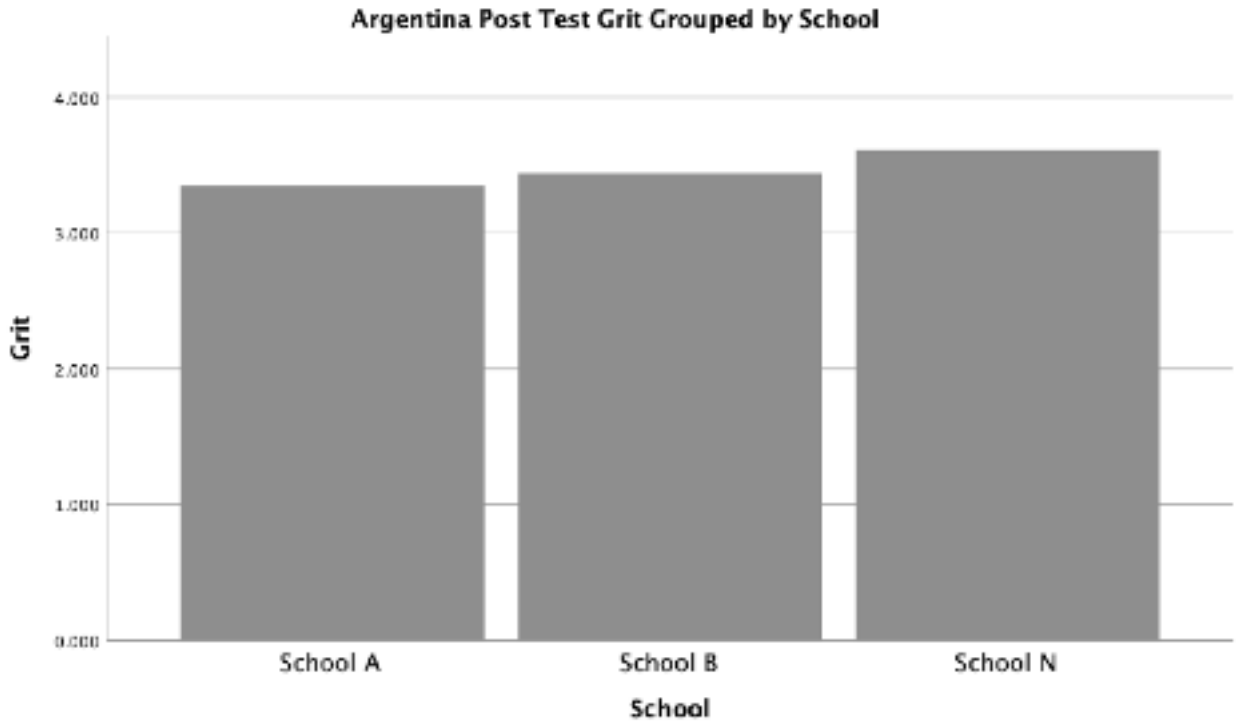

Figure 9: *Histogram of Argentina grit grouped by school.*

4.4 Comparing Argentina and United States Grit

An independent-samples *t*-test was conducted to compare post test grit means in the United States and Argentina data. Results of the *t*-test shows that grit mean differs between United States (M = 3.30, SD = 0.62, N = 257) and Argentina (M = 3.44, SD = 0.56, N = 150) at the .05 level of significance (t = -2.34, df = 405, p = 0.02, 95% CI for mean difference -0.26 to -0.02).

On average, Argentina participants tend to have higher grit means than United States participants.

Table 7: *T-test results and descriptive statistics of post test grit mean by country.*

	Country						95% CI for Mean Difference		
	United States			Argentina					
	M	SD	n	M	SD	n		t	df
Grit mean	3.30	0.62	257	3.44	0.56	150	-0.26, -0.02	-2.34*	405

* $p < .05$.

4.5 Grit Scores and the Use of MathSpring

Pretest grit means and post test grit means will be compared separately to the effort variables calculated through MathSpring. Out of the one hundred and sixty five pretests and one hundred and fifty four post tests, only one hundred and thirty four participants will be considered. These participants have completed both their pre and post tests in full and left no blanks. To note, for the cases where p significant values are significant and r values are at an absolute value of 0.31 or less will not be considered. The r squared of an r value of 0.31 is less than 0.1, which means that the correlation it represents accounts for less than 10% of variance and therefore overall it is not impactful to the given data.

4.5.1 Pretest Means

Table 8, displays the descriptions of each variable. Pretest grit had a mean of 3.25 (SD = 0.54, N = 134). Variable ATT had a mean of 0.09 (SD = 0.06, N = 134). Variable GIVEUP had a mean of 0.08 (SD = 0.05, N = 134). Variable NOTR had a mean of 0.02 (SD = 0.04, N=134). Variable

SKIP had a mean of 0.14 (SD = 0.10, N = 134). Variable SHINT had a mean of 0.15 (SD = 0.11, N = 134). Variable SOF had a mean of 0.26 (SD = 0.11, N 134). Variable GUESS had a mean of 0.09 (SD = 0.06, N = 134). Variable Solved Correctly had a mean of 0.70 (SD = 0.12, N = 131). Variable Mistakes had a mean of 1.09 (SD = 0.63, N = 131). Variable Hints had a mean of 0.41 (SD = 0.27, N = 131). Variable Attempts had a mean of 1.47 (SD = 0.61, N = 130).

