

# The Impact of an Art History Education on Short-Term Memory Rates in High School Students

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## Abstract

Despite their value, art programs are declining in schools as a result of a rise in standardized testing. Reinstating funding to the arts begins with highlighting their benefits, such as short-term memory, as necessary for career preparedness. Students in Westlake High School's Art History program allegedly encoded details from learned artworks into their short-term memory, but it remained unknown if the memory loop was simply perceived by students or occurred due to enrollment in the Art History courses. Previous research in the field addressed art analysis and short-term memory respectively, but the two factors had not been linked, inspiring the question: How Does Pursuing an Art History Education Impact Short-Term Memory Rates in High School Students? The researcher replicated George Miller's Digit Span Test and hypothesized higher memory rates among the Art History students with improved test scores among successive course levels. Recorded variables included Digit Span Test scores and accuracy rates out of 10, while student grade level, Honors course enrollment, and AP course enrollment were collected to minimize confounding variables in scores. Results revealed that all Art History courses had higher mean Digit Span Test scores and accuracy rates than the general population at Westlake High School, while the confounding variables showed no trend with scores. The researcher's hypothesis was correct, and the findings may prompt lawmakers to reinstate funding to school art programs amidst budget cuts. Future research might consider expanding the findings beyond Westlake High School and linking other art forms to short-term memory.

*Keywords: Art History, Short-Term Memory, Digit Span Test*

## Introduction

The popularity of the arts is declining in schools nationwide as art programs are defunded in favor of strengthening STEM (science, technology, engineering, and math) departments due to their stereotype of having “more applicable” skills for the workforce. While strengthening STEM programs is certainly important, it must not occur at the expense of art programs, as students are prevented from receiving a well-rounded education with a balance of STEM and the arts.

The prioritization of STEM over the arts originated from President George Bush’s “No Child Left Behind Act” which aimed to close the gap between Title I schools and their wealthier counterparts through increased standardized test scores. This resulted in schools favoring subjects with tests attached while defunding those that didn’t: the arts were especially targeted due to the field’s encouragement of project-based learning through painting, sculpting, and art analysis. The “No Child Left Behind Act” defunded visual arts programs nationwide, with “25 percent of principals [cutting] art education and 33 percent [anticipating] future reductions” in response to the law (Chapman, 2005). This law set a precedent of art programs being replaceable compared to STEM subjects.

A short win for the arts came about in 2015 when President Barack Obama signed the “Every Student Succeeds Act” which acknowledged the presence of art programs in lower education and distinguished a place for the arts in STEM, changing it to STEAM (Vargas, 2017). Although well-intentioned, the law let states decide how to integrate art into school curriculums as long as they prioritized standardized testing, creating a loophole where states could waive the law if they proposed a more adequate method for improving statewide test scores. One such state is California which successfully had a waiver approved in 2022 to replace the “Every Student Succeeds Act” requirements in their state with their own method of improving statewide student achievement. While the updated plan addressed the distribution of federal funding for test-heavy curriculum, there is no mention of art programs being sustained within the new budget, thus emphasizing the lack of recognition for the field in state education policies (California Department of Education, 2022). This has resulted in art programs being compromised in schools as they once were during the “No Child Left Behind Act.”

Reinstating funding to the arts begins with changing mindsets about its applications by highlighting its benefits. Many students at Westlake High School enrolled in AP Art History, the study of art analysis, found themselves memorizing 250 pieces through a combination of short and long-term memory. Art History students would associate distinctive

features of each piece with its identity, then encode each new work into their short-term memory. With time and repetition, the encoded information eventually shifted to their long-term memory. However, it is yet to be tested if the memory loop was simply perceived by students or actually occurred as a result of taking Art History courses. Short-term memory includes additional benefits inside the classroom, including “improved vocabulary acquisition, conceptual development, performance on multi-step arithmetic problems, and increased IQ scores” (Cockcroft, 2015). These skills as potentially obtained through Art History can improve memory skills both within the field and in the STEM subjects schools highly prioritize, allowing students to receive the benefits of a well-rounded education. Short-term memory can also be applied to the workforce as it influences problem solving, decision making, troubleshooting, and plan development, thus proving that there are viable applications of the arts as necessary for career preparedness (Hambrick & Engle, n.d). Therefore, a link between Art History and memory provides schools with an incentive to retain art programs amidst budget cuts towards the arts.

### Definitions

Art History is the study of art analysis, including its form, content, function, and context (AP Art History Course and Exam Description, n.d.).

- Form is defined as the visual appearance and medium of the work
- Content refers to the work’s subject matter
- Function is the artist’s purpose of creation
- Context is a historical timeframe of the era of creation

College Board utilized this four-way analysis technique to create its Art History curriculum of 250 pieces to be taught in the class. Due to the popularity of Westlake High School’s AP (Advanced Placement) Art History class, two additional classes were created to make an Art History track available to students: Art Historical Methods and Art History Thesis.

