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Comparing Silence with Verbal & Non-Verbal Music and Irrelevant Speech in Mathematics Assessment

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Comparing Silence with Verbal & Non-Verbal Music and Irrelevant Speech in Mathematics Assessment

by

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Dedication

This work is dedicated to my wife and three boys who have put up with no summer trip for the last three years while I've participated in this program. Without their support and understanding, this report and completion of my Master's Degree would not have been possible.

Abstract

Comparing Silence with Verbal & Non-Verbal Music and Irrelevant Speech in Mathematics Assessment

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This study looks at the effects of silence as compared to two different types of music and one type of irrelevant speech to analyze the effects on an assessment of 4 categories of mathematical questions. The hypothesis tested was that students would perform best when subject to no distraction (silence), followed closely by non-verbal music (dubstep), while verbal music (Rap) and irrelevant self-speech (repeating the word 'za') would result in a decrease in performance. The hypothesis was not found to be statistically significant, but a general trend supporting the hypothesis was present and found to be consistent with similar research.

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Chapter 1: Introduction

Secondary students often prefer to study with many distractions: listening to music, conversing with friends (about social topics not related to study material) and in a general environment that is completely at odds with the traditionally accepted idea study setting. Popular opinion claims that 'Technology and Multitasking has Rewired How Students Learn' (Willingham, 2010). As shown in Figures 1, 2, and 3, the average American between the ages of 8 and 18 in 2009 was exposed to 10 hours and 45 minutes of media content daily, over the course of 7 hours and 38 minutes of media use, some of which is spent multitasking (Rideout, Foehr & Roberts, 2010). Music is by far the largest growing component of media exposure. In the contemporary classroom music is omnipresent, with both positive and negative impacts on the academic environment. Even in classrooms and schools that heavily restrict the use of portable music players, there are often a number of children who are granted their use via their Individual Education Plan (IEP) as an environment modification to reduce distractions (Burns, 2003).

It follows naturally that if a strategy is good for special populations, there also may be an application for regular populations as well. In addition to the suggested role of music to reduce classroom distractions, there is also a suggestion that music may also lead to an increase in academic performance. Initial reports focused on spatial task performance (Rauscher, Shaw & Ky, 1993), but the effect was rapidly generalized to all academic performance resulting in a popular belief (exploited by aggressive commercialization) that music enhances learning. There are current studies asserting that the Mozart Effect positively impacts the demonstration of learning in mathematics (Taylor & Rowe, 2012), yet results are far from conclusive. Taylor and Rowe (2012) looked specifically at trigonometry students in college. They tracked the results of six assessments and found that the group which listened to Mozart while testing scored significantly better than the group testing in a traditional ‘silent’ environment. The

Media Use Over Time

Among all 8- to 18-year-olds, average amount of time spent with each medium in a typical day:

	2009	2004	1999
TV content	4:29[a]	3:51[b]	3:47[b]
Music/audio	2:31[a]	1:44[b]	1:48[b]
Computer	1:29[a]	1:02[b]	:27[c]
Video games	1:13[a]	:49[b]	:26[c]
Print	:38[a]	:43[ab]	:43[b]
Movies	:25[a]	:25[ab]	:18[b]
TOTAL MEDIA EXPOSURE	10:45[a]	8:33[b]	7:29[c]
Multitasking proportion	29%[a]	26%[a]	16%[b]
TOTAL MEDIA USE	7:38[a]	6:21[b]	6:19[b]

Notes: See Methodology section for a definition of terms, explanation of notations, and discussion of statistical significance. See Appendix B for a summary of key changes in question wording and structure over time. **Total media exposure** is the sum of time spent with all media. **Multitasking proportion** is the proportion of media time that is spent using more than one medium concurrently. **Total media use** is the actual number of hours out of the day that are spent using media, taking multitasking into account. See Methodology section for a more detailed discussion. In this table, statistical significance should be read across rows.

Figure 1: Media Use over Time (Rideout et al., 2010)

Personal Media, by Age

Among 8- to 18-year-olds, percent who own each item:		AGE		
	Among all	8–10	11–14	15–18
iPod/MP3 player	76%	61%[a]	80%[b]	83%[b]
Cell phone	66%	31%[a]	69%[b]	85%[c]
Handheld video game player	59%	65%[a]	69%[a]	41%[b]
Laptop	29%	17%[a]	27%[b]	38%[c]
Portable CD/ tape player	16%	9%[a]	16%[b]	20%[b]

Note: Statistical significance should be read across rows.

Figure 2: Personal Media, by Age (Rideout et al., 2010)

authors state: "Our findings indicate that the Mozart Effect does impact the demonstration of learning in mathematics. Whether it is through priming cortical firing patterns, reducing anxiety, and/or generating arousal is a theoretical matter beyond the scope of this experiment. Of most importance to educators is that the Mozart Effect is not merely a lab experience, but has potential to assist students in performing their best on mathematical assessments." (Taylor and Rowe, 2012).

The purpose of this study is to compare the effects of two different types of popular music (Rap/Hip-Hop and Dubstep/Dance), with the control conditions of silence and repeating the word 'za,' during a brief mathematic assessment to see if there is a statistically relevant effect on assessment performance. The two types of music include both vocal and non-vocal music, and are wholly different from the traditional music associated with a 'Mozart Effect,' but are more in line with students' current preferences.