Table 8: *Descriptive statistics of each variable.*

Variable	N	M	SD
PreGrit	134	3.25	0.54
ATT	134	0.09	0.06
GIVEUP	134	0.08	0.05
NOTR	134	0.02	0.04
SKIP	134	0.14	0.10
SHINT	134	0.15	0.11
SOF	134	0.26	0.11
GUESS	134	0.09	0.06
Solved Correctly	131	0.70	0.12
Mistakes	131	1.09	0.63
Hints	131	0.41	0.27
Attempts	130	1.47	0.61

A Pearson correlation analysis was conducted to see if there was any significance between pretest grit means and effort variables (i.e. ATT, SKIP, SHINT, etc.) or the working variables (i.e. number of hints made–Hints, number of attempts made–Attempts, etc.) that were collected through the participants' use of MathSpring, as seen in Table 9. There was no significant

correlation between the pretest grit and ATT, $r = 0.04$, $p = 0.67$, $N = 134$. Also, there was no significant correlation between the pretest grit and GIVEUP, $r = 0.01$, $p = 0.88$, $N = 134$. No significant correlation was found with the pretest grit and NOTR, $r = -0.16$, $p = 0.07$, $N = 134$. There was no significant correlation between pretest grit and SKIP, $r = -0.14$, $p = 0.11$, $N = 134$. Also, no significant correlation was found with the pretest grit and SHINT, $r = 0.04$, $p = 0.69$, $N = 134$. No significant correlation was found between the pretest grit and SOF, $r = 0.16$, $p = 0.06$, $N = 134$. There was no significant correlation between pretest grit and GUESS, $r = -0.03$, $p = 0.69$, $N = 134$. Also, there was no significant correlation between pretest grit and Solved Correctly, $r = 0.13$, $p = 0.15$, $N = 131$. No significant correlation was found between pretest grit and Mistakes, $r = 0.07$, $p = 0.42$, $N = 131$. A significant correlation was not found between pretest grit and Hints, $r = 0.01$, $p = 0.91$, $N = 131$. There was no significant correlation found between the pretest grit and Attempts, $r = 0.11$, $p = 0.20$, $N = 130$.

However, a significantly positive relationship was found between GUESS and ATT, $r = 0.53$, $p < 0.01$, $N = 134$, where these variables are marginally correlated and if one increases the other will increase as well; if a participant guesses more often then they are more likely to also make more attempts. There was a significantly positive relationship between Mistakes and ATT, $r = 0.42$, $p < 0 .01$, $N = 131$, where if a student makes a mistake on a problem, they are more likely to get the problem wrong the first time then get it right the second time. Attempts and ATT were found to have a significantly positive relationship, $r = 0.46$, $p < 0.01$, $N = 130$, where both variables could increase should one of them increase as well. Solved Correctly and GIVEUP have a significantly negative relationship, $r = -0.41$, $p < 0.01$, $N = 131$, where if Solved Correctly increases, it is somewhat likely that GIVEUP with decrease. There was a significantly weak

relationship between SHINT and SKIP, $r = -0.33$, $p < 0.01$, $N = 134$, where if SHINT increases then SKIP could decrease. SOF and SKIP have a significantly negative relationship, $r = -0.48$, $p < 0.01$, $N = 134$, where if a student solves a problem on the first attempt without help, then they are less likely to skip a problem. A significantly strong negative association is seen between Solved Correctly and SKIP, $r = -0.87$, $p < 0.01$, $N = 131$, where the more a participant solved problems correctly then it correlated with the participant skipping problems less. There was also a significantly negative weak relationship between Attempts and SKIP, $r = -0.36$, $p < 0.01$, $N = 130$, where the variables can possibly inversely affect each other. Solved Correctly and SHINT have a significantly positive association, $r = 0.40$, $p < 0.01$, $N = 131$, where if Solved Correctly increases, the other will increase as well. There was a significantly strong positive relationship between Hints and SHINT, $r = 0.81$, $p < 0.01$, $N = 131$, where the more a participant asks for hints, the more the participant will get the problem correct. A significantly strong positive association was found between Solved Correctly and SOF, $r = 0.70$, $p < 0.01$, $N = 131$, where the more a participant solves a problem correctly, the more likely they are also able to solve a problem correctly the first time. Mistakes and GUESS had a significantly positive weak relationship, $r = 0.37$, $p < 0.01$, $N = 131$, where if one increases, the other will increase as well. A significantly positive weak relationship was found between Attempts and GUESS, $r = 0.33$, $p < 0.01$, $N = 130$, where if Attempts were increased then the number of GUESSs can also increase, too. Attempts and Solved Correctly had a significantly positive association, $r = 0.47$, $p < 0.01$, $N = 130$, where the more a participant attempts a problem, then the more likely they are to solve the problem correctly. There was also a significantly strong positive relationship

between Attempts and Mistakes, $r = 0.83$, $p < 0.01$, $N = 130$, where the more a participant attempts a problem, the more likely they are to make a mistake.

