

Music: The Link between Science and the Humanities

Paula Bobrowski
Auburn University

Ann Knipschild
Auburn University

Abstract

“Music and Science” is a course designed specifically to foster the integration of STEM and the humanities and to incorporate an undergraduate research project into a general education class. In addition to studying theories presented in readings, class activities include lectures, video presentations, case study discussions, guest speakers, listening experiences, and a significant team-based undergraduate research project. Students learn how concepts in science and music are intertwined while engaging in actual research that demonstrates the physical and emotional effects that music has on the human body. Students are able to make important connections that show how music can be used for different types of therapies and how it can be used to improve one’s quality of life. Preliminary findings based on student feedback and SALG assessment (Student Assessment of Their Learning Gains) indicate that the research project has a significant impact on student learning, interest in science and music, and acquisition of career skills.

Introduction

In response to the need for new courses with innovative teaching strategies, faculty at Auburn University developed a “Music and Science” general education course to promote the integration of STEM and the humanities. This class is intended to develop students’ interest and engagement in music and science in order to enhance their understanding of the connection between the two disciplines throughout history and in today’s world. We used several class activities to actively engage the students during the course, including guided listening exercises, concert experience analysis, and an experiential learning based research project. A primary goal of adding the research project was to provide the students with a deeper understanding of research methodology, physiology, the neuroscience of music, and how the use of music can be designed into settings to improve one’s quality of life. Undergraduate research projects have been found to improve the learning experience in general education courses and may also help students as they prepare for careers in today’s world (Cerrito 2008). The purpose of this article is

to summarize the Music and Science course and encourage others to develop programs that nurture and advance the integration of STEM and the humanities.

Music is culturally understood by all people and has been an integral part of society since our origins. According to neuroscientist Daniel Levitin (2006), human beings in all civilizations have personal identities that involve music. There is archeological evidence in Europe of the use of musical instruments created with stone tools dating from at least 40,000 years ago (Higham et al. 2012). Music has also played an important role in the development of our ability to listen and communicate with each other. “Musical components are the fundamentals of communication . . . and rhythm, in particular, is the musical aspect of communication fundamental to the way in which we relate to ourselves and to others” (Aldridge 1989, 743).

The connections between music and science have been studied since the time of Pythagoras, and we can find relationships between music and mathematics, physics, and technology throughout our history. Music has also been used in healthcare as a therapeutic tool in stress and pain management, rehabilitation, and behavior modification. Recent studies in neuroscience show the effects of music on our emotions and physiology: exposure to various genres of music can affect changes in our breathing, heart rate, and the amount of stress hormones that our bodies release (Novotney 2013). The physiological effects of music can be measured and then used as an effective instrument in the healing professions and can contribute to the understanding of the human experience.

“The body of the speaker dances
in time with his speech.

Further, the body of the listener dances in rhythm
with that of the speaker!”

(Condon and Ogston 1966, 338)

Development and Context of the Course

After attending a workshop given by SENCER (Science Education for New Civic Engagements and Responsibilities), the authors sought to create a course

that would foster the interdisciplinary connections between science and music. Due to the need for new general education courses and the university’s emphasis on undergraduate research, we chose to develop a course that would fit into the existing undergraduate core curriculum. We received a SENCER Post-Institute Implementation Award and Auburn University funding to help with this project.

Auburn University is a land grant university with a student population of over 25,000 students. Students are required to take one three-hour course in the fine arts as part of the university’s core curriculum. MUSI 2750 Music and Science was accepted by the University Curriculum Committee as a Fine Arts core course beginning Fall 2014. The first offering of the course in Fall 2014 included thirty-four students (70.6 percent male, 29.4 percent female), and Spring 2015 included thirty students (76.7 percent male, 23.3 percent female) for a total of 64 students, all taught by the authors. These students were traditional college-age students, the majority of whom were engineering and science majors, predominantly in their freshman and sophomore years. This was the first time that such a high percentage of STEM majors were attracted into a single core music course.

