Surviving Set Theory: A Pedagogical Game and Cooperative Learning Approach to Undergraduate Post-Tonal Music Theory

DISSERTATION

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Abstract

Undergraduate music students often experience a high learning curve when they first encounter pitch-class set theory, an analytical system very different from those they have studied previously. Students sometimes find the abstractions of integer notation and the mathematical orientation of set theory foreign or even frightening (Kleppinger 2010), and the dissonance of the atonal repertoire studied often engenders their resistance (Root 2010).

Pedagogical games can help mitigate student resistance and trepidation. Table games like Bingo (Gillespie 2000) and Poker (Gingerich 1991) have been adapted to suit college-level classes in music theory. Familiar television shows provide another source of pedagogical games; for example, Berry (2008; 2015) adapts the show Survivor to frame a unit on theory fundamentals. However, none of these pedagogical games engage pitch-class set theory during a multi-week unit of study.

In my dissertation, I adapt the show Survivor to frame a four-week unit on pitch-class set theory (introducing topics ranging from pitch-class sets to twelve-tone rows) during a sophomore-level theory course. As on the show, students of different achievement levels work together in small groups, or “tribes,” to complete worksheets called “challenges”; however, in an important modification to the structure of the show, no students are voted out of their tribes. Challenges are graded individually, and these
grades are averaged together to yield a score for each tribe. At the end of the unit, each member of the tribe that earned the highest cumulative average score on the challenges receives a modest gift card as a non-academic prize. While students’ grades are based solely on their own work, the game element promotes peer mentoring through cooperative learning (Johnson and Johnson 1999; Slavin 2012) and inspires constructive peer pressure that motivates all students to do their best. Aspects of the game designed to enhance student enjoyment and build tribe unity include tribe names, a customized logo, and an opening credits video.

I present empirical results of implementing Set Theory Survivor in the classroom and discuss student responses to questionnaires exploring their attitudes toward post-tonal music, their self-perceived abilities to use set-theoretical analysis to study post-tonal music, and their views of Set Theory Survivor as a framework for studying pitch-class set theory. The self-reported ability of students to perform specific set-theoretical operations increased to a statistically significant extent during the unit, and the majority of students enjoyed the game-like format. By combining the peer support of cooperative learning with the motivational force of constructive competition and the fun of a pedagogical game, Set Theory Survivor provides an innovative approach to a subject that often sparks student resistance and presents a valuable tool with which to enhance the pedagogy of pitch-class set theory.
To my students, the original Set Theory Survivors.
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Chapter 1: Introduction

During their required courses in music theory, undergraduate music students often encounter pitch-class set theory as a means of analyzing atonal music from the twentieth century. This branch of music analysis and the repertoire it concerns diverge from the principles of tonal music that students have internalized during their previous studies of music theory. As I will show in this chapter via a review of the literature, the pedagogy of post-tonal music analysis poses a number of problems, not the least of which are the overtly mathematical features of pitch-class set theory and the dissonance of the repertoire studied. In my dissertation, I propose an innovative approach to teaching set-theoretical analysis to undergraduate music students. This approach combines cooperative learning and constructive competition within the framework of an enjoyable pedagogical game loosely based on the television show *Survivor*. After reviewing literature on cooperation, competition, and pedagogical games, I detail the implementation of my pedagogical game, Set Theory Survivor, in the music theory classroom.

Chapter Two presents foundational aspects of cooperative learning and constructive competition; these seemingly disparate strands of educational theory unite in intergroup competition, the organizing force behind Set Theory Survivor. In Chapter Three, I explore a wide variety of pedagogical games from music theory as well as other disciplines. I introduce several of my own theory and aural-skills games, and I discuss
antecedents of Set Theory Survivor. Chapter Four details my implementation of Set Theory Survivor as a research study conducted with fifteen music majors enrolled in a sophomore-level theory course at The Ohio State University. Results of this study appear in Chapter Five; I present data from my own observations, student comments, and pre- and post-test questionnaires to illuminate the effects of Set Theory Survivor. As shown by the data from this study, the learning of students increased in a statistically significant way during the four-week unit covered by Set Theory Survivor, and the vast majority of students found Set Theory Survivor interesting and enjoyable. Finally, Chapter Six provides a concluding summary of my research and examines several challenges and benefits of including pitch-class set theory in the undergraduate core curriculum. By transforming the potentially difficult process of learning pitch-class set theory into an enjoyable pedagogical game, Set Theory Survivor provides a valuable tool for instructors and students of post-tonal music analysis.

Two potentially problematic aspects of teaching and learning pitch-class set theory are the dissonance of the concomitant post-tonal repertoire and the overt connections between pitch-class set theory and mathematics.¹ In light of the unfamiliar— and frequently dissonant—construction of atonal music, Jena Root notes that students may mistakenly believe this new repertoire is devoid of beauty and order.² According to Daniel Arthurs, many students “close their ears” to the music of the Second Viennese

¹ The pre-test and post-test questionnaires for my research study explored students’ attitudes toward post-tonal music and provided opportunities for students to identify which elements of post-tonal music, and which elements of the Set Theory Survivor unit, they respectively liked and disliked most.

School when first encountering this repertoire, so a substantial investment of time is required for students to grasp the “complexity, wit, and aesthetic thought” of these composers. Students may even experience trepidation when confronted with music seemingly independent of any particular syntax, and this apprehension may be amplified by the diversity of post-tonal music in which, as Courtenay Harter observes, compositional techniques and harmonic practices—no longer bound by tradition—vary widely from one composer to the next. Peter Silberman aptly describes post-tonal music as a “foreign language” to many undergraduate students.

In addition to the resistance of students toward studying music they might expect to sound like “cacophonous nonsense,” Stanley Kleppinger realizes that the explicit connection between set theory and mathematics can be intimidating to students. According to David Mancini, students may find it difficult to conceptualize musical relationships with integer notation. Modulo 12 arithmetic can also present a “stumbling block” for some students. Because the terminology and applications of set theory differ

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5 Peter Silberman, “Post-Tonal Improvisation in the Aural Skills Classroom,” *Music Theory Online* 9, no. 2 (July 2003): [1].

6 Stanley V. Kleppinger, “Strategies for Introducing Pitch-Class Set Theory in the Undergraduate Classroom,” *Journal of Music Theory Pedagogy* 24 (2010): 131–32. By way of illustration, Kleppinger describes a conversation he had with a student who, despite performing above the average in Kleppinger’s undergraduate theory course, expressed anxiety about studying the “‘atonal music with all the math in it.’”

considerably from the methods of analysis with which they are already familiar, students may experience a “steep learning curve,” and perhaps even “frustration.” However, Joseph Straus offers hope to perplexed students:

Despite its occasionally forbidding appearance, atonal set theory is not particularly complicated, at least in its basic applications. No high-powered computers or advanced degrees in mathematics are needed—just a commitment to twentieth-century music, the ability to add and subtract small integers, and some good will.9

Mancini emphasizes the importance of presenting set-theoretical concepts in a musically relevant way and cautions musicians against conflating the goals and tools of analysis.10 However, these tools remain important to the analytical success of students. Kleppinger argues that students who are taught to engage unfamiliar music with the analytical tools appropriate to that repertoire are rewarded with broadened tastes and a greater openness to new aesthetic experiences. Such expansion of the musical palate prepares students to engage in a responsible manner the diverse repertoire they may encounter as music professionals.11

In an effort to promote curricular continuity, some authors address the challenge of teaching post-tonal music by using analytical methods similar to those commonly found in theory courses focused on tonal music. For example, Henry Martin proposes a system of species counterpoint that extends the categories of consonance and dissonance

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10 Mancini, “Teaching Set Theory,” 97, 105.
to engage two- and three-part modal compositions from the twentieth century. Harter locates modified versions of conventional cadence types within Prokofiev’s colorful harmonic vocabulary, and Arthurs relates a twelve-tone composition, Schoenberg’s Opus 33a, to the familiar paradigm of sonata form. Matthew Santa and Mark Sallmen both utilize homophonic part-writing exercises in their post-tonal pedagogy. Santa emphasizes parsimonious voice leading, while Sallmen teaches students to harmonize melodies with a variety of musical constructs such as extended tertian sonorities, pentatonic collections, and the set class (016). Craig Cummings argues that connections between post-tonal music and earlier musical traditions should be emphasized. These connections, such as the generic ties between the nineteenth-century German Lied and its twentieth-century successors, may mitigate the often negative response of students to music that is highly dissonant.

Brian Aelligent and Gordon Sly unite tonal and post-tonal music analysis in a pedagogical approach that interprets changes in pitch-class collection as indicators of formal boundaries. Aelligent and Sly encourage students to show the journey of prominent musical elements through a composition by constructing a “road map” to convey each

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person’s own experience of the piece.\textsuperscript{16} Examining in detail the pitch construction of atonal works, Miguel Roig-Francolí explores the possibility of large-scale pitch connections with his theory of “pitch-class-set extension” (PCSE). In the absence of an overarching, tonally-based coherence, Roig-Francolí proposes a system in which pitch collections may be related through set-class identity, cardinality, inclusion, pitch-class invariance, and voice-leading proximity. According to Roig-Francolí, PCSE can enhance students’ appreciation of the underlying structure of post-tonal music through its applicability to a broad repertoire encompassing works by composers like Crumb and Ligeti as well as those of the Second Viennese School.\textsuperscript{17}

Highlighting the musical relationships represented by set-theoretical concepts, Mancini uses staff notation to teach students how to find the normal order and interval-class vector of a pitch-class set. He also emphasizes the “successive-interval array” (SIA), which depicts with integers the directed intervals of a pitch-class set. According to Mancini, the SIA, which replaces the usual set-class designation or Forte name, is especially useful for understanding inclusion relations. Students can readily find all the subsets of a given pitch-class set simply by manipulating its SIA.\textsuperscript{18}


\textsuperscript{18} Mancini, “Teaching Set Theory,” 97–99. Robert Morris, on the other hand, does not encourage using staff notation to represent pitch classes; he argues that this practice may contribute to students’ conflation of pitch classes with their specific realizations. See Robert D. Morris, “Recommendations for Atonal Music Pedagogy in General; Recognizing and Hearing Set-Classes in Particular,” \textit{Journal of Music Theory Pedagogy} 8 (1994): 88.
Similarly, Michael Schiano endeavors to demystify the structure of atonal music by using a pedagogical system he calls “underground set theory.” This system reveals many properties of a given set through its nomenclature. For instance, the label “5133” denotes a tetrachord whose members form the directed intervals of a perfect fourth, minor second, and two minor thirds. The inversion of a set, its interval-class vector, and any symmetry it displays can also be apprehended from its name. Although more traditional aspects of set theory may be introduced later, Schiano believes that initially avoiding them increases the degree to which students find set-theoretical operations accessible and appealing.\(^{19}\)

Like Mancini, Kleppinger uses staff notation to help reduce the initial difficulty of introducing students to pitch-class set theory. He also employs a number of “playful, memorable metaphors” in his teaching. One such metaphor compares finding the normal order of a pitch-class set to designing a building that, in response to a hypersensitive architectural concern for fire safety, is as short as possible. Should the quest for the shortest building result in a tie, further deliberations can favor the safety of the CEO whose penthouse office is represented by the second-highest note of the registral ordering.\(^{20}\)

Lora Gingerich combines a theoretical investigation into subsets and superset with a familiar table game in her article “Pitch-Class Poker.” In this game, student players calculate interval-class vectors for their five-card hands, each of which represents


a collection of two to five pitch classes. The hand with the highest-ranking interval-class vector—in the “Tritone Trump” version, the hand with the greatest number of large interval classes—wins. According to Gingerich, a skilled player of Pitch-Class Poker must understand abstract subset and superset relations among pitch-class sets. This understanding is put into practice when deciding which card, or cards, to discard in an effort to improve the original hand by drawing replacements from the deck. Despite the competitive orientation of Pitch-Class Poker, the ultimate object of the game is not to finish with the highest-ranking hand. Rather, it is to increase the ability of each player to recognize interval classes and to modify a given pitch-class collection to maximize a desired interval class. Regardless of the final score, a player’s true success in Pitch-Class Poker is measured by his or her increased understanding of interval-class vectors, subsets, and supersets.\footnote{Lora L. Gingerich, “Pitch-Class Poker,” \textit{Journal of Music Theory Pedagogy} 5, no. 2 (Fall 1991): 161–63, 169, 177. For further discussion of this game, see Chapter Three. While Gingerich’s game offers a useful way to enliven the pedagogy of interval-class vectors, subsets, and supersets, it is designed as a relatively brief activity and does not engage students in peer interactions over an extended period of time. In contrast, my pedagogical game Set Theory Survivor does incorporate such peer interactions into its multi-week exploration of pitch-class set theory.}

Deborah Mawer believes the “criterion of fun” is particularly important when teaching students to analyze atonal music with set theory. She connects analysis to student performance through a series of exercises—such as improvising a melody on the set (012)—designed to increase student interest and participation in set-theoretical analysis.\footnote{Deborah Mawer, “Enlivening Analysis through Performance: ‘Practising Set Theory,’” \textit{British Journal of Music Education} 20, no. 3 (2003): 259, 264–65, 270.} Silberman extends post-tonal improvisation into the aural-skills classroom by means of structured improvisational exercises featuring specific intervals, pitch-class
sets, and scales. In this way, he provides students with simultaneous experience as composers and performers of post-tonal music.\textsuperscript{23}

Lawrence Starr emphasizes the need for students to cultivate their listening skills to inform their analysis. Equipped with sensitive and discerning ears, students can avoid the pitfall of consciously or unconsciously viewing the post-tonal repertoire as an incoherent body of exceptions to the ostensible norm of common-practice-period tonality.\textsuperscript{24} Morris also stresses the importance of ear-training, singing, and playing to students’ comprehension of atonal music. Without such active involvement, Morris argues, students are likely to consider atonal music entirely cerebral and divorced from audible relationships among pitches and pitch-classes. On the contrary, such relationships can and ought to be heard in order to understand and appreciate this repertoire.\textsuperscript{25}

With the goal of fostering good will and openness toward studying post-tonal music, my dissertation proposes an innovative approach to teaching pitch-class set theory in the undergraduate core curriculum. This approach adapts the popular television show \textit{Survivor} to frame a four-week-long unit on pitch-class set theory. My version of \textit{Survivor}, Set Theory Survivor, facilitates peer tutoring and student learning within the enjoyable framework of a pedagogical game undergirded by cooperative learning and constructive competition. As students work together toward the goal of winning a non-academic prize, they provide each other with valuable educational and social support that

\textsuperscript{23} Silberman, “Improvisation,” [6]–[8], [1].