Table 9: *Correlations between the pretest grit and various other variables.*

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. PreGrit	–											
2. ATT	0.04	–										
3. GIVEUP	0.01	0.07	–									
4. NOTR	-0.16	-0.11	-0.13	–								
5. SKIP	-0.14	-0.13	0.26**	0.30**	–							
6. SHINT	0.04	-0.23*	0.07	-0.27**	**-0.33****	–						
7. SOF	0.16	0.13	-0.13	-0.17	**-0.48****	0.13	–					
8. GUESS	-0.03	**0.53****	0.17*	-0.01	0.09	-0.30**	0.08	–				
9. Solved Correctly	0.13	0.26**	**-0.41****	-0.16	**-0.87****	**0.40****	**0.70****	-0.01	–			
10. Mistakes	0.07	**0.42****	0.14	-0.15	-0.18*	0.13	-0.02	**0.37****	0.23*	–		
11. Hints	0.01	-0.29**	0.23**	-0.22*	-0.25**	**0.81****	-0.13	-0.29**	0.14	0.02	–	
12. Attempts	0.11	**0.46****	-0.20*	-0.12	**-0.36****	0.19*	0.12	**0.33****	**0.47****	**0.83****	0.00	–

* . Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

From viewing the Pearson correlation analysis, a stepwise simple regression analysis was done to see if there were certain relationships that could help predict pretest grit from the dataset as seen in Table 10. The analysis collected one hundred and thirty cases between all the variables. A significant regression equation was found ($F(1, 128) = 7.02$, $p = 0.01$), with an R^2 of 0.05. Predicted pretest grit is equal to 2.93 + 1.17 (SOF) is coded as the count of SOF seen divided by

the total number of problems a student solved. While SOF was found as a significant predictor of pretest grit, it only accounts for 5% of variance and is therefore unreliable.

Table 10: *Summary of simple regression analysis for variables predicting pretest grit.*

	Pretest		
Variable	*B*	*SE B*	*β*
SOF	1.17	0.44	0.23
R^2		0.05	
F		7.02	

4.5.2 Post Test Means

Table 11, displays the descriptions of each variable. Post test grit had a mean of 3.44 (SD = 0.58, N = 134). Variable ATT had a mean of 0.09 (SD = 0.06, N = 134). Variable GIVEUP had a mean of 0.08 (SD = 0.05, N = 134). Variable NOTR had a mean of 0.02 (SD = 0.04, N=134). Variable SKIP had a mean of 0.14 (SD = 0.10, N = 134). Variable SHINT had a mean of 0.15 (SD = 0.11, N = 134). Variable SOF had a mean of 0.26 (SD = 0.11, N 134). Variable GUESS had a mean of 0.09 (SD = 0.06, N = 134). Variable Solved Correctly had a mean of 0.70 (SD = 0.12, N = 131). Variable Mistakes had a mean of 1.09 (SD = 0.63, N = 131). Variable Hints had a mean of 0.41 (SD = 0.27, N = 131). Variable Attempts had a mean of 1.47 (SD = 0.61, N = 130).

Table 11: *Descriptive statistics of each variable.*

Variable	N	M	SD
PostGrit	134	3.44	0.58

ATT	134	0.09	0.06
GIVEUP	134	0.08	0.05
NOTR	134	0.02	0.04
SKIP	134	0.14	0.10
SHINT	134	0.15	0.11
SOF	134	0.26	0.11
GUESS	134	0.09	0.06
Solved Correctly	131	0.70	0.12
Mistakes	131	1.09	0.63
Hints	131	0.41	0.27
Attempts	130	1.47	0.61

A Pearson correlation analysis was conducted to see if there was any significance between post test grit means and effort variables (i.e. ATT, SKIP, SHINT, etc.) or the working variables (i.e. number of hints made–Hints, number of attempts made–Attempts, etc.) that were collected through the participants' use of MathSpring, as seen in Table 12. There was no significant correlation between the post test grit and ATT, $r = 0.02$, $p = 0.86$, $N = 134$. Also, there was no significant correlation between the post test grit and GIVEUP, $r = 0.01$, $p = 0.93$, $N = 134$. A significant correlation was found with the post test grit and NOTR, $r = -0.24$, $p < 0.01$, $N = 134$, however, it does not account for at least 10% variance. There was no significant correlation between post test grit and SKIP, $r = -0.10$, $p = 0.23$, $N = 134$. Also, no significant correlation was found with the post test grit and SHINT, $r = 0.05$, $p = 0.59$, $N = 134$. No significant correlation was found between the post test grit and SOF, $r = 0.17$, $p = 0.05$, $N = 134$. There was no significant correlation between post test grit and GUESS, $r = -0.03$, $p = 0.74$, $N =$

134. Also, there was no significant correlation between post test grit and Solved Correctly, r = 0.13, p = 0.15, N = 131. No significant correlation was found between post test grit and Mistakes, r = 0.09, p = 0.32, N = 131. A significant correlation was not found between post test grit and Hints, r = -0.04, p = 0.66, N = 131. There was no significant correlation found between the post test grit and Attempts, r = 0.08, p = 0.34, N = 130. Because the effort variables and working variables are one value, the significant values are still the same as the pretest results.

