Integrating STEM and the Arts: A Call for Partnerships across Disciplines

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Integrating STEM and the Arts: A Call for Partnerships across Disciplines

Newly obtained data at a Midwestern University identify low numbers of underrepresented minority students (URMs) enrolled in a top-ranked engineering program. These numbers match national trends highlighting concerns about the absence of diverse students enrolled in science, technology, engineering, and mathematics (STEM) programs. An analysis of 2010-2011 STEM student data, however, highlighted that STEM students enrolled in band and orchestra at this university excel in numerous areas when compared to STEM students not enrolled in band and orchestra. STEM students also represent approximately 70% of all band and orchestra students. Band and orchestra students earned higher average GPAs (3.18 vs. 2.89), earned more credit hours, reported higher SAT scores and retention rates, and completed their degrees in less time than students not enrolled in band and orchestra. Despite the positive correlations between enrollment in both band and engineering, few URMs at this institution are involved in a music community during their undergraduate student experiences.

In an effort to identify ways that URM engineering students might benefit from instrumental music experiences and to engage STEM and non-STEM departments in a model to enhance the experiences of undergraduate engineering students, this paper presents information about a small group seminar designed to expose undergraduate engineering students to a community of like-minded, well-rounded students. Within this seminar, students will engage in conversations with professionals, will connect with other engineering students who have succeeded in engineering, and will engage in leadership opportunities early in their academic careers. Led by an underrepresented minority faculty in the band and orchestra department who served as a former recruiter for engineering students, this seminar provides a unique opportunity for students to (1) demonstrate uses of campus resources to enable academic success, (2) acknowledge the importance of music in society, (3) participate in service projects within the department, (4) connect to successful STEM alumni, (5) explore opportunities for participation in music-related student leadership positions, and (6) utilize the study tables provided by the departmental service organizations in which many STEM students are members. Future work related to this model along with plans for engaging diverse students is presented along with suggestions for replicating this model on other campuses.

Introduction

According to the U.S. Department of Labor, science, technology, engineering, and mathematics (STEM)-related occupations make up 15 of the 20 fastest growing occupations. Among these include fields such as information technology, which is expected to grow 24% between 2006 and 2016. By 2018, STEM fields are expected to add 2.7 million new jobs, but there is still a major lack of representation of women and minorities in these fields. Despite this demand, the majority of students in the U.S. are not choosing to pursue STEM degrees. Also alarming is the fact that underrepresented minorities (URMs) such as African-Americans and Hispanics comprise approximately 15% of undergraduate students in STEM, a much smaller percentage than the overall U.S. representation of URMs.
Although STEM numbers are low within undergraduate education, many students entering higher education have been exposed to STEM concepts in traditional and nontraditional ways in K-12 education. One of the nontraditional ways, engagement in music, exposes students to mathematical aspects of music (e.g., ratios and proportions) and may provide a foundation for success throughout students’ educational experiences. SETDA also notes occasions where students have connected music and technology to better understand mathematics through real-world application.

Similar to national trends noting the connections between music participation and academic achievement in K-12 education, an analysis of 2010-2011 student data at a Midwestern University highlight that STEM students enrolled in band and orchestra excel in numerous areas when compared to STEM students not enrolled in band and orchestra. Within the band and orchestra program at this university, which does not offer majors or minors in music but supports approximately 150 first-year students and approximately 700 students across all years (including graduate levels), approximately 70% of students represent STEM majors, and these STEM students excel over non-STEM students in several ways. Band and orchestra students majoring in STEM earned higher average GPAs (3.18 vs. 2.89), earned more credit hours (16.7 vs. 13.9), reported higher math and verbal SAT scores, and achieved higher first-year retention rates (94% vs. 90%). STEM band students also completed their degrees in less time than students not enrolled in band and orchestra.

Positive correlations such as those listed above provide motivation for the development of innovative activities that begin to integrate STEM and music for undergraduates. With such activities, questions arise about the role(s) that music might play in the achievement and retention of undergraduate STEM students, particularly URM students. It is hypothesized that if minorities pursuing degrees in STEM participate in music and/or music-related activities, their success in STEM might increase. This paper describes a pilot program within a College of Engineering that combines music and engineering, presents future work related to this model along with plans for engaging diverse students, and offers suggestions for replicating this model on other campuses.

**Literature Review**

Most studies connecting music and STEM have occurred within K-12 education. In a study on test scores of students in urban Ohio who are involved in an organized instrumental music classes versus students who were not involved in instrumental music classes, Kinney discovered that students involved in instrumental music classes outperformed students who were not involved with instrumental music classes.

