DIALOGUES
IN MUSIC THERAPY
EDUCATION

OPEN ACCESS

ARTICLE

Student music stimuli composition in a scaffolded course-based undergraduate research experience

[1]Abbey L. Dvorak, PhD, MT-BC
[2]Eugenia Hernandez-Ruiz, PhD, MT-BC
[3]Halle Nick, MME, MT-BC
[2]Ruowen Qi, MM
[3]Tianna M. Gilliam
[2]Celeste Alderete
[3]Zach Frieze, BME
[3]Kirstin Georgeson
[3]Autumn Hatcliff
[3]Alice Kirsch, BME
[2]Jessica Kunst
[2]Raquel Medina
[2]Mitchell Weeks

[1]School of Music, The University of Iowa, Iowa City, Iowa
[2]School of Music, Dance, and Theatre, Arizona State University, Tempe, Arizona
[3]School of Music, University of Kansas, Lawrence, Kansas

Dvorak et al., Dialogues in Music Therapy Education, *1*(1). DOI https://doi.org/10.18060/24287

Publisher: Department of Music and Arts Technology, Indiana University-Purdue University Indianapolis

Abstract

Course-based undergraduate research experiences (CURE) allow students opportunities to develop research skills. Different from previous bounded CUREs, our students composed, evaluated, and selected the music stimuli used in a music and mindfulness multi-site study. This increased student autonomy and elevated the project into a scaffolded CURE.

The purposes of this perspectives on practice paper are to (a) describe the process of student music stimuli composition and evaluation for use in a course-based undergraduate research experience and (b) identify benefits, challenges, and lessons learned from the viewpoints of students, graduate assistants, and faculty who participated in the project. Nine students, two graduate assistants, and two faculty provide an overview of the model, assignments related to music stimuli composition and evaluation, and share first-person accounts of their experiences with the project.

Keywords: *music therapy education, advanced clinical techniques*

Publisher: Department of Music and Arts Technology, Indiana University-Purdue University Indianapolis

Introduction

The first two authors embedded authentic research projects within required music coursework to increase research skill development of music therapy and music education students (Dvorak & Hernandez-Ruiz, 2019b; Dvorak et al., in press; Hernandez-Ruiz & Dvorak, 2020b). In a recent study, the embedded project was modified to allow more student involvement within the research project creation due to previous student feedback and curricular changes. The embedded course project also attempted to bridge science and practice by facilitating the composition of music for a specific goal according to research principles established in the literature. The purposes of this perspectives on practice paper are to (a) describe the process of student music stimuli composition and evaluation for use in a course-based undergraduate research experience and (b) identify benefits, challenges, and lessons learned from the viewpoints of students, research assistants, and faculty who participated in the project.

Background

Research skill development in undergraduate music programs is important to support future evidence-based practices among music therapy and music education students. *Evidence-based music therapy practices* "integrate the best available research, the music therapists' expertise, and the needs, values, and preferences of the individual(s) served" (American Music Therapy Association, 2010; 2015). *Evidence-based educational practices* – important in music education training – include activities, strategies, or interventions that demonstrate a "statistically significant effect on improving student outcomes or other relevant outcomes" based on strong, moderate, or promising evidence from high-quality research studies (Every Student Succeeds Act

Sec. 8101, 2018, p. 388). Despite differences in definition and profession, *intent* is similar as both require development of research skills necessary to locating, comprehending, analyzing, and applying the best available literature to improve outcomes for people served. To support research skill development, many universities offer undergraduate research experiences, considered high impact practices with documented learning outcomes (Brownell et al., 2015; Cuthbert et al., 2012; Kuh, 2008). One type of research opportunity implemented in higher education – both nationally and internationally – is course-based undergraduate research experiences (Brewer & Smith, 2011; Wang, 2017).

Course-based undergraduate research experiences (CURE) are a specific type of research opportunity in which an authentic research project is embedded into a course, allowing all students the chance to conduct research (Auchincloss et al., 2014). CUREs involve students in use of scientific practices, discovery of new knowledge or insights, relevant work with impact beyond the classroom setting, collaboration with others, and iterative processes building new knowledge on existing (Auchincloss et al., 2014). CURE benefits may include improved research literacy skills (Cuthbert et al., 2012), greater understanding of and confidence about research (Carboni et al., 2007; Olimpo et al., 2016), plans to use research in their careers (Shaban et al., 2015), higher student retention rates (Kerr & Yan, 2016), excitement about conducting "real-world" research (Cuthbert et al., 2012), changes in attitude and world views (Riley et al., 2006; Russell et al., 2015), and improved understanding of course material and how research could improve practice (Chase et al., 2017; Olimpo et al., 2016). Originally conducted in science courses (Dvorak et al., 2019), CUREs are now used in music therapy education and training (Dvorak & Hernandez-Ruiz, 2019b; Dvorak et al., in press; Hernandez-Ruiz & Dvorak, 2020b).

The first two authors facilitated the first CUREs for music students in helping professions (i.e., music therapy, music education) in required music psychology courses at two research-intensive universities (Dvorak & Hernandez-Ruiz, 2019b; Dvorak et al., in press; Hernandez-Ruiz & Dvorak, 2020b). The embedded research project in the course compared four music stimuli to support mindfulness meditation for undergraduate non-musicians (Dvorak & Hernandez-Ruiz, 2019; Hernandez-Ruiz & Dvorak, 2020) and musicians (Hernandez-Ruiz & Dvorak, in press; Hernandez-Ruiz et al., 2020). The embedded project was *bounded research* in which the instructor set study parameters and directions, and students worked within them (Willison et al., 2015). As a result of CURE participation, students reported gains in scientific thinking, personal gains, research skills, and attitudes and behaviors (Dvorak & Hernandez-Ruiz, 2019b; Dvorak et al., in press; Hernandez-Ruiz & Dvorak, 2020b). However, students' open-ended responses indicated they wanted increased student involvement and autonomy within the project (Dvorak & Hernandez-Ruiz, 2019b; Dvorak et al., in press; Hernandez-Ruiz & Dvorak, 2020b). This feedback across semesters – combined with increasing opportunities for student research experiences earlier in the curriculum – indicated a scaffolded research level may be more appropriate.

Scaffolded research involves scaffolds (i.e., step-by-step process in which supports are gradually decreased as progress is made) placed by the educator that enable students to independently respond to questions or tasks generated from instructions; choose from a range of structure or approaches; and evaluate, organize, and analyze information using criteria related to the aims of the inquiry (Willison et al., 2015). Scaffolded research is one of seven stages of the Research Skill Development (RSD) framework (Willison & O'Regan, 2008; 2015), which describes the process of research development from undergraduate novices who require high structure and modeling to discipline-leading experts in their field. The stages include supervisor instigated (i.e., prescribed, bounded, scaffolded research), researcher instigated (i.e., self-initiated, open research), and discipline leading (i.e., adopted, enlarging research) (Willison & O'Regan, 2008; 2015).