\textsuperscript{25} Morris, “Recommendations,” 80, 97.
facilitates the process of learning pitch-class set theory. In the following chapters, I locate Set Theory Survivor within the spheres of intergroup competition and pedagogical games, detail the method and results of implementing Set Theory Survivor in the classroom as a research study, and consider the contributions of Set Theory Survivor—and pitch-class set theory in general—to the undergraduate core music theory curriculum.
Chapter 2: Cooperation and Competition in the Classroom

The interactions of students in the classroom can take many forms. Students may focus on their own progress with little concern for that of their classmates, or they may work together to solve problems and solidify their understanding of new concepts. They may compete with each other for grades and other rewards, or their performance may be evaluated independently from that of their peers. Between these extremes lie many nuances that contribute to the overall classroom environment. In this chapter, I present foundational aspects of cooperative learning and constructive competition via a review of the literature, and I discuss the synthesis of these seemingly disparate strands of educational theory in intergroup competition, the organizing force behind the pedagogical game Set Theory Survivor that comprises the focus of my dissertation.

Cooperation

During the last several decades, instructional strategies involving students working together in small groups have come to the fore under the broad canopy of cooperative learning. Instructors retain the responsibility for designing cooperative-learning activities; once implemented, however, such activities emphasize interactions among students while the instructor functions more as facilitator than leader. According to Colleen Conway and Thomas Hodgman, cooperative learning is particularly authentic to the discipline of music because music-making often involves multiple musicians working cooperatively. In a music theory class, one example of a cooperative-learning
activity consists of students working in groups to provide a formal or harmonic analysis of a given score.²⁶

Although it may superficially appear that cooperative learning takes place whenever a group of students works together on a teacher-designed task, several contrasting theoretical perspectives underlie such methods of teaching and learning. According to Robert Slavin, the four major theoretical perspectives concerning the effects of cooperative learning on achievement are social motivation, social cohesion, cognitive development, and cognitive elaboration. These perspectives can complement, rather than contradict, one another.²⁷ In her discussion of the same four perspectives, Angela O’Donnell observes that the cognitive-developmental perspective is informed by the theories of Jean Piaget and Lev Vygotsky, whereas the cognitive-elaboration perspective draws on information processing theory.²⁸ The following discussion will focus primarily on theories of social motivation and social cohesion.

Slavin, whose own educational approach reflects the perspective of social motivation, notes that scholars with a motivationalist orientation emphasize the reward or goal structure within which students operate, holding that the engagement of students in learning processes such as planning and helping is fueled by their “motivated self-

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²⁶ Colleen M. Conway and Thomas M. Hodgman, “Strategies for Active Learning in Music Classrooms,” in *Teaching Music in Higher Education* (New York: Oxford University Press, 2009), 126, 124. For further examples of Conway and Hodgman’s active learning techniques, see Chapter Three.


interest.” On the other hand, the social cohesion perspective attributes the effects of cooperative learning primarily to the group’s internal cohesiveness. From this point of view, students help their groupmates out of altruistic motives and a sense of belonging.29

A widely used learning method proposed by Slavin is his “Student Teams-Achievement Divisions” (hereafter STAD). In STAD, students work together in four- or five-person groups that are heterogeneous in performance level, gender, and race. After the instructor introduces new material through lecture or discussion, students work to master the material through review and practice in their groups. Each student demonstrates his or her understanding by taking an individually completed quiz. Improvement scores (up to ten points) are calculated for each student and combined to form a team score.30 High-scoring teams and much-improved students may receive a certificate or obtain recognition in a weekly class newsletter.31 Competition between teams in STAD can also motivate students to work cooperatively with other members of their teams.32

According to Slavin, the “improvement point system” of STAD provides each student—whether a low, medium, or high achiever—with an equal opportunity to contribute the maximum number of points to the team by doing his or her best on the


31 Slavin, “Classroom Applications,” 361; Slavin, Cooperative Learning, 24.

32 Slavin, Cooperative Learning, 29. Competition between cooperative groups, or intergroup competition, is discussed in more detail later in this chapter.
quiz. In this way, students do not run the risk of being rejected by their teammates because they are unable to contribute many points to the team. Slavin explains,

When the group task is to do something, rather than to learn something, the participation of less able students may be seen as interference rather than help. It may be easier in this circumstance for students to give each other answers than to explain concepts or skills to one another…When the group’s task is to ensure that every group member learns something, it is in the interests of every group member to spend time explaining concepts to his or her groupmates, and to ask groupmates for explanations and help in understanding the topic of study.

Thus, the combination of group goals with individual accountability can encourage students to seek and provide the explanations that cognitive-elaboration theory finds so effective for student learning.

The theoretical approach of David Johnson and Roger Johnson, two pioneering and prolific authors in the field of cooperative learning, is primarily rooted in social cohesion. According to Johnson and Johnson, the effectiveness of cooperative-learning groups proceeds from five elements of cooperative learning: positive interdependence, face-to-face promotive interaction, individual and group accountability, social skills, and group processing. Each element is important; however, Johnson and Johnson argue that positive interdependence is essential for cooperation to exist. Positive interdependence is

33 Slavin, Cooperative Learning, 24.

34 Slavin, “Classroom Applications,” 361.

present when members of a group know that their individual success and the success of the group are mutually dependent. According to Johnson and Johnson,

Individuals will contribute more energy and effort to meaningful goals than to trivial ones. Being responsible for others’ success as well as for one’s own gives cooperative efforts a meaning that is not found in competitive and individualistic situations. The efforts of each group member, therefore, contribute not only to one’s own success but also to the success of groupmates. When there is meaning to what they do, ordinary people exert extraordinary effort. It is positive goal interdependence that gives meaning to the efforts of group members.

In addition to positive goal interdependence, Johnson and Johnson identify eight other types of positive interdependence: reward, resource, role, identity, environmental, fantasy, task, and outside enemy interdependence. Set Theory Survivor features five of the nine types of positive interdependence (goal, reward, identity, environmental, and outside enemy), thus fulfilling Johnson and Johnson’s recommendation that multiple forms of positive interdependence appear within a cooperative lesson.

Hand in hand with positive interdependence, promotive interaction occurs when each member of a group encourages and facilitates the efforts of fellow group members in pursuit of their common goals. While each member contributes to the success of others, individual accountability plays a pivotal role in ensuring that every student benefits from learning cooperatively. After learning new material in cooperative groups, students should exhibit mastery of that material through individual assessment.

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37 Ibid., 76.

38 Ibid., 77, 29.

39 Ibid., 81–82.
to interact constructively with each other, students also need appropriate social skills. Johnson and Johnson maintain that interpersonal and small-group skills do not arise spontaneously; on the contrary, these skills must be intentionally taught.\textsuperscript{40} Finally, Johnson and Johnson recommend group processing in which group members reflect together on a recently completed cooperative session in order to enhance their contributions to the group’s progress toward its goals.\textsuperscript{41}

Praising the pedagogical effectiveness of the genuinely committed cooperative-learning group, Johnson and Johnson identify three types of cooperative-learning groups: formal, informal, and base. An \textit{informal} cooperative-learning group can help students to engage course material through peer discussions and activities; this type of group is particularly beneficial in a lecture setting. Lasting from a few minutes to one class period, this group features the shortest duration of the three types of cooperative-learning groups. At the other end of the time continuum is the cooperative \textit{base} group, a long-term group with stable, heterogeneous membership. Members provide each other with support and accountability over periods of time ranging from a single course to multiple years. Group identity and cohesion are important elements that may be facilitated through team-building activities as well as the adoption of a group name, flag, or motto. Finally, \textit{formal} cooperative-learning groups, which Johnson and Johnson call “the heart of cooperative

\textsuperscript{40} At Ohio State, students are permitted and encouraged to work together with their classmates to complete in-class activities as well as homework assignments throughout the four-semester core music theory curriculum. Because Set Theory Survivor takes place during the last of these semesters, students have already had ample opportunity to develop the social and small-group skills that Johnson and Johnson recommend.

\textsuperscript{41} Johnson and Johnson, \textit{Learning Together}, 83, 85.
learning,” may last as briefly as one class period or as long as several weeks. These groups provide students with relatively extended opportunities to work together in order to master and contextualize new material or to accomplish an assigned task. Ideally, group membership should remain stable long enough for cohesion to develop within the group. The tribes featured in Set Theory Survivor are formal cooperative-learning groups that also incorporate elements of the cooperative base group, such as group names and colors, in order to foster group cohesion.

Paul King and Ralph Behnke identify several advantages of using group projects in the classroom. One frequent argument in favor of this teaching technique is that the process of working together in groups facilitates teamwork and ultimately helps students to achieve both individual and corporate success. Other aims of group work include enhancing student motivation, developing personal responsibility, and improving the organizational, presentation, and leadership skills of students. Slavin argues that students who work in structured groups are likely to be “highly motivated, excited, and engaged.” Even shy students are likely to take active roles in small groups that render participation “safe, supportive, and difficult to avoid.” In light of these positive potential effects of cooperative learning, it is not surprising that the use of cooperative

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43 Ibid., 172–74, 136.


45 Slavin, “Classroom Applications,” 376.
learning is growing in a number of academic disciplines.\textsuperscript{46} One such discipline is music theory.

Lawrence Zbikowski and Charles Long present four detailed, cooperative lessons for the music theory classroom. These lessons are designed for an optimal group size of four students and vary in complexity from modifying a root-position chord progression to include first-inversion chords, or reviewing music theory fundamentals with a partner, to preparing and presenting a music analysis project over the course of four weeks.\textsuperscript{47} Students are free to divide responsibilities among the members of their group; however, Zbikowski and Long encourage students to trade responsibilities during the activity in order to broaden their understanding of the content. For example, the third of the lessons proposed by Zbikowski and Long applies cooperative learning to the aural-skills component of a music theory course. Each of the four students in a group takes on a specific role. While the first two students listen respectively to the soprano line and bass line, the third student focuses on the harmonic progression as a whole. Meanwhile, the fourth student combines and records the answers of the other three students. The recorder is also responsible for checking the composite answer for discrepancies or errors. During subsequent exercises, roles rotate among students so each person has the opportunity to work in each capacity.\textsuperscript{48}

\textsuperscript{46} King and Behnke, “Problems,” 57.


\textsuperscript{48} Ibid., 148–50.
While all four lessons hold students individually accountable for learning the material, students must also ensure that their fellow group members understand and learn the material. In this way, students can simultaneously solidify their grasp of course content and experience the joy of helping others learn.\textsuperscript{49} By embracing opportunities for cooperative learning, instructors can help students to engage more interactively with the subject of music theory and encourage students to forge deep, meaningful connections with their peers and future colleagues.

