# AP® RESEARCH
# 2016 SCORING GUIDELINES

**AP Research Performance Task Rubric: Academic Paper**

| Content Area | Performance Levels | | |
|---|---|---|---|
| **1 Understand and Analyze Context** | The paper identifies the topic of inquiry.<br>2 | The paper identifies the topic, and describes the purpose and focus of the inquiry.<br>4 | The paper explains the topic, purpose, and focus of the inquiry and why further investigation of the topic is needed by connecting it to the larger discipline, field, and/or scholarly community.<br>6 |
| **2 Understand and Analyze Argument** | The paper identifies or cites previous works and/or summarizes a single perspective on the student's topic of inquiry.<br>2 | The paper summarizes, individually, previous works representing multiple perspectives about the student's topic of inquiry.<br>4 | The paper explains the relationships among multiple works representing multiple perspectives, describing the connection to the student's topic of inquiry.<br>6 |
| **3 Evaluate Sources and Evidence** | The paper uses sources/evidence that are unsubstantiated as relevant and/or credible for the purpose of the inquiry.<br>2 | The paper uses credible and relevant sources/evidence suited to the purpose of the inquiry.<br>4 | The paper explains the relevance and significance of the used sources/cited evidence by connecting them to the student's topic of inquiry.<br>6 |
| **4 Research Design** | The paper presents a summary of the approach, method, or process, but the summary is oversimplified.<br>3 | The paper describes in detail the approach, method, or process.<br>5 | The paper provides a logical rationale by explaining the alignment between the chosen approach, method, or process and the research question/project goal.<br>7 |
| **5 Establish Argument** | The paper presents an argument, conclusion or understanding, but it is simplistic or inconsistent, and/or it provides unsupported or illogical links between the evidence and the claim(s).<br>3 | The paper presents an argument, conclusion, or new understanding that the paper justifies by explaining the links between evidence with claims.<br>5 | The paper presents an argument, conclusion or new understanding that acknowledges and explains the consequences and implications in context.<br>7 |
| **6 Select and Use Evidence** | Evidence is presented, but it is insufficient or sometimes inconsistent in supporting the paper's conclusion or understanding.<br>2 | The paper supports its conclusion through the compilation of relevant and sufficient evidence.<br>4 | The paper demonstrates a compelling argument through effective interpretation and synthesis of the evidence and through describing its relevance and significance.<br>6 |
| **7 Engage Audience** | Organizational and design elements are present, but sometimes distract from communication or are superfluous.<br>1 | Organizational and design elements convey the paper's message.<br>2 | Organizational and design elements engage the audience, effectively emphasize the paper's message and demonstrate the credibility of the writer.<br>3 |
| **8 Apply Conventions** | The paper cites and attributes the work of others, but does so inconsistently and/or incorrectly.<br>2 | The paper consistently and accurately cites and attributes the work of others.<br>4 | The paper effectively integrates the knowledge and ideas of others and consistently distinguishes between the student's voice and that of others.<br>6 |

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| | | | |
|---|---|---|---|
| **9 Apply Conventions** | The paper's use of grammar, style and mechanics convey the student's ideas; however, errors interfere with communication and/or credibility.<br>1 | The paper's word choice and syntax adheres to established conventions of grammar, usage and mechanics. There may be some errors, but they do not interfere with the author's meaning.<br>2 | The paper's word choice and syntax enhances communication through variety, emphasis, and precision.<br>3 |

**NOTE:** To receive the highest performance level presumes that the student also achieved the preceding performance levels in that row.

**ADDITIONAL SCORES:** In addition to the scores represented on the rubric, readers can also assign scores of **0** (zero).

- A score of **0** is assigned to a single row of the rubric when the paper displays a below-minimum level of quality as identified in that row of the rubric.

# AP® RESEARCH
# 2016 SCORING COMMENTARY

## Academic Paper

### Overview

This performance task was intended to assess students' ability to conduct scholarly and responsible research and articulate an evidence-based argument that clearly communicates the conclusion, solution, or answer to their stated research question. More specifically, this performance task was intended to assess students' ability to:

- Generate a focused research question that is situated within or connected to a larger scholarly context or community;
- Explore relationships between and among multiple works representing multiple perspectives within the scholarly literature related to the topic of inquiry;
- Articulate what approach, method, or process they have chosen to use to address their research question, why they have chosen that approach, and how they employed it;
- Develop and present their own argument, conclusion, or new understanding;
- Support their conclusion through the compilation, use, and synthesis of relevant and significant evidence;
- Use organizational and design elements to effectively convey the paper's message;
- Consistently and accurately cite, attribute, and integrate the knowledge and work of others, while distinguishing between the student's voice and that of others;
- Generate a paper in which word choice and syntax enhance communication by adhering to established conventions of grammar, usage, and mechanics.