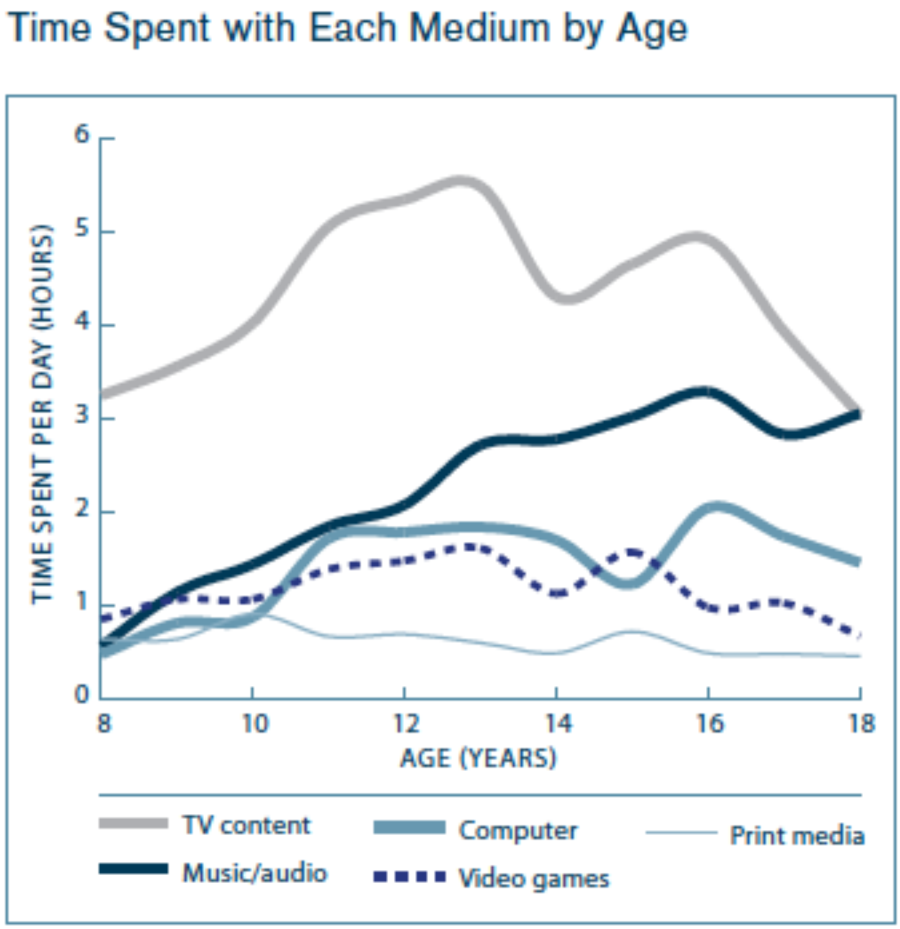

Figure 3: Time Spent with Each Medium by Age (Rideout et al., 2010)

Chapter 2: Review of Literature

The focus of this literature review was to explore research on the proposed effects of music on cognition and classroom distractions. The main focus was on auditory inputs, particularly any research that validated or invalidated the proposed cognitive benefits of music for scholastic performance. The use of silence as a control setting was straightforward, but it was also important to search for auditory distractions that are likely to have a significant negative effect on cognitive and scholastic performance. The search for benefits led to the 'Mozart Effect,' for which there is a substantial body of research reporting mixed results for subjects exposed to music while working. Based upon this research, the following research hypothesis was proposed:

Non-vocal music will lead to superior mathematical performance, relative to vocal music.

MUSIC AND COGNITION

There are wildly varying reports on the efficacy of music to enhance cognition and task performance. Everything from tempo (Mayheld & Moss, 1989) to music familiarity has been investigated with varying results. In particular, Mayheld and Moss (1989) completed two studies analyzing both quantity (volume of calculations) and quality (accuracy of calculations) of work while listening to either fast paced, slow paced or no music. In the first they found no significant differences between the quantity or quality, while in the second they found that their subjects performed better while listening to the fast paced music, compared to either the slow or no music. It was also noteworthy that the subjects reported greater perceived distraction in the music conditions.

The Mozart Effect

The first reported research on the Mozart Effect was published by Rauscher, Shaw and Ky in 1993 (Rauscher et all., 1993). They reported that college students who listened to ten minutes of Mozart's sonata for two pianos in D major, prior to an administration of spatial-temporal testing showed significant improvement versus listening to a relaxation tape or silence. Marketers greeted their report with much enthusiasm, and researchers greeted it with much skepticism. Popular figures quickly linked the Mozart Effect to all cognition, and suggested widespread applicability, spawning television shows for children, listening CDs for babies in the womb and prompting teachers everywhere to play classical music in their classrooms. The Mozart Effect was linked in 1998 by Drs. Rauscher and Shaw (Rauscher & Shaw, 1998) strictly to spatial-temporal tasks using Dr. Shaw and Dr. Leng's 'Trion Model' which proposed that complex musical compositions (such as found in classical music) excite cortical firing patterns similar to those used in spatial-temporal reasoning. They even predicted that music lacking in complexity might interfere with rather than assist reasoning (Rauscher et al., 1993). The distinction between an assistive noise and one that interferes seems very nuanced and influenced by a traditional notion of musical sophistication. Pleasing complexity may be very different for a modern undergrad or secondary student. What may be distracting for one generation could be very pleasant for another; therefore, it is useful to look at distractions in the modern classroom.