Despite the potential of cooperative learning to enhance the education of students, there are several possible drawbacks to this instructional approach. Among these are a number of potential hindrances to group effectiveness identified by Johnson and Johnson. Two of these problems concern group composition: both excessive size and insufficient heterogeneity within a group can contribute to a lack of effectiveness. If group members lack necessary teamwork skills, or if the time they spend working together is not enough for the group to mature, the group may fail to reach its full potential. Additionally, the level of reasoning and depth of understanding may be limited within a group whose members offer their dominant responses without exploring other options or who fall into “groupthink” due to an overly strong desire for consensus. Other potential hindrances to group effectiveness arise from negative interactions among group members. For instance, students who perceive that their individual efforts are not essential to the success of the group may reduce their effort (“social loafing”) or withdraw their participation altogether (“free riding”). These negative responses may subsequently cause other students to

\textsuperscript{49} Zbikowski and Long, “Cooperative Learning,” 140, 138, 156.
reduce their own efforts in order to avoid being unfairly taken advantage of by their groupmates. Nevertheless, Johnson and Johnson believe that such hindrances may be eradicated through consistent application of the five elements of cooperative learning.\textsuperscript{50}

One particularly thorny issue concerning cooperative learning is that of assessment. Johnson and Johnson suggest a variety of methods for grading work done in cooperative settings; most of these methods entail either combining the scores of individual students in some way or choosing a single product to represent the efforts of the group as a whole. Alternatively, instructors may add bonus points to individual scores on the basis of a specified criterion of group achievement.\textsuperscript{51}

Bobbette Morgan explores the responses of 140 university seniors who participated in group examinations for group grades. After completing their first examination together with the other members of their cooperative base groups, students reflected on their experiences preparing for and taking the examination. Notably, all of the students considered the cooperative examination less stressful than an individual examination and identified feelings of support within their groups. However, some students also identified feelings of stress and concern that their groupmates would not prepare adequately for the examination. Many students reported enhanced confidence, deeper levels of understanding, and feelings of responsibility toward their groupmates.\textsuperscript{52}

Similarly positive results appear in a study by Philip Zimbardo, Lisa Butler, and Valerie

\begin{footnotesize}
\begin{itemize}
  \item Johnson and Johnson, \textit{Learning Together}, 74.
  \item Ibid., 120–22.
\end{itemize}
\end{footnotesize}
Wolfe. In this study, the improvement of team-testing participants exceeded expectations based on these students’ initial levels of achievement. Student feedback also described shared knowledge, negotiation of differences, reductions in test anxiety and cheating, and enhanced learning.⁵³

King and Behnke acknowledge the negative reactions of some students toward working together in groups. The issue for many students is not the group work itself; rather, their negative reactions stem from the prospect of being graded as a group or being evaluated by other group members. When all members of a group share the same grade, instructors are, in essence, “using a mean to describe a population” without considering “dispersion.” On the other hand, when students participate in evaluating their own peers, one could argue that the instructor has abandoned his or her responsibility, leaving students vulnerable to the possibility of being rated by their peers on the basis of non-academic criteria.⁵⁴

According to King and Behnke, instructors should usually refrain from trying to represent the performance of an entire group of students with a single grade. However, group grades may still be appropriate at times since these grades can be based on instructor-observed materials rather than subjective student recollections. King and Behnke remind instructors that not all classroom activities must be graded; instead, groups may be used for academic preparation and completion of assignments while grades are determined on an individual basis. Students may also be motivated to


contribute satisfactorily to their groups by the “social pressure to appear prepared” during oral presentations. King and Behnke conclude that candid discussions with students can help them to embrace the benefits of cultivating teamwork skills while giving students fair warning about the activities and grading methods of the class and warding off the problem of free riding.55

Another alternative to group grades appears in an assessment method suggested by Johnson and Johnson. This method combines both academic and non-academic rewards. Johnson and Johnson explain, “Group members prepare each other for a test, take it individually, and receive an individual grade. On the basis of their group average, they are awarded free time, popcorn, extra recess time, or some other valued reward.”56 By framing individual assessment with cooperative preparation and a non-academic reward based on group achievement, this approach eliminates the problematic assignment of group grades. I adopt this approach to assessment in the pedagogical game Set Theory Survivor. Here, students work with other members of their tribes to complete individually graded challenges. The grades of all members of a tribe are subsequently averaged together to yield a tribe score. At the end of the unit, each member of the tribe that earned the highest cumulative average on the challenges receives a non-academic reward in the form of a modest gift card. In order to discourage social loafing or free riding, students must complete the final challenge without assistance from their tribes. Because the scores for this challenge still contribute to tribe scores, students are held accountable for their

55 King and Behnke, “Problems,” 59–60.
56 Johnson and Johnson, Learning Together, 122.
own learning and are motivated through positive goal and reward interdependence to help the other members of their tribe better understand the course material.

*Competition*

Focusing on individual achievement, some instructors employ competitive strategies in the classroom in hopes of increasing the motivation of their students. Richard Ryan and Edward Deci differentiate between intrinsic motivation, which leads people to do something because they find it “inherently interesting or enjoyable,” and extrinsic motivation, which leads people to do something because it results in a “separable outcome.” Intrinsic motivation is generally thought to foster the learning and creativity of students to a greater degree than extrinsic motivation.⁵⁷ According to Johnmarshall Reeve and Deci, positive feedback about one’s performance (winning instead of losing) is the element that most supports intrinsic motivation within a competitive situation. Competence valuation, which Reeve and Deci describe as “emotional involvement in attaining competence,” also influences intrinsic motivation; people who consider it important to do well exhibit higher intrinsic motivation than people who do not consider it important to do well. The intrinsic motivation of winners in a competitive situation can be bolstered by feelings of heightened competence; however, intrinsic motivation among winners can also be undermined by a setting that pressures them to win, thereby reducing their perceived self-determination.⁵⁸

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⁵⁷ Richard M. Ryan and Edward L. Deci, “Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions,” *Contemporary Educational Psychology* 25 (2000): 55. However, Ryan and Deci recognize multiple types of extrinsic motivation, some of which can be valuable for teaching and learning.

motivation of *winners* can be reduced through a pressured competitive setting, the intrinsic motivation of *losers* may be further threatened by negative performance feedback and a lower perceived competence relative to that of winners.

Other potential drawbacks of competition, according to Marlow Ediger, might include hostile responses or unfavorable comparisons among competing students. It is also possible that competition may run counter to the learning style of some students. Ediger concludes that competition is neither inherently good nor inherently bad; rather, its appropriateness depends on how it affects participating individuals. On the other hand, Susan Black argues that competition among students should be voluntary and take place only outside the classroom in order to minimize excessive pressure on high-achieving students and chronic discouragement among low-achieving students. Alfie Kohn goes even further when he argues against competition regardless of its setting; for Kohn, competition is fundamentally detrimental while cooperation is beneficial.59

Although eliminating competition altogether would be extreme, its potential drawbacks should not be ignored. Some potentially negative effects may be avoided through a cooperative framing of competitive activities. Johnson and Johnson insist it is of paramount importance to initiate a competition only after establishing a cooperative classroom environment. Indeed, competition necessarily relies on cooperation as competitors jointly determine the competitive setting and which rules and procedures to

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follow during the competition. According to Ediger, in-class competition should take place among competitors whose skills are somewhat evenly matched and who share positive interpersonal attitudes as well as a desire to participate and learn. In this setting, competing students strive to achieve specific goals while bearing in mind that it may not be possible for every individual to win the competition. Within an overarching cooperative framework, students can engage in appropriate competition with peers who know each other and who have a history of developing cooperative skills and celebrating mutual accomplishments.

Dean Tjosvold and his colleagues (including Johnson and Johnson) explore outcomes of constructive competition and factors contributing to constructive competition in a study involving managers and employees in China. Outcomes of constructive competition include task effectiveness, personal and relational benefits, positive impressions of the experience, motivation to embrace future challenges, confidence in future collaborations with competitors, and loyalty to the organization. According to Tjosvold and his colleagues, fairness—comprising the existence and appropriate administration of clear rules for competing and clear criteria for winning—may be the most influential factor in determining whether an interpersonal competition is

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constructive or not. Previously existing positive and strong relationships among competing colleagues also contribute to the constructiveness of their competition.\textsuperscript{64}

Other findings of the study by Tjosvold et al. contradict those of previous experimental research. For example, a greater perceived importance of winning contributes positively—not negatively—to constructive competition in this study. Additionally, participants who believe they have a competitive advantage experience more constructive competition than those who believe all participants have equal chances of winning. Tjosvold and his colleagues characterize their study as primarily “exploratory” and wisely call for further research to clarify the findings that contradict those of previous studies. While emphasizing the generalizability facilitated by the findings of this study that are similar to those of studies conducted in Western cultures, Tjosvold and his colleagues do not examine the possibility of cultural effects on their contradictory findings.\textsuperscript{65} Hence, the disjunction between the findings of Tjosvold et al. and those of previous studies may potentially arise from an over-generalization of findings across cultural boundaries.

In her investigation of factors contributing to the happiness or unhappiness of competitors, Márta Fülöp observes that people from different cultures can view competition in markedly different ways.\textsuperscript{66} These varying perspectives are evident in responses from Japanese, Hungarian, and Canadian university students to questions

\begin{itemize}
\item \textsuperscript{64} Tjosvold et al., “Constructive,” 78–80.
\item \textsuperscript{65} Ibid., 76–79.
\item \textsuperscript{66} Márta Fülöp, “Happy and Unhappy Competitors: What Makes the Difference?” Psychological Topics 18, no. 2 (2009): 352.
\end{itemize}
concerning their perception and understanding of competition. In Fülöp’s study, Japanese students primarily consider competition an opportunity for the mutual improvement of competitors and society. Contrastingly, many Hungarian students view competition as a process of social-Darwinist selection. Finally, Canadian students describe competition as a vehicle for goal achievement. All three concepts of competition are present to some degree in each of these cultures; however, Fülöp argues that personal and situational views of competition are impacted by “historically and culturally embedded” notions of competition that influence the degree to which competition may be constructive or destructive. Fülöp concludes that competing in a cooperative way is possible when competition is carried out fairly and framed as an opportunity for the improvement and growth of all participants.\(^6\)

In order to engage a competition constructively, students must exercise appropriate competitive skills which, according to Johnson and Johnson, include fair play, good sportsmanship, and an awareness of how students stand in the competition. To offset the tendency of students to overemphasize the importance of winning, instructors can keep the reward given for winning the competition small. Johnson and Johnson also emphasize the importance of reflecting upon and discussing competitions after they take place. Students may process their reactions individually by completing a questionnaire, or their processing may occur in small- or large-group settings. Johnson and Johnson maintain that holding a candid discussion at the end of a competition can help reduce hurt

feelings and improve the constructiveness of future competitions. By framing competition in cooperative terms that emphasize mutual growth and fairness, instructors may successfully harness the potential of competition to motivate their students.

**Cooperation and Competition Combined**

Although cooperation and competition are frequently viewed as opposing paradigms, they may be productively combined in a classroom setting through intergroup competition. Intergroup competition blends the social benefits of cooperative learning with the motivational forces of competition in a powerful pedagogical synthesis. According to Johnson and Johnson, intergroup competition combines intragroup cooperation with competition between groups. The cooperative element of intergroup competition is of primary importance to Johnson and Johnson, who argue that the degree to which a competition is constructive depends on the strength of the underlying cooperative foundation. They suggest that intergroup competition in the context of a pedagogical game can provide students with an enjoyable break in the classroom routine without influencing their grades based on the outcome of the game. However, instructors must be careful not to allow the intergroup competition to overshadow the intragroup cooperation. According to Johnson and Johnson, the benefits of intergroup competition include help and support from one’s teammates, greater enjoyment of the competition, and decreased responsibility for losing. Thus, the pressure students feel to achieve is

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68 Johnson and Johnson, *Learning Together*, 147, 167, 142. Both questionnaire and group-discussion processing are used in Set Theory Survivor.

69 Ibid., 145.
properly balanced with a commensurate degree of support from their peers.\textsuperscript{70} Provided that all groups have generally equal chances of winning, Slavin argues that intergroup competition provides students in each group with a challenging, but attainable, standard of success that renders the competition both motivating to students and palatable to instructors. Furthermore, Simon Attle and Bob Baker, who advocate intergroup competition among professional-studies students, point out that the balance between competition and cooperation may be adjusted at the discretion of the instructor.\textsuperscript{71}

John Tauer and Judith Harackiewicz investigate the effects of three conditions—cooperation, competition, and intergroup competition—on the performance and intrinsic motivation of students in a sport setting. Based on the results of four related studies, they determine that intergroup competition leads to heightened task enjoyment as well as similar or higher performance levels in relation to pure cooperation or competition. According to Tauer and Harackiewicz, participant enjoyment is particularly facilitated by a “sense of unity” among members of a competitive team.\textsuperscript{72} Furthermore, participants’ enjoyment of intergroup competition is not merely a byproduct of their interaction with more people than in purely cooperative or purely competitive settings. Tauer and Harackiewicz anticipate and control for this possibility by including a cooperative

\textsuperscript{70} Johnson and Johnson, \textit{Learning Together}, 178, 145, 208. For a detailed exploration of a variety of pedagogical games, see Chapter Three. Set Theory Survivor is a pedagogical game designed as an intergroup competition.


condition that has as many participants as the intergroup competition condition. They conclude that intergroup competition is an effective way to enhance “interpersonal enthusiasm” among participants and to increase the extent to which participants value competence and perceive challenge. Additionally, results from a study by Paul Mulvey and Barbara Ribbens show that intergroup competition increases group efficacy, goals, and productivity while decreasing group inefficiency.