- Art Historical Methods explores various theories and lenses through which art is observed (ex: color theory, racial lens, gender lens)
- Art History Thesis is an independent study in which students write a year-long thesis about an Art Historical topic

### Literature Review

Art Analysis and Improved Observation

Researchers at Yale University who tested their medical school students for improved observation skills through art analysis concluded that “using visual art images with guided questions [related to art analysis] appear[ed] useful to train medical school students in clinical observation skills” (Jasani & Saks, 2013). The study was conducted on 110 third year medical students enrolled at Yale Medical School who analyzed eight different works of art as a group; collaboration and banter were encouraged as students were asked to analyze the visual content and artist’s interpretation of each work using a set of guided questions. Questions included “What do you see?” and “What do you think this means?” (Jasani & Saks, 2013). These are Art Historical analysis techniques which interpret works from formal and functional perspectives. Results concluded that the art analysis activity improved observation skills among participants through increased mindfulness in observing patient conditions which improved accuracy in successful diagnoses. This pre-existing knowledge successfully links art analysis to improved observation and is of importance to conduct research linking Art History to short-term memory, since memorization and observation share the same analysis techniques as used to associate features of an artwork with the piece itself.

#### Short-Term Memory and Visual Fixation of Art

Researchers have discovered that visual fixations across paintings involve brain stimulation in regions associated with short-term memory as individuals encode specific features of works while viewing a piece (Conway & Livingstone, 2007). This source describes the significance of “visual machinery” in art which directs the viewer to contrasting features of the piece in order to stimulate associations between details of a work and its identity. Viewers then encode these visual details in the “higher level regions of our visual system [concerned] with object representation and memory” where they are eventually shifted from short-term to long-term memory with time (Conway & Livingstone, 2007). This pre-existing research links short-term memory with art analysis by describing the psychological process behind the brain’s interpretation and encoding of the gazed object which helps individuals remember various artworks through linking each piece with its defining features.

Research has also been conducted on visual fixations of color and its role in short-term memory. Using the same gaze-encode-memory cycle as above, this study found that the color center of an image, the area where the brightest, richest colors are concentrated, matches up with the color center in the brain, the region in the prefrontal where stimuli are processed

and associated with various colors (Frey, et al., 2008). The brain has separate areas for processing different colors, and upon viewing a picture, it categorizes its visual details into one of these color regions for eventual encoding into long-term memory. The purpose of the color center is to associate works by color instead of other defining traits; therefore, color is a useful method of classifying art for associations and memorization. This source discusses the role of color as a visual fixation point for art analysis and encoding into one's short-term memory which allows individuals to recall various pieces through associating their respective identities with specific colors. Both sources on visual fixations support the assumption that Art History students have higher memory rates than their non-Art History peers due to their frequent use of the gaze-encode-memory cycle to associate contrasting features and colors of various pieces with their identities.

#### Visual Working Memory and Digit Span Test

Research has been conducted on the Digit Span Test as used to measure visual working memory in humans, defined as temporary brain storage capacity until information is relayed into one's long-term memory. Psychologist George Miller created the original Digit Span Test in his research on "item capacity limits on working memory" to test how much information individuals could store in their short-term memory at a time. Miller performed this test by showing participants printed number sequences, then asking them to repeat each list of digits out loud in the correct order (Miller, 1956). Miller showed each digit for one second and the frequency of the sequences increased by one number for every correctly memorized set. The test continued until a participant incorrectly stated a digit before scores were calculated. Miller's study is groundbreaking for its findings on "the magic number seven"; he discovered that the average participant remembers a sequence of 7 numbers on the Digit Span Test, with two more or less (Miller, 1956). This pre-existing study establishes the Digit Span Test as a reputed method for testing visual working memory which supports further research linking Art History courses to improved short-term memory, since the researcher used an online version of Miller's model to test their hypothesis.

#### Gap in Research

The pre-existing research successfully links Art Historical analysis to improved observation, visual fixations of contrast and colors in artworks to short-term memory, and visual working memory to the Digit Span Test.

However, the pre-existing research does not indicate if taking Art History classes results in improved short-term memory (visual working memory) in high school students. The purpose of this study is to address this gap and is important to restore funding to art programs nationwide amidst budget cuts and perception of the arts as disposable compared to STEM. To analyze short-term memory rates among Art History students at Westlake High School, the guiding research question is: How Does Pursuing an Art History Education Impact Short-Term Memory Rates in High School Students? The researcher's original hypothesis is that pursuing an Art History education positively impacts short-term memory rates in high school students, with an improved performance in Digit Span Test scores among successive course levels. This is due to the additional art analysis experience gained in the subsequent courses which improves performance of the gaze-encode-memory cycle when learning new works.