DISTRACTIONS

In a rated list of self produced distractions (Tesch, Coelho, & Drozdenko, 2011), portable music players rank 6th of 21 potential distractions, with a mean difference of only 0.33 on a 1 to 7 scale versus sleeping. Students seem to recognize that music in the

Table 1: Self Produced Distracters (Tesch et al., 2011)

Self Produced Distracters	**Mean**	**SEM**
Your illness symptoms (coughing, sneezing, sniffling, etc.)	4.98	0.13
Sleeping	4.96	0.16
Your phone / pager ringing	4.83	0.16
Playing video games	4.76	0.16
Talking with others in class	4.75	0.14
Using your MP3 player	4.63	0.17
Doing work for other courses	4.57	0.15
Using a laptop for checking your email, surfing, etc.	4.44	0.16
Poor personal hygiene (odors, looking dirty, etc.)	4.39	0.14
Texting during class	4.38	0.15
Using your smart phone	4.20	0.17
Arriving late to class	3.93	0.14
Leaving early	3.91	0.15
Playing paper and pencil games, doodling ,etc.	3.77	0.15
Leaving/returning to class	3.74	0.15
Student response devices(Clickers)	3.09	0.16
Eating in class	2.73	0.14
Wearing provocative clothing	2.52	0.13
Wearing clothing with unusual words, colors, styles, etc.	2.09	0.11
Drinking in class	2.06	0.13
Wearing hats, hoods, etc. to class	1.94	0.12

classroom can be very distracting, but the popular concepts of the Mozart Effect and other supports for music in the classroom convince them that music player use is acceptable. The only distractions that 'outrank' use of a portable music player are: Your (own) illness symptoms (coughing, sneezing, sniffling, etc.), Sleeping, Your phone/pager ringing, Playing video games, and Talking with others in class. One purpose of this research is to determine if there is a differential effect of different types of music that would validate the use of a MP3 player and to determine if there are only certain conditions which make MP3 player use distracting. Music use is the primary self-produced distraction evaluated in this study, but for comparison purposes, the study will also include self-induced distraction related to talking.

The Irrelevant Speech Effect

Research has strongly established findings supporting a disruptive effect of irrelevant noises and speech on cognition, problem solving and task performance. The disruption is thought to have a detrimental impact on performance, as high as 30-50% overall impairment compared to a quiet control (Hughes & Jones, 2003). The effect is hypothesized to be consistent regardless of intensity (within a range of volume between that of a humming refrigerator and a vacuum cleaner: 40-80 dB), and the effect is particularly relevant to problem solving tasks, which require temporal sequencing of events (Hughes & Jones, 2003). Alley and Greene (2008) postulated that verbal language (spoken or sung) affects the phonological loop and therefore disrupts working memory. In their study they found a trend similar to that experienced in this study between groups working in silence, exposed to irrelevant speech, or while listening to vocal music and karaoke versions of the vocal songs. Interestingly they noted that the karaoke versions of songs well recognized by the participants were more similar to silence than the vocal music, though the results were not statistically significant (Alley & Green, 2008).

Musical Distractions

Over 83% of high-school aged children report ownership of iPods/MP3 players (Rideout et al., 2010), and they consume nearly 3 hours of music on a daily basis. Beyond the actual effect of the music the students are listening to, there is an additional distraction offered by these MP3 players which is not considered in this study but should be noted. More often than not the current generation of MP3 players/cell phones also allows access to the internet, gaming, and text messages, so while the effects of music use in the classroom may be adequately analyzed via study design, the externalities of these other uses are harder to quantify. There is an enormous number of scholarly articles, reports and studies that consider the effect of music on cognitive tasks. In particular, Dr. Adrian Furnham is well published in his studies looking at the effect of background music on 'Introverts and Extroverts.' (Furnham & Bradley, 1997) Furnham found that there was a significant and detrimental effect of 'pop' music (in this study the pop music was upbeat vocal pop music) on a recall test of both ten introverts and ten extroverts when music was played. Alley and Greene (2008), in a study of 60 college students, failed to find a statistically significant difference between silence control groups and instrumental (non-vocal) pop music though there was a visible trend in their data. They suggest "instrumental music does not seriously impair working memory but may be worse than silence for some people or under some conditions." Based upon their conclusions it seemed reasonable to compare the effects of vocal and non-vocal music of different types.

HYPOTHESES BASED ON RESEARCH

After completing this literature review, a hypothesis was developed that suggests students working in a silent condition should have the greatest performance on an assessment of four types of mathematics questions. Secondary hypotheses are that dubstep music (non-verbal) will outperform rap music and irrelevant speech on the same questions, while underperforming silence.

Chapter 3: Methodology

PARTICIPANTS

The participants in this study were high school geometry students at Rouse High School in the Leander School District. The data was gathered during a class lesson on study habits prior to a unit of test preparation. The population was a generic sampling of 'on level' geometry students. Initially, about ninety students participated, but due to recording errors or failure to follow instructions properly (completing all questions under one condition, failure to record condition on recording sheet, etc.), the data was only admissible from thirty-four of the participants. Both male and female students participated. Their ages ranged from 14 to 19. Ethnic groups included: Non-Hispanic Caucasian, Hispanic, African American, Pacific Islander, Asian and combinations thereof. Four sections participated in the study, and there were between 20 and 25 students in each section. Participants were randomly divided into four starting groups of between five and seven students each.