Student responses to intergroup competition in an academic setting appear in an article by Kevin Cannon, Tina Mody, and Maureen Breen. The authors use competitive group exercises to facilitate student engagement and learning in undergraduate courses in organic chemistry and biochemistry. Exercises include pedagogical games such as “Chemical Blackjack” and “Chemical Jeopardy.” As evidenced by survey responses, these exercises increased interactions among students both inside and outside the classroom while expanding students’ knowledge of, and interest in, the subject at hand. Importantly, the aim of winning did not detract from students’ learning. Additionally, most students reported positive interactions with their classmates, citing respect and value for each other’s opinions and contributions, and nearly all students considered the exercises “fun and interesting.”

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In addition to promoting student learning and engagement, intergroup competition may help address gender-specific concerns related to competition. Marion Wittchen and her colleagues find that the levels of effort and positive affect among male participants do not differ between intergroup and interindividual competitions. However, intergroup competition does lead to increased effort and more positive affect than interindividual competition for female participants. In light of this finding, Wittchen et al. suggest that competitive stress in the workplace may be reduced for female employees by using intergroup, instead of interindividual, competition.\textsuperscript{76} Intergroup competition may likewise present a beneficial way to motivate students of both genders without placing undue competitive stress on female students.

According to Slavin, rewards for group output may positively affect student achievement in cooperative settings in several ways. Reward interdependence motivates students to take an interest in how their peers perform academically because their own receipt of rewards depends, in part, upon the individual learning and performance of their groupmates. Additionally, the presence of group rewards will likely inspire students to encourage each other to learn through an “interpersonal incentive structure” that supports academic achievement. Peer monitoring of student achievement may be especially effective because positive or negative feedback can be delivered in closer proximity to the efforts of each student than is the case with the slower-moving system of instructor-assigned grades. Citing the results of more than thirty cooperative-learning studies,

Slavin concludes that providing group rewards only enhances learning if each member of the group is individually accountable to the group for his or her learning.\textsuperscript{77} Hence, the success of intergroup competition as a marriage of cooperation and competition may rely principally upon one of the five central elements of cooperative learning set forth by Johnson and Johnson: individual accountability.

Our examination of cooperation, competition, and intergroup competition now comes full circle. Through positive interdependence, students in cooperative groups realize the importance of helping each other master the material; through individual accountability, they take responsibility for their own work. Face-to-face promotive interaction fosters strong relationships among group members, and constructive competition provides students with additional motivation to do their best in a quest for both a tangible reward and the mutual growth of all concerned.

Set Theory Survivor, the pedagogical game whose design and implementation I discuss in subsequent chapters, incorporates the building blocks of cooperative learning and constructive competition described in this chapter. During a four-week unit of study, students work together in formal cooperative learning groups (tribes) to complete in-class worksheets (challenges). The extended time frame of Set Theory Survivor, combined with other features of Johnson and Johnson’s cooperative base group (most notably, tribe names and colors), fosters group cohesion within each tribe. All five of Johnson and Johnson’s core elements of cooperative learning—positive interdependence, promotive interaction, individual accountability, social skills, and group processing—are present in

Set Theory Survivor. The most important of these elements, positive interdependence, appears in multiple forms throughout the game. Students in each tribe embrace identity interdependence as they rally around a shared tribe name and color. Tribe members also sit together in class, thus tapping into positive environmental interdependence. As students work together toward the common aim (i.e., goal interdependence) of earning the highest cumulative tribe score on the challenges and thereby winning a non-academic prize (i.e., reward interdependence), they engage outside enemy interdependence by competing against other tribes. Positive interdependence within each tribe inspires promotive interaction as tribe members share answers and explanations with one another. Students remain responsible for their own learning (individual accountability) because the scores for an individually completed challenge still contribute to the cumulative scores of their tribes, thus affecting the outcome of the game. In order to help their tribes function optimally, students must employ appropriate social skills—honored through several semesters of group work in class—in their interactions with fellow tribe members. Finally, Set Theory Survivor includes elements of questionnaire- and discussion-based group processing at the end of the unit.

The theoretical underpinnings of Set Theory Survivor synthesize social cohesion and social motivation as students develop supportive peer relationships while striving to win the offered prize. Student motivation is augmented through intergroup competition, which remains constructive by ensuring all tribes have equal chances of winning the game, encouraging fair play, and limiting the offered reward to a modest, non-academic
prize. In order to avoid common pitfalls of cooperative-learning assessment, students’ course grades are based solely on their own work.

While Set Theory Survivor is structured as an intergroup competition, its practical appeal comes from its identity as a pedagogical game. In the next chapter, I review a wide variety of pedagogical games from the literature; describe several pedagogical games that I use in my own classes; and share the inspiration for, and immediate predecessors of, Set Theory Survivor. A detailed discussion of this game and empirical results of its implementation in a sophomore-level music theory course appear in subsequent chapters.
Chapter 3: Using Pedagogical Games to Facilitate Active Learning

“In every job that must be done, there is an element of fun.
You find the fun, and snap! The job’s a game.”

—Mary Poppins

Amid the routine of lectures, activities, and assignments, both students and instructors of undergraduate music theory courses may long for “an element of fun” to make the process of learning and teaching challenging concepts more enjoyable. By framing educational processes with creative, lighthearted elements drawn from television, sports, or other facets of popular culture, instructors can transform classroom activities into pedagogical games. Pedagogical games linking unfamiliar course content to familiar cultural constructs provide variety during class and invite students to invest more fully in their education through active participation and new avenues of thought. In this chapter, a brief introduction to active learning precedes discussion of a number of pedagogical games employed in courses both inside and outside the field of music theory. In addition to reviewing games presented in the literature, I describe several pedagogical games that I use in my own classes. Finally, this chapter presents the inspiration for, and immediate predecessors of, the pedagogical game Set Theory Survivor which comprises the focus of my dissertation. A detailed discussion of this game and empirical results of its implementation in a sophomore-level music theory course appear in subsequent chapters.

Active student learning, as opposed to passive student reception of instructor-presented material, features prominently in current educational practice. In the article
“Learning by Doing: An Empirical Study of Active Teaching Techniques,” Jana Hackathorn and her colleagues compare the effectiveness of four teaching techniques—lecture, demonstration, discussion, and in-class activity—in a semester-long social psychology course. Hackathorn et al. note that many of the prior empirical studies that investigate active learning “treat one class of students as an active teaching class…and compare it to another class of students that emphasizes lectures…with the two courses commonly being taught by two separate instructors.” This problematic methodology may be partially responsible for the “mixed results” obtained by such studies. For example, if a class taught by one instructor emphasizes lectures, and another class taught by a different instructor emphasizes discussions, it would be difficult to compare the effectiveness of lecture with that of discussion because any advantage that one class has over the other might stem from a facet of the instructor’s teaching approach unrelated to either lecture or discussion.

In their study, Hackathorn et al. avoid the confounding variable of different instructors by examining the use of all four teaching techniques within a single course. Throughout the semester, each course topic is presented by the instructor in a way consistent with that topic. According to Hackathorn et al., the findings of this study reinforce the idea that active techniques help increase learning because higher overall scores emerged in response to in-class activities while the lowest overall scores were those associated with lecture. Although “no one method emerged as the ‘easy button’ of


79 Ibid., 42.
teaching or learning” in this study, the findings of Hackathorn et al. suggest that active techniques affect deeper levels of learning and can be useful when engaging students with different learning styles.80

Suzanne Court argues that the process of learning music notation and theory should be a “creative experience” through which “prior experiential learning is integrated with formal analysis.”81 According to Court, one of the reasons music theory textbooks may not fully explore avenues of creative learning is that “didactic music theory…seems to be driven by the need to be factually objective (positivistic), thereby alienating itself from the very creativity that attracted many students to music in the first instance.” She concludes that the prioritization of “factual accuracy” has marginalized possible applications to theory pedagogy of insights drawn from educational research and modern musicology.82 Court recommends emphasizing the high connectivity of musical elements by integrating verbal, visual, and aural materials in the classroom. She also suggests tracing the historical narratives through which conventions like staff notation emerged; such a narrative approach presents another means by which to embrace the high connectivity of music theory. Deborah Mawer similarly emphasizes musical connectivity when she proposes an active learning approach that synthesizes analysis and student


82 Ibid., 88.
performance in an effort to enhance student interest and participation in set-theoretical analysis.  

Colleen Conway and Thomas Hodgman also encourage the use of active teaching and learning techniques in music classes through such activities as case studies, simulations, and games. A case study in a music theory class might compare two pieces demonstrating the same compositional technique, while a simulation could consist of a staged debate between two theorists with differing harmonic analyses of a given passage of music. Games frequently work well in classes, like music theory, whose content is “fact-based.” In this case, the tendency of theory pedagogy to overemphasize facts—which Court identifies as a shortcoming—may be redeemed by framing factual instruction with pedagogical games. According to Conway and Hodgman, “[a]ny game that gets students active in the class will be valuable for their learning.”

One game that reinforces set-theoretical constructs in a novel way appears in the article “Pitch-Class Poker” by Lora Gingerich. Using the structure and rules of traditional poker, the adaptation presented by Gingerich is designed to help its players better understand the concepts of interval-class vectors, supersets, and subsets that they encounter in pitch-class set theory. The game may be played either with a custom deck of forty-eight cards, each of which displays a particular pitch in a specific register and clef,

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84 Colleen M. Conway and Thomas M. Hodgman, “Strategies for Active Learning in Music Classrooms,” in *Teaching Music in Higher Education* (New York: Oxford University Press, 2009), 123, 131–32. For a discussion of a cooperative learning activity that Conway and Hodgman propose for the music theory classroom, see Chapter Two.

85 Lora L. Gingerich, “Pitch-Class Poker,” *Journal of Music Theory Pedagogy* 5, no. 2 (Fall 1991): 161. See also the discussion of this game in Chapter One.
or with a regular, fifty-two-card deck from which the Queens have been removed. Pitch-class poker departs from traditional poker in its ranking system; hands are ranked from high to low on the basis of the total interval content (i.e., interval-class vector) of the pitch-class set corresponding to the cards held in each hand. Gingerich introduces two versions of pitch-class poker: Tritone Trump and Semitone Sweep. In Tritone Trump, the hand whose interval-class vector contains the most tritones (interval class 6) ranks the highest, while in Semitone Sweep the highest-ranking hand is the one whose interval-class vector contains the most semitones (interval class 1).86

Although this game offers an intriguing and resourceful way to enhance students’ knowledge of analytical tools from pitch-class set theory, its complexity could present a disadvantage. Some students may not know how to play poker; for these students, the process of learning the rules of the game might be overly time-consuming. Additionally, some students might object to playing pitch-class poker for conscientious reasons because of its associations with gambling. While these potential concerns are significant, they may be alleviated by careful guidance from instructors who clearly explain the educational purpose of the game and minimize its competitive orientation.

An assortment of simpler music theory games appears in the ten-day intensive fundamentals course Jeffery Gillespie provides for incoming freshman music majors at his institution. Two of these games are the “relay race” and “theory bingo.” Students are divided into two teams for the relay race. In this activity, students go to the board to answer questions, some of which are rather complicated. One question reads, “In bass

clef, notate the submediant pitch of the natural minor scale that has a tonic of G#,” while another question instructs students to “[w]rite the compound duple meter signature that has a beat division of a sixteenth note.” Before asking teammates for assistance, each student must come to an individual answer. This activity builds team work in a fun setting while helping students to make connections among many different concepts and to “rely on accuracy and speed.” Gillespie’s version of “theory bingo” helps students engage “challenging questions in a comprehensive manner.” Players use pre-popped popcorn as their playing pieces, and the bingo cards feature an “‘I love theory’ free space.” According to Gillespie, these fun activities contribute to the “relaxed atmosphere” of the course despite the intensive ten-day schedule.

Inspired by Gillespie’s article, Rebecca Atkins and Michael Murray developed an abbreviated version of Theory Camp for their institution. Throughout this four-day intensive, instructors use a combination of worksheets, board work, and games to monitor the progress of students. Course material is presented by a team of instructors who cultivate a “focused but relaxed” classroom atmosphere through games, singing, and relays. Consistent with the results described by Gillespie, Atkins and Murray conclude that their camp effectively prepares students to enter the first semester of the core theory

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88 Ibid., 55. Gillespie does not provide examples of theory bingo questions in his article. While theory bingo, like pitch-class poker, has the potential to be associated by students with gambling, Gillespie minimizes this association by excluding the monetary aspect of the game. Gingerich, on the other hand, indicates that the procedure for betting remains the same in pitch-class poker as in regular poker (Gingerich, “Pitch-Class Poker,” 161, 170).
sequence.” Perhaps the success of both theory camps can be partially attributed to the active teaching and learning strategies revealed in their pedagogical games.

I incorporate several pedagogical games—including theory bingo and relay races—into my own teaching. For theory bingo, I provide students with custom-made bingo cards containing the answers to a variety of music-theoretical questions. One of my bingo cards appears in figure 3.1. Each square displays the answer to one or more questions; for instance, the top right square (6/5) provides the correct answer to the question “What is the figured-bass symbol for a first-inversion seventh chord?” This game is especially useful for an examination review session. Students use small candies as their playing pieces (and as a snack), and the pressure of exam preparation seems temporarily to lift as students answer review questions in hopes of obtaining a “bingo” and thereby winning a small, holiday-themed prize. Because false bingos may arise through incorrect answers, it is necessary to check student answers carefully.