Student Music Stimuli Composition and Evaluation

Previous publications (Dvorak & Hernandez-Ruiz, 2019b; Dvorak et al., in press; Hernandez-Ruiz & Dvorak, 2020b) described CURE assignments facilitated in the classroom. This paper focuses on describing and sharing perspectives related to two new assignments added for this CURE: composing and evaluating music stimuli used for the embedded project.

Assignment Overview

CURE assignments were similar to those used in previous studies (Dvorak & Hernandez-Ruiz, 2019b; Dvorak et al., in press; Hernandez-Ruiz & Dvorak, 2020b) and included completing ethics and training requirements, locating and analyzing research, engaging in experiential activities, collecting data and debriefing study participants, and interpreting and writing about findings. The two major assignment changes that lifted this CURE to the scaffolded stage occurred with the music stimuli used in the embedded project. Different than previous studies, students composed and then evaluated the music stimuli, thus selecting the stimuli used in the embedded music and mindfulness study with non-musicians at Arizona State University (site 1) and musicians at the University of Kansas (site 2).

Building Teams

Faculty at the two sites approached team creation in different ways based on their unique situations. Site 1 included students in a music psychology class (including majors in music therapy, music education, and digital media). Students were instructed to self-select into groups of four participants to create the musical compositions. Site 2 included music therapy, music education, and non-music majors; the music education and non-music majors – and their skills – were unfamiliar to the music therapy faculty member. Therefore, Site 2 students completed a brief online survey in which they provided their name, major, and rated their level of comfort and experience with music stimuli creation tasks using a 4-point Likert-type scale from *no comfort/experience* to *high comfort/experience.* The tasks included: composing music according to guidelines, writing notation using a music software program, playing single-line written music on a piano/keyboard, recording music using a computer/equipment, and mixing music to provide a high-quality recording. The faculty member created teams of 3-4 students based on levels of comfort and experience, attempting to group students of different majors, applied instruments, and strengths and needs. The variation in team creation between the two sites demonstrates that even if faculty need to complete tasks or assignments differently – due to circumstances at their universities – the project can still function.

Composition

Teams of students crafted novel music stimuli based on the compositional principles of the stimuli used in previous studies. The compositional principles of the original stimulus were decided within parameters found in the music psychology literature (Dvorak & Hernandez-Ruiz, 2019). These principles are included in the assignment description in Appendix A. Teams of 3-4 students from both sites created a total of 16 music stimuli. Students then evaluated the 16 music stimuli and selected three after an initial and final evaluation.

Evaluation

In an online anonymous survey, students at both sites listened to all sixteen recordings while viewing the associated 16-measure notated scores. On a 7-point Likert-type scale from *strongly disagree* to *strongly agree*, students evaluated each music stimuli in seven different categories based on compliance to music guidelines and appropriateness for mindfulness meditation practice. Please see Appendix C for the Student Music Stimuli Evaluation. The initial evaluation resulted in a tie between five stimuli – two more than needed for the study – so students completed a re-evaluation between the five finalists. The resulting three stimuli which were ranked the highest were used – along with the original – for the embedded study. See Appendix D for the 16-measure scores of the three music stimuli and listen to the recordings (i.e., original and three student-created stimuli) at https://soundcloud.com/mindfulness-music/sets/music-and-mindfulness-study-4/s-ezKcLU6avij.

Scaffolded Research

The resulting scaffolded project embedded in this CURE involved music students composing novel music stimuli for mindfulness meditation, following similar research-based compositional principles to the original stimuli used in previous studies (Dvorak & Hernandez-Ruiz, 2019; Hernandez-Ruiz & Dvorak, 2020; Hernandez-Ruiz & Dvorak, in press; Hernandez-Ruiz et al., 2020). Students chose from a range of provided structures, approaches, pathways, or sources to craft the music stimuli (Willison et al., 2015). Students were given initial modeling, support, and guidance in low stakes group assignments to practice working with team members, and were provided with example stimuli used in three previous studies as models for creating their own stimuli.

Experiences from Multiple Viewpoints

Throughout the CURE, students, graduate assistants, and faculty experienced benefits and challenges as a result of participating in this multi-site study. Eleven students volunteered to write this paper with faculty sharing their experiences creating and evaluating the music stimuli used in the CURE. The motivation to work outside of class time on research is consistent with other CUREs in which students were motivated and willing to work outside of class – or beyond the course timeline or requirements – on a research project (Foy et al., 2006; Kowalski et al., 2016; O'Brien & Roberts, 2008; Smith et al., 2015; Wiley & Stover, 2014). Two *graduate assistants* described their roles and responsibilities and provided insight into their personal experiences as a result of coordinating the study at each site. Nine students wrote a description of their experiences in the areas of group process, equipment/materials, benefits, and challenges. The *process* of music stimuli creation differed within each group; some groups started on the bass line, some on harmony, and others on melody lines with team members working together on everything or dividing the tasks (e.g., composing, playing, recording, mixing) according to individual strengths. The *equipment* *and materials* used by groups differed depending on access to and knowledge of software programs and recording equipment. Students reported academic, intrapersonal, and interpersonal *benefits* as a result of participating in the music stimuli creation. *Challenges* included scheduling and time constraints, using music software/mixing the tracks, and composing a creative stimulus while staying within the melodic, harmonic, and timbral parameters of the study. Students also had *suggestions* to help with future implementation of the project. The following sections illustrate these experiences through firsthand narratives.

Graduate Assistants

The graduate assistants included Author 4, a Graduate Research Assistant (GRA) at Site 1 and Author 3, a Graduate Teaching Assistant (GTA) at Site 2. Our primary responsibilities for the CURE involved creating the schedules for the music labs where data collection took place, collecting students' schedules, pairing students into dyads, creating the overall lab schedule for running participants, and supervising the students who were engaged in data collection. As the GRA for Site 1, Autor 4 was hired solely for this project, without teaching responsibilities, but had the additional task of assisting with statistical analyses. Author 3's GTA position also had added responsibilities of assisting in the classroom, taking attendance, completing minor grading, and facilitating one lecture related to their area of expertise. Both of us gained leadership and project management experience, and improved problem-solving and time management skills by fulfilling these various duties in addition to completing graduate degrees.

Although we both served as graduate assistants for the courses and research project, our roles also provided unique experiences and challenges. At Site 1 (GRA), I needed to consider the project in a holistic way and take into account the various learning styles, learning pace, and learning methods needed before the training was conducted. I also had to anticipate problems that may occur and work preventatively to avoid them. This mindset helped in preparing for the unpredictable situations that can sometimes happen throughout the research process. One challenge at Site 2 (GTA) I faced was experiencing feelings of being a “middleperson” in that students frequently came to me with small questions related to their roles or responsibilities rather than asking the faculty member. Although this was a challenge, it also provided the opportunity to gain project management experience, deepen my understanding of the research study as a whole, and empower the students to think critically in order to come to necessary conclusions.