ASSESSMENT

Eight questions were prepared for the assessment instrument. The questions were evenly divided into four categories: Fractions, Word Problems, Square Roots and Exponents, and Inequalities. The questions are available in Table 2 below. The level of rigor utilized for the questions was intended to be representative of that expected by the Texas Essential Knowledge and Skills (TEKS) for the eighth grade level. The questions were not multiple choice, although one of the inequality questions asked the participants to select all the answers that would satisfy the inequality in an answer bank.

Table 2. Math questions used in the assessment

Fractions
1. What is the sum of ½ plus ¼?
2. If you split a tray of 32 brownies evenly with your best friend, and they share their brownies evenly with 3 more friends, what fraction represents the amount of the tray that you have left?
Word Problems
3. The sum of two numbers is 15. One number is 3 less than the other. What is the larger number?
4. A team won 5 more games than it lost. It lost 7 games. How many total games did the team play?
Square Roots and Exponents
5. What is the value of the equation $7x^2 + 2x - 12$ when $x = 4$?
6. What is the value of the equation $\sqrt{3y^2 + 4y + 2}$ when $y = 1$?
Inequalities
7. If X is the number of people at a One Direction concert, write an equation(inequality) to represent the number of people at the concert if there are less than 500 men at the concert and less than 200 women:
8. Which of the following numbers is a solution to the equation: $7x - 10 > 10$ 1 2 3 4 5

PROCEDURES

The design was a four by four experiment in which participants were divided into four groups at the beginning of the session. Each group was assigned to one of four initial conditions (distractions/influences): silence, rap/hip hop music, dubstep/dance music, and irrelevant speech (students silently repeated the word ‘za’). Each participant answered one category of questions (two of eight) with an allotment of ninety seconds for each station. When the ninety seconds had passed, each group rotated to the next station where they experienced the next distraction/influence (i.e., the students who had previously worked in silence would then work while listening to Rap/Hip Hop music) until they had each completed all eight questions and experienced each of the four conditions. In this manner there were sixteen total conditions/question types that the participants could experience:

1. Silence/Fractions
2. Silence/Word Problems
3. Silence/Roots & Exponents
4. Silence/Inequalities
5. Rap/Fractions
6. Rap/Word Problems
7. Rap/Roots & Exponents
8. Rap Silence/Inequalities
9. Dubstep/Fractions
10. Dubstep/Word Problems
11. Dubstep/Roots & Exponents
12. Dubstep Silence/Inequalities
13. Irrelevant Speech/Fractions
14. Irrelevant Speech/Word Problems
15. Irrelevant Speech/Roots & Exponents
16. Irrelevant Speech Silence/Inequalities

The participants used a listening station for each of the music conditions. They wore headphones connected to a CD player while completing the music selections, and worked in silence at the ‘za’ and silence stations. At the ‘za’ station the students were instructed to work while silently repeating the word/sound ‘za’ to themselves. They were welcome to either repeat it silently in their own ‘inner voice’ or could softly verbalize the ‘za’ sound. Most students chose to use their inner voice.

The songs selected for the Rap Music condition were the ‘clean’ versions of Drake’s ‘The Motto’ and Tyga’s ‘Rack City’ purchased on iTunes. The song selected for the dubstep station was Skrillex’s ‘Scary Monsters and Nice Sprites’ also purchased on iTunes. The songs were selected on the basis of their current popularity and the availability of ‘clean’ versions. Upon completion of each section, the participants were to record the condition (Rap, Dubstep, Silence, Za) and refrain from proceeding to the next section. The allotment of ninety seconds was more than adequate for the students to complete their two assigned questions, and many were able to complete the entire packet in that time (see discussion).

Analysis

After the experiment the questions were graded on a strict binary basis: correct/incorrect. One point was awarded for each correct answer, and zero points were awarded for each incorrect answer. The results were recorded in Excel. The mean score for each of the sixteen different combinations of condition/question type were compared by paired sample t-tests. Then, each condition was compared to the other conditions (for all types of questions) by one-way ANOVA. Additionally, the types of questions (regardless of condition) were compared by one-way ANOVA as well. The results are displayed in a bar chart with error bars representing one standard deviation.

Assumptions

This study contained a number of assumptions. First was the assumption that working in a silent classroom would approximate a control group with minimal distraction, and that repeating the word/syllable ‘za’ would be the greatest disruption. As such it was expected that the performance during the silent condition would exceed that during the ‘za’ portion, and that the dubstep and rap portions would fall between the silence and ‘za.’ A further assumption was made that the vocal/prose component of rap music would be more distracting than the non-verbal dubstep music.

Chapter 4: Results

Participant scores were determined by the award of one point for a correct response and zero points for an incorrect response. The number of responses for all conditions/categories was 272, and the mean score was 0.41 with a variance of 0.24 and standard deviation of 0.49. The overall mean was calculated for each separate combination of condition and category, as well as for the aggregate for each condition and each question category. The results are published in Table 3.

Table 3: Means, standard deviations and number of samples for each combination.