Relay races are particularly well suited to part-writing exercises. Students work together in teams of four to six people to write a given progression on the board in four-part chorale style. Each team receives a single marker (or piece of chalk) and an eraser. The students on a team take turns writing one chord each until the progression is complete. Team members help each other with suggestions and error detection. When all members of a team are satisfied with their progression, the team surrenders its marker or chalk, and I write down the amount of time it took them to complete the progression. After all teams have finished, I check their work and mark any errors in spelling,

doubling, or voice-leading. For each error, I add five to ten seconds to that team’s total time. Once these adjustments are made, the team with the lowest total amount of time is declared the winner. Sometimes I offer a small, non-academic prize, but “bragging rights” can also suffice as a reward.

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Figure 3.1. Sample card for theory bingo.

I also use pedagogical games in my aural skills classes. For example, my students and I sometimes play interval tag as a way to practice interval identification. After I play a melodic or harmonic interval on the piano two or three times, I call on a student to identify the interval by size and quality (i.e., minor sixth). If he or she does so correctly,

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90 As an exercise in error detection, I sometimes have teams check the work of their opponents. Naturally, students are quite motivated to find any errors that are present. However, if a team incorrectly identifies something as an error, that team receives the penalty of having time added to its own score. This encourages students to be thorough, but circumspect, in their error detection.
we go on to a new interval. If not, another student tries to identify the same interval. After a student identifies an interval, that student “tags” another student who must then identify the next interval. The game continues until every student has at least one turn.

A more elaborate game I use for classes in aural skills is my chord dictation tournament. This game can be used to practice identification and notation of individual triads or seventh chords. I announce the upcoming game several days in advance in order to give students time to practice on their own with available software or online resources. On the day of the game, I divide the class into teams of three to four students. Team names reflect school spirit; I use the school colors and mascot of my institution to generate these names. Each team receives a bag containing one colored slip of paper and one white slip of paper for every chord included in the tournament. These blank slips of paper are distributed as evenly as possible among the members of each team. I also provide students with a simple worksheet showing the lowest note of each chord on the staff, with extra staves for work in progress. As I play the chord several times on the piano, students write their individual answers on the worksheets. One member of each team then volunteers to write his or her answer on the board. After notating the chord and labeling its quality and inversion, that person returns one colored slip of paper to the team’s bag. Another team member serves as consultant to the person recording the answer; the consultant returns one white slip of paper to the bag. I play the chord once more to allow students to finalize their answers. We repeat this procedure for each subsequent chord. In order to ensure equal participation, each student can volunteer to write the answer only once per colored piece of paper—and to serve as consultant only
once per white piece of paper—allotted to him or her. Students are not allowed to trade or
donate their pieces of paper. Teams gain one point for each correct quality, one point for
each correct inversion, and one point for each correctly notated chord. The team finishing
with the most points wins holiday-themed pencils (a favorite of music students), and all
participating students receive candy.

Student responses to the chord dictation tournament are positive; my students
describe participating in the tournament as fun, and they enjoy practicing dictation in
teams. This pedagogical game can also help increase the confidence of students. At one
tournament, one of the teams appeared less confident than the others. Throughout the
tournament, I monitored the progress of each team and encouraged students on the less-
confident team to keep trying. When the final scores were tabulated, that team won the
tournament by two points! Their success provided these students with a timely increase in
confidence as we entered the last few weeks of the semester.

A variety of pedagogical games from outside the discipline of music theory
appear in fields like business and sociology. In these contexts, pedagogical games
facilitate students’ understanding of complex and sensitive issues. For instance,
Venkatapparao Mummalaneni and Soumya Sivakumar recount their use of a board game
called You Can’t Fire the Customer™ to sensitize students—enrolled in either an
introductory course or an advanced course in services marketing—to aspects of the
customer relationship construct. Players encounter a variety of scenarios involving
interactions with customers and choose their responses from among several options. Both the content and the tone of each participant’s response are evaluated.  

By means of a questionnaire that students completed both before and after playing the game, Mummalaneni and Sivakumar compare the responses of students who played *You Can’t Fire the Customer™* with the responses of students who played another game (*Financial IQ™*) that does not engage the customer relationship construct. While the game played by students in the *Financial IQ™* control group did not lead to a change on any of the variables examined in this study (trust, interdependence, communication, shared values, customer needs, and personal relationship), students who played *You Can’t Fire the Customer™* modified their positions on dimensions of “interdependence, identification of customer needs, and personal relationship orientation.” Intriguingly, these changes “were in the negative direction.”  

According to Mummalaneni and Sivakumar,  

> The explanation for this counterintuitive finding lies in the true purpose of customer orientation and the need to rein in the impulse to accommodate the customer in all situations and at all costs…Because the game rewards appropriate behaviors, including those that deny [customer] requests at times, the participants consequently shifted their relational orientations downward and not upward. This is a subtle shift that is attributable to the nuance of the game.

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92 Ibid., 264–265, 267.

93 Ibid., 267–68.
In light of this conjecture, it appears that students’ understanding of the complex role of customer service representatives may be enhanced by playing the board game *You Can’t Fire the Customer.*

Pedagogical games can also help students interact with potentially sensitive subjects. Warren Waren uses a truncated version of *Monopoly* in his sociology classes in order to illuminate issues of race and ethnicity—including the challenging construct of “colorblind racism.” He and three to five students serve as players while the rest of the class observes. In order to demonstrate “direct institutional racism,” Waren modifies the game rule “Pass Go, Collect $200” to exclude anyone with the name of one of the student players. He involves student observers in calculating how much money each of the players has accumulated after 349 turns. The player who is excluded from earning income on the basis of his or her name has no money; however, each of the other players now has $69,800. Waren then reinstates the original rule awarding $200 to every player as he or she passes “Go.” After highlighting the significant financial inequality that remains after the simulated 375th turn, Waren ends the abridged game of *Monopoly* and debriefs the student players.94

Waren observes that the “emotions and experiences” of students concerning this game are “much stronger” than their experiences in his regular lectures. During the post-game discussion, students identify both the parallel to direct institutional racism stemming from the explicitly unequal playing rule and the situation analogous to

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“colorblind racism” that begins with the cessation of direct racism and premature declaration of equality. This opens the door for further discussion of “reparations and affirmative action.” According to Waren, the ensuing discussions among students are substantially “better informed and richer” as well as “more likely to be connected to personal experience.”

Although the previous examples favor table games, television can also provide a wealth of material from which to construct pedagogical games. In the article “‘I’ll Take Ideology for $200, Alex’: Using the Game Show Jeopardy to Facilitate Sociological and Critical Thinking,” Dan Pence describes a creative essay assignment he uses when teaching introductory sociology courses. This assignment directs students to link themes or assumptions that underlie American education with the television game show Jeopardy! According to Pence, two primary elements of the exercise include recognizing implicit assumptions informing the abstract values and concepts that society deems important and cultivating an understanding of “one’s place and time in our culture—one’s standpoint.” Some of the themes addressed by students include social class, gender, and appearance. While Pence acknowledges that sociological and critical thinking are difficult to measure, he declares that this assignment consistently yields “thoughtful and creative” results. In addition to making the learning process more enjoyable for students, Pence argues that the incorporation of familiar television shows


96 Dan Pence, “‘I’ll Take Ideology for $200, Alex’: Using the Game Show Jeopardy to Facilitate Sociological and Critical Thinking,” Teaching Sociology 37 (April 2009): 171, 173.
can “reduce students’ unfamiliarity with or even resistance to addressing abstract material by framing these concepts in their personal experiences.”\textsuperscript{97}

As seen above, television shows like \textit{Jeopardy!} can enliven pedagogical activities and provide frameworks for active learning. According to Courtney Hunt, the majority of students watched television regularly while growing up and “are quite familiar with the characters and typical situations encountered in many shows.” Therefore, familiar television shows can offer “fun and meaningful examples” and can inspire experiential activities related to course concepts. Hunt concludes that television-based activities can help students form connections between what they learn in class and the “‘real’ world (even if it is fictitious!).” Other possible benefits include the introduction of humor and fun into courses and the possibility of bridging the teacher-student generation gap.\textsuperscript{98}

Yolanda Sarason and Catherine Banbury confirm the widespread experience of television watching among many students and maintain that “[t]he use of the game show in the classroom is consistent with the underlying assumptions of active learning that portray students as actively engaged in their learning and their world.” Additionally, this pedagogical tool can help learners to use the high-level cognitive skills of analysis, synthesis, and evaluation in their work. Sarason and Banbury conclude that “we all win” by facilitating learning in a “fun and engaging” manner.\textsuperscript{99}

\textsuperscript{97} Pence, “Ideology,” 174–75, 171.

\textsuperscript{98} Courtney Shelton Hunt, “Must See TV: The Timelessness of Television as a Teaching Tool,” \textit{Journal of Management Education} 25, no. 6 (December 2001): 640, 633, 638.

\textsuperscript{99} Yolanda Sarason and Catherine Banbury, “Active Learning Facilitated by Using a Game-Show Format or Who Doesn’t Want to be a Millionaire?” \textit{Journal of Management Education} 28 (2004): 511,
One television program that offers a particularly intriguing framework for classroom activities is CBS’s *Survivor*, now in its thirtieth season. In this popular reality game show, sixteen to twenty contestants are divided into two or more tribes that spend several weeks living in a remote (often tropical) location with limited food and supplies. Tribe members work together to survive and to compete against the other tribe, or tribes, in a variety of mental and physical “challenges.” As the game progresses, contestants also take part in individual challenges. Contestants are gradually eliminated from the game through voting at Tribal Council; the last remaining contestant wins the title of Sole Survivor and one million dollars.

An adaptation of *Survivor* to an educational setting appears in an article by Mary Howard, Heidi Collins, and Stephen DiCarlo as a review method for a medical-school class in pulmonary physiology. According to Howard, Collins, and DiCarlo, this review method encourages widespread student participation by “including the student audience in the game.” This version of “Survivor” uses multiple-choice questions in order to reflect the format of the Medical Board Examination and emphasizes both “peer instruction and a capacity to gather information and solve novel problems.”

513–14. The game shows that Sarason and Banbury adapt for classroom use are *Who Wants to be a Millionaire?* and *Jeopardy!*

100 CBS, www.cbs.com/shows/survivor/.


Merging classroom instruction with long-term exam preparation, Robert Burks uses an instructional version of *Survivor* with college freshmen enrolled in his remedial pre-calculus course. Burks realizes that students may perceive the mathematics classroom as a location akin to the “remote hostile environment” encountered by contestants on *Survivor*; hence, this television show provides a particularly appropriate means of framing part of the course as a pedagogical game.\(^\text{103}\) By requiring students to solve mathematical problems within specified time limits, Burks prepares students to pass a timed “Gateway” (Fundamental Concepts) exam assessing their mastery of fundamental math skills and concepts. Burks incorporates three types of questions, or challenges, into *Survivor Math*: individual, group, and reward. According to Burks, individual questions deal with “topic areas or concepts students should have mastered prior to the activity.” Group questions, however, involve “material that has been reviewed and practiced but may not be completely mastered by the student.” Burks permits students to work together in tribes on group questions in order to reinforce the material and encourage “peer-to-peer teaching and learning.”\(^\text{104}\) For both types of questions, students work either individually or in their tribes to “completely work out the solution, showing all work, in the allotted time.” Reward questions are designed to prompt “rapid recall” and to increase the interest of students in the activity. Preferred rewards include cookies and chocolate;


\(^\text{104}\) Ibid., 69, 64, 66–67. These tribes are typically composed of three students and may be either spontaneously formed by students or assigned by the instructor. In the case of instructor-formed tribes, Burks groups students heterogeneously according to achievement (66). Burks also normally reorganizes the tribes after the second of four *Survivor Math* episodes in the semester (66, 71).
these are awarded to the first person to answer the question correctly. Burks incorporates a variety of question types into a single class period, or “episode,” of Survivor Math; for example, a 30-question episode might include 18 individual questions, 9 group questions, and 3 reward questions.\(^{105}\)

Students answer questions and show their work while standing at the board. As long as students continue to answer correctly, they stay at the board. However, students who answer a question incorrectly are sent to “Skull Island” (their desks) where they continue working challenges on paper until they correctly answer a challenge and thereby earn the right to return to the board. Burks awards bonus points to students who answer questions correctly while standing at the board. An additional reward is given to students who remain standing at the end of the activity. Burks argues that using bonus points provides an extrinsic motivator for students and enables all students to benefit by competing solely against themselves to win a reward that benefits their course grades.\(^{106}\)

While each student has the opportunity to earn bonus points during Survivor Math, only one student will win the title of sole survivor or “ultimate ‘Mathlete’” at the end of the semester. Burks awards this title to the student who obtains the highest combined score on performance criteria including “performance on the final FCE [Fundamental Concepts Exam]…most improved FCE grade…performance during the individual episodes (in class competitions)…[and] ‘Fan Favorite.’” The final criterion is


\(^{106}\) Ibid., 70.
based on subjective student feedback regarding which classmates were most helpful in enhancing their understanding of the fundamental concepts covered in class.\textsuperscript{107}

Burks goes to great lengths to build excitement and anticipation among students prior to the onset of \textit{Survivor Math} each semester. Impressively, he develops and shows a brief “opening credits” video at the beginning of each episode. According to Burks, this video is approximately 90 seconds long and combines “actual \textit{Survivor} scenery footage and theme song” with photos of his students. Burks uses pictures from student IDs, as well as “action photos of common student activities,” in his opening credits. He finds that students appreciate the “personal touch of having their own movie” and sometimes respond to the first screening of the opening credits with applause. Other elements of atmospheric preparation include bringing props, such as “Halloween flaming skulls” for the “Skull Island theme,” into the classroom.\textsuperscript{108} Finally, Burks modifies the \textit{Survivor} logo to fit \textit{Survivor Math} and sends his new logo to students as part of an e-mail announcement of the episode taking place in the next class (see figure 3.2).\textsuperscript{109}

According to Burks, student views of \textit{Survivor Math} are largely positive. Feedback obtained during the semester reveals that the majority of students (22 to 24 out of a total of 28) believed that “winning the competition was important” and that “the competition promoted learning the fundamental concepts.” Additionally, 20 to 22 students out of 28 “felt that the interaction with other students during the competition

\textsuperscript{107} Burks, “\textit{Survivor Math},” 65–66.