# To What Extent Does Music Impact Mathematical Achievements and Anxiety?

# AP® RESEARCH
# 2016 SCORING COMMENTARY

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- Generate a paper in which word choice and syntax enhance communication by adhering to established conventions of grammar, usage, and mechanics.

# Introduction

Mathematics and music are used in very different ways in today's society. However, these two topics may have more in common that society believes. Mathematics is commonly associated with stress, anger, and frustration as opposed to music, which is accompanied by happiness and is often a stress reliever. It is something that no calculator or computer can genuinely create. Music has been part of thousands of different civilizations' history and culture all throughout the world. Music tells stories and changes the way people think. Mathematics is something that can come quite easily to many people, but its also something many people struggle with.

I wanted to understand to what extent does being musically literate (playing an instrument, reading music, or listening to music) impact overall achievement in mathematics and stress levels of students. I believed that the more musically literate a student was, the less stressed mathematics would make them feel and the higher they would achieve academically.

Mathematics is something I have always struggled with. I have had a tutor since I was in 6$^{th}$ grade trying to help me through my classes. To this day, I and countless others struggle with numbers, solving for x, and many other mathematical operations. I needed to know if there was in any way, shape, or form an alternative to relive my stress, anxiety, and improve my overall performance when it came to mathematics. The research topic in question is so important because, if my results prove there is in fact a relationship between mathematics and music, students of all ages and backgrounds can intertwine music into their study habits; whether it be listening to music while practicing equations, learning how to read music or play an instrument to improve mathematical abilities.

What initially attracted me to this research topic was my father. My father can play the guitar, sing, and read sheet music; Math comes easy to him. He often helps me with homework and tries to teach me the material. I used to wonder why I couldn't be more like my father and be better at math. But, maybe I could have. Maybe if I played an instrument or was able to read sheet music like him I would not struggle so much in this subject. The answer to this question is what I was set on finding out.

## Literature Review

According to a current research study conducted by Kathryn Vaughn (2012), students that play instruments, such as the piano, have better reasoning skills when it comes to solving equations, simplifying fractions, playing chess, or conducting mathematical deductions. Studies like this improve the probability of the connection between mathematics and music.

Kathryn Vaughn is a professor of arts at the University of Illinois and has one several awards for her studies over the past two decades. She has been working for nearly seven years on studies like the one mentioned before. Vaughn wrote *The Journal of Aesthetic Education.* After researching her work and her overall status as a professor and researcher, I came to the conclusion that she is highly reliable as a source. She has conducted other studies in the field and has never been reviewed by the board for any inconsistencies. The only reason she may be considered biased is because she is a professor of arts. Obviously, she would want to prove that there is, in fact, a positive correlation between mathematics and music. However, after extensive research, I found no reason to believe she would skew her results in her favor. I have concluded that her study is highly reliable and accurate.

Darby Southgate and Vincent J. Roscingo (2009) published the peer-reviewed journal *Social Science Quarterly: Volume 90.* They are both professors in the department of Sociology at Ohio State University. There were no hints to their unreliability. After researching the two professors and their other works, I have only found extensive accurate studies. The studies these two professors conducted focused more on out of school music participation and in-school overall academic achievement. Their study found that music does have a positive impact on math and reading levels in both genders. However, the impact is only minimal.

Marie Forgeard, Andrea Norton, and Gottfried Schlaug (2010) work for the department of Neurology at Harvard University in Boston. Harvard University is an Ivy League school and very well known for its reliability and effectiveness. Only the brightest minds in the world are able to attend a university like Harvard. After researching and reviewing the professors and their other work, I found no inclinations to any biases. Their study is accurate and will only further my understanding of the correlation between music and math. Their peer-reviewed article was published on a site entitled *PLOS ONE. PLOS ONE* has also published studies of professors from other universities like Princeton, Boston, and Stanford. I read several reviews about the website's reliability and discovered no biases, plagiarism incidents, or any wrong doings. I concluded that the site and the professors are highly reliable.