		Rap	Dubstep	Za	Silence	Totals
Fractions	μ	0.44	0.57	0.35	0.56	0.47
	σ	0.51	0.51	0.49	0.51	0.50
	n	18	14	20	16	68
Words	μ	0.42	0.38	0.47	0.00	0.41
	σ	0.51	0.49	0.51	0.00	0.50
	n	12	24	30	2	68
Roots	μ	0.46	0.54	0.50	1.00	0.51
	σ	0.51	0.51	0.52	0.00	0.50
	n	28	26	12	2	68
Inequalities	μ	0.30	0.17	0.00	0.25	0.24
	σ	0.48	0.41	0.00	0.44	0.43
	n	10	6	4	48	68
Totals	μ	0.43	0.46	0.41	0.34	0.41
	σ	0.50	0.50	0.50	0.48	0.49
	n	68	70	66	68	272

The mean scores published in Table 3 clearly demonstrate the difference in performance between the different problem categories. Square root and exponent problems were the highest scoring category, but the fraction and word problems were not very far behind. The inequality questions were very far behind the other three categories. Comparing the conditions is not as straightforward. When looking at the totals of the means they are all fairly close with the exception of the silence condition, which lags behind the others. This is due to the fact that the calculation of the mean in the total column is a simple mean of all results from the silence condition. Since the inequality category scores were significantly lower than the other categories, the inequality results had an oversized impact on the simple means in the totals row for conditions. Particularly relevant is the fact that n = 48 for silent inequalities. This particular combination results in the simple mean for silence being less than that of the other conditions. To address this effect, an alternate evaluation method was employed averaging the means, with the results discussed below.

A t-test was also performed comparing the average of each of the conditions and the average of each of the categories of problems (see tables below). The tables display the p-values of each condition and category compared with the others by a two-tailed t-test. The totals column compares the responses in each condition or category with all responses in the study to determine if there is a statistically relevant difference between the condition and the entire data set. The t-tests did not support the hypothesis that condition had an effect on performance, while they do expose a significant difference in performance between the Inequalities category and the Fractions and Roots/Exponents category. The students generally performed very poorly on the Inequalities category (μ = .24) while they did relatively well on the Roots and Fractions categories (μ = .51 and .47 respectively).

Table 4: t-test comparing Conditions (p-values)

	Rap	Dubstep	Za	Silence	Totals
Rap		0.48	0.28	0.42	0.48
Dubstep	0.48		0.30	0.44	0.46
Za	0.28	0.30		0.32	0.33
Silence	0.42	0.44	0.32		0.42
Totals	0.48	0.46	0.33	0.42	

Table 5: t-test comparing Categories (p-values)

	Fractions	Word Problems	Roots/ Exponents	Inequalities	Totals
Fractions		0.11	0.18	0.01	0.12
Word Problems	0.11		0.055	0.16	0.24
Roots/ Exponents	0.18	0.055		0.01	0.09
Inequalities	0.01	0.16	0.01		0.02
Totals	0.12	0.24	0.09	0.02	

Another way to quantify the trends among conditions is by calculating a metric called the overall mean, which is plotted in Figure 5 and Table 6. As documented in Table 3, the number of samples for each condition was not consistent as intended, resulting in mean scores for some conditions being skewed by including a relatively large number of responses from high- or low-scoring categories. The intention was to have an equal number of samples for each combination of condition and category. Since the numbers of samples were not consistent and the range of samples for each combination ranged from 2 to 48, the overall mean for each condition is calculated by averaging