The logistics of creating a data collection schedule for the music labs was the greatest challenge for both graduate assistants. At Site 2, the music perception lab was reserved for three weeks for the two-week data collection phase; the GTA then created a template synthesizing their and faculty available schedules. The GTA gathered the 40 student schedules, organized them from least to most available, and placed students with least availability first into the template. The GTA then filled available timeslots with a single student first in order to keep as many timeslots open for students with more difficult schedules, and ultimately for participants when choosing timeslots in which to complete the study. The GTA then provided the schedule to faculty for review, and faculty entered the approved schedule into SONA (i.e., the online participant recruitment system at the university). Although the GRA at Site 1 only needed to consider 20 students' schedules, the clinical practicum schedule was not yet decided. The GRA paired two students with similar schedules as a team, then placed them in the available lab and faculty schedule, allowing for multiple practicum possibilities. Both systems for scheduling worked; graduate assistants and faculty are encouraged to identify a scheduling process that works within their academic culture and setting.

Group Process

The process of music stimuli creation differed among groups of student researchers; some started on the bass line, some on harmony, and others on melody, with team members working together or dividing tasks depending on individual strengths. Students at Site 1 created six compositions and students at Site 2 created ten, working within compositional guidelines of a steady beat bass line, cello harmony composed of I vi IV and ii chords, and a viola melody that progressed in a stepwise movement. Authors 12 and 9 describe their own group processes and then summarize the processes from other groups' survey and discussion responses.

In our group at Site 1, we decided upon a turn-taking process in which one person would write one measure, followed by the next person writing the next measure, and so on until we had fulfilled the length requirement of 16 measures. After this, we edited the melody to streamline any part of it that sounded – in our creative opinion – unnatural. Our goal was to create a piece of music that elicited a feeling of comfort and predictability, while also providing a bit of novelty to hold interest and attention. As such, we included a diatonic, stepwise, ascending and descending melody line that was meant to evoke a culturally familiar melodic sequence. We also paid attention to melodic phrasing by composing the melody in a “question and answer” style, ensuring that the peak of the melody occurred near the middle of the phrase.

At Site 2, my group (Author 9) met during designated class time to plan out our composition using an online music score-generating program called MuseScore.[1] We picked the key and wrote the bass line, then developed the harmony and melody. We used the built-in orchestral instruments on my Yamaha MOX8 keyboard to generate bass, cello, and viola lines. I recorded the three separate tracks on GarageBand[2] and inserted the fourth and final voice track, mixing the EQ slightly to create the complete auditory stimuli.

Other groups of students at Site 2 wrote their music stimuli in somewhat different ways. Four out of ten groups began the composition by notating the bass line, one group by notating the harmony line, and one with the melody line. The remaining four groups did not specify the order of line composition. Teams met outside of class to record their projects on MIDI keyboards using music software such as Logic Pro[3], Ableton[4], and GarageBand. The projects were uploaded to Blackboard (i.e., university learning management system) in a .wav format for the recording and .pdf for the music score. Faculty downloaded the projects from Blackboard and uploaded to the Qualtrics survey for evaluation.

Equipment and Materials

The equipment and materials used by groups differed depending on access to and knowledge of software programs and recording equipment. Two students, Authors

[1] https://musescore.org/en
[2] https://www.apple.com/mac/garageband/
[3] https://www.apple.com/logic-pro/
[4] https://www.ableton.com/en/

11 and 7, provide descriptions of the equipment and materials used in their groups. These two groups had their music stimuli chosen to use in the study. The Site 2 student, Author 7, also acted as a consultant in the class for other groups due to their background in composition and recording.

In the creation process at Site 1, we used an online notation software called Noteflight[5] to create a rough outline of the stimuli; we then put that outline into GarageBand using an iPad. Within GarageBand, we used sample double bass, cello, and viola sounds to create the music stimuli. By using GarageBand, this allowed all the groups to ensure that the timbre and tone quality of the sample sounds being used in the music stimuli were the same. The participants in the experiment used iPads and headphones in order to listen to and rate the stimuli. All of the iPads at both sites were set at half volume in order to ensure that each participant was listening to the stimuli at the same volume.

At Site 2, we used an AKAI LPK 25 wireless MIDI keyboard[6] to input notes and rhythms into Logic Pro X. This keyboard is small and easy to transport, but also has terrific response and sufficient keys. The notes were then quantized (i.e., lined up) to be perfectly in time and balanced, using the user interface mixing software. One example of this balancing process includes adjusting the velocity input for certain notes. The velocity affects the timbre of the instruments, which could affect the mindfulness results in the study. In another example, we balanced the volumes of each individual track in order to achieve a nice blend. The voice track was quite loud by default and the volume

[5] https://www.noteflight.com/
[6] https://www.akaipro.com/lpk25-wireless

was lowered in order to create a more blended sound. Sibelius[7] notation software was used to write the full score for each stimulus. We used the MIDI keyboard again to input the notes for the project. The exporting process consisted of bouncing the tracks or taking audio and making it into a new MP3 or WAV format. Several headphones and speakers were used to mix in order to achieve a general balance that sounded good on most headphones and speakers, including the half volume on the iPad used for the embedded project. The mixing and balancing continued until members of the group were pleased with the stimuli.

Benefits

Students reported academic, intrapersonal, and interpersonal benefits as a result of participating in the music stimuli creation. Authors 6 and 10 share their experiences. As a student participant at Site 1, I found the stimuli creation beneficial in increasing my personal confidence in myself and group work. In regard to group collaboration, I found that working with students at differing points in their academic careers and music training allowed all group members to learn from one another and make important individual contributions from their own respective experiences. As a result of this collaboration, I gained confidence in composition and have increased the assuredness of my ability to create a musical product that can be utilized by others.

As a student participant at Site 2, I found the stimuli creation experience to be beneficial on both an academic and personal level. The creative process allowed me to gain newfound knowledge and experience with the music software GarageBand. I also had the unique experience of collaborating with my interdisciplinary colleagues in music

[7] https://www.avid.com/sibelius

therapy, music education, and psychology. This interaction allowed for professional networking and the acquisition of skills that will help in my cooperative and collaborative work with future coworkers. A course survey conducted at Site 2 also found that other student participants benefited from the music stimuli creation experience. Students gained knowledge and experience with music creation software, and they benefited from practicing their compositional skills and employing inventive strategies to create unique auditory stimuli. Students noted they found personal satisfaction through the composition of successful and purposeful goal-directed music stimuli.

Jointly, we found benefit from the project in regard to our ability to work with diverse groups of individuals with varying skill sets, musical expertise, world views, and impressions of music. The unification of the individual strengths of each member of the group allowed for the creation of a mindful stimuli that adhered to the predetermined requirements for the study.

Challenges

As student participants at Site 1 and Site 2, our (Authors 13 and 5) music stimuli groups faced several challenges including scheduling and time constraints, using music software/mixing the tracks, and composing a creative stimulus while staying within the melodic, harmonic, and timbral parameters of the study. As groups with both undergraduate and graduate students from three different music disciplines, our varying schedules made it difficult to organize meeting times outside of class to complete the project. Both authors' music stimuli groups consisted of musically inclined individuals, so we were able to complete the project within a short amount of time; however, different groups at Site 1 included non-music major students, which presented additional challenges with scheduling and full-group participation.