The study from these three professors focused on instrument training and improvements in mathematical skills. They discovered that children who received three to five years of instrument training out performed children with zero to two years of instrumental training in word problems associated with solving variables. They also discovered that children with more instrumental training improved in memory retention of vocabulary. Although this has little to do with mathematics, their study showed that instrumental training does improve memory. This is

significant because it can only help with memory when it comes to mathematics, other studies, and my research.

Ellen Winner (2008) was also published on the online, peer-reviewed cite *PLOS ONE*. She attended Boston University where she earned a degree in Psychology. She obtained her associates degree from Harvard University School of Education. She wanted to validate the results by the three authors mentioned before. She recreated the experiment using 67 children, ages 11-14, learning to play the guitar. They were divided up into three categories: zero two years of instrumental training, three to five years of instrumental training, and six to seven years of instrumental training. Her results accurately proved the results of the previous study. The category of six to seven years of instrumental training further proved the accuracy of the past results. This category outperformed all other categories, which proves that the more musical training a student has, at the very the least, the more they will out perform students with lesser training in academic studies.

Leon Harkleroad (2010) attended Cambridge University. He is an award-winning professor of sciences at the University. He wrote a book entitled *The Math Behind Music*. His study focused on finding the mathematical details behind everyday music. Whether it is in elementary school or college, he used tuning systems, scales, and overtones in his research. In section 3 of his book, he looked into the stress levels caused by mathematics. He discovered that, at a minimal level, students that played 3 or more instruments had less anxiety compared to students who played 2 or less instruments. Results like these continue to help prove my hypothesis. He is a reliable source that attended a well know and challenging university. There were no inclinations of invalid results or anything of that nature.

Ernst Bloch (2011) in another Cambridge University student. He wrote the *Essay on the Philosophy of Music and Academics.* Bloch has been teaching and researching at Cambridge for 19 years. His essays outline the importance of music on the developing mind. He also delves into the philosophy of music and its importance. He believes the philosophy of music should be taught at all ages. Bloch also discussed his findings after researching this philosophy. He found that students who were taught the philosophy of music, its importance and what it truly meant, were more opened minded. Because of this, their stress levels were, although minimally reported, lower than that of other students.

Trudi Garland and Charity Kahn (2012) wrote *Harmonious Connections.* They both attended Indiana University and are professors in the subjects of Social Science and Psychology. They found that students studying and practicing different harmonies scored 33.57% higher on a 100-question test they gave to research participants. The test consisted of algebra 1, geometry, algebra 2, pre calculus, and calculus mathematical leveled questions. They gave this test to a group of 79 freshmen university students. All students were tested on the same day and in the same environment. At the end of the test, there was an optional survey about stress levels and family medical history. Garlkand and Kahn found that two percent of the 34 of the students studying and practicing different harmonies that answered the optional survey recorded lower stress levels when it came to calculus and similar level mathematic courses. Although two percent is nearly nothing and has an extremely low effect, it still shows a minimal impact.

Jim Henle (2011) is a professor at Boston University. He has researched many topics relating to music and academic achievement. He participated in and conducted other studies such as the relationship between extracurricular and success in and outside of the classroom, the relationship between bilingualism and language arts anxiety, and the relationship between different genders

and bilingualism. In this particular study, Henle evaluated the relationship between mathematics, classical music, and anxiety levels. Henle discovered that participants who listened to classical artists such as Mozart and Beethoven reported less anxiety pertaining to mathematics. However, his experiment was flawed in that the results of the test suggested that students who didn't listen to classical music performed just as well or as poorly as students who did listen to classical music. His results are contradicting. They help me better understand that students listening to music have less anxiety, but his results showed that listening to music did not help the studnets over all achievement. He is currently re-conducting his experiment to determine if he gets the same or similar results.

Ernest Mclain (2009) is a graduate student studying at American University. He did not conduct an experiment, but he did write a paper evaluating different musical theories and how they relate to mathematics. His essay was very helpful in helping me better understand the research topic at hand. After reading his paper, I made sure to further research his information. Everything seemed to be correct and factual. Mclain was a very important aspect in my paper and helped me understand the many musical theories. His research helped me understand how there is a connection between mathematics and music as opposed to just showing me results of other experiments that I had no control of.