Course Objectives and Expected Outcomes

Course Description: This course explores the relationship between music and science in society from antiquity to the modern day. It is designed for non-music majors who have an interest in music and science. (See *table 1 for objectives and expected outcomes.*)

Course Design

The first offering of the course was primarily a lecture-based class. The class met once a week for two and a half hours. Each week, a new topic exploring the connection between music and science was discussed. Areas included music and its relationship to math, physics, technology, sociology, neuroscience, biology, and healthcare. In addition to the traditional course format (lectures, readings and discussion, quizzes, and final exam), students were expected to participate in two experiential learning

TABLE 1. Course Objectives

Course Objectives and Expected Outcomes: By the end of the semester, students should be able to:
1. Demonstrate an overall understanding of the relationship between music and the sciences throughout history.
2. Demonstrate an understanding of the scientific process as applied to a research project.
3. Demonstrate the ability to work as a team member on a project.
4. Demonstrate an understanding of basic music principles and their origins in society.
5. Demonstrate the ability to identify common elements of music and to use appropriate musical terminology in writing about music.
6. Demonstrate an understanding of the development and characteristics of musical instruments and compositional techniques as a result of advances in science and technology.
7. Demonstrate an understanding of the influence of society on music and related scientific advancements during the various historical periods.
8. Demonstrate an understanding of the effect of music and technology on cultural development.
9. Demonstrate an understanding of the process of listening to music and its effect on the listener.
10. Demonstrate an understanding of the creative process.
11. Demonstrate the ability to articulate aesthetic judgment regarding their listening experiences.

activities: concert attendance/report and a team-based research project/presentation. The concert experience occurred in both semesters, including the initial class offering, while the research project was added the second semester the class was taught.

Concert Experience

Students were expected to attend and report on a live concert. They were given guided-listening exercises during class to help prepare them for this assignment. In their report, they were expected to incorporate terms and concepts learned from the course, discuss the scientific and technological developments in society that affected the music and musicians, describe the listening experience using aesthetic judgment, and give an observation of the creative process in the concert.

Team-Based Undergraduate Research Project

Five teams of five or six students were formed to participate in the research project that measured the physiological

effects of two contrasting selections of music on human subjects. Teams were constructed using theories on the creation of high-performance teams (Katzenbach and Smith 2006). Students were given guidelines on team building and how to make teams effective. They were given some class time in which to meet, but were also expected to meet outside of class. (This was factored in the time required for course assignments.) Each team was required to submit a team charter due during the sixth week of class. Guidelines were given for the research project with due dates for various stages of the project. The project report components included a title page, abstract, introduction and research question, description of methods/data collection, presentation of data, results, conclusion, future work that might come out of the project, and bibliography. (See grading rubric below.) The first half of the project was due during the ninth class meeting and feedback from both instructors was given. Data were collected with a BIOPAC system and analyzed using SPSS 22. The final report was due the last day of class, and teams presented their projects to the rest of the

TABLE 2. Course Schedule

COURSE SCHEDULE	
Week 1	The Origins of Music
Week 2	Music Elements and Terminology
Week 3	Pythagoras: Music, Mathematics, and the "Harmony of the Spheres"; Intro to team building
Week 4	Quiz 1; Guided Listening; Teams assigned
Week 5	Music and Mathematics; Discussion of team charter and research project
Week 6	Music and Physics; Team charter due
Week 7	Music and Technology; Discussion of essay assignment
Week 8	Quiz 2; Guided Listening; The Creative Process; Discussion of concert report assignment
Week 9	Music and Sociology; First half of research project due
Week 10	Music and Neuroscience
Week 11	Music and Neuroscience
Week 12	Quiz 3; Guided Listening
Week 13	Music and Healthcare; Essay assignment due
Week 14	Music and Biology: What Makes a Musician ?; Concert report due
Week 15	Research project report due; Team presentations
Finals	Final exam

class. Team members filled out an evaluation form on the work of each student in their own team and on the overall presentations of the other teams.

Preliminary Findings

COURSE GRADING COMPONENTS	
3 Quizzes (100 pts. each)	300 pts.
Team Charter	50 pts.
Research Project	275 pts.
Written Essay	100 pts.
Concert Report	100 pts.
Final Exam	175 pts.
Total	1000 pts.