Our groups also faced challenges in mixing the tracks for the stimuli. Due to an initial background survey that helped shape the groups, at least one person in each group had prior experience with creating music samples on computer software. This member typically took charge of mixing the stimulus with music software while the remaining members gave more time and input on composing and/or playing the music. We also encountered difficulties in finding instrument timbres on music software programs (i.e., Noteflight, GarageBand) that were “pleasing” according to music stimuli creation guidelines. Many of the timbres that we found on readily available software programs either sounded abrasive or distracting. We resolved these challenges by transferring the tracks to more advanced software programs like Logic Pro with more pleasing instrument timbres. Our access to university-provided software programs helped mitigate these challenges.

Other Site 2 groups also experienced challenges during the music stimuli creation experience. The largest reported issue involved software and equipment challenges. From the course survey at Site 2, groups had difficulty learning to use the software (*n* = 4 groups), converting file types between software programs (*n* = 4), locating software programs (*n* = 3), and difficulty accessing composition equipment (*n* = 2). Groups also reported obstacles with the logistics of working together; some mentioned issues with scheduling and time constraints (*n* = 4), or difficulties dividing tasks between group members (*n* = 3). Another challenge category involved the composition process, where six groups (*n* = 6) encountered difficulties composing a creative stimulus while staying within the melodic, harmonic, and timbral constraints of the study. One group also reported motivational challenges, stating that it was difficult to stay motivated “knowing that our [stimulus] probably won’t be used.”

Faculty

After reflecting on CURE facilitation over the past six years, we have suggestions that may assist other faculty interested in implementing this type of research training in their courses. First, be open to research team member feedback. Students have new and innovative ideas that may work better than those originally planned. In addition, a process may not work the way it was initially intended; problem-solving with students may identify a solution. Second, make sure the students have the basic skills needed to complete the CURE. The tasks may be challenging, but they also need to be manageable and complement their background and experience. For example, the music students all knew how to complete a music score and understood the fundamental theory behind the music composition tasks (e.g., the construction of a minor chord) because of curriculum prerequisites; however, this type of task would be considered outside the common knowledge of all students in a course not in a school or department of music. Third, plan time in the schedule for the unexpected. Some aspects of research seem to take longer than expected, while other challenges unexpectedly occur and need immediate solution. For example, we had to fix one of the music stimuli in a very short time due to problems with the initial recording.

This CURE project was at a higher level (i.e., scaffolded) than three previous projects, but even though students were more involved in the research process, they seemed to feel constrained by the research requirements and thought the music stimuli would end up sounding all the same. However, most were surprised at the resulting variety they could create even within somewhat strict guidelines. This struggle, and the resulting discovery, was an important part of their learning and promoted cognitive flexibility. Instead of being told it is possible to be creative within constraints, they experienced it, which can be a more meaningful and memorable lesson. Several students also mentioned they would have liked to use live instruments to record and test the differences between recorded and live instruments. In future studies, students could expand this CURE by exploring differences in live instrument timbre, such as their own primary instrument, on participant responses.

Technology was accessible on campus and most students were required to learn and use the software programs in their earlier music theory courses, but this did not necessarily mean all students knew how to use the software proficiently. Several students mentioned struggling with software and equipment, and that they needed to relearn or train themselves for this project. In addition, although GarageBand was available to all students, not everyone used it due to instrument quality. The differences in software could have introduced bias into the final selection of music stimuli for the project. When implementing a similar CURE in the future, we would want to ensure all students have access to the same high-quality software and equipment, and refer to informational videos, easily available on the internet.

Future Implementation

Faculty are encouraged to incorporate research skill training within their courses and to connect such training to students’ future professional work in their respective fields. For example, most music therapists and music educators are asked to compose music for use in the clinic or classroom, focused on a specific goal or purpose. This research project allowed students the opportunity to practice the skills needed to compose music based on a set of research principles and to evaluate their compliance to those principles and the effectiveness of the resulting musical product. These tasks mirror similar ones they may encounter in their future work. By practicing these tasks in a supportive environment and receiving feedback – from faculty, peers, and study participants – these interconnected skills of researching, composing, and evaluating may be strengthened.

This type of research project is important and has implications for the future development of evidence-based music therapy practice. Evidence-based practice combines the use of research, clinical wisdom, and client characteristics and preferences to provide high quality health care outcomes for clients. As clinicians use music – either co-created or previously composed – in their practice, identifying guiding principles from the research before implementation is important. Beginning clinicians may use music somewhat instinctually at first drawing on their academic knowledge, and as they gain experience, develop their clinical wisdom based on client responses to uses of music. However, if we can already identify – from the research studies available – general human responses to the crafting of specific musical features, we can assist students in building their clinical wisdom in a different way. This synergetic relationship between the development of research skills and clinical skills (Dvorak et al., 2017) may also help students feel more comfortable overall in the clinic (Gregory, 2009), alleviate some of their typical concerns about competence, knowledge, and effectiveness when working with clients (Baker & Krout, 2011), and motivate them by providing them with more effective ways of helping others in a consistent manner (Clark & Kranz, 1996; Dvorak et al., 2017; Lim, 2011; 2014). Thus, by improving research skills in this way, students' clinical or classroom skills – and their use of evidence-based practice – may improve as well (Dvorak et al., 2017; Dvorak et al., 2019).

The CURE should be connected to the objectives and typical content of the course, as well as the overall academic curriculum. For example, as students were learning about effects of music on the human experience, they were putting these ideas and skills into practice by creating and evaluating their music stimuli. Although students found many different ways to create the music stimuli – and used a variety of group process, equipment, and software – all students completed and met competency for the required tasks. As a result, students reported they gained confidence in composition, creating a musical product that may be used by others, and working effectively with diverse group members of a variety of backgrounds, experiences, world views, and musical expertise. However, students also reported difficulty with scheduling outside of class time to work on the project. Future CUREs should allow time to work in class on the project in a team-based model.

Although CUREs may be an effective training platform for postgraduates interested in becoming faculty members (Dvorak & Hernandez-Ruiz, 2019b; Hernandez-Ruiz & Dvorak, 2020b; Cascella & Jez, 2018; Dolan & Johnson, 2010), when including graduate students as CURE assistants, carefully consider their needs, strengths, and development. Graduate students could play different roles or completely different tasks based on their strengths, even for the same CURE and/or GRA/GTA position. For example, a GTA with a strong statistical background could analyze the data and share the results with the class, but another GTA may feel more comfortable training students on music composition software and the recording process. Both roles and skill sets are valid and important for the project; practicing this flexibility allows the graduate assistant to contribute to the CURE by focusing on their strengths.

Faculty should consider their own skills, resources, research interests, and previous experiences when identifying and crafting potential CUREs for a course. From interviews with experienced CURE faculty, Shortlidge et al. (2016) identified three necessary attributes to develop and teach a CURE: the ability to deal with uncertainty, a background in scientific research, and a willingness to invest the necessary time and effort. With these important attributes in mind, if a music therapy faculty member decides to implement a CURE, they are encouraged to analyze their research line to identify potential opportunities for students to collaborate. Perhaps at first, this may seem uncomfortable for faculty used to working individually on projects, but the sense of discovery, excitement, and the highs and lows of research can be a valuable shared experience with students. In addition, CUREs may not be appropriate for all courses or programs. Faculty may choose a different type of research opportunity to meet their course learning objectives and AMTA competencies.