According to Mclain's research, musical notes and symbols are read similarly as students would read mathematical symbols. Symbols in both mathematics and music represent a certain bit of information about that symbol. One symbol in music may clue the reader to play a higher pitch, just like an addition symbol in mathematics would clue the reader that the number is going to become larger in quantity. As the math courses become more challenging and rigorous, the relationship between the two becomes more complex.

After reading Mclain's research paper, I decided to look for more essays like this. Papers evaluating theories are just as valuable as examining and analyzing other similar experiments. Alison Motluk is a professor at the University of Central Florida. She critically analyzed the Fibonacci sequence and its impact on the relationship between mathematics and musical literacy.

The Fibonacci sequence is a well-known sequence that is represented as the following: 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, … and so on. Each term is added to the other term preceding it to form the next musical term. That is, 6 + 9 = 15, 9 + 15 = 24, 15 + 24 = 39, and infinitely continuing. Musically, the Fibonacci sequence is usually used for piano scales and the ratios between each term are about 0.618, also known as the Golden Ratio. Pythagoras was the one who first realized that a multitude of sounds could be made and represented with different vibrations and weights. Because of this realization, he was able to understand that the length of the string can control the pitch of vibrating string.

The last paper, rather than experiment, I included was written by Harvey Reid (2013). Reid is a student studying at Stanford University. This was his first paper on the subject, but I concluded that he was still a reliable source. He analyzed pitches, tones, notes and how they work in music and their mathematical structure. Pieces of music are divided and sectioned into things called measures or bars. One measure consists of an equal amount of time depending on the type. As details continue to become more present, measures are divided into same sized portions called beats. Fractions are to indicate certain lengths of notes, beats, and measures. These fractions are used to tell the reader how high, low, long, or short a certain note or part of a song is to be played. It also helps the reader figure out the rhythm of the song. A signature of time on a music sheet is usually written as integers with one located above the other. Each musical note is represented by a different symbol to indicated length, time, pitch, or beat. Musical notes are

classified as numbers just like this. Whole numbers represent one note per measure, half notes represent two notes per measure, quarter notes represent four notes per measure, and eighth notes represent eight notes per measure and so one. Each note is divided and gets smaller and smaller. These numbers allow the reader to know how long the numerous notes last. The mathematical expression for this according to can be expressed as $4 \times 1/4 = 1$.

One thing that I have noticed after my extensive research is, that although a relationship between music and mathematics is present, the impact of this relationship is minimal. The gap within the research that I have discovered is that there are no studies that delve into the level at which the impact is evident and how that exactly correlates to stress and anxiety levels. All the studies and research papers that I have found focus academic achievement and music, rather than how that correlates to stress and anxiety levels. Although some sources briefly discuss about the topic, I don't believe they go deep enough into the psychological aspects and how the music theories discussed previously impact these aspects.

## Methodology

All participants in this experiment turned in a parent signed student consent form. The study was conducted in a South Florida 9-12 senior high school. The South Florida high school is 40 percent African American and 60 percent white, Hispanic, and Asian. It is rated an A school, offers AP and honors classes to all students, and in comprised of 2700 students and staff. Participants of this experiment were randomly selected from regular, honors, and AP level classes of all ages. This was an important aspect in the selection process in order to make sure the end results of the experiment were not skewed to higher or lower level students. 61 students were used and tested for this research experiment. The school's review board approved this study.

I explained all aspects of the experiment to the participants such as purpose and importance before handing out the survey. I allowed participants to ask questions before answering the 14-questioned survey (Roberts, 2011) (See Appendix A). Students were given scenarios such as "I get emotionally upset when doing or thinking about math (i.e. anger, frustration, sadness, etc.)" and "I feel like I have no control over my math grades". Students were asked to rate these scenarios on a 1-5 scale, one being the lowest level and five being the highest rating. At the end of the scenarios, students were asked to circle yes or no on questions asking "Do you play an instrument? (If so, for how long?)", "Can you read sheet music?", "Do you listen to music while studying for math?", and "Have you ever noticed a lower level of anxiety when in came to math after playing and instrument, listening to music, or reading sheet music?". Based on the answers participants put for the last four questions determined the relation ship between mathematics and music for that particular student.