Table 12: *Correlations between the post test grit and various other variables.*

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. PostGrit	–											
2. ATT	0.02	–										
3. GIVEUP	0.01	0.07	–									
4. NOTR	-0.24**	-0.11	-0.13	–								
5. SKIP	-0.10	-0.13	0.26**	0.30**	–							
6. SHINT	0.05	-0.22*	0.07	-0.27**	**-0.33****	–						
7. SOF	0.17	0.13	-0.13	-0.17	**-0.48****	0.13	–					
8. GUESS	-0.03	**0.53****	0.17*	-0.01	0.09	-0.30**	0.08	–				
9. Solved Correctly	0.13	0.26**	**-0.41****	-0.16	**-0.87****	**0.40****	**0.70****	-0.01	–			
10. Mistakes	0.09	**0.42****	0.14	-0.15	-0.18*	0.13	-0.02	**0.37****	0.23*	–		
11. Hints	-0.04	-0.29**	0.23**	-0.22*	-0.25**	**0.81****	-0.13	-0.29**	0.14	0.02	–	
12. Attempts	0.08	**0.46****	-0.20*	-0.12	**-0.36****	0.19*	0.12	**0.33****	**0.47****	**0.83****	0.00	–

* . Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

From these results, a stepwise simple regression analysis was done to see if there were certain relationships that could help predict post test grit from the dataset as seen in Table 13.

The analysis collected one hundred and thirty cases between all the variables. A significant regression equation was found ($F(1, 128) = 7.52$, $p = 0.01$), with an R^2 of 0.06. Predicted post test grit is equal to 3.51 – 3.42 (NOTR) is coded as the count of NOTR seen divided by the total number of problems a student solved. While NOTR was found as a significant predictor of post test grit, it only accounts for 6% of variance. NOTR is a behavior consisting of the student acting fast, in less than 4 seconds, not having enough time to read the math problem and think briefly about how to solve it. This is a behavior generally associated to disengagement. The results suggest that, for a student to score a higher posttest grit score, the student had to be minimally involved in solving the problems and listening to the characters talking to them.

Table 13: *Summary of simple regression analysis for variables predicting post test grit.*

	Post Test		
Variable	*B*	*SE B*	*β*
NOTR	-3.42	1.25	-0.24
R^2		0.06	
F		7.52	

4.6. Comparing Argentina Pre and Post Tests

One hundred and fifty four post tests were collected from the participating students. Twenty participants were omitted due to them not completing the pretest in the beginning. A paired-samples t-test was conducted to compare grit from the pretest data and posttest data as seen in Table 14. Results of the *t*-test shows that grit mean differs between pretest (M = 3.25, SD

= 0.54, N = 134) and post test (M = 3.44, SD = 0.58, N = 134) at the .05 level of significance (t = -4.11, df = 133, p < 0.01, 95% CI for mean difference -0.27 to -0.10). On average, Argentina participants saw an increase in grit post test means after using MathSpring. One can also see in Figure 10 the increase in grit from pretest to post test.

Table 14: *T-test results and descriptive statistics of change in grit.*

	Pretest			Posttest			95% CI for Mean Difference		
	M	SD	n	M	SD	n		t	df
Grit mean	3.25	0.54	134	3.44	0.58	134	-0.27, -0.10	-4.11*	133

* p < .05.