## Methodology

### Digit Span Test

The researcher conducted a quantitative method approach using an online version of George Miller's Digit Span Test to measure visual working memory in high school students. The test was administered using BrainScale.net, a website for memory training where a set of digits flashed on the screen and users typed the numbers in the order they appeared (BrainScale.net Training App, n.d.). After each round, participants received a synopsis of their results where green digits represented correctly typed numbers and red digits represented incorrectly typed numbers. If they correctly memorized the complete set of digits, the test displayed their results and reprogrammed to the next round where participants repeated the process. For each subsequent round, the frequency of the number sequence increased by one digit. The test ended when a participant either mistyped a digit or correctly memorized a set of ten digits, receiving a perfect score. The software then generated the total number of correctly memorized digits, following Miller's model, along with the user's accuracy rate on a scale of ten.

### Equipment/Materials

The researcher used the following facilities and materials to accurately conduct this experiment: An enclosed environment for testing with limited distractors and constant conditions for each participant (no windows and a closed door with a sign stating "testing in progress"), one laptop with a premium Brainscale.net subscription to avoid advertisements present

between testing rounds, printed consent forms for participants, an online spreadsheet for data entry, and a table and chair for testing. Appendix A listed below displays the random selection email sent to participants, Appendix B contains the script with testing instructions, and Appendix C includes the consent form distributed to participants.

### Participants

Sixty participants were randomly selected from Westlake High School: 30 participants were obtained from a combined roster of all Art History courses and 30 students representing the general population were chosen from a schoolwide roster of attendees. The students were divided into two groups of 30 in accordance with the Central Limit Theorem's designation of 30 as a statistically sound value for generating a normal sampling distribution of mean Digit Span Test scores (Mascha & Vetter, 2018). Within the 30 Art History students, 10 were randomly selected from each course level to initiate comparisons in memory rates among the courses. The 30 general population students were randomly selected as the control group for comparisons in memory rates between Art History and non-Art History students. All participants from the general population confirmed that they were not previously enrolled in any Art History classes to avoid any Digit Span Test scores which significantly differ from the average high school student.

Course Demographics and Number of Participants at Westlake High School

Course	Number of Participants
General Population	30
AP Art History	10
Art Historical Methods	10
Art History Thesis	10

Participants who received a selection email were asked to respond with their chosen date and class period to take the Digit Span Test for scheduling purposes to accommodate the large number of participants.

Each subject also signed a consent form granting the researcher permission to anonymously record, analyze, and present their data from the study. To maintain confidentiality during data entry, students were labeled on the online spreadsheet using variables corresponding to their Art History course, if applicable: X for AP Art History, Y for Art Historical Methods, Z for Art History Thesis, and G for General Population.

#### Variables/Measures

**Explanatory Variables:** The rounds attained in the Digit Span Test varied for all participants depending on the quantity of number sequences they correctly remembered. However, all participants began the test at Level 2 (two digits) before their individual performances determined additional rounds attained. The student distribution of Art History experience was split in groups of 10 to stimulate memory comparisons between the courses, assuming subsequent course levels indicate further Art History experience, resulting in higher memory rates. Meanwhile, 30 General Population students were chosen alongside 30 Art History students as a control variable due to this number's association as a statistically-sound value for quantitative testing. Student grade level, Honors class enrollment, and AP class enrollment for the current academic year were also assessed to determine any confounding variables which may otherwise explain a high performance on the Digit Span Test.

**Response Variables:** The number of correctly memorized digits was measured through the online Digit Span Test and compared to Miller's "magic number seven" to analyze score differences between Art History and General Population students and within the different Art History classes. The software also generated an accuracy score out of ten representing each participant's proximity to ten correctly memorized digits in a row.

#### Procedure

Prior to testing, the researcher ensured that the testing environment was constant for every participant by using the same table, chairs, and laptop to maintain consistency in digit typing speed. The participant and researcher sat on opposite sides of the table while the laptop containing the Digit Span Test was faced towards the participant. Extra time was allotted each day to accommodate walk-in participants who didn't respond to the selection email. Lastly, the researcher placed a sign on the door asking

students to enter once the participant inside finished testing to maintain a quiet testing environment.

Upon entering the room, participants were welcomed and asked to sign a consent form permitting the anonymous use of their data for research purposes. The researcher explained that the consent forms would later be randomized to select one recipient for a \$20 Amazon gift card.

Next, the researcher verbally asked each participant a series of demographic questions regarding their grade level, Honors class enrollment, and AP class enrollment for the current year to track confounding variables which may impact Digit Span scores. The researcher subsequently entered the responses into a Google spreadsheet under the anonymous variable representing the student group (X, Y, Z, or G).

Participants were then shown the Digit Span Test and informed of its purpose for testing short-term memory. The researcher also explained how the digits flashed on the screen, how to type the sequence into the software, and that the test would end once participants incorrectly typed in a digit. Participants were then offered a practice round to familiarize themselves with the software and began their formal attempt of Digit Span Test shortly after. Upon completion of the test, the researcher recorded individual scores and accuracy rates into the spreadsheet alongside the demographic data.