\textsuperscript{108} Ibid., 68, 70.

\textsuperscript{109} The original \textit{Survivor} logo uses the words “Outwit, Outplay, Outlast.” I also develop and use a logo and opening credits video (with pictures of composers rather than students) in my pedagogical game \textit{Set Theory Survivor}. For a detailed discussion of these elements, see Chapter Four.
increased their knowledge of the fundamental skills” and “felt better prepared entering the final FCE.” Burks concludes that students participating in *Survivor Math* exhibit increasing involvement in the activity with each successive episode and tend to display “more confidence in their ability to answer a question during the game” than they do during traditional classes.\textsuperscript{110}

![Survivor Math logo](image)

Figure 3.2. *Survivor Math* logo from Burks, p. 69.

An adaptation of *Survivor* to the music theory classroom appears in two publications by Whitney Berry: “Surviving Lecture: A Pedagogical Alternative” and “Beyond Survival: Using Games to Thrive in Lecture.”\textsuperscript{111} As a pedagogical strategy, *Theory Survivor* presents an optimal synthesis of the effectiveness of active and cooperative learning with the efficiency of lecture within the “novel and motivational

\textsuperscript{110} Burks, “*Survivor Math*,” 71. Burks does not include any analysis of test outcomes for students who participated in *Survivor Math*.

context of a games-based learning approach.” Berry uses Theory Survivor to frame an eight-week unit on music theory fundamentals for undergraduate students. Explicitly linking her pedagogical game to the Student Teams-Achievement Divisions (STAD) instructional strategy proposed by Robert Slavin, Berry draws parallels between the four primary components of *Survivor* (tribal membership, challenge communication, survivor challenges, and tribal council) and those of STAD (heterogeneous grouping of students, teacher-presented lesson, team work, and individual assessment in the form of a quiz).

In Theory Survivor, student tribes are heterogeneously composed according to performance level on a pretest; each tribe contains a high-scoring member appointed as tribal leader in addition to a variety of middle- and low-scoring members. In order to ensure each tribe has a fair chance of winning the game, Berry is careful to balance the total pretest scores among tribes. She highlights the importance of “team equity,” finding that teams will be more motivated to try to “improve their performance and standing” when they “perceive that they are starting the game on equal terms.” Berry also attends to the balance of male and female students within each tribe. As the game continues, “group cohesion increases as tribes work together toward the goal of winning the ‘fabulous prize’ promised at the end.”

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112 Berry, “Beyond Survival,” 60, 65, 47.
113 Ibid., 54–58. For a detailed discussion of STAD, see Chapter Two.
114 Berry, “Surviving Lecture,” 152.
115 Berry, “Beyond Survival,” 55.
A typical lesson, or challenge communication, takes the form of a brief “mini-lecture” presented to the class by the instructor. Berry stresses the importance of keeping this lecture concise; it should contain just enough “essential material” to permit students to practice the new concept being introduced. Demonstrations or questions may be incorporated, but they, like the lecture, are kept brief in order to maximize time available for the daily survivor challenge. Occasionally, a practice challenge precedes the featured survivor challenge in order to give tribes a chance to interact with the content without the prospect of losing points for incorrect answers.

Following the challenge communication and any practice challenge, each tribe engages in the team-work component of STAD by completing a survivor challenge, which normally comprises “exercises from the course workbook to be completed within specified time limits.” Time limits are enforced with stopwatches. Once a challenge is complete, tribes check their answers against a provided key and calculate individual scores which are averaged together to form a tribe score expressed as a percentage. Berry then posts tribe scores on both a classroom bulletin board and the course website in order to keep tribes apprised of one another’s progress. Leading tribes are rewarded by having their pictures posted above the scoreboard on the course website. According to Berry, the pursuit of the “ultimate goal” of Theory Survivor—winning the “‘fabulous prize’” awarded to the tribe that finishes with the highest score—inspires higher-

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117 Berry, “Beyond Survival,” 56.

118 Ibid. Berry notes that using a percentage provides a simple means of scoring each challenge and accommodates tribes of different sizes. This method of scoring departs somewhat from that used in STAD. Students playing Theory Survivor still earn points to contribute to the tribe score, but these points are not based on their own past performances as they are in STAD (58).
achieving students to “teach and mentor their peers” and sparks constructive peer pressure that motivates lower-achieving students to succeed. Berry explains, “In the many years I have been using this technique, it has been my experience that these [lower-achieving] students tend to rise to the challenge and try to improve rather than give up because they feel they are dragging down their tribe’s scores.”

Although STAD includes an individually completed quiz to assess student understanding, Berry frames Theory Survivor as “purely an instructional strategy” that is “not an assessment of any kind.”

Berry modifies the tribal council component of Survivor in an important way: in Theory Survivor, no students are voted out of their tribes during the game. However, Berry argues that “personal pride, peer pressure, and a sense of belonging motivate individuals to do their best.” Berry cautions instructors to ensure that each person’s contributions to his or her tribe are “recognized and cast in a positive light.” She explains, “Peer pressure can act as a motivational force, but it is important that weaker team members not be made to feel inferior. One way to accomplish this within a competitive environment is to provide an extrinsic reward in addition to grades.”

By limiting the “‘fabulous prizes’” to purely extrinsic rewards in the form of “custom-made T-shirts,”

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120 Ibid., 57–58.
Berry argues that students can enjoy Theory Survivor and participate freely without worrying about their grades being affected by the outcome of the game.122

Berry describes the effects of participating in Theory Survivor as transformative for her students. The time students spend on “Music Theory Island” leads to increased confidence and “a deeper understanding of and fluency with the fundamental concepts of the discipline.”123 Furthermore, students may receive significant emotional and social support from the other members of their tribes. This support—bordering on that of a “pseudo family”—is especially beneficial for students as they undertake their first few weeks of college. While students may not readily articulate such benefits when reflecting upon their experience with Theory Survivor, these benefits underlie the consistent student description of the game—and the class—as “‘fun.’”124 By combining the benefits of cooperative learning with the fresh perspective of “participating” in a familiar television show, Theory Survivor provides a creative tool with which the freshman music theory curriculum may be enhanced. Students who find the process of learning music theory fundamentals tedious, or who feel overwhelmed by the high learning curve of studying music theory for the first time, may particularly benefit from the interactive format and peer support system built into the Theory Survivor game.

As discussed in the opening chapter, students studying pitch-class set theory for the first time also experience a high learning curve as they encounter an analytical system very different from what they have learned in other music theory courses. The

122 Berry, “Beyond Survival,” 57.
123 Ibid., 65.
124 Ibid., 51, 65.
abstractions of integer notation and the mathematical orientation of set theory may seem foreign—or even frightening—to students. Potential resistance and trepidation among students may be mitigated by using pedagogical games. As seen in this chapter, a number of pedagogical games have been implemented in the music theory classroom. However, these tend either to focus on topics outside the purview of set-theoretical analysis or to take place within the confines of a single class, thus leaving underdeveloped the potential for longer-term connections among students. My own adaptation of Survivor, which I call Set Theory Survivor, addresses these issues by engaging pitch-class set theory during a multi-week unit of study.

In Set Theory Survivor, as on the show, students work together in small groups, or “tribes,” providing each other with valuable academic and social support during a four-week period. However, in an important modification to the structure of the show, no students are voted out of their tribes. At the end of the unit, each member of the tribe that earned the highest cumulative average score on the in-class “challenge” worksheets receives a non-academic prize in the form of a modest gift card. In contrast to Berry’s exclusive use of challenges for in-class practice without assessment, I include a low-stakes assessment element by incorporating each student’s grades on the challenges into the quiz portion of that student’s course grade. While students’ grades are based solely on their own work, the game element promotes peer mentoring through cooperative learning and inspires constructive peer pressure that motivates all students to do their best.

Recall Burks’s recognition of the mathematics classroom as a potentially “hostile environment” and Pence’s discussion of the efficacy of familiar television shows in reducing students’ resistance toward engaging abstract material.

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125 Recall Burks’s recognition of the mathematics classroom as a potentially “hostile environment” and Pence’s discussion of the efficacy of familiar television shows in reducing students’ resistance toward engaging abstract material.
Discussions of the implementation and results of this new pedagogical game appear in the next two chapters. The purpose of presenting the unit via the framework of Set Theory Survivor is to facilitate students’ understanding and retention of course content by combining lecture with cooperative, small-group activities, to enhance student motivation through constructive intergroup competition, and to provide students with a novel and enjoyable approach to a subject that often sparks student resistance.
Chapter 4: Methodology for Set Theory Survivor

Introduction

Inspired by Whitney Berry’s game “Theory Survivor,” I adapted the television show *Survivor* to frame a sophomore-level unit on pitch-class set theory.\(^{126}\) My pedagogical game Set Theory Survivor is an intergroup competition that synthesizes the research on cooperative learning, constructive competition, and pedagogical games discussed in previous chapters.\(^{127}\) During Set Theory Survivor, students work together in cooperative groups to master course material while engaging other groups in a constructive competition within the framework of a pedagogical game. In this chapter, I detail the process of implementing Set Theory Survivor in my classroom. I identify connections between Set Theory Survivor and the television show *Survivor*, describe the research elements included in my implementation of the game, and explain the practical workings of Set Theory Survivor. Results of Set Theory Survivor appear in the next chapter.

Set Theory Survivor occupied a four-week unit (weeks eight through eleven) within the existing curriculum of Theory IV, a semester-long exploration of extended-

\(^{126}\) For a detailed discussion of Berry’s “Theory Survivor,” see Chapter Three.

\(^{127}\) Although Berry also addresses these topics, we principally engage different bodies of literature.
tonal and post-tonal music from the late-nineteenth and twentieth centuries. This was the final course in the core music theory sequence for undergraduate music majors at Ohio State. The course began with tonal ambiguity, enharmonic modulation, and symmetry before engaging chromatic common-tone chords, chromatic sequences, and other non-functional harmonic progressions. After the midterm examination, the focus shifted toward post-tonal music with analysis of pieces by Debussy and Bartók in light of new formal, chordal, and scalar constructions. The unit on set-theoretical analysis (Set Theory Survivor) subsequently provided a concise introduction to topics ranging from pitch-class sets to twelve-tone rows. Finally, the remaining weeks of the semester featured advanced rhythmic and timbral elements of post-tonal music while guiding students through the process of creating their own post-tonal compositions.

Links to Television Show Survivor

As a pedagogical game, Set Theory Survivor contained many elements referring to aspects of the television show Survivor (hereafter, Survivor). These elements, which included a logo, an opening credits video, tribes, buffs, survival supplies, challenges, Treemail, and a prize, forged connections between Survivor and Set Theory Survivor that transformed routine classroom activities into an elaborate pedagogical game. Inspired by Robert Burks’s “Survivor Math” logo, I created a new adaptation of the original Survivor

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logo for Set Theory Survivor (see figure 4.1). This logo framed tropical scenery (palm trees and waves) with the ubiquitous clock face, or Krenek diagram, used to teach pitch-class set theory. The word “Survivor” was surrounded by the phrase “Set Theory,” producing the full title, “Set Theory Survivor.”

The logo appeared for the first time in a brief opening credits video I designed. This video, also inspired by Burks and modeled after the opening credits for Survivor, was shown at the beginning of Set Theory Survivor, immediately after students were grouped into tribes.130

![Logo for Set Theory Survivor](image)

Figure 4.1. Logo for Set Theory Survivor.