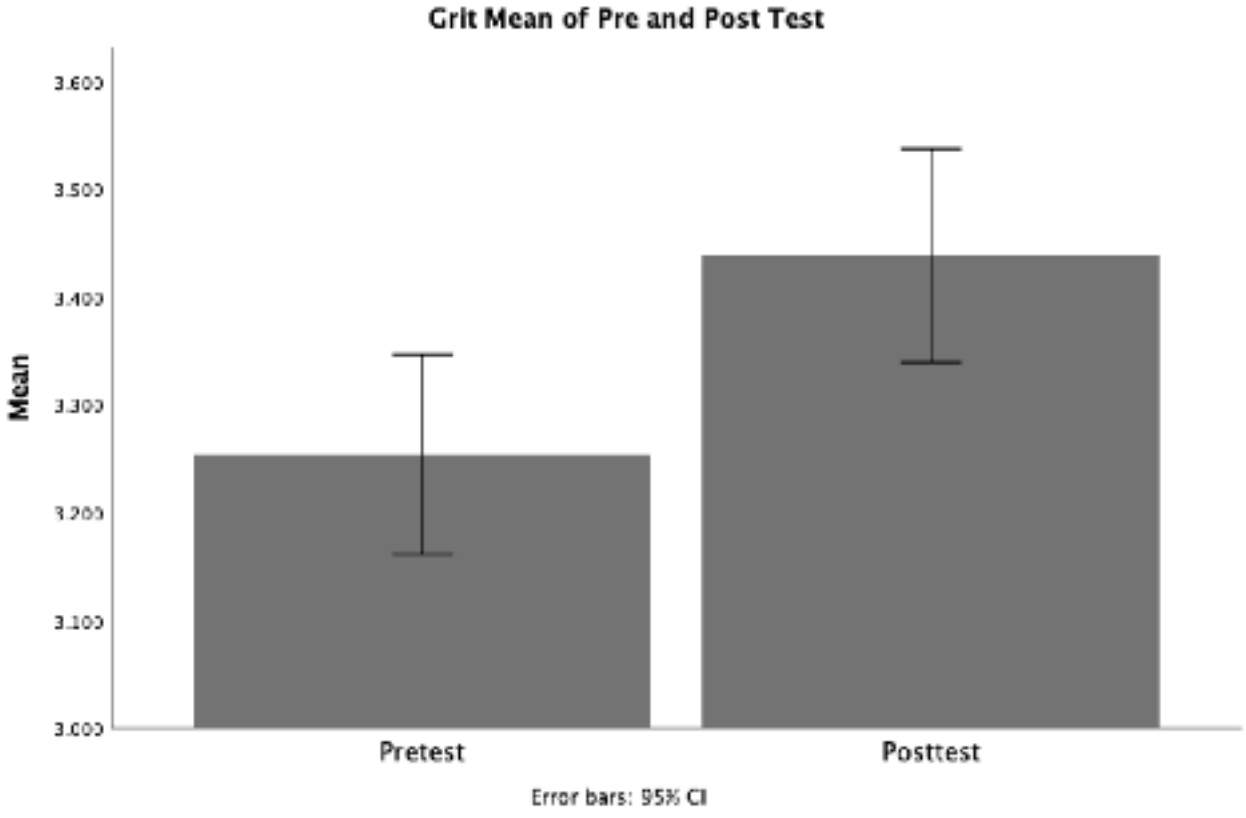

Figure 10: *A graph displaying pretest and post test grit means.*

5. Discussion

Comparing the post test of both the United States and Argentina data, it was found that Argentine students displayed higher grit than United States students. It could be, as stated previously, due to how Argentina is more collectivist leaning than the United States. In this ideology, they technically have more to lose as they are not only failing themselves but their support system as well. While the participants were children and might not have significant responsibilities, the pressure can still be implicit and ingrained into their psyche.

Correlation and regression analyses were conducted on both pretest grit scores and post test grit scores. While there were many different behavioral correlations between the variables gathered through MathSpring, there were no significant associations found between pretest grit scores or posttest grit scores and a student categorization of how students interacted with math problems. It was found that SOF can significantly predict pretest grit, however R values suggest this accounts for only 5% of the variance. This relationship suggests that students who have higher grit will also solve more problems correctly overall. One possibility is that gritty students are investing more time and effort into thinking through problems, with the effect that they would solve them correctly with a higher chance. In the same regard, NOTR can significantly predict post test grit, but only accounts for 6% of the variance. This relationship suggests that students with higher posttest grit had less of this kind of problem solving behavior in MathSpring. NOTR means the students rushed to answer without enough time to even read the math problem. Because the predictive power of these effects is so low, less than 10% of the variance is explained by them, could be that more detailed information needs to be gathered, or that there were too many unidentified confounds that lead to such a low predictive power.

Comparing the Argentina pretest and post test grit data, there was a significant gain seen between the two tests. While the gain itself is not large, it does suggest that what MathSpring is doing is helping the students in some way. It could be the Learning Companion encouraging and praising students for their effort in their work, and training their growth mindset, is the cause for this. However, it could also be that the hints are helping students understand math topics better, or it could be the constant practice of doing math problems, or it could be a combination of all of the above.

5.1 Limitations

Several limitations were found through the duration of the study. Because the United States data was collected from previous studies, a full comparison could not be done as those groups had not completed a pretest or have clean data recorded of the work they did in MathSpring. There were also different groups within the United States data where some cases were from camps instead of a school-style setting. A change in setting could potentially have an effect on students' perceptions.

Lack of experimenters was a limitation. Each session there were always at least two experimenters observing students as they worked with MathSpring. However, there was also always at least twenty students in one session. Because the experimenters could not be everywhere, monitoring each and every student was difficult. It allowed for more students to share their answers with other students if they wanted to. We also noticed some students would go to other websites that can distract them from the work they were doing.

Finally, another potential issue that was realized early on, was the lack of computers in labs and the unreliability of the internet. There were two sections in one school that had to pair

up because the school did not have enough computers for the number of students that had to work in a certain period. Due to students having to pair up, while we kept the partners consistent, it was difficult to ensure that each student was sharing time with using MathSpring. There were also some schools that had faulty internet connects and on occasion it forced the class to pair up at least one session without planning so there were various times were we could not record who was with who. It also caused lapses in time where we had to wait for certain computers to reconnect, which causes some students to have less time working with MathSpring than other students.

5.2 Plans for the Future

One idea that could be implemented is extending the research to first generation students. There does seem to be a difference between Argentina grit and United States grit. As a person who is a first generation college student, it is easy to see the cumulation and clash of both cultures from the family and from institutions. It would also be interesting to see the study extend to other countries, as there are countries that have various levels of whether they lean individualistic or collectivistic.