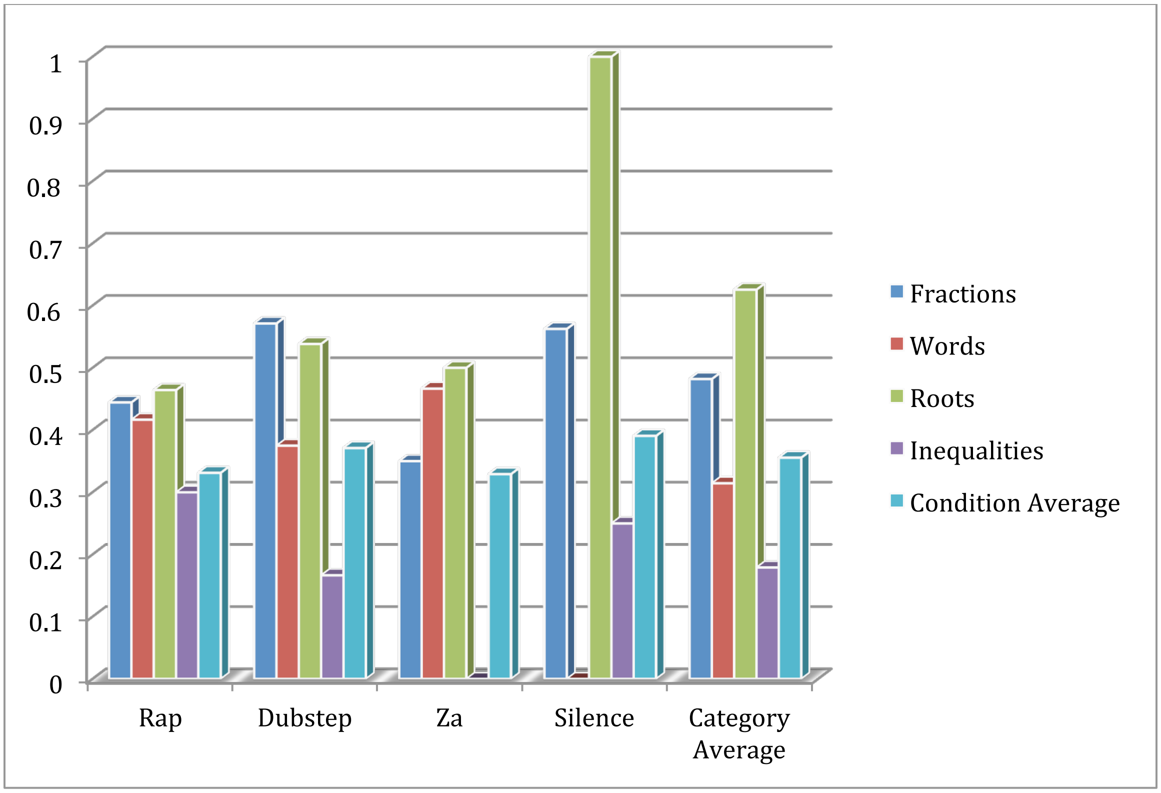

Figure 4: Comparison of Mean Scores between conditions by category with Category and Condition averages (data in Table 6).

Table 6: Mean Scores for Categories and Conditions.

	Rap	Dubstep	Za	Silence	Category Average
Fractions	0.44	0.57	0.35	0.56	0.48
Words	0.42	0.38	0.47	0.00	0.31
Roots	0.46	0.54	0.50	1.00	0.63
Inequalities	0.30	0.17	0.00	0.25	0.18
Condition Average	0.33	0.37	0.33	0.39	0.36

the means for each combination of condition and category within a condition. Likewise, the overall mean for each category is calculated by averaging the means for each combination within a category. Calculating the overall means in this manner is intended to minimize the effect of the differences in the number of responses for the conditions with high and low N. The trend is clearly visible when calculated as the 'overall mean,' but when the mean is calculated by evaluating all responses in a category regardless of condition, or all responses in a condition regardless of category the trend is no longer present because the distribution of responses in a condition may be more weighted towards one of the higher scoring categories. Based on the overall means, there was a visible trend that supported the hypothesis that subjects would perform best while working in silence, followed by the Dubstep (non-vocal music group), with Rap and Za coming in 3rd and 4th positions respectively (see Figure 5 and Table 6).

A t-test of the results did not provide an adequate level of statistical significance to recognize anything other than the trend. ANOVA was performed to see if it was possible to assume that condition had an effect on performance. While there was no significance for the difference between the means of the conditions (one-way ANOVA, $p = 0.92$) there was significance between the different problem categories (one-way ANOVA, $p = 0.03$). The trend is more visible when looking at a direct comparison of overall means of the four conditions as found in the Table 3. Particularly notable is that the Inequality category was the lowest scoring category regardless of condition. This meant that the differences in number of samples needed to be accounted for, which is why the 'overall mean' method was employed.