Conclusion

Course-based undergraduate experiences are one way of embedding research and clinical skill development within academic courses. Student, GRA, and faculty voices reflected here indicate that successful CUREs include consideration of all team members' opinions and interests, incorporation of meaningful objectives and topics of interest, related to the academic course, and consideration of student, assistant, and faculty skill sets. Through engaging in creative, “real-life” music research, team members develop flexibility, problem-solving, and teamwork skills, all essential attributes of a successful music therapist.

References

American Music Therapy Association (2010). *Strategic priority on research*. https://www.musictherapy.org/about/musictherapy/

American Music Therapy Association (2015). *Music therapy research 2025: Proceedings.* Silver Springs, MD: American Music Therapy Association. https://www.musictherapy.org/assets/1/7/MTR2025proceedings.pdf

Auchincloss, L. S., Lauresen, S. L., Branchaw, J. L., Eagan, K., Graham, M., Hanauer, D. I., Lawrie, G., McLinn, C. M., Pelaez, N., Rowland, S., Towns, M., Trautmann, N. M., Varma-Nelson, P., Weston, T. J., & Dolan, E. L. (2014). Assessment of course-based undergraduate research experiences: A meeting report. *CBE-Life Sciences Education, 13*, 29-40. https://doi.org/10.1187/cbe.14-01-0004

Dvorak, A. L., Davis, J., Bernard, G., Beveridge-Calvin, R., Monroe-Gulick, A., Thomas, P., & Forstot-Burke, C. (2019). Systematic review of course-based undergraduate research experiences: Implications for music therapy education. *Music Therapy Perspectives*. https://doi.org/10.1093/mtp/miz023

Dvorak, A. L., & Hernandez-Ruiz, E. (2019). Comparison of music stimuli to support mindfulness meditation. *Psychology of Music.* https://doi.org/10.1177/0305735619878497

Dvorak, A. L., & Hernandez-Ruiz, E. (2019b). Outcomes of a course-based undergraduate research experience (CURE) for music therapy and music education students. *Journal of Music Therapy*. https://doi.org/10.1093/jmt/thy020

Dvorak, A. L., Hernandez-Ruiz, E., & Weingarten, K. M. (in press). Course-based undergraduate research experience (CURE): Music education and music therapy student outcomes. *Journal of Music Teacher Education.*

Dvorak, A. L., Hernandez-Ruiz, E., Jang, S., Kim, B., Joseph, M., & Wells, K. E. (2017). An emerging theoretical model of music therapy student development. *Journal of Music Therapy*. https://doi.org/10.1093/jmt/thx005

Brewer, C. A., & Smith, D. (2011). *Vision and change in undergraduate biology education: A call to action.* American Association for the Advancement of Science with support from the National Science Foundation. ISBN#: 978-0-87168-741-8.

Brownell, S. E., Hekmat-Scafe, D. S., Singla, V., Chandler Seawell, P. Conklin Imam, J. F., Eddy, S. L., Stearns, T., & Cyert, M. S. (2015). A high-enrollment course-based undergraduate research experience improves student conceptions of scientific thinking and ability to interpret data. *CBE-Life Sciences Education, 14*, 1-14.

Carboni, L. W., Wynn, S. R., & McGuire, C. M. (2007). Action research with undergraduate preservice teachers: Emerging/merging voices. *Action in Teacher Education, 29*(3), 50-59. https://doi.org/10.1080/01626620.2007.10463460

Chase, A., Clancy, H., Lachance, R., Mathison, B., Chiu, M., & Weaver, G. (2017). Improving critical thinking via authenticity: the CASPiE research experience in a military academy chemistry course. *Chemistry Education Research and Practice, 18*(1), 55-63. https://doi.org/10.1039/C6RP00171H

Cuthbert, D., Arunachalam, D., & Lincina, D. (2012). 'It feels more important than other classes I have done': An 'authentic' undergraduate research experience in sociology. *Studies in Higher Education, 37*(2), 129-142. https://doi.org/10.1080/03075079.2010.538473

Every Student Succeeds Act (ESSA) (2018). Reauthorization of the Elementary and Secondary Education Act of 1965 [As Amended Through P.L. 115-224, Enacted July 31, 2018].

Foy, J., Feldman, M., Lin, E., Mahoney, M., & Sjoblom, C. (2006). Neuroscience workshops for fifth-grade school children by undergraduate students: A university-school partnership. *CBE-Life Sciences Education, 5*(2), 128-136. https://doi.org/10.1187/cbe.05-08-0107

Hernandez-Ruiz, E., & Dvorak, A. L. (2020). Music stimuli for mindfulness practice: A replication study. *Journal of Music Therapy*. https://doi.org/10.1093/jmt/thaa018

Hernandez-Ruiz, E. & Dvorak, A. L. (2020b). Replication of a course-based undergraduate research experience for music students. *Nordic Journal of Music Therapy*. https://www.tandfonline.com/doi/full/10.1080/08098131.2020.1737186

Hernandez-Ruiz, E., & Dvorak, A. L. (in press). Music and mindfulness meditation: Comparing four music stimuli composed under similar principles. *Psychology of Music.*

Hernandez-Ruiz, E., Dvorak, A. L., & Weingarten, K. (2020). Music stimuli in mindfulness meditation: Comparison of musician and non-musician responses. *Psychology of Music*. https://doi.org/10.1177/0305735620901338

Kerr, M. A., & Yan, F. (2016). Incorporating course-based undergraduate research experiences into analytical chemistry laboratory curricula. *Journal of Chemical Education, 93*(4), 658-662. https://doi.org/10.1021/acs.jchemed.5b00547

Kowalski, J., Hoops, G., & Johnson, R. (2016). Implementation of a collaborative series of classroom-based undergraduate research experiences spanning chemical biology, biochemistry, and neurobiology. *CBE-Life Sciences Education, 15*(4), 1-17. https://doi.org/10.1187/cbe.16-02-0089

Kuh, G. D. (2008). High-impact educational practices: *What they are, who has access to them, and why they matter.* Washington, DC: Association of American Colleges and Universities.

O'Brien, R., & Roberts, J. A. (2008, Nov/Dec). Teaching the principles of geomicrobiology and the process of experimental research to undergraduate and first-year graduate students. *Journal of College Science Teaching, 38*(2), 30-38.