On Survivor, photographs of contestants and exotic, on-location scenery are accompanied by phrases detailing the number of contestant “castaways,” the duration of the game, and

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130 The rationale for, and process of, grouping students into tribes will be discussed later in this chapter.
other information specific to that season of the show. Burks incorporates the *Survivor* theme song and video clips of scenery from *Survivor* into his opening credits; photographs of his students round out the video and connect the television show to the classroom.\(^{131}\) My video for Set Theory Survivor interspersed phrases like “15 Castaways” and “4 Tribes” with pictures of the exotic location for the game—namely, our classroom—and photographs of the four composers (Schoenberg, Bartók, Stravinsky, and Berg) for whom the respective tribes were named. In order to protect the privacy of students, the composers’ photographs took the place of student pictures in this video.\(^{132}\) Like Burks, I incorporated the *Survivor* theme song into my video. The conclusion of the video featured the Set Theory Survivor logo, which later reappeared on the “scoreboard” slide shown at the beginning of subsequent classes. This PowerPoint slide, which was updated after each challenge, kept students informed of their tribe’s progress relative to that of the other tribes as all tribes worked toward the goal of winning the game (see figure 4.2).\(^{133}\) The slide shown here displayed the Set Theory Survivor logo against a background associated with the leading Bartók tribe by the color orange. Rankings for all four tribes appeared; in this example, the Bartók tribe occupied first place, the Schoenberg and Stravinsky tribes were tied for second place, and the Berg tribe was in third place.

\(^{131}\) Burks, “*Survivor Math*,” 68.

\(^{132}\) The order in which the pictures of composers appeared in the video corresponded to the order of their birth dates from earliest to latest. Thus, the order was Schoenberg (1874–1951), Bartók (1881–1945), Stravinsky (1882–1971), and Berg (1885–1935).

\(^{133}\) In order to protect students’ privacy, the scoreboard slides were not posted on the online class server, nor were specific tribe scores announced. Only the relative rankings of tribes were announced.
Two material elements from Survivor, buffs and survival supplies, had direct counterparts in Set Theory Survivor. On the television show, members of each tribe wear tube-shaped pieces of cloth called “buffs” (as headbands, arm-bands, etc.) that display their tribe colors and visually identify members with their tribes. Similarly, participants in Set Theory Survivor had cloth bandannas—which we called buffs, alluding to the original version—that they wore or tied to their backpacks. These brightly colored bandannas were purple (Schoenberg tribe), orange (Bartók tribe), green (Stravinsky tribe), and gold (Berg tribe). I avoided choosing pink and blue because of their possible

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gender implications and refrained from assigning our school colors (scarlet and gray) to any tribe in order to avoid implicitly privileging that tribe.\footnote{I included a marker in each tribe’s color in the assortment of markers I kept at the front of the classroom for general use. Additionally, I used red ink (instead of my usual purple) to grade the challenges so my grading color would not match the color of a particular tribe (in this case, the Schoenberg tribe).}

While the survival supplies provided to contestants on \textit{Survivor} take the form of basic tools and limited food supplies,\footnote{“\textit{Survivor} (TV Series),” \textit{Wikipedia}, last modified November 30, 2014, http://en.wikipedia.org/wiki/Survivor_(TV_series).} the survival supplies distributed to each tribe in Set Theory Survivor consisted of a two-pocket, letter-size folder and a plastic bag containing an eraser and four dry-erase markers, one for each member of the tribe. The markers in each bag presented a basic assortment of colors—black, blue, green, and red—that would show up well on the whiteboard. Each folder matched the color of its tribe and was decorated with two stickers displaying the Set Theory Survivor logo. Students wrote their names on self-adhesive labels and added them to the front of their tribe’s folder; the inside of the folder was labeled with the name of the tribe. Each folder contained both musical staff paper and lined notebook paper for scratch-work during challenges.

A prominent part of \textit{Survivor} is the undertaking of physical or mental “challenges” by tribes or individuals. In Set Theory Survivor, challenges consisted of paper worksheets containing a variety of exercises related to pitch-class set theory. An example of a challenge appears in figure 4.3. Students completing this challenge were asked to determine whether two given pitch-class sets were inversionally equivalent, to perform a $T_{NI}$ operation on a given pitch-class set, and to calculate the prime form of a
given pitch-class set. A bonus question offered students an opportunity to earn extra credit by relating the previously calculated prime form to the common musical structure it represents: namely, the major or minor triad (037).

Figure 4.3. Challenge 3: Inversion and Prime Form.
A day or two before an upcoming challenge, I sent out an e-mail announcing the day of the challenge and informing students of its content. By including the word “Treemail” in the subject line, I explicitly connected each announcement to *Survivor*’s delivery of messages regarding upcoming challenges to a basket or box on a tree near a tribe’s camp. Alluding to the word “e-mail,” these messages have become known as “Treemail.” For an example of “Treemail” in Set Theory Survivor, see figure 4.4.

Subject: Treemail: Challenge 3 on Wednesday

Hello all,

Our next challenge will take place at the beginning of class on Wednesday. For this challenge, you will need to determine whether sets are inversionally equivalent (and, if so, give the index of inversion), perform inversion/transposition operations, and calculate the prime form of pitch-class set(s). You’ll be able to work with your fellow tribe members, but you won’t be allowed to use your notes. For review, see worksheets 2.1 and 2.2, which are posted on Carmen along with their respective answer keys.

See you Wednesday!

Ms. Ripley

Figure 4.4. Treemail for Challenge 3.

As mentioned in this Treemail, students had access to practice worksheets and answer keys through the online course server, Carmen. Parts of these worksheets were completed in class to give students immediate opportunities to practice new skills; other portions of the worksheets were reserved for additional student practice outside of class.

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Lecture slides and handouts were also available online. Finally, I posted each challenge and its associated answer key online after we completed it in class and before the next scheduled challenge. Because a wide variety of course materials were available on Carmen, students had ample opportunity to review, catch up on anything they had missed, and prepare thoroughly for each challenge.

The ultimate goal of contestants on *[Survivor]* is to reach the end of the game as the “Sole Survivor” and thereby win one million dollars.\(^\text{138}\) Though much more modest in scope, the prospect of winning of a prize also played an important role in Set Theory Survivor. Students’ grades were not affected by the outcome of the game; however, the hope of earning a non-academic prize provided impetus for tribes to pull together and do their best on challenges. This reflected the social motivation approach to cooperative learning espoused by Robert Slavin (see Chapter Two) and fostered constructive competition by keeping the reward relatively small. For Set Theory Survivor, the prize consisted of a $15 Starbucks gift card for each member of the winning tribe. While I revealed the amount of the gift card at the outset of Set Theory Survivor, I maintained an element of surprise (akin to Berry’s coy description of a “‘fabulous prize’”) by waiting to reveal the type of gift card until the end of the game.\(^\text{139}\) Because the prize awarded at the end of Set Theory Survivor did not influence course grades, students could participate freely and help their classmates without fear of their own grades being adversely affected by the outcome of the game; this assessment plan reflected the social cohesion approach

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to cooperative learning set forth by David Johnson and Roger Johnson (see Chapter Two).

Research Elements

As a research study, Set Theory Survivor combined research elements (consent process, pre-test and post-test questionnaires, in-class videotaping) with educational elements commonly found in the classroom (lectures, practice exercises, graded worksheets, working in groups). Two of the research elements, in-class videotaping and obtaining student feedback via questionnaires, are also common in an educational context. The close alignment of educational and research elements in Set Theory Survivor thoroughly integrated this pedagogical game into the fabric of the course. Throughout the game, I observed the interactions of students during class and documented my observations in a teaching journal. In order to enhance the detail and accuracy of these observations, I also videotaped portions of classes during Set Theory Survivor. This made it possible for me to focus on individual tribes via videotaping while still circulating the classroom to monitor the progress of the class as a whole. I did not begin videotaping until several days into the game; thus, students had time to settle comfortably into their tribes before being videotaped. By leaving the camera stationary on a tripod, I was able to minimize the attention drawn to the process of videotaping and maintain my normal role as teacher, rather than videographer.

Participants were recruited from among students enrolled in the intact section of Theory IV that I taught in Spring 2015. Early in the semester, I announced the research study in general terms when foreshadowing the upcoming schedule of the course. At the
beginning of the unit on set theory, I introduced the pedagogical game Set Theory Survivor to the class, emphasizing the activities of the game that fell within the purview of normal educational practice. I informed students that no one would be voted out of their tribes and that their course grades would depend solely on their own work without regard to the outcome of the game. Before beginning to videotape class activities, I provided students with a sheet of information about the research study and asked for their consent to participate.\textsuperscript{140} In order to ensure that students’ participation was voluntary, arrangements were made for any students who did not wish to participate in the study to move to another section of the course that met on the same days, and at the same time, as the section I taught. Because the curriculum was closely coordinated across sections, students’ progress would still continue smoothly if they chose to switch sections. In order to indicate their decision whether or not to participate in the study, students completed a single-question survey on the Carmen course server (see Appendix G). After reading a description of the study, each student selected his or her answer (“Yes, I agree to participate in this study” or “No, I do not agree to participate in this study”) by clicking on a small circle beside the desired response. All fifteen students enrolled in my section of Theory IV chose to participate in the study.

Students completed two paper questionnaires: one at the beginning of the unit (pre-test) and the other at the end of the unit (post-test).\textsuperscript{141} They completed the pre-test questionnaire one class period before the first challenge, just prior to being assigned to

\textsuperscript{140} This research study was approved by the Institutional Review Board at OSU. A copy of the approval letter appears in Appendix F.

\textsuperscript{141} For the complete pre-test questionnaire, see Appendix D. For the complete post-test questionnaire, see Appendix E.
their tribes. Students completed the post-test questionnaire one class period after the final challenge and one class period before receiving their grades for the last challenge and learning which tribe won the game. Both questionnaires consisted of open-ended questions as well as questions presented as statements to which students responded by circling their answers on a 7-point Likert scale ranging from “strongly disagree” (1) to “strongly agree” (7). Students’ responses were confidential and did not affect their grades in the course.

Based on my review of the literature, I anticipated that students would find the mathematical aspects of pitch-class set theory off-putting and that students would initially dislike listening to post-tonal music but might (through increased exposure and hearing music by their tribe’s namesake composer when their tribe was in the lead) enjoy listening to this music more by the end of Set Theory Survivor. This change in attitude would be reflected by an increase in pre- to post-test student agreement with Likert-type Question 7 (“I like to listen to post-tonal music”). I also expected students to bond positively with their fellow tribe members and be motivated to exert their best efforts not only because of the offered non-academic prize (social motivation) but also because of their care for, and sense of responsibility toward, the other members of their tribe (social cohesion). In the event of such positive bonding among tribe members, I anticipated that students might shift their learning preferences toward the cooperative end of the spectrum, as evidenced by increasing student agreement with Question 3 (“I prefer to complete assignments with other people”) and decreasing student agreement with

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142 See the respective discussions of work by Slavin (social motivation) and Johnson and Johnson (social cohesion) in Chapter Two.
Question 2 (‘I prefer to complete assignments by myself’) from pre-test to post-test. Finally, I anticipated that students would learn a great deal during the unit—although it would not be possible to distinguish learning related to the Set Theory Survivor framework from that related to normal instruction—and that students would find Set Theory Survivor enjoyable. Student learning would be reflected through increasing pre-to post-test student agreement with the questions pertaining to their experience with set theory and ability to perform set-theoretical operations (Questions 9–17). Student enjoyment of Set Theory Survivor would appear in high levels of agreement with post-test Question 20 (‘The ‘Theory Survivor’ format made the unit on set theory enjoyable’).

Accordingly, the pre-test questionnaire explored students’ attitudes toward post-tonal music, their learning and working preferences, their previous experience, if any, with set-theoretical music analysis, and their engagement with the television show Survivor. This questionnaire was made up of nineteen numbered questions, with room for additional comments at the end. Seventeen of the questions were presented as statements, such as “I appreciate the underlying structure of post-tonal music” and “I can find the prime form of a pitch-class set,” to which students responded by circling their answers on a 7-point Likert scale. These Likert-type questions facilitated a statistical analysis that compared student responses on the pre-test to those on the post-test.

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143 For the complete pre-test questionnaire, see Appendix D. Students’ levels of motivation and their views of the mathematical orientation of pitch-class set theory were not directly addressed by the pre-test and post-test questionnaires; however, students were free to discuss these topics in response to open-ended questions on the post-test or to supply additional comments on either questionnaire. Student responses to the pre-test and post-test questionnaires are discussed in Chapter Five.

144 Students’ answers to this question may have been affected by their recent study of form in post-tonal music.
Interspersed among the Likert-type questions were two open-ended questions, i.e., “What do you like the most about post-tonal music?” These questions provided a qualitative glimpse into the attitudes and experiences of students.

Questions 1–3 addressed the learning and working preferences of students, while student attitudes toward post-tonal music were probed in Questions 4, 6, 7, and 8. Laying a foundation for exploring the content-specific learning of students during Set Theory Survivor, Questions 5 and 17 gauged students’ levels of experience and comfort with set theory while Questions 9–16 assessed the self-reported ability of students to perform specific set-theoretical operations, such as transposing a pitch-class set or finding its interval-class vector. Finally, Questions 18 and 19 explored students’ engagement with the television show *Survivor*.