Another idea would be to prolong the use of MathSpring to see if any of the results can be increased more with further exposure to MathSpring over a longer period of time. Five weeks was significant enough to produce significant results. A greater difference in grit could result from using MathSpring longer than just five weeks. Potentially having participants use MathSpring as part of a full school curriculum could lead to interesting results.

6. Conclusion

While it was initially disputed that grit is this static characteristic of an individual, that may not entirely be the case. More work needs to be done, however, this study poses a perspective focusing on how a person is this multifaceted, *malleable* individual. Every aspect of their lives can affect how an individual's perception is shaped, how they learn, or simply how they act in their everyday life. Using tools like MathSpring, allows more opportunities for individuals to keep growing. Instead of an instructor giving up on a student who might not have a high perseverance to see the importance in school, they can cultivate that characteristic and grow that student's garden.

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Appendices

Appendix A

Parent Letter Describing the Study

WORCESTER POLYTECHNIC INSTITUTE

SOCIAL SCIENCE AND POLICY STUDIES DEPARTMENT

Estimados Padres, Junio del 2019

Nuestro equipo de investigadores del Instituto Politécnico de Worcester (Worcester Polytechnic Institute, Massachusetts, USA) viene a la escuela de su hijo, a hacerlos usar un software especial de matemáticas llamado "Cultivando Matematicas" (CultivandoMatematicas.org) como parte de una experiencia piloto en Córdoba, una actividad de investigación dirigida por profesores y estudiantes de esta Universidad, en colaboración con la Universidad Blas Pascal, y la escuela de su hijo.

Este es un proyecto financiado por la Fundación Nacional de Ciencia de los Estados Unidos, en un esfuerzo por crear software personalizado que comprenda los estados mentales de los estudiantes, para promover la perseverancia y la agilidad al resolver problemas de matemáticas. Este software ya ha sido usado en escuelas de Estados Unidos, y sabemos que el programa ayuda a los alumnos a aprender nuevas estrategias para abordar problemas de matemáticas, y que desarrollan sentimientos más positivos con respecto a las matemáticas después de usar el software.

Como parte de la actividad, los estudiantes trabajarán con el software durante 1 clase de matemáticas todas las semanas entre Agosto y Octubre. Usarán CultivandoMatematica.org y trabajarán en problemas de matemáticas, recibiendo ayuda automatizada a medida que la necesiten. Esto es parte del currículo típico de una clase de matemáticas de su hijo. Durante este proceso, también les pediremos a los alumnos que nos den su opinión sobre lo que les resultó más útil, lo que fue confuso y sobre sus sentimientos hacia las matemáticas. Sus opiniones y comentarios nos serán muy útiles a medida que sigamos creando más material en los próximos años.

A la vez, para nuestra investigación, nos gustaría ocasionalmente hacer videos de los alumnos usando el software. En particular, algunos de los alumnos serán invitados a usar una laptop para que su cámara nos ayude a grabar información sobre gestos faciales: sonrisas, fruncimientos de seño, etc., lo que nos ayudaría en nuestra investigación que está intentando hacer que el programa comprenda automáticamente cómo se sienten los chicos *mientras* usan el software. Si usted acepta y su hijo fuera seleccionado, grabaríamos la cara de su hijo durante 1 sesión de 40 minutos (solo nos interesan los gestos de sus expresiones faciales, para ayudarnos a recopilar información sobre lo que estaban sintiendo, cuánto podrían estar confundidos, etc.). Reiteramos que, mientras que el uso del software es parte del curriculum, necesitamos su permiso para grabar video.

Nos gustaría que usted sepa que no hay riesgos para la privacidad de su hijo si lo deja participar en la sesión de video. La grabación de video es solo para fines de investigación y se guardará sólo en las computadoras de los investigadores. El nombre personal de su hijo NO se guarda, y los datos recopilados y las respuestas que proporcionan no se pueden vincular a ellos personalmente. Todos los datos se analizan en base a números anónimos, y cualquier referencia personal se destruye poco después de que los estudiantes usen el programa. También, su hijo puede optar por dejar de participar en cualquier momento.

No dude en contactarme si tiene alguna pregunta sobre esta investigación , que está regulada por la Junta de Revisión de Investigación Institucional de la Universidad (Worcester Polytechnic Institute) para proteger los derechos de los participantes humanos en las investigaciones, el Dr. Kent Rissmiller (correo electrónico: kjr@wpi.edu, +1 508-831-5019) si tiene alguna duda, o simplemente mándeme un email a mí personalmente.

Dra. Ivon Arroyo
Programa de Technologia Educativa y Ciencias del Aprendizaje
Worcester Polytechnic Institute
Email: iarroyo@wpi.edu

___ SI autorizo a mi hija/o a ser grabado en video como parte de la investigación
___ NO autorizo a mi hija/o a ser grabado en video como parte de la investigación

Firma del padre, madre o tutor: _____

508-831-5296 (TEL) 508-831-5896 (FAX)
100 INSTITUTE ROAD, WORCESTER MA 01609-2280 USA
WPI.EDU

Appendix B

Pretest, Grit Measures and Math Problems

Nombre: _____ Grado: _____ Division: ___ Colegio: _____

Hacé un círculo para marcar la respuesta que mejor describe cómo sos vos. Por favor, sé sincero/sincera, nadie va a ver lo que digas, ni juzgarte por lo que digas.