Middle school and high school students in band, compared to students not enrolled in band, received a greater number of academic honors and scored higher than their peers on classroom tests and on the SAT tests. Abril and Elpus constructed a study based on demographics of participants in high school music ensembles throughout the United States. The study determined that 21% of seniors in the U.S. were participants in school music ensembles. There were significant connections regarding gender, race/ethnicity, socioeconomic status, native language, parents’ education, test score, and school GPA. Students who were male, English language...
learners, Hispanic, children of parents who obtained a high school diploma or less, and had a low socioeconomic status were described as “significantly underrepresented” in music programs throughout the U.S. On the other hand, white students with higher socioeconomic levels, higher GPAs, and parents with education beyond the high school diploma were overrepresented in school music programs. The authors determined the overall makeup of music programs throughout the US is not congruent with the makeup of the country’s diverse population.

Drawing upon the positive aspects of music at the K-12 level and extending those practices to the collegiate level, the pilot program presented in this paper draws upon Martin’s suggestions for creating a multicultural music program that does not compromise academic excellence and does not minimize performance standards. With an emphasis on leadership, authors recommend the inclusion of STEM students in a learning community (LC) with goals to increase retention and achievement of undergraduate STEM students with musical backgrounds and inclinations.

Creation of an Engineering/Band Learning Community

Course Overview

In an effort to identify ways that URM engineering students might benefit from band and orchestra experiences and to engage STEM and non-STEM departments in a model to enhance the experiences of undergraduate engineering students, this paper presents information about a small group seminar designed to expose undergraduate engineering students to a community of like-minded, well-rounded students. Within this first-year engineering seminar, students will engage in conversations with professionals, will connect with other engineering students who have succeeded in engineering, and will engage in leadership opportunities early in their academic careers.

Led by an underrepresented minority faculty in the band and orchestra department who served as a former recruiter for engineering students and co-taught by engineering faculty with interests in acoustical engineering, an area that integrates music and engineering, this seminar provides a unique opportunity for students to (1) demonstrate uses of campus resources to enable academic success, (2) acknowledge the importance of music in society, (3) participate in music-related service projects, (4) connect to successful STEM alumni, (5) explore opportunities for participation in music-related student leadership positions, and (6) utilize study tables provided by music service organizations in which many STEM students are members. A unique aspect of this seminar is its designation as a learning community (LC), in which students within this seminar also take their first semester, first-year core engineering course together. This course will serve as one of many supported by a larger university initiative in which students engage in community-building inside and outside of the classroom.

Course objectives include the following:
1. Identify and understand the importance of music in society.
2. Explain and demonstrate connections between music and engineering.
3. Explore the university’s history.
4. Demonstrate uses of campus resources that will enable academic success.
5. Participate in music-related service projects.
6. Attend and reflect on music ensemble performances.
At the end of the course, students will
1. Embody skills necessary to serve as student leaders in band ensembles.
2. Demonstrate abilities to organize and lead music-related service initiatives.
3. Acquire professional and study skills that will promote students’ development, achievement, and retention in engineering.

This course will include readings, discussion, and reflection (in class and/or on the blog), presentations by visiting speakers, and course assignments. Distribution of activities is presented in Table 1.

### Table 1 - Course Activities and Grade Distribution

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Grade Distribution</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Participation</td>
<td>15%</td>
<td><strong>Weekly in class.</strong> See details and expectations for attendance and participation in the following.</td>
</tr>
<tr>
<td>Seminar Reflections/Questions for Speakers/Concert Attendance</td>
<td>35%</td>
<td><strong>Due each Sunday by 5 P.M.</strong> See rubric for additional requirements.</td>
</tr>
<tr>
<td>Assignments</td>
<td>40%</td>
<td>Details and due dates for each assignment are provided within the syllabus. Personal Introductions – 5%</td>
</tr>
<tr>
<td>Learning Community (LC) Activities</td>
<td>10%</td>
<td>Students will attend LC activities that are required within each course. Approximately $20 will be allocated to support these activities.</td>
</tr>
</tbody>
</table>

**Participation**

Discussions are a major portion of this class, and students will be asked to provide questions and feedback on a weekly basis. They must be “present” (i.e., engage in discussions as active contributors). It is students’ responsibilities to be present on time, since tardiness will be treated as an absence and a grade deduction for that day. Points may also be deducted if students are not engaged (e.g., sleeping, using a mobile device, and/or working on homework for another class). To make up for excused absences, students will complete a make-up assignment (such as an article reflection related to acoustical engineering). Failure to complete the make-up assignment by the due date will result in zero credit for participation on the date of absence.