Participants were given one number in order to enhance testing security and privacy. Students answered the survey in a quiet environment and had no time limit. It was very important that students did not feel rushed or pressured. The survey was given out over a period of one week to accommodate all participant schedules. Sometimes participants were absent or unable to answer survey questions at the designated time they were given. After that one-week, students were no longer able to submit any survey answers. I wouldn't have been able to observe them and their testing environment to guarantee the survey environment was kept to accurate testing standards.

After collecting the survey, I began to review and upload the results into a Microsoft Excel sheet. Results were based on the accumulation of points depending on how the different participants rated the 1-5 scale questions relating to certain mathematical and musical scenarios.

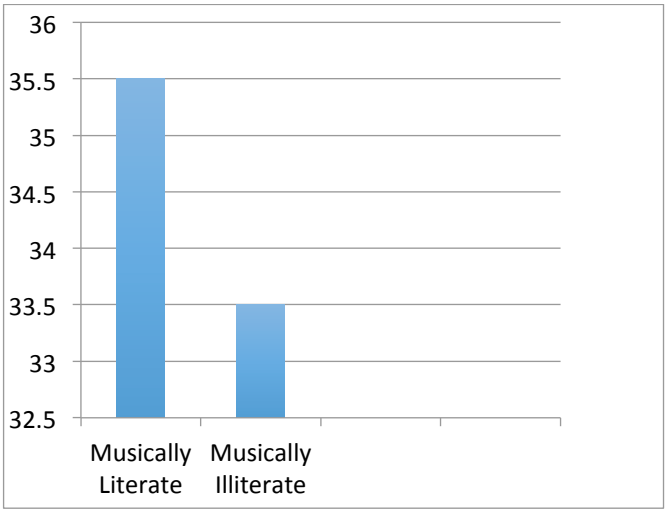
The research design that was conducted was kept as accurate as possible. I saw no other way of performing the experiment without something not going as planned. I tried to learn from past studies as mentioned and evaluated in my literature review. It was essential that I observed the students as they took the survey to make sure everything went well and there were no inaccuracies. I needed to ensure the surveying environment was kept as peaceful, quiet, and stress-free as possible. This was important to ensure results were not rushed and that students did not guess on the questions in order to alleviate stress brought upon by the survey.

## Results

It was hypothesized that if participants listened to, read, or played music, they would have less anxiety and a higher success rate when it came to the subject of mathematics. A T-Test was performed to separate those who were musically literate and those who were not. Participant's total surveys were scored by the process of adding all their rating to the questions in the survey. Of those who were musically literate, student number 24 received the lowest total score comprised from the survey. Participant number 24 scored 11 out of 70. This participant did not play any instruments or read music, but still had a very low anxiety when it came to math and still scored high on exams. Student number 55 received the highest cumulative score. Participant 55 played the guitar and scored of 63 out of 70. This showed high math anxiety levels and average test scores. 12.5 was the standard deviation of those who were not musically literate. The standard deviation for those who are musically literate was 16.5. The lower the standard deviation presented, the smaller the range between the highest and lowest scores between the two groups. Furthermore, because the group comprised of non-musically literate participants presented a lower standard deviation, there answers to the given survey had an increased consistency with one another. Figure 1 presents the mean math anxiety scores for both musically

literate and non-musically literate. The group that could read music and or play an instrument had a mean score of 35.5. The group of participants comprised of students who could not read music or play an instrument had a mean score of 33.5. The p-value of this experiment was .67. This determined that the finding of this experiment were minimal and had now ever present significance. The p-value did not prove my hypothesis. This presents that students who were musically literate still experienced exceptionally high levels of math anxiety, and depending on participants, still acquired a wide variety of academic success.

P=0.67




(Points accumulated from survey)

*Figure 1:* Mean of math anxiety levels of the two groups.

## Discussion

It was originally hypothesized that students who were musically literate (could play an instrument, read sheet music, etc.) would achieve higher, academically, in mathematics and have

less anxiety related to the subject. The data collected from participant surveys suggests that my hypothesis was not correct. The data provides evidence that the relationship between the two, mathematics and music, is insignificant. With a p-value of .67, there is little to no correlation between the two. The results of the data were disappointing, but I believe with more time and research, I can prove a substantial relationship between mathematics and music.

A study conducted by Darby E. Southgate and Vincent J. Roscingo (2009), previously mentioned in the literary review, concluded that music has not just an impact, but also a positive impact on academic studies. However, my study and the research conducted by the two professors differ. My experiment focused on a survey based students' opinions and feelings, while the other study conducted focused on test scores and in and out of school music participation. And, like my study, the impact of music on mathematics is only minimal.