Finally, participants were thanked for their participation and reminded that their data would remain anonymous before the next participant was invited inside. Each test took approximately five minutes, and the process was repeated for all 60 participants. This concludes the data collection of the experiment.

## Results

The data was analyzed by tracking two main factors between the General Population, AP Art History, Art Historical Methods, and Art History Thesis students: Digit Span Test scores and accuracy rates on a scale of 10. Testing data was subsequently categorized by student demographic to determine if Art History students scored higher and with more accuracy than their non-Art History peers. Grade level, along with Honors and AP class enrollment for the current year, respectively, were also recorded to limit confounding variables which may impact memory scores.

The researcher's collected data is listed below in box plots using Stapplet, a datasheet software which graphs quantitative data. A statistical significance test with an alpha value of 0.05 was utilized to determine

whether scores and demographic data between various Art History classes were statistically distinct from one another. This threshold was used due to its widespread recognition in the field of statistics as an appropriate measurement of statistical significance when conducting hypothesis tests (Mascha & Vetter, 2018).

Figure 1 displays the average Digit Span Test scores by Art History class using a horizontal box plot. These scores display the highest number of correctly memorized digits in a row and range from 5 to 9 on the graph, with 10 as the highest attainable score.

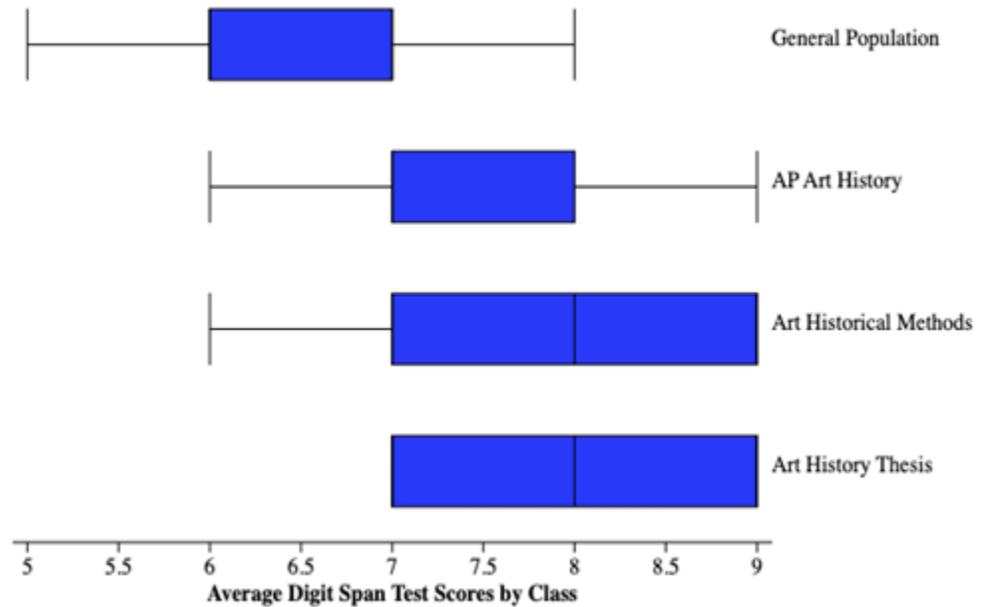


FIGURE 1. Average Digit Span Test Scores by Class

The median score among the General Population was 6.5, while the median score among AP Art History students was 7.5. Meanwhile, the median score among both Art Historical Methods and Art History Thesis students was 8. The statistical significance test which calculated the extent of the score differences revealed a P-value of <0.001.

The null hypothesis used was listed as H0:

$$\mu_{0 \text{ AP classes}} = \mu_{1 \text{ AP Classes}} = \mu_{2 \text{ AP Classes}} = \mu_{3 \text{ AP Classes}} = \mu_{4 \text{ AP Classes}} = \mu_{5 \text{ AP Classes}} = \mu_{6 \text{ AP Classes}} = \mu_{7 \text{ AP Classes}}$$

(AP classes enrollment does not impact mean scores). The alternative hypothesis was listed as Ha: *at least one*  $\mu_{0 \text{ AP classes}}, \mu_{1 \text{ AP Classes}}, \mu_{2 \text{ AP Classes}}, \mu_{3 \text{ AP Classes}}, \mu_{4 \text{ AP Classes}}, \mu_{5 \text{ AP Classes}}, \mu_{6 \text{ AP Classes}}, \mu_{7 \text{ AP Classes}}$  *is different from the others*(AP classes enrollment does impact mean scores).