**Required Activities/Assignments**

- **Orchestra, Jazz, and Wind Band Performances**: Students must attend one jazz performance and one orchestral or wind band performance. For each performance, students must retrieve signatures from conductors after the concert. (Attendance forms will be provided by course instructors.) After attending the performances, students will complete a 200-word reflection about the concert. They will be asked to describe connections between aspects of the concert.
(e.g., musical themes, acoustics) and engineering. Reflections with signed performance attendance forms must be submitted one week after the scheduled performance.

- **Pre-Speaker Questions** - Students will submit a minimum of five questions before each class session. Students will be informed about the presentation topics prior to creating their questions.

- **Personal Introduction** - Students will create a PowerPoint to introduce themselves to the class. This PowerPoint will allow students to present information about their music backgrounds and their engineering aspirations.

- **Three required office visits with instructor** - Students will schedule times to meet with instructors at the beginning of semester, before midterm exams, and before finals. These check-ins will allow students to engage face-to-face with faculty and to obtain feedback about their progress in course.

- **Pre-Evaluation Paper Assignment** - Students will write a two-page typed paper about why they chose to enroll in the university’s engineering program and why they chose to participate in a band ensemble.

- **Personal Résumé** - A draft will be submitted for course instructors to review, and a final résumé will be due at the end of the semester.

- **Post-Evaluation Paper Assignment** - Students will write a two-page paper about what they gained from their experience in this course. They will be encouraged to review some of their previous speaker reflections and reflections of other experiences throughout the semester.

- **Service-Activity Descriptions** - Students will engage in service activities via several organizations. Students will organize, communicate, and facilitate a service project for the semester. These extracurricular-related and social events will be coordinated by instructors over the course of the semester. Students’ attendance at the events will be tracked.

### Tentative Course Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Instructor Introductions; Course Expectations; Discuss Assignment # 1</td>
</tr>
<tr>
<td>2</td>
<td>Personal Introductions</td>
</tr>
<tr>
<td>3</td>
<td>Visit On-Campus Writing Lab</td>
</tr>
<tr>
<td>4</td>
<td>Meet Band Service Organizations or Engineering Students</td>
</tr>
<tr>
<td>5</td>
<td>Introduction to the University</td>
</tr>
<tr>
<td>6</td>
<td>Hazing Training/Visit</td>
</tr>
<tr>
<td>7</td>
<td>How to Prepare the Perfect Resume; Discuss Assignment # 3</td>
</tr>
<tr>
<td>8</td>
<td>Semester Break</td>
</tr>
<tr>
<td>9</td>
<td>Transitioning from First-Year to Engineering Professional School</td>
</tr>
<tr>
<td>10</td>
<td>Audiology and Music Discussion</td>
</tr>
<tr>
<td>11</td>
<td>Meet the Faculty or Engineering Student(s); Meet Band Officers; Discuss Assignment # 2</td>
</tr>
<tr>
<td>12</td>
<td>Exploring Opportunities Beyond Undergraduate Engineering</td>
</tr>
<tr>
<td>13</td>
<td>Final Resume Due or IDE Student</td>
</tr>
<tr>
<td>14</td>
<td>Dinner with the Faculty and Staff</td>
</tr>
<tr>
<td>15</td>
<td>Linkages between Music and Engineering</td>
</tr>
<tr>
<td>16</td>
<td>Course Wrap-Up</td>
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</table>
Discussion and Conclusion

Authors present the integration of engineering and music as a nontraditional method of engaging and retaining underrepresented minority students with strong interests in music, leadership, service, and engineering. The course presented within this paper provides a unique opportunity to explore connections between music and STEM, in this case, engineering and to present content of interest to engineering and music audiences. Although prior reports highlight positive correlations between music participation and engineering learning outcomes, this formal seminar serves as a pedagogical test bed for exploring the impacts of engagement in a music learning community on URM student engagement. Future work will assess these efforts in more depth and will explore formal connections between K-12 students with interests in STEM and participation in band. This is of particular interest given the consistent and positive performance from students who are in STEM and are involved in the Band and Orchestra Department at this university. Relationships and partnerships often are developed within this department before the semester begins, and with the piloted learning community, all first-year engineering band students enrolled in a musical ensemble will have access to network that may increase their likelihood of success.

References

http://www.setda.org/; accessed 1/5/13