Olimpo, J., Fisher, G., & DeChenne-Peters, S. (2016). Development and evaluation of the tigriopus course-based undergraduate research experience: Impacts on students' content knowledge, attitudes, and motivation in a majors introductory biology course. *CBE-Life Sciences Education, 15*(4), 1-15. https://doi.org/10.1187/cbe.15-11-0228

Riley, D. R., Thatcher, C. E., & Workman, E. A. (2006). Developing and applying green building technology in an indigenous community: An engaged approach to sustainability education. *International Journal of Sustainability in Higher Education, 7*(2), 142-157. https://doi.org/10.1108/14676370610655922

Russell, J. E., D'Costa, A. R., Runck, C., Barnes, D. W., Barrera, A. L., Hurst-Kennedy, J., Sudduth, E. B., Quinlan, E. L., & Schlueter, M. (2015). Bridging the undergraduate curriculum using an integrated course-embedded undergraduate research experience (ICURE). *CBE-Life Sciences Education, 14*(1), 1-10. https://doi.org/10.1187/cbe.14-09-0151

Shaban, K., Abdulwahed, M., & Younes, A. (2015). Problem-centric process for research-based learning. *The International Journal of Engineering Pedagogy, 5*(2), 24-30.

Smith, J., Harris, J., Lopez, O., Valverde, L., & Borchert, G. (2015). "On the job" learning: A bioinformatics course incorporating undergraduates in actual research projects and manuscript submissions. *Biochemistry and Molecular Biology Education, 43*(3), 154-161. https://doi.org/10.1002/bmb.20848

Wang, J. T. H. (2017). Course-based undergraduate research experiences in molecular biosciences: Patterns, trends, and faculty support. *Federation of European Microbiological Societies Microbiology Letters, 364*(15), 1-9. https://doi.org/10.1093/femsle/fnx157

Wiley, E. A., & Stover, N. A. (2014, March). Immediate dissemination of student discoveries to a model organism database enhances classroom-based research experiences. *CBE-Life Sciences Education, 13*(1), 131-138. https://doi.org/10.1187/cbe.13-07-0140

Willison, J., O'Regan, K., & Kuhn, S. K. (2018). Researcher skill development framework (US English Edition). *Open Educational Resources, 6.* https://commons.und.edu/oers/6/*.*

Appendix A
Psychology of Music – Music Stimuli Creation Assignment

Music Stimuli Creation *25 points*

Working in teams, students will create a 5-minute music stimulus following the guidelines provided, by the due date (Sep 23). Each group will provide a good quality recording of their composition, and a written excerpt (i.e., steady beat, basic harmonic progression, melodic motif) in formal score notation. "Good quality" means no mistakes, no extraneous sounds, no saturated sound, audio mixed so that all tracks are distinguishable and the melody is slightly predominant, with pleasing timbres (as close to acoustic string instruments as possible). Please listen to the online stimuli for an example of the quality required. Music software should be used for this score (available on the SoM computers or free online). Students will listen to and evaluate all music stimuli created by peers using a detailed assessment rubric. The top three will be included as auditory stimuli in the course-based undergraduate research experience.

To be consistent with previous stimuli and allow experimental comparisons, please follow these guidelines carefully:

1. Sampled (i.e., keyboard) instruments: double bass for steady beat, cello for harmonic progression, viola for melody
2. Meter = 4/4 with a tempo of 65 bpm, and constant dynamics (*mp-mf*).
3. 16-bar phrase that will repeat as many times as needed to complete the 5-minute stimuli
4. Track 1 should be a steady beat (i.e., bordun) on the tonic. Keep that note throughout; do not change to the root of each chord. Play it using a double bass sampled sound.
5. Track 2 should be a simple harmonic progression: **I vi IV ii,** one chord per measure, repeated four times (to create the the 16-bar progression). Do not use sevenths or any other added or sustained notes. Harmonic complexity is provided by the superposition of the chords on the bordun (tonic), and by passing notes on the melody. Use chords with a sampled cello sound. Do not use "orchestral" sampled sounds. End your 5-minute recording on the **I chord**.
6. Track 3 should be a simple stepwise melody played on a viola sound. You are encouraged to use half and whole notes, but you can play around with some quarter notes, as long as it does not get too "busy". Do not use syncopation. Use two-bar motifs, 4-bar phrases, that can be varied by simple transposition (**e-f-g** to **f-g-a**), inversion (**e-f-g** to **e-d-c**), or retrogradation (**e-f-g** to **g-f-e**). Repeat the motifs so that you have a repetitive melody, while at the same time being careful to provide interest, especially at the 8-bar and 16-bar points.

Products: 5-minute recording, 16-bar score (i.e., steady beat, basic harmonic progression and melody)

Appendix B
Music Stimuli Creation Assignment Grading Rubric

Levels of Achievement

Criteria	Novice 50%	Competent 75%	Proficient 100%
Written Excerpt 14%	Formal score notation is not included in the submission. The student submits the notation as written by hand.	The 16-bar phrase includes three staves: in formal score notation. The written excerpt is complete with minimal (1-3) errors. The staves may not be clearly marked or other discrepancies may be apparent.	The 16-bar phrase includes three staves: steady beat, basic harmonic progression, and melodic motif in formal score notation. The written excerpt is complete with no errors.
Instruments 14%	Double bass, cello, and/or viola are not used as instruments, and the timbre is not pleasing. Orchestral sounds may be used.	The instruments include double bass, cello, and/or viola but the timbre is not pleasing, or one of the instruments is incorrect. "Orchestral" sampled sounds are not used.	The instruments include double bass for steady beat, cello for harmonic progression, viola for melody. The instruments are of a pleasing timbre as close to acoustic string instruments as possible. "Orchestral" sampled sounds are avoided.
Music Elements 14%	Two or more of the music elements (meter, tempo, dynamics, rhythm, steady beat etc.) do not follow the guidelines. Syncopation is used.	One of the music elements (meter, tempo, dynamics, rhythm, steady beat etc.) does not follow the guidelines. Syncopation may be used.	The meter is 4/4, tempo of 65 bpm, with constant dynamics (mp-mf). A steady beat continues throughout the piece; syncopation is avoided throughout.
Bordun 15%	Inconsistencies in steady beat and pitch variations occur in the double bass track.	Inconsistencies are apparent in the double bass steady beat or variations of pitch occur.	The double bass track is a steady beat on the tonic that continues throughout with no variations in pitch.
Harmonic Progression 14%	The requested harmonic progression is not followed. The piece does not end on the I chord. Sevenths or sustained notes may be apparent.	The requested harmonic progression is inconsistent or not repeated. The piece ends on the I chord; sevenths or sustained notes may be included.	The cello track repeats a simple harmonic progression (i.e., I vi IV ii) four times with one chord per measure. The piece ends on the I chord; sevenths or sustained notes are avoided.
Melody 15%	The requested stepwise melody is not followed. Two-bar motifs, 4-bar phrases are not used or not repeated. Too many quarter notes make the piece too busy, or the piece does not vary from stepwise motion (making the piece too boring).	The requested simple stepwise melody is inconsistent or not repeated. Half and whole notes are used The viola track includes a simple stepwise melody, using half and whole notes. Two-bar motifs, 4-bar phrases are varied by simple transposition, inversion, or retrogradation.	The viola track includes a simple stepwise melody, using half and whole notes. Quarter notes may be used if not too "busy." Repeated two-bar motifs, 4-bar phrases are varied by simple transposition, inversion, or retrogradation.
Recording 14%	The audio recording contains mistakes, extraneous sounds, and/or saturated sound. The audio tracks are indistinguishable or tracks are not balanced.	Some inconsistencies or mistakes in recording, with a few mistakes or extraneous sounds, Good quality recording with no mistakes, no extraneous sounds. Some difficulties in distinguishing tracks and/or tracks are not balanced.	Good quality recording with no mistakes, no extraneous sounds, and no saturated sound. Audio mixed so that all tracks are distinguishable and the melody is slightly predominant.