Since the P-value is  $<0.05$ , the null hypothesis that all participants will have the same mean Digit Span Test score is rejected. There is significant evidence that at least one class has a different mean score. Therefore, the hypothesis that Art History students have higher short-term memory rates than their non-Art History counterparts still stands.

Figure 2 displays the average accuracy scores attained on the Digit Span Test by Art History class. Accuracy scores on the graph range from 5 to 9.75 on the graph on a scale of 10. While Digit Span scores calculate the highest round of all correctly memorized digits in a row, accuracy rates measure student proximity to a perfect score by accounting for all correctly memorized digits, even if the entire set wasn't correctly recalled.

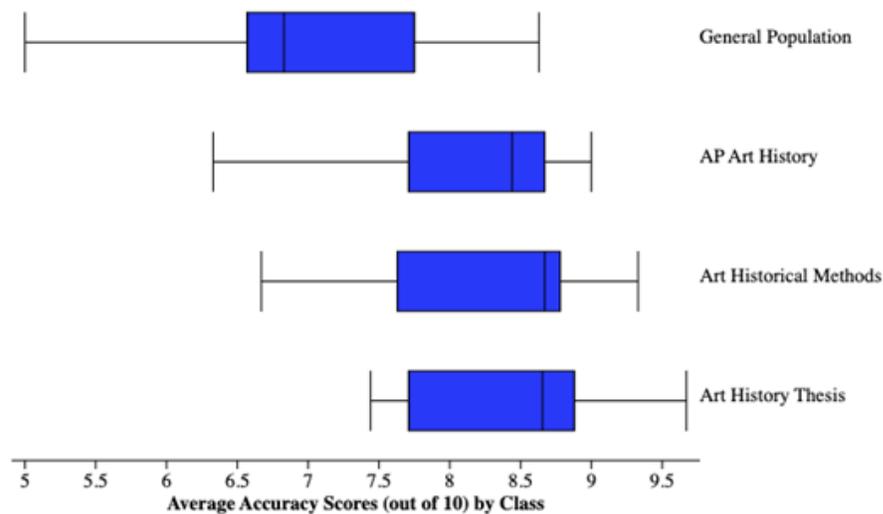


FIGURE 2. Average Accuracy Scores (Out of 10) by Class

The median accuracy score among the General Population was 6.75, while the median score among AP Art History students was 8.5. The median scores for Art Historical Methods and Art History Thesis were 8.6 and 8.65 respectively. The statistical significance test which calculated the extent of the accuracy score distribution revealed a P-value of  $<0.001$ .

The null hypothesis used was listed as  $H_0: \mu_{non\ Art\ History\ accuracy} = \mu_{AP\ Art\ History\ accuracy} = \mu_{Art\ Historical\ Methods\ Accuracy} = \mu_{Art\ History\ Thesis\ accuracy}$  (all classes will have the same mean accuracy rate).

The alternative hypothesis was listed as  $H_a: \textit{at least one } \mu_{non\ Art\ History\ accuracy} \neq \mu_{AP\ Art\ History\ accuracy} \neq \mu_{Art\ Historical\ Methods\ Accuracy} \neq \mu_{Art\ History\ Thesis\ accuracy} \textit{ is different from the others}$  (at least one class will have a different mean accuracy rate).

Since the P-value is  $<0.05$ , the null hypothesis that all participants will have the same average accuracy rate is rejected. There is significant

evidence that at least one class has a different average accuracy rate on the Digit Span Test. Therefore, the hypothesis of Art History students having higher short-term memory rates than their non-Art History counterparts still stands.

Figure 3 displays the average Digit Span Test scores by student grade level at Westlake High School. This factor was recorded to limit confounding variables in scores due to upperclassmen enrollment in advanced classes which involve more memorization and increased adolescent brain development through high school.