RESEARCH PROJECT GRADING RUBRIC	
Abstract	20 pts.
Introduction/Background and Research Question	50 pts.
Methods/Data Collection	50 pts.
Presentation of Data and Results	50 pts.
Conclusion	25 pts.
Future Work	15 pts.
Group Presentation of Project	50 pts.
References	15 pts.
Total	275 pts.

To assess the impact of the course on academic gains, the students were given a SALG (Student Assessment of Their Learning Gains) pre-test survey at the start of the course and a post-test survey at the end of the course. Areas assessed by both pre- and post- SALG surveys included (1) student understanding of concepts explored in the class, (2) increase in skills as a result of work in class, (3) class impact on student attitudes, and (4) integration of learning. The responses to the survey were anonymous and did not affect the students' overall academic grades in the class.

Preliminary results of these surveys, comparing Fall 2014 (no research project) to Spring 2015 (research project added), showed gains in each of the areas listed above. Student comments on teaching evaluations

indicated that students felt they improved their individual communication skills and ability to work in teams.

Future Directions

We will continue to offer the course with the undergraduate research project. An IRB application is in progress, as we plan to complete an in-depth analysis of the SALG survey assessments and also use the physiological results of the student projects for a study on how different types of music affect human physiology. We will be working with an honors student and have plans to publish the results and present them at a conference.

We have recently received outreach funding to add a civic engagement component to the course. In Spring 2016, student teams will share their knowledge of music and science with K-12 students. The teams will be given assignments to develop various activities for elementary students based on material learned in the Music and Science course. These activities will engage the elementary students with interactive learning, such as constructing simple musical instruments or listening/reacting to various kinds of music. The teams will document their experiences, get feedback from the elementary school students, and present reports to the rest of the Music and Science class at Auburn. A primary goal of the outreach project is to connect with future generations of students who may chose careers in fields involving STEM and the humanities.

Summary and Conclusion

We have successfully implemented a new general education course that integrates the disciplines of music and science. After initially offering it primarily as a lecture-based course, we added a team-based research component that engages the students in an active learning experience. We have evaluated the course using the SALG assessment tool and are in the process of applying for IRB approval so that we can publish the results of the students' work.

This course has helped us promote the relationship between science and the humanities with the understanding of the past and connections to today's world and the future. We appreciate the support of SENCER and Auburn University in this endeavor.

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About the Authors



Paula Bobrowski (bobrope@auburn.edu.) is Associate Dean of Research, Faculty Development, and Graduate Studies at Auburn University. She is a professor in the Health Administration Program and is the past Executive Director of the Women's Leadership Institute. She teaches a variety of courses including healthcare innovation and technology management, marketing, and finance. Her extensive professional career in healthcare and international business includes working with the World Health Organization and the International Eye Foundation in Saudi Arabia and as a Fulbright scholar in Japan. She holds a BSN from Oregon Health & Science University, an MBA in International

Business and Marketing from the University of Oregon, a PhD in Marketing and International Technology Management from Syracuse University, and a Certificate in Leadership from Harvard University. She has been at Auburn University since 2005 and has been PI on several grants from funding agencies such as SENCER, the Department of Education, the Fulbright Association, and the Aspen Institute in Washington, DC. She serves as Past President Elect of the Alabama Fulbright Chapter and has recently been elected to serve as a SENCER Leadership Fellow.



Ann Knipschild (knipsak@auburn.edu) is Professor of Music at Auburn University where she teaches oboe, woodwind theory, and a new undergraduate general education course, "Music and Science," which explores the connections between music and science. She received the Doctor of Musical Arts degree from the State University of New York at Stony Brook and the Master of Music degree from Yale University, studying oboe with Ronald Roseman. She holds baccalaureate degrees in both music and agronomy from the University of Missouri-Columbia. Ann is active as a music performer throughout the country and has been featured on concerts in Puerto Rico, Greece, Italy, Austria, England, Scotland, and the Netherlands. In addition to her performing, she has published baroque performing editions with Musica Rara, Breitkopf & Härtel, and Doblinger. She has participated in conferences of the College Music Society, International Double Reed Society, Imagining America, and the SENCER Summer Institute.