Appendix C
Student Music Stimuli Evaluation

Please access the Music Stimuli Evaluation Survey by clicking on the link below. Remember, find a quiet environment or use headphones to listen. As you listen, follow the 16-bar music notation provided. You only need to listen to the first 16 bars and then complete the ratings for each. Allow yourself approximately 45-60 minutes to complete this task. Be sure to evaluate all 16 stimuli.

The ratings from this survey will determine the next phase of the study. We want to make sure to choose the stimuli that best meet the research requirements listed in the ratings. This survey must be completed by Sunday, September 29th by midnight. Thank you again for all of your continued hard work on this project!

{Music Evaluation Survey Link}

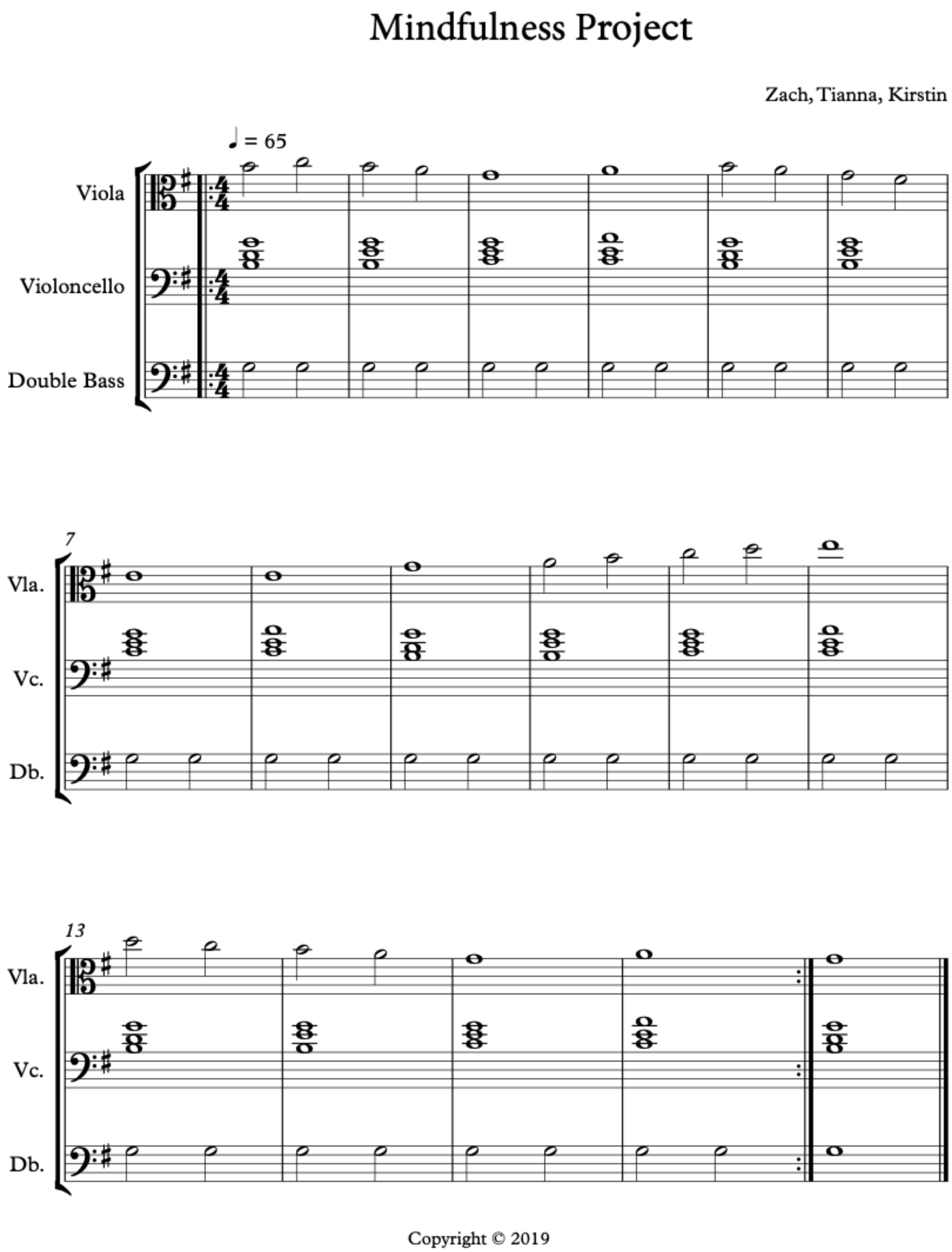
Directions: When listening to the recordings, focus only on the music. Follow the 16-bar notation as you listen. Rate your level of agreement with each statement below the score. If you have comments, please provide them in the text box after each scale.

Item	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
The instruments include double bass for steady beat, cello for harmonic progression, viola for melody. The instruments are of a pleasing timbre as close to acoustic string instruments as possible. "Orchestral" sampled sounds are avoided.							
The meter is 4/4, tempo of 65 bpm, with constant dynamics (mp-mf). A steady beat continues throughout the piece; syncopation is avoided throughout.							
The double bass track is a steady beat on the tonic that continues throughout with no variations in pitch.							
The cello track repeats a simple harmonic progression (i.e., I vi IV ii) four times with one chord per measure. The piece ends on the I chord; sevenths or sustained notes are avoided.							
The viola track includes a simple stepwise melody, using half and whole notes. Quarter notes may be used if not too "busy." Repeated two-bar motifs, 4-bar phrases are varied by simple transposition, inversion, or retrogradation.							
Good quality recording with no mistakes, no extraneous sounds, and no saturated sound. Audio mixed so that all tracks are distinguishable and the melody is slightly predominant.							
I could use this audio recording for meditation.							

Do you have any other comments about this stimulus?