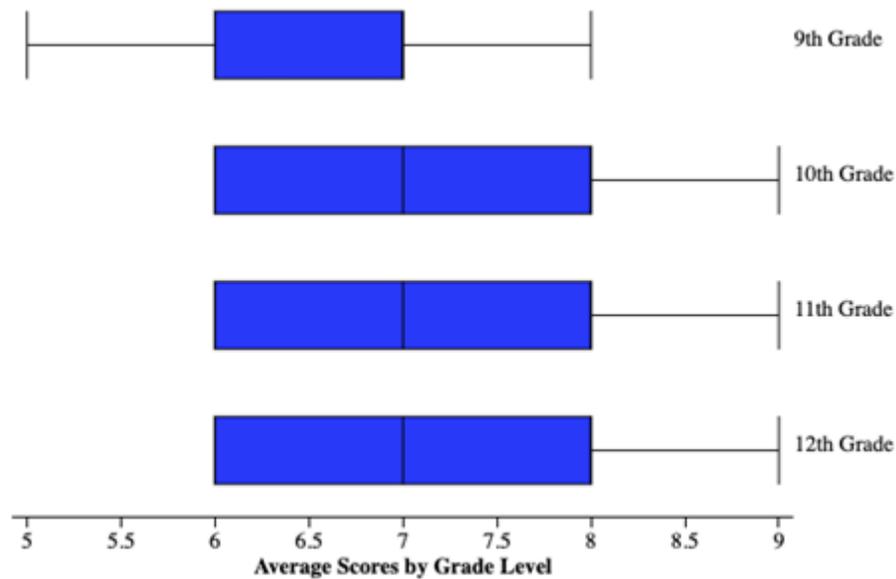


FIGURE 3. Average Scores by Grade Level

Freshmen had average Digit Span Test scores between 5 and 8, while sophomores, juniors, and seniors all had average scores from 6 to 9. The upper three grades also had the same median score of 7 and the same first and third quartile scores (6 and 8). Due to similarities in score distribution between grades, this box plot supports the notion that grade level has no impact on Digit Span Scores. The statistical significance test which calculated the extent of score differences by grade revealed a P-value of 0.376.

The null hypothesis used was listed as  $H_0: \mu_{\text{freshmen scores}} = \mu_{\text{sophomore scores}} = \mu_{\text{junior scores}} = \mu_{\text{senior scores}}$  (grade level does not impact mean scores).

The alternative hypothesis was listed as  $H_a: \text{at least one } \mu_{\text{freshmen scores}}, \mu_{\text{sophomore scores}}, \mu_{\text{junior scores}}, \mu_{\text{senior scores}} \text{ is different from the others}$  (grade level does impact mean scores).

Since the P-value is significantly >0.05, there is not enough evidence to disprove the null hypothesis that grade level does not impact mean Digit Span Scores. Therefore, the data is not statistically significant enough to prove student grade level as a confounding variable to the results.

Figure 4 displays the average Digit Span Test scores by number of Honors classes taken at Westlake High School during the current school year. These classes are weighted between grade level and advanced placement classes and add a five-point multiplier to student grade point averages. This factor was recorded to limit confounding variables in scores due to student enrollment in advanced classes which require additional memorization.

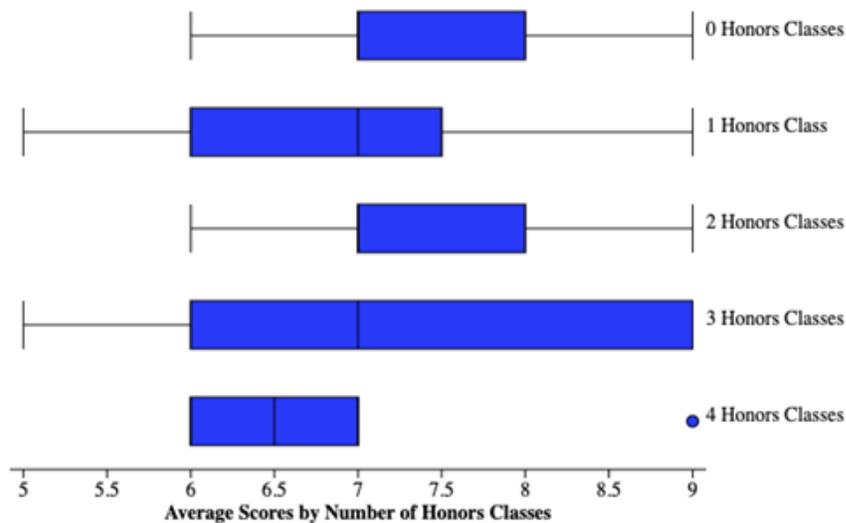


FIGURE 4. Average Scores by Number of Honors Classes

Most Honors classes have a median score of 7, with the exception of 4 Honors classes with a median score of 6.5. However, all the box plots have different first and third quartiles. A statistical significance test to determine the extent of scores differences by number of Honors classes displayed a P-value of 0.693.

The null hypothesis used was listed as  $H_0: \mu_{0 \text{ Honors classes}} = \mu_{1 \text{ Honors class}} = \mu_{2 \text{ Honors classes}} = \mu_{3 \text{ Honors classes}} = \mu_{4 \text{ Honors classes}}$  (Honors classes enrollment does not impact mean scores). The alternative hypothesis was listed as  $H_a: \text{at least one } \mu_{0 \text{ Honors classes}}, \mu_{1 \text{ Honors class}}, \mu_{2 \text{ Honors classes}}, \mu_{3 \text{ Honors classes}}, \mu_{4 \text{ Honors classes}}$  is different from the others (Honors classes enrollment does impact mean scores).

Since the P-value is  $>0.05$ , there is not enough evidence to disprove the null hypothesis that the number of Honors classes taken does not impact Digit Span Test scores. Therefore, the data is not statistically significant enough to prove Honors classes enrollment as a confounding variable to the results.