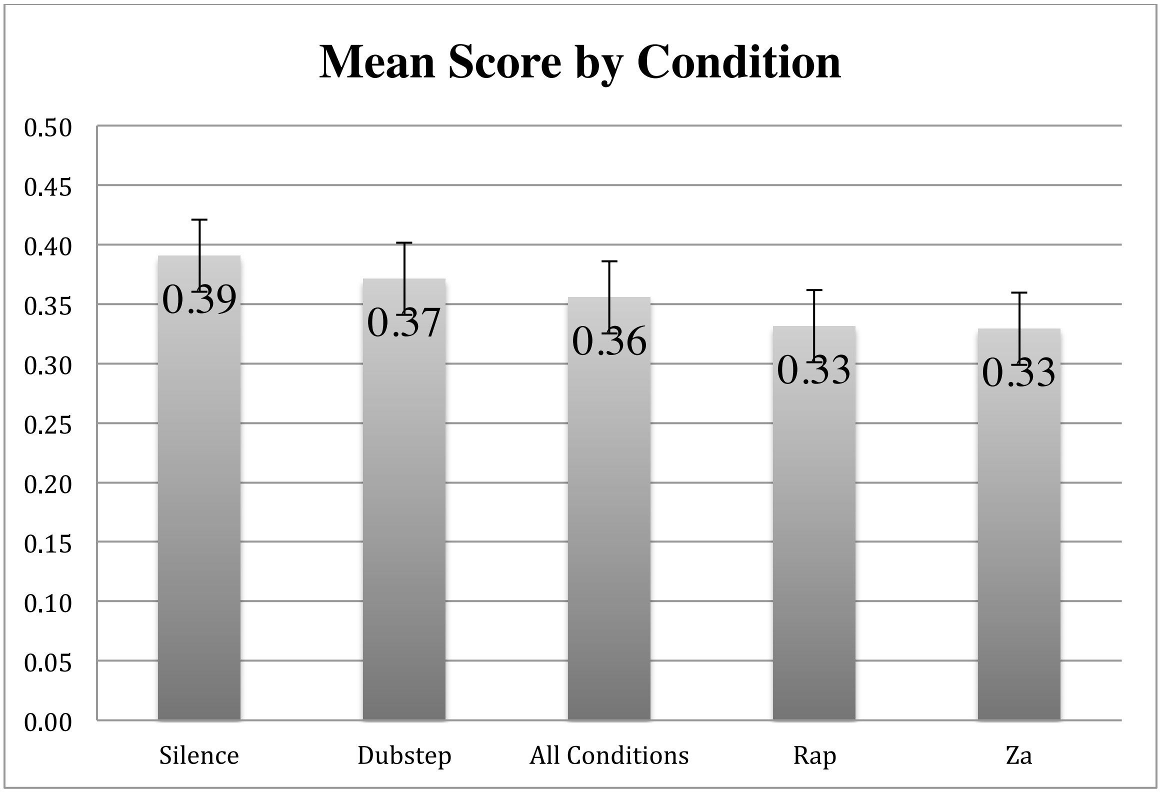

Figure 5: Overall Mean Scores by Condition (Error Bars represent 1 Standard Deviation in Mean Scores. The y-axis is the mean score between 0 and 1.)

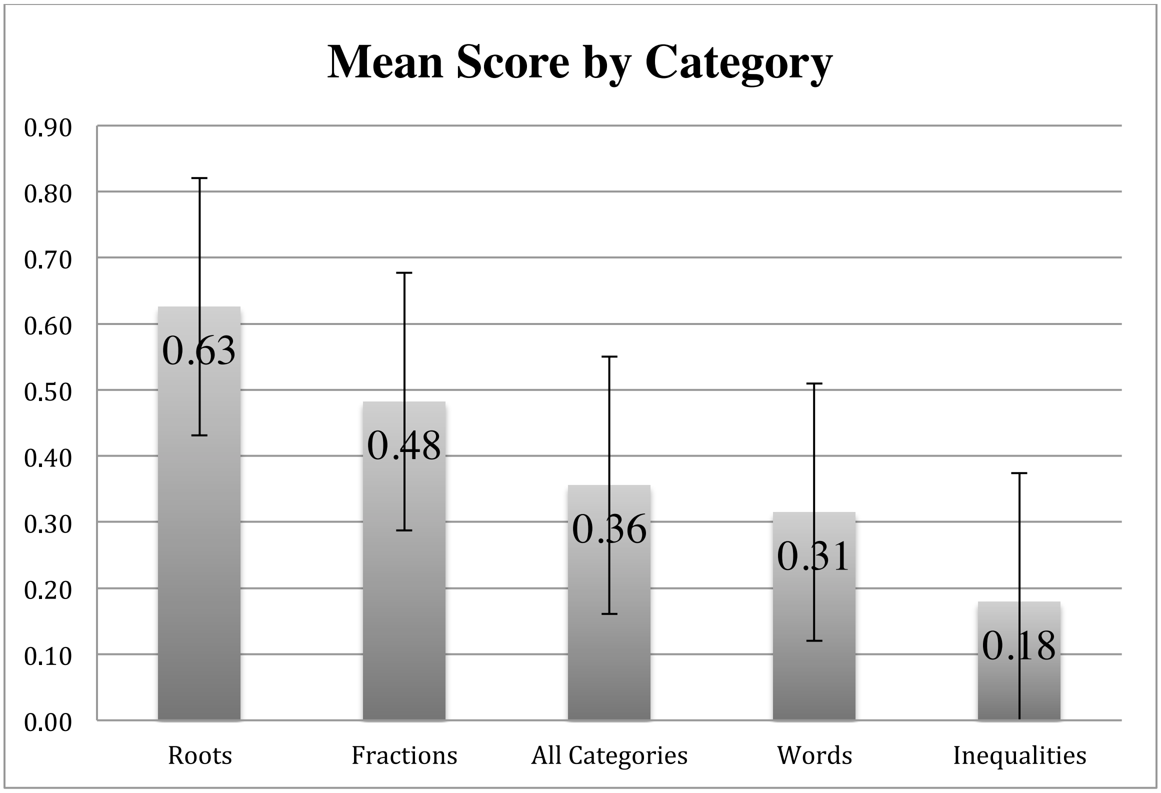

Figure 6: Overall Mean Scores by Category (Error Bars represent 1 Standard Deviation, y-axis is the mean score between 0 and 1)

Chapter 5: Discussion

The lack of a significant difference could be attributed to a number of challenges while executing the study. The first major challenge was the lack of adequately completed answer documents. The study was intended to result in equal numbers of results for each of the sixteen combinations of condition and distraction, but resulted in an imbalance where the range of responses for the sixteen categories varied from two to forty-eight (see Figure 5). The range of responses may have resulted in the lack of statistical significance when running the t-tests comparing each condition. The range was particularly notable as the silence condition had two samples in the roots/exponents category, which had the highest mean of all categories, while having forty-eight samples in the inequalities category, which had the lowest mean of all the categories. An additional execution of the study could investigate whether that inequality had a notable impact on the results. It is reasonable to suggest that may be the case given the low number of overall results and the hypothesis that Silence should show a significant separation from Rap and the 'Za' condition.

The second major challenge in the study was the development of relevant testing instruments. The study design was an attempt to control for differences between the difficulties of the question categories by randomizing each of the sixteen conditions equally amongst the study population. Given the lack of significance in the condition results, it is notable that there is significance between the categories ($p = 0.02577$). Ideally a number of questions for each category would have been field tested and selected on the basis of normalized results. Field testing was not performed for these questions and the questions employed were intended to be generally representative of 8^{th} grade level TAKS questions.