In another study previously mentioned in my literary review conducted by Ellen Winner found interesting results compared to my study. She created an experiment using 67 children, ages 11-14, learning to play the guitar. They were divided up into three categories: zero two years of instrumental training, three to five years of instrumental training, and six to seven years of instrumental training. Her results accurately proved the results of the previous study. The category of six to seven years of instrumental training further proved the accuracy of the past results. This category outperformed all other categories, which proves that the more musical training a student has, at the very the least, the more they will out perform students with lesser training in academic studies.

Her study showed that students with more musical experience perform higher than students with lesser experience. She found a slight correlation between music and math, unlike my study,

but similarly to my hypothesis. Studies like this show that there are still ways to prove the ever-present relationship between mathematics and music.

My literary review contains many other studies that my research can be compared to. All studies produced different results, sometime even contradicting each other.

I have concluded that the experimental results did not completely prove my hypothesis because of some of my limitations. I was limited to 61 high school students. I would have preferably liked to use at least 100 students. I believe that the more students participating in the study, the more accurate my results would have been. Therefore, I would have been able to more accurately prove my hypothesis.

I originally planned to, instead of just a survey, have a teacher teach a mathematical lesson and then give a quiz with music playing in the background and see how that impacted the participants. I would compare those results to a group of participants who were taught the same lesson by the same teacher, but without music playing in the background of the exam. I would then give them a survey to observe their stress levels and determine if they are musically literate or not. I would then compare those results to the results of the quiz. However, when I attempted this process, I observed the testing environment and saw that students were not all paying attention to the lesson. When participants were given the short quiz, I observed cheating. I concluded that instances like this would make the experimental results inaccurate. My study would have been better if I was able to find a group of participants who took the study more seriously instead of using high school students who might not fully understand the implications and benefits of this study.

## Conclusion

Conclusively, the relationship between mathematics and music was not proven by my experiment. Part of this can be attributed to the limitations, but also the style of the experiment. However, with more research, time, and participants, I believe I can prove the correlation between mathematics and music. The study used 61 high school students to determine the relationship between mathematics and music and how that impacts anxiety.

My study impacted the field by guiding future researchers on the appropriate procedures, both in the positive and the negative. The survey I conducted and distributed to research participants gathered a plethora of information that can go into calculating the relationship between mathematics and music. However, for future experiments, researchers should also look at grades and test score to make results more accurate. Also, for future studies, age, gender, race, ethnicity, and social status should be evaluated to determine any correlation.

Mathematics and music hold two very different places in society. Math can often cause anxiety that playing music can eliminate. I wanted to determine whether a relationship existed between the two very different subjects. I gathered information and modeled my experiment after many other studies I evaluated. My results were unable to prove my hypothesis significant, but I believe that future studies can model their experiments after mine to ensure accurate results. Results from future experiments should be synthesized and used to improve teaching styles for all students.

**Word Count: 4197**

## Appendix

Appendix A: Survey

Key:
1 = Low
3 = Medium
5 = High

1. I get emotionally upset when doing or thinking about math (anger, crying, extreme frustration, etc.).

   1 2 3 4 5

2. I feel like I have no control over my grades in mathematics.

   1 2 3 4 5

3. I tend to do very poorly on mathematical exams.

   1 2 3 4 5

4. I feel like I need to prepare much more for math tests than for other subjects.

   1 2 3 4 5

5. Math tests are much more stressful to me than other tests.

   1 2 3 4 5

6. I feel that I understand certain math concepts in class but do poorly on tests.

   1 2 3 4 5

7. I have trouble concentrating during math tests (racing thoughts, can't focus, "blanking out", etc.).

   1 2 3 4 5

8. I do not feel confident when taking math tests no matter how much I study.

   1 2 3 4 5

9. I feel that I can't trust my intuition and often second-guess myself during math tests.

   1 2 3 4 5

10. I generally feel that tests in any subject are a reflection of my worth as a person.

    1 2 3 4 5

11. When studying for a math test, I find myself showing anxious behavior (fidgeting, pacing, making excuses, avoiding the situation, etc.).