Figure 5 displays average Digit Span Test scores by the number of AP classes taken at Westlake High School. These classes are college-equivalent and add a ten-point multiplier to student grade point averages. This factor was recorded to limit confounding variables in scores due to student enrollment in the most advanced classes which require significant memorization.

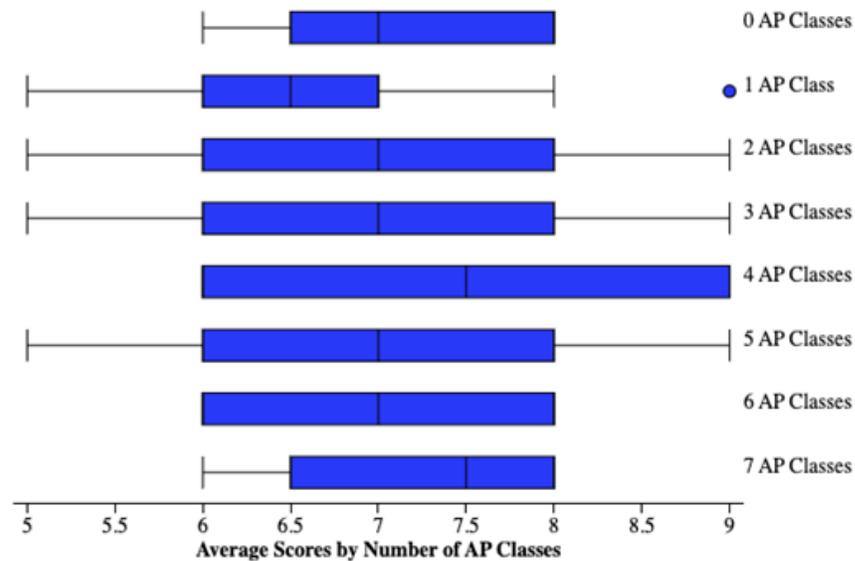


FIGURE 5. Average Scores by Number of AP Classes

Students taking four AP classes had the largest distribution of scores, ranging from 6 to 9. Additionally, participants enrolled in two, three, five, and six APs had the same first and third quartile scores (6 and 8). A statistical significance test to determine the extent of scores differences by number of AP classes displayed a P-value of 0.924.

The null hypothesis used was listed as  $H_0: \mu_{0 \text{ AP classes}} = \mu_{1 \text{ AP Classes}} = \mu_{2 \text{ AP Classes}} = \mu_{3 \text{ AP Classes}} = \mu_{4 \text{ AP Classes}} = \mu_{5 \text{ AP Classes}} = \mu_{6 \text{ AP Classes}} = \mu_{7 \text{ AP Classes}}$  (AP classes enrollment does not impact mean scores).

The alternative hypothesis was listed as  $H_a: \textit{at least one } \mu_{0 \text{ AP classes}}, \mu_{1 \text{ AP Classes}}, \mu_{2 \text{ AP Classes}}, \mu_{3 \text{ AP Classes}}, \mu_{4 \text{ AP Classes}}, \mu_{5 \text{ AP Classes}}, \mu_{6 \text{ AP Classes}}, \mu_{7 \text{ AP Classes}} \textit{ is different from the others}$  (AP classes enrollment does impact mean scores).

Since the P-value is significantly  $>0.05$ , there is not enough evidence to disprove the null hypothesis that the number of AP classes taken does not impact Digit Span Test scores. Since the data is not statistically significant enough to prove a difference in scores due to AP class enrollment, it is not a confounding variable to the results.

### Discussion

The statistical results show a significant difference between Art History class enrollment and Digit Span Test performance compared to the general population at Westlake High School. Based on Figure 1, all Art History classes had a higher median Digit Span score than that of the General Population. The two subsequent classes had the same median score, but both were higher than that of AP Art History. A likely explanation for this result is that Art History Thesis is an independent study class where students don't learn new art analysis techniques, so their memory capacity remains equivalent to Art Historical Methods students. According to Figure 2, all Art History classes had a higher median accuracy rate than the General Population, with successively higher median scores by Art History level. Since Art History Thesis only had a slightly higher median score than Art Historical Methods, this graph supports the notion that students in both classes have the same memory capacity. The confounding variables of grade level, Honors classes, and AP classes as graphed in Figures 3, 4, and 5, respectively, appeared to show no correlation with scores and were deemed statistically insignificant. Therefore, these factors were not responsible for the increased Digit Span Test scores and accuracy rates among Art History students.

### Conclusion

Given the graphed data which supports the notion that Art History students perform higher on the Digit Span Test, the statistical insignificance of the confounding variables, and the test itself as an accurate measure of working memory capacity, the researcher concluded that their hypothesis was correct: Art History students have higher short-term memory rates than their non-Art History peers. This is likely due to frequent visual fixations of artworks in Art History classes which utilize working memory to encode important characteristics of each piece, such as color and contrast, into one's brain. Conclusively, pursuing an Art History education was found to positively impact short-term memory rates in high school students, with an improved Digit Span Test performance among successive course levels.