1) Las nuevas ideas y proyectos nuevos a veces me distraen de los que ya tenía de antes.

A. Esto es MUY TIPICO de como soy yo.
B. Esto es BASTANTE como soy yo
C. Esto es MAS O MENOS como soy yo.
D. Esto NO es TIPICO de como soy yo.
E. Esto NO es PARA NADA como soy yo.

2) Los contratiempos no me desaniman.

A. Esto es MUY TIPICO de como soy yo.
B. Esto es BASTANTE como soy yo
C. Esto es MAS O MENOS como soy yo.
D. Esto NO es TIPICO de como soy yo.
E. Esto NO es PARA NADA como soy yo.

3) He estado obsesionado/a con una cierta idea o proyecto por un corto tiempo, pero luego perdí el interés.

A. Esto es MUY TIPICO de como soy yo.
B. Esto es BASTANTE como soy yo
C. Esto es MAS O MENOS como soy yo.
D. Esto NO es TIPICO de como soy yo.
E. Esto NO es PARA NADA como soy yo.

4) Soy muy trabajador/trabajadora.

A. Esto es MUY TIPICO de como soy yo.
B. Esto es BASTANTE como soy yo
C. Esto es MAS O MENOS como soy yo.
D. Esto NO es TIPICO de como soy yo.
E. Esto NO es PARA NADA como soy yo.

5) Frecuentemente me fijo un objetivo pero después decido cambiar, de repente me interesa otra cosa.

A. Esto es MUY TIPICO de como soy yo.
B. Esto es BASTANTE como soy yo
C. Esto es MAS O MENOS como soy yo.
D. Esto NO es TIPICO de como soy yo.
E. Esto NO es PARA NADA como soy yo.

6) Tengo dificultad para mantenerme enfocado/a en proyectos que tardan más de unos meses para completarse.

A. Esto es MUY TIPICO de como soy yo.
B. Esto es BASTANTE como soy yo
C. Esto es MAS O MENOS como soy yo.
D. Esto NO es TIPICO de como soy yo.
E. Esto NO es PARA NADA como soy yo.

7) Termino todo lo que empiezo.

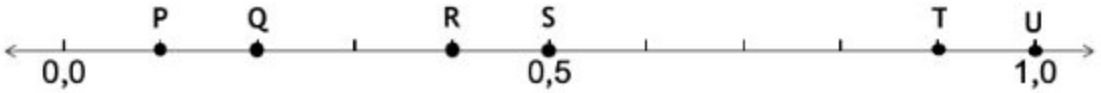
A. Esto es MUY TIPICO de como soy yo.
B. Esto es BASTANTE como soy yo
C. Esto es MAS O MENOS como soy yo.
D. Esto NO es TIPICO de como soy yo.
E. Esto NO es PARA NADA como soy yo.

8) Pongo esmero en todo lo que hago.

A. Esto es MUY TIPICO de como soy yo.
B. Esto es BASTANTE como soy yo
C. Esto es MAS O MENOS como soy yo.
D. Esto NO es TIPICO de como soy yo.
E. Esto NO es PARA NADA como soy yo.

Ahora vamos a hacerte algunas preguntas de matemáticas. Respondé lo mejor que puedas. Si no sabés, no hay problema: estimá la respuesta lo mejor que puedas.

9) En esta recta numérica, ¿cuál de los puntos representa mejor la ubicación de la fracción 1/5?



A. El punto P
B. El punto Q
C. El punto R
D. El punto S
E. El punto T

10) Horacio puso estampillas en algunas postales como se muestra en el dibujo.

¿Qué fracción de las postales tienen una estampilla?

Respuesta: _____

11) ¿Cual es el resultado de esta expresión?

$$\frac{2}{3}+\frac{7}{9}-\frac{5}{6}$$

A. 1/2
B. 3/4
C. 11/18
D. 5/9
E. 5/18

12) Juan quiere comprar una libreta que cuesta $ 1,64, una caja de plasticolas por $2,66, una caja de lápices por $ 2,81 y una goma de borrar por $ 0,78. ¿Cuál es el costo total de los cuatro artículos que Javier quiere comprar?

A. 7,57
B. 7,96
C. 7,81
D. 7,89
E. 7,74

13) Valeria compra **3 metros** de cordón para hacer pulseras. Ella necesita **22 centímetros** de cordón para hacer **1 pulsera**. ¿Cuántas pulseras puede hacer Sofía si usa todo el cordón que compra?

Respuesta: _____

14) Un carpintero usa 3/7 de metro de una barra de madera para construir uno de los lados del marco de una ventana cuadrada. El carpintero necesita 4 pedazos iguales para enmarcar la ventana (porque la ventana es cuadrada). ¿Cuantos metros de madera necesitará el carpintero para completar el marco de la ventana?