Other minor challenges for implementation were evident in the number of discarded student answer documents. Participation in this study was not an optional classroom activity, but rather a daily activity for the students participating. In an effort not to influence the study results, the students were only given a very broad explanation of the intent of the study. The rationale for keeping the participants 'in the dark' was to avoid sullying the results with student bias towards a preferred condition. The full intent of the study was explained after completion and participants reported their perceived levels of distraction (both on answer documents and verbally to the class in discussion after the activity). It would have been useful to gather the feedback on perceived distraction in a systematic fashion to see how closely the students are able to recognize their distraction level with the varying conditions. Additionally, a possible solution for helping the participants adhere to the directions and to simplify administration might be to have each student start with a different question category and rotate in order. In that manner it would be possible to administer each condition to the entire classroom at once without the need for headphones since you could play the music over a radio. Use of the listening stations with headphones was problematic since the students were required to shift from one station to the next, and when students wear headphones they are often in a bubble. The 'bubble' effect resulted in a number of students completing almost the entire packet on their first station, resulting in lost data points.

A good follow-up to this study would be to employ similar types of music and conditions with a larger population and with clearer instructions and expectations for adherence to the study design. Completing a practice question or two to demonstrate how to properly participate in the study and complete the recording sheets would be useful. Additionally, it may be useful to include different types of non-verbal and verbal music, such as classical music as a counterpoint to the very active non-verbal dubstep, and country music to pair up with the verbal rap.

Chapter 6: Applications to Practice

Management of the classroom environment is a topic that will be actively discussed and passionately debated as long as there are forums for educators to discuss their trade. Managing the auditory environment is certainly a major part of setting the atmosphere for the learning environment and as such is a worthy topic for study and analysis. Despite the current 'data driven' movement in education, there are certain dogmas that seem to be accepted as fact with little justification. The first is the popular notion that there is a most appropriate type of music that is acceptable for classroom use, namely 'Mozart Effect' types of music: complex classical arrangements that theoretically activate certain regions of the brain, helping people learn. A seemingly central tenet of this dogma is that there is an appropriate music to use in the classroom and that other types of music are inappropriate. The data from other published reports is very mixed on the effect or lack of effect of various types of music. This study found no significance between a silent condition and repeating the word 'za' though students reported that they were very distracted while repeating 'za' and almost unable to concentrate at all. There was also a noticeable though insignificant trend supporting the hypothesis that silence or non-verbal music was less distracting than verbal music or repeating 'za.' As such it is reasonable to consider that non-verbal music is less distracting than verbal music, though the effect may be small, and the type of non-verbal music may not matter. Without demonstrating outright statistical significance and without a greater number of conditions to evaluate, it is impossible to make definitive statements regarding the type of music to employ in the classroom, but it is very likely that music is not as great a distraction or benefit for secondary students as some may believe.

Reflections on the MASEE Program

The UTeach Summer Masters purpose is to grow teacher-leaders capable of bringing reform ideas to their school districts. This study has been much in keeping with that ideal. In conducting this study, we were able to utilize the habits of mind reinforced over the seven semesters of the program. Particularly, as this study evolved from an idea to the final product, the focus was on an analytical evaluation of student environment and its effect on student performance. Throughout the program we were empowered with tools to systematically research and analyze educational literature and apply that research in our classrooms and our schools with a focus on student improvement and an awareness of social justice.

From our very first summer semester of the program, we were exposed to curriculum and content approaches we could apply in our classrooms, both in terms of an engaging approach to allow for hands-on, exploratory learning, and with actual activities for students to engage in. In this regard, the MASEE program both gave us direct tools, and provided exemplar activities and approaches for us to emulate. This particular study expands those approaches by applying an analytical approach to the evaluation of environment.

It is no secret that one of the most effective ways of meeting our objective of educating our charges is to meet them on the ground of their choosing, and that ground often has a soundtrack. If we can find the ideal ‘soundtrack’ for their educational experiences, and that soundtrack is of their choosing, we will meet them on the ground of their choosing. The goal of social justice cannot be realized by allowing students equal access to opportunities, but also requires that students take advantage of their opportunities. Environment plays a critical role in helping students make the decision to engage in the learning opportunities presented to them. Once this type of reform can be successfully supported and implemented (if it does indeed support student achievement as hypothesized), one more scholarly student-focused reform can be realized. This study is just one of the reform approaches applied by the members on our cohort. There are others working on curriculum, exploring laboratory approaches, and utilizing the latest freeware tools to support our classrooms and schools. Our particular subject area focuses on the Science, Technology, Engineering and Math (STEM) disciplines, but our results are broadly applicable throughout our entire school districts.

Chapter 7: Conclusion

Despite demonstrating no statistical significance to support the research hypotheses, the results of this study do lend credence to some of the published case reports in which the role of music in inhibition of working memory and decreased cognition is tenuous. This study showed a very slight trend toward the expected results of silence being superior to music, and irrelevant speech being the greatest distraction. The differences were not significant and it is impossible to draw a definitive conclusion that would preclude a student's personal experience using music to help study. It would be interesting to gather more data to attempt to confirm the trend and possibly provide statistical significance and allow for an actionable conclusion. Another follow-up to this experiment could compare groups exposed to Mozart, since there are studies showing significant improvement while listening to that music (Taylor & Rowe, 2012), with popular music as used in this study.

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