    1 2 3 4 5

12. During math tests, I find myself comparing my progress to those around me.

    1 2 3 4 5

13. I feel that I will never be able to learn math no matter how hard I try.

    1 2 3 4 5

14. I rely on other people to help me with day to day math situations (calculating tips, balancing checkbook, estimations, etc.).

    1 2 3 4 5

1. Do you play any instruments (if so, for how long)?
2. Can you read sheet music?
3. Do you listen to music while studying?
4. Rate your academic success in mathematics and indicate course level.

    1 2 3 4 5

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# AP® RESEARCH
# 2016 SCORING COMMENTARY

## Academic Paper

**Sample: B**
**Content Area: Understand and Analyze Context — Row 1 Score: 4**
**Content Area: Understand and Analyze Argument — Row 2 Score: 4**
**Content Area: Evaluate Sources and Evidence — Row 3 Score: 4**
**Content Area: Research Design — Row 4 Score: 5**
**Content Area: Establish Argument — Row 5 Score: 5**
**Content Area: Select and Use Evidence — Row 6 Score: 4**
**Content Area: Engage Audience — Row 7 Score: 2**
**Content Area: Apply Conventions — Row 8 Score: 4**
**Content Area: Apply Conventions — Row 9 Score: 2**

**MEDIUM SAMPLE RESPONSE**

"To What Extent Does Music Impact Mathematical Achievements and Anxiety"

**Content Area: Understand and Analyze Context — Row 1**
The response earned 4 points on this row because it states the purpose of researching whether music literacy affects math anxiety (see p. 2 for personal connection and the hope to generalize that experience to others). It did not earn 6 on this row because the inquiry is not connected to the broader discipline or scholarship on math anxiety or benefits of music literacy. The student states at the top of page 3 that the research is based on a personal observation.

**Content Area: Understand and Analyze Argument — Row 2**
The response earned 4 points on this row because it includes multiple studies, with different findings, on the effects of music training. It did not earn 6 on this row because each source is summarized in turn; the Literature Review (pp. 3–9) does not draw connections among the sources or to the student's own topic of inquiry.

**Content Area: Evaluate Sources and Evidence — Row 3**
The response earned 4 points on this row because each source is related to the topic area (effects of music training) and the sources are credible, some explicitly stated as so (e.g., Henly, p. 6 and Mclain, p. 7), and some apparently so from the bibliography. It did not earn 6 on this row because the sources are not connected to the paper's research question about math anxiety.

**Content Area: Research Design — Row 4**
The response earned 5 points on this row because each step of the research method (surveying high school students) is described (beginning in the Methods section on p. 9). The paper did not earn 7 on this row because it does not provide a rationale for the survey or how it aligns with the research question.

**Content Area: Establish Argument — Row 5**
The response earned 5 points on this row because it shows that the data gathered from the survey disprove the hypothesis and that the statistical analysis shows a lack of significance in the results. The paper did not earn a 7 on this row because it does not explain the consequences/implications of concluding that the impact of music on math anxiety is minimal.

# AP® RESEARCH
# 2016 SCORING COMMENTARY

## Academic Paper

**Content Area: Select and Use Evidence — Row 6**
The response earned 4 points on this row because its conclusion — that playing music does not significantly correlate with reduced math anxiety — is basically supported with the survey data. It did not earn 6 on this row because the survey data (the paper's only evidence) are not interpreted to explain why the data are significant.

**Content Area: Engage Audience — Row 7**
The response earned 2 points on this row because the section headings and organization convey the message. The graph on p. 12 helps explain the information mentioned, and the referenced items from the text are included in the Appendix. It did not earn 3 on this row because the reporting of survey data is not easy to follow, and there are insufficient transitions between paragraphs, especially in the Literature Review to further enhance the meaning of the paper. Although the message is still understandable, it is not enhanced by the paper's organization or design elements.

**Content Area: Apply Conventions — Row 8**
The response earned 4 points on this row because other scholars' conclusions are properly attributed in each paragraph of the Literature Review. Although the student's voice is distinguished from those of other scholars', the paper did not earn 6 on this row because it does not achieve the first criterion of a score of 6, the integration of the ideas of others; information from the Literature Review is not integrated with the student's inquiry or with each other.

**Content Area: Apply Conventions — Row 9**
The response earned 2 points on this row because grammar, mechanics, and usage are mostly correct. It did not earn 3 on this row because the syntax is repetitive and word choices are simple. The paper's meaning is communicated but not enhanced by the way the paper is written.