Respuesta: _____

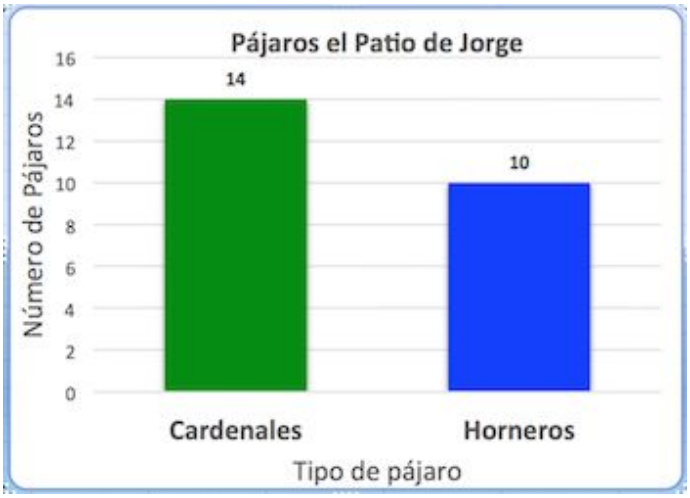
15) Lucía quiere comprar 5 aros de hula hula para jugar con sus amigas. Cada aro cuesta $1,25. Lucía tiene un cupón de descuento de $ 0,75 del precio de un aro. ¿Cuánto deberá pagar Lucía por los 5 aros de hula hula?

A. $ 6,00
B. $ 6,50
C. $ 5,75
D. $ 5,25
E. $ 5,50

16) Carlos tomó un ómnibus para ir a visitar a sus tíos por cuatro días. En la estación de autobuses, esperó 2/3 de hora hasta que llegó el momento de abordar el autobús. ¿Cuántos minutos esperó Carlos para abordar el autobús?

Respuesta: _____

17) Jorge contó todo los pájaros en que vió en su patio en una semana. Los resultados están representados en la figura de abajo. ¿Qué fracción de los pájaros eran horneros?



A. 10/24
B. 10/14
C. 14/24
D. 14/10
E. 24/10

18) Mariana llenó una regadera con 2,93 litros de agua. Usó 70 mililitros para regar su Jazmín y 220 mililitros para regar sus Margaritas. ¿Cuál es la cantidad de agua que queda en la regadera después de regar?

A. 3 mililitros
B. 264 mililitros
C. 587 mililitros
D. 1244 mililitros
E. 2640 mililitros

Appendix C

Post-Test, Grit Measures and Math Problems

Primer Nombre: _____ Grado: _____ Edad: ___ Colegio: _____

Nombre(s) de Usuario: _____ Mujer o Varon? _____

Queremos ver si has cambiado tu opinión sobre las respestas que nos diste el primer día, o si todavía pensás lo mismo que antes.
Hacé un círculo para marcar la respuesta que mejor describe cómo sos vos. Por favor, sé sincero/sincera, nadie va a ver lo que digas, ni juzgarte por lo que digas.

1) Las nuevas ideas y proyectos nuevos a veces me distraen de los que ya tenía de antes.

A. Esto es MUY TIPICO de como soy yo.
B. Esto es BASTANTE como soy yo
C. Esto es MAS O MENOS como soy yo.
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2) Los contratiempos no me desaniman.

A. Esto es MUY TIPICO de como soy yo.
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B. Esto es BASTANTE como soy yo
C. Esto es MAS O MENOS como soy yo.
D. Esto NO es TIPICO de como soy yo.
E. Esto NO es PARA NADA como soy yo.

4) Soy muy trabajador/trabajadora.

A. Esto es MUY TIPICO de como soy yo.
B. Esto es BASTANTE como soy yo

C. Esto es MAS O MENOS como soy yo.
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7) Termino todo lo que empiezo.

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8) Pongo esmero en todo lo que hago.

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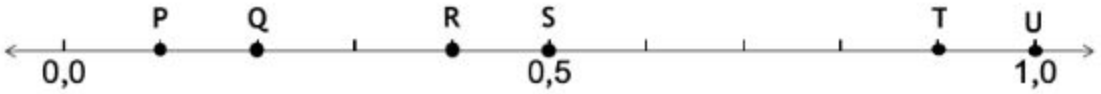

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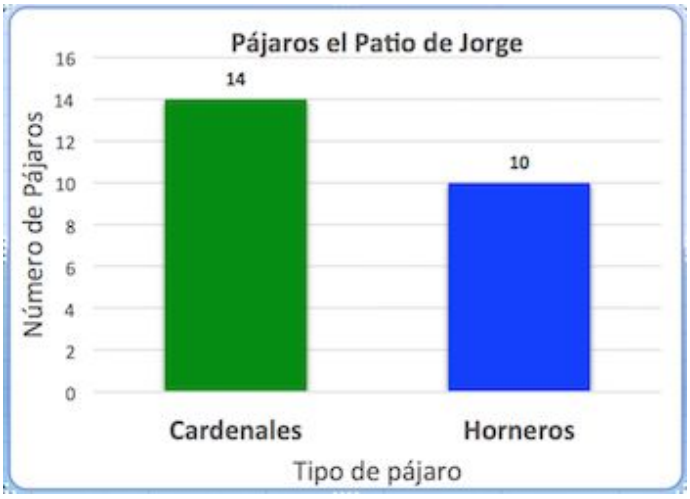

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B. 10/14
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