### Limitations

Two limitations to this study became apparent when conducting the experiment and after reviewing the results. First, randomly selected students were asked to respond to the selection email with their chosen date and time of arrival for scheduling purposes. This may have caused response bias since diligent students who respond to emails will likely skew scores higher than the average student. However, many participants who did not respond to the email still arrived at the testing location and scored within the same range as those who did. Another limitation is the lack of another recorded variable to prevent confounding influences on test scores: the study of a foreign language. Learning a new language strengthens short-term memory with daily exposure to new written characters, and Westlake High School has a foreign language requirement which may have skewed all participants' scores. However, the researcher believes this didn't occur since the foreign language classes are weighted as Honors for underclassmen and AP for upperclassmen at Westlake High School; both class levels showed no link to test scores in the above figures.

### Implications

The results of this study successfully prove the memory loop between Art History students and the artworks they study using visual fixations on the contrasting features or color of each piece to form memory associations. Given the applications of short-term memory in the workforce, increased short-term memory rates among high school students proves that the arts teach applicable skills for career preparedness alongside STEM subjects. Ultimately, this may convince lawmakers to reinstate funding to art programs which were previously removed due to a supposed lack of practical applications outside the classroom. In addition, the results of this study may convince more students to enroll in the program at Westlake High School to apply memorization to their other coursework. Sharp memorization may prove useful for improved standardized test performance in STEM classes which reinstates the need for both art and STEM programs in schools to create a well-rounded education for students.

### Future Research

This study's delimitations are catalysts for future research. The subject pool can be expanded to include Art History programs at other schools to

establish whether the results are applicable outside Westlake High School and its exclusive three-year program. Future research can also expand beyond Art History to other forms of visual art such as drawing. Perhaps a future study may test whether the process of viewing objects and replicating still-life sketches involves a short-term memory loop. Since Art History only applies to art analysis and typically covers one course in a visual arts department, a link between creating still-life artwork and short-term memory will convince educators to retain more visual arts courses in schools.

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## Appendices

### Appendix A: Random Selection Email

YOU have been randomly selected to participate in a student survey for the AP Capstone Research class.

The purpose of this study is to explore whether pursuing an Art History education improves short-term memory rates in high school students.

As a student currently in [course], you were randomly selected to participate in the study and will be asked to take a short-term memory test.

The test will be hosted in the Mentorship Room from January 9th until January 27th. It will take place during 4th and 5th period.

The test should take around 5 minutes and everyone who participates will be entered into a raffle to win a \$20 gift card.

You do not need to bring any materials and your identity will remain anonymous. Your participation would be greatly helpful!

\*Please respond to this email letting me know your date of preference so I can expect your arrival during 4th or 5th period that day.

### Appendix B: Testing Script

Welcome! Thank you so much for coming.

We're going to start by having you fill out this consent form. Please read through it and let me know if you have any questions. If you change your mind about participating, there are no hard feelings. Once you finish reading, there's a pen to sign it. After you finish, I'll sign it as well. These will be randomized for selecting a gift card recipient.

I will now ask you a series of demographic questions as mentioned with the consent agreement.

1. What Art History course, if any, are you in?

2. What grade level are you in?
3. How many Honors classes are you in, if any?
4. How many AP classes are you in, if any?

Now we will get started with the test. This is called the Digit Span test and it's popularly used for testing short-term memory. It goes from levels 2 to 10 and each level will have numbers flashing on the screen. The amount of numbers will increase as the levels increase. The goal is to type the correct digits in the order they appear. For example, level 2 will have two digits flash and then you'll have to type them in the order they appeared. If you get both digits correct, you'll move onto the next level with three digits. Level 5 will have five digits, etc. The test goes to level 10. A perfect score is getting 10 digits correct. Whenever you type an incorrect digit, the test ends. I will calculate the max number of digits you correctly guess and your accuracy score on a scale of 10. We will start with a practice round so you can familiarize yourself with the test. After the practice round: We will now begin the Digit Span Test. After recording Digit Span Test scores into a spreadsheet: Would you like to know your scores? Thank you so much for participating. Your scores will be kept anonymous and used in data graphs for my AP Research project.

#### Appendix C: Consent Form

Art History Education and Short-Term Retention Rates in High Schoolers

Consent to take part in research:

I, \_\_\_\_\_, voluntarily agree to participate in this research study.

I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question regarding my demographics without any consequences of any kind.

I understand that participation involves stating my grade, Art History course (if applicable), number of Honors classes, and number of AP classes for data collection as well as taking the Digit Span Test.

I understand that all information I provide for this study will be treated confidentially and may anonymously be quoted in published papers.

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Signature of research participant

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Date

I believe the participant is giving informed consent to participate in this study.

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Signature of researcher

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Date