The post-test questionnaire also probed students’ attitudes toward post-tonal music, their learning and working preferences, their self-perceived ability to perform specific set-theoretical operations, and their engagement with the television show *Survivor*. Additionally, this questionnaire investigated students’ views of the effects of Set Theory Survivor on the unit of study. The post-test questionnaire consisted of twenty-four numbered questions, with room for additional comments at the end. Many of the questions from the pre-test questionnaire reappeared verbatim on the post-test questionnaire. Questions 1–4 and Questions 6–16 were the same on both questionnaires. Pre-test Question 17 (“I am comfortable using set theory to analyze post-tonal music”) became post-test Question 5, and pre-test Questions 18–19, concerning student

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145 For the complete post-test questionnaire, see Appendix E.
engagement with Survivor, became Questions 22–23 on the post-test. Pre-test Question 5 (“I have studied set theory before”) did not appear on the post-test. Several new questions appeared on the post-test questionnaire. Four new, Likert-type questions (Questions 18–20 and Question 24) addressed student perceptions of the Set Theory Survivor format of the unit on set-theoretical analysis. Two new, open-ended questions (Questions 17 and 21) explored what students respectively liked and disliked most about the unit on set theory. For a complete listing of the pre-test and post-test questions and their motivations, see table 4.1 (Likert-type questions) and table 4.2 (open-ended questions).

From the start of the semester, we began almost every class period by listening to a recording of a brief piece of music, or a movement from a longer piece, by a variety of nineteenth- and twentieth-century composers. Going beyond the compositions we studied in the course, these recordings broadened the repertoire to which students were exposed. Beginning with pieces like Brahms’s *Intermezzo in A Minor* (Op. 116, No. 2), we gradually incorporated less tonal works, such as Debussy’s *Nuages*. We began listening to atonal compositions three weeks before the beginning of the unit on set theory in order to ensure students had previous exposure to this body of post-tonal music before completing the pre-test questionnaire, portions of which examined their attitudes toward this repertoire. The works played during this three-week period included one piece by each composer for whom a tribe was later named, as well as music by other prominent twentieth-century composers. The repertoire list for this portion of the class appears in figure 4.5.

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146 Technological difficulties prevented us from playing musical recordings for several days near the beginning of the semester.
Table 4.1. Likert-type questions and motivations from pre-test and post-test questionnaires. Unless otherwise indicated, the questions were numbered identically on both pre-test and post-test. If the same question was numbered differently from pre-test to post-test, both numbers are shown in the format pre-test number/post-test number. The symbol + denotes a question that appeared only on the pre-test questionnaire; the symbol * denotes a question that appeared only on the post-test questionnaire.

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>MOTIVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Learning and Working Preferences</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>I like to learn about new techniques for analysis.</td>
</tr>
<tr>
<td>2</td>
<td>I prefer to complete assignments by myself.</td>
</tr>
<tr>
<td>3</td>
<td>I prefer to complete assignments with other people.</td>
</tr>
<tr>
<td><strong>Attitudes toward Post-Tonal Music</strong></td>
<td>Addressed student appreciation of structural elements of post-tonal music on an academic (not aesthetic) level. Students could potentially “appreciate” the structure (i.e., recognize that it exists and respect it) without yet being able to “understand” it fully.</td>
</tr>
<tr>
<td>6</td>
<td>I appreciate the underlying structure of post-tonal music.</td>
</tr>
<tr>
<td>7</td>
<td>I like to listen to post-tonal music.</td>
</tr>
<tr>
<td><strong>Experience with Set Theory and Ability to Perform Set-Theoretical Operations</strong></td>
<td>Measured students’ prior experience (if any) with set-theoretical analysis. Probed the self-reported ability of students to perform specific set-theoretical operations. Operations were listed separately (not combining skills learned early in the unit with skills learned late in the unit) in order to facilitate a nuanced understanding of student learning.</td>
</tr>
<tr>
<td>5</td>
<td>I have studied set theory before.</td>
</tr>
<tr>
<td>9</td>
<td>I can find the normal order of a pitch-class set.</td>
</tr>
<tr>
<td>10</td>
<td>I can find the prime form of a pitch-class set.</td>
</tr>
<tr>
<td>11</td>
<td>I can find the interval-class vector of a pitch-class set.</td>
</tr>
<tr>
<td>12</td>
<td>I can transpose a pitch-class set that is in normal order.</td>
</tr>
<tr>
<td>13</td>
<td>I can invert a pitch-class set that is in normal order.</td>
</tr>
<tr>
<td>14</td>
<td>I can invert and transpose a pitch-class set that is in normal order.</td>
</tr>
<tr>
<td>15</td>
<td>I can identify pitch classes that remain invariant under transposition.</td>
</tr>
<tr>
<td>16</td>
<td>I can identify pitch classes that remain invariant under inversion.</td>
</tr>
<tr>
<td>17/5</td>
<td>I am comfortable using set theory to analyze post-tonal music.</td>
</tr>
<tr>
<td><strong>Engagement with Television Show Survivor</strong></td>
<td>Explored whether students were fans of Survivor in case engagement with Survivor influenced their perceptions of Set Theory Survivor, or vice versa.</td>
</tr>
<tr>
<td>18/22</td>
<td>I enjoy watching the television show Survivor.</td>
</tr>
<tr>
<td>19/23</td>
<td>I watch the television show Survivor regularly.</td>
</tr>
<tr>
<td><strong>Perspectives on Set Theory Survivor</strong></td>
<td>Examined student perceptions of how Set Theory Survivor contributed to students’ learning and affective experience during the unit.</td>
</tr>
<tr>
<td>18*</td>
<td>I learned a lot during the unit on set theory.</td>
</tr>
<tr>
<td>19*</td>
<td>The “Theory Survivor” format made the unit on set theory challenging.</td>
</tr>
<tr>
<td>20*</td>
<td>The “Theory Survivor” format made the unit on set theory enjoyable.</td>
</tr>
<tr>
<td>24*</td>
<td>The “Theory Survivor” format made the unit on set theory interesting.</td>
</tr>
</tbody>
</table>
Table 4.2. Open-ended questions and motivations from pre-test and post-test questionnaires. Unless otherwise indicated, the questions were numbered identically on both pre-test and post-test. The symbol * denotes a question that appeared only on the post-test questionnaire.

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>MOTIVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes toward Post-Tonal Music</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>What do you like the most about post-tonal music?</td>
</tr>
<tr>
<td>8</td>
<td>What do you dislike the most about post-tonal music?</td>
</tr>
<tr>
<td>Attitudes toward Set Theory Unit</td>
<td></td>
</tr>
<tr>
<td>17*</td>
<td>What aspect of the unit on set theory did you most like?</td>
</tr>
<tr>
<td>21*</td>
<td>What aspect of the unit on set theory did you most dislike?</td>
</tr>
<tr>
<td>Additional Comments</td>
<td></td>
</tr>
<tr>
<td>N/A</td>
<td>Please write any additional comments that you have.</td>
</tr>
</tbody>
</table>

- Milton Babbitt, *Semi-Simple Variations*
- Pierre Boulez, *Le marteau sans maître*, No. 3 “L’artisanat furieux”
- Igor Stravinsky, *Epitaphium*
- Anton Webern, *Variations for Piano*, Op. 27, II (Sehr schnell)
- Arnold Schoenberg, *3 Stücke*, Op. 11, No. 3 (Bewegt)
- George Crumb, *Vox Balaenae*

Figure 4.5. Repertoire list for three weeks prior to Set Theory Survivor. These works were chosen to ensure student exposure to atonal music prior to completing the pre-test questionnaire. For the broader list of works from which the compositions by Bartók, Berg, Schoenberg, and Stravinsky were drawn, see Appendix C.

Students engaged the in-class listening exercises in several ways. On some occasions, I played recordings as background music while students were arriving for
class or simply asked students to listen to a piece without overtly responding to it. At other times, I asked students to share their observations on the music with a single classmate or with the class as a whole. Occasionally, I asked students to write their thoughts about the music on blank index cards and turn them in for me to read. By the beginning of the unit on set theory, students had practiced listening and responding to tonal and post-tonal repertoire in multiple ways. Between these music listening exercises and the repertoire to which the vast majority of students (13 out of 15) were introduced through their concurrent enrollment in a music history course focusing on European and American art music of the twentieth- and twenty-first centuries, students possessed the previous listening experience needed to answer the pertinent questions on the pre-test.

Tribe Composition

Perhaps the most important connection between Survivor and Set Theory Survivor was the grouping of students into cooperative teams called “tribes.” The metaphor of tribal membership was chosen to promote positive interdependence and to foster supportive relationships among members of each tribe through a sense of belonging. According to Elisa Robyn, the more common metaphor of a “team” can evoke group dynamics that place undue burdens on a few members while restricting the individuality of other members. On the other hand, the metaphor of a “tribe” can inspire tribe members to seek “the greater good of the group” without losing sight of the “vital role” played by every individual.¹⁴⁷

Students were assigned to tribes on the basis of their cumulative course averages after the midterm examination. These averages encompassed four homework assignments, three quizzes, and one examination. Tribes were heterogeneous with regard to achievement; every tribe contained at least one higher-achieving, one middle-achieving, and one lower-achieving student. To the extent permitted by the gender balance of the class, tribes were also heterogeneous with regard to gender. This class of fifteen students was made up of nine women and six men. The class was divided into three four-person tribes and one three-person tribe. Two tribes each included two women and two men; one tribe included three women and one man; and one tribe included two women and one man.

The reason for dividing the class into four tribes of varying sizes instead of five three-member tribes was two-fold. First, the choice of predominantly four-member tribes provided more of a cushion to offset occasional student absences. If one member of a four-person tribe was absent, the remaining three members could still form a robust tribe; however, a single member’s absence from a three-person tribe could have a greater impact. Class attendance during the first half of the semester was generally good; however, one student was frequently absent. If this attendance issue persisted, that student’s tribe might often be reduced to a dyad, which did not seem sufficiently large to form a tribe. By assigning this student to a four-person tribe, the anticipated impact of

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148 No rankings of students within their tribes were announced. In contrast to Berry’s designation of a leader for each tribe, all members of a tribe were afforded equal status in Set Theory Survivor. “Surviving Lecture: A Pedagogical Alternative,” *College Teaching* 56, no. 3 (Summer 2008): 151.

149 According to Patrick Laughlin et al., a group size of three people is necessary and sufficient to outperform the “best of an equivalent number of individuals on intellective problems.” “Effects of Group Size,” *Journal of Personality and Social Psychology* 90, no. 4 (2006): 650.
continuing absences would hopefully be mitigated. In essence, the class might then consist of two four-member and two three-member tribes. Second, grouping students into four tribes instead of five facilitated greater uniformity of initial course averages among tribes. The respective tribe averages at the outset of Set Theory Survivor were 86.3%, 85.8%, 85.5%, and 83.8%, with a range of 2.5% (SD = 1.08) between the highest- and lowest-ranked tribes. On the other hand, dividing the class into five three-member tribes would have yielded a range of 5% (SD = 1.79) between the highest- and lowest-ranked tribes. Thus, dividing the class into four tribes provided each tribe with a more equitable chance of winning the game. Five-person tribes were not utilized because of their potential either to reduce contributions by individual members or to take longer to reach consensus during challenges.

On Survivor, each tribe receives a name inspired by the locale. Reflecting the focus of the unit, each Set Theory Survivor tribe was named after a prominent twentieth-century composer whose oeuvre included atonal compositions. The four composers selected were Schoenberg, Bartók, Stravinsky, and Berg. The names of these composers were randomly assigned to the four tribes. The name of the third member of the Second Viennese School, Anton Webern, was not assigned to a tribe. Because of the conciseness and depth of Webern’s music, the music analysis in this unit focused on several of his compositions. Therefore, naming a tribe after Webern might have implicitly privileged that tribe.

Class Location and Activities

During Set Theory Survivor, my class met three times per week (Monday, Wednesday, and Friday from 9:10–10:05 a.m.) in a second-floor classroom in one of the music buildings. While the room was somewhat small, it had large windows providing an abundance of natural light, a Smart Board at the front of the room, ample whiteboard space on three sides of the room, an upright piano, and plenty of folding chairs with attached desks. For the first half of the semester, students sat at their desks in rows facing the front of the room. They occasionally moved their chairs slightly in order to interact more easily with other students during group work, but they primarily stayed in their rows.

Beginning on the day of the first challenge, I rearranged the chairs into four semi-circles: one for each tribe. All of the chairs still faced the front; however, this seating arrangement better facilitated interactions among members of each tribe. The first student to arrive from each tribe chose where his or her tribe would sit that day. Not wanting to limit the choices of the three-person Bartók tribe, I included four chairs in every grouping for the first two classes of the new seating arrangement. The students, however, quickly settled into a routine. Without exception, tribes continued to sit in the same places they selected on the day of the first challenge. Room between tribes allowed me to circulate freely among the students, and students also took advantage of this space to move closer to other members of their tribes from time to time.

In order to maintain a clear line of sight to both the whiteboard at the front of the room and the PowerPoint slides shown on the Smart Board, I moved the piano against the
wall near the front of the room, where it remained accessible for musical demonstrations. I then placed the survival supplies for each tribe on top of the piano. It took me several extra minutes to rearrange the room before each class, but the resulting arrangement was much more conducive to student interactions than the original seating arrangement. As a finishing touch to the