Appendix D
Three Student Music Stimuli Compositions

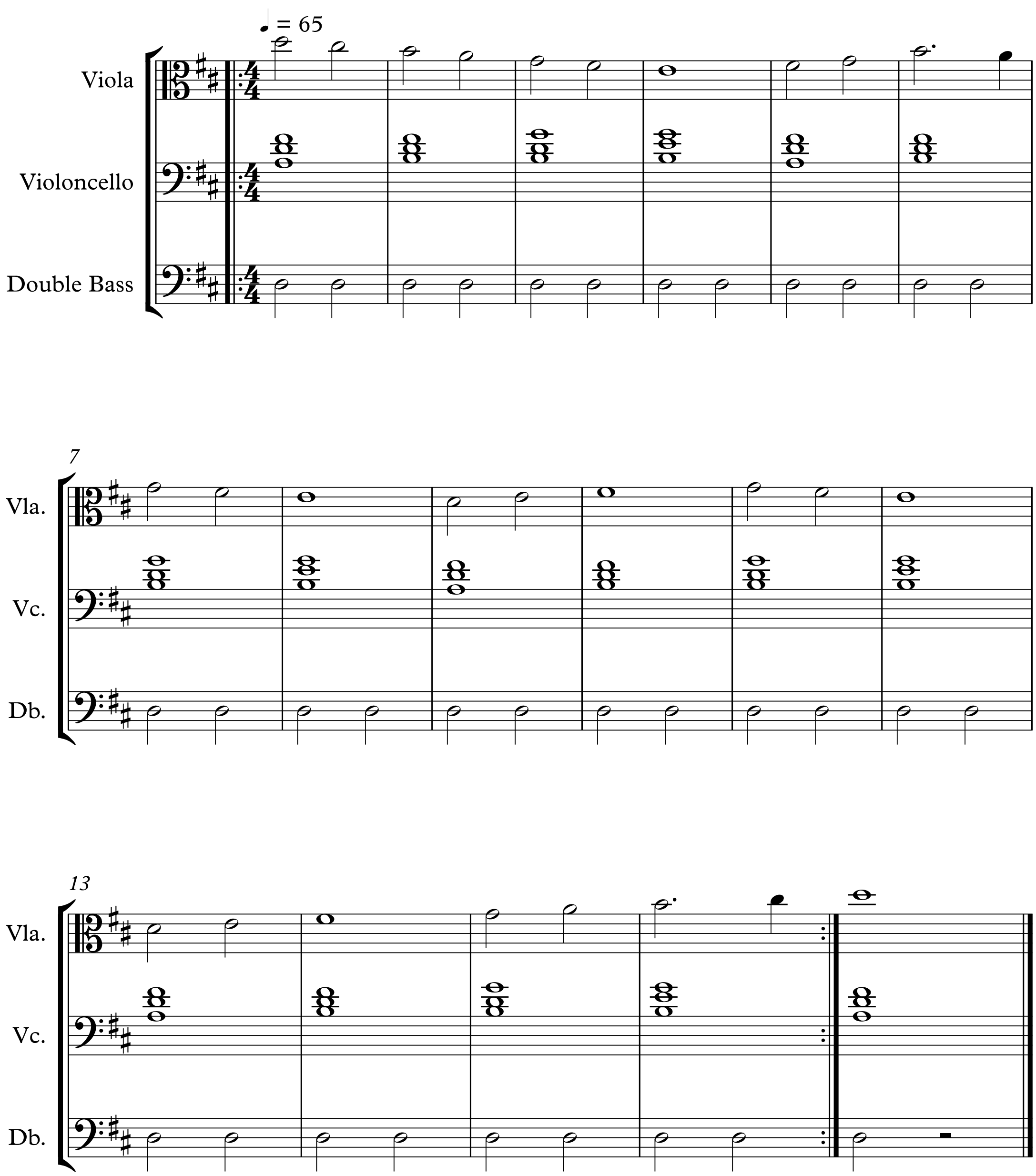
Stimulus 1



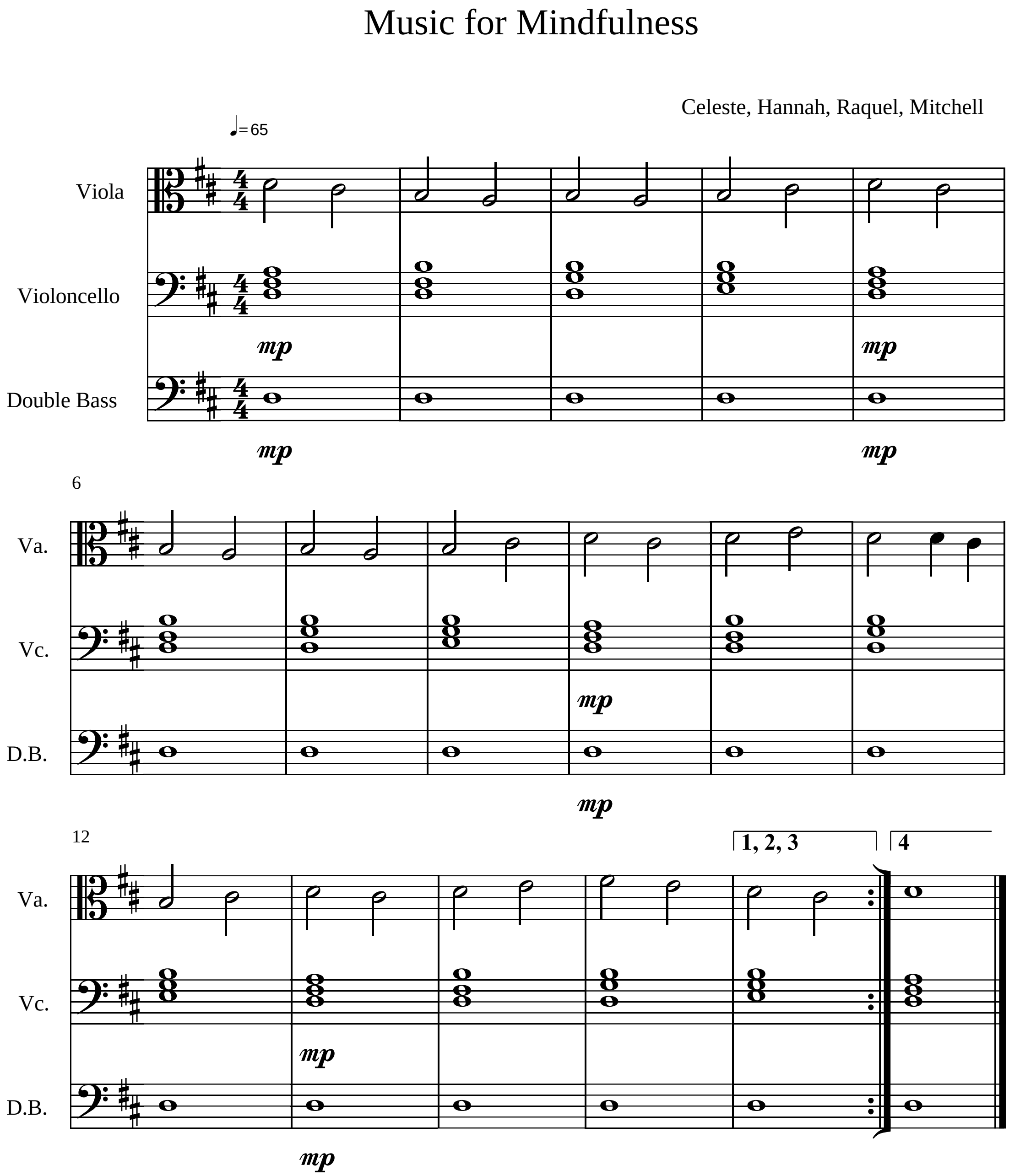
Stimulus 2

Music Stimuli Project

Tony, Madeline, Tamieka



Stimulus 3


Music for Mindfulness
Celeste, Hannah, Raquel, Mitchell
♩=65
Viola
Violoncello
Double Bass
mp
6
Va.
Vc.
D.B.
12
1, 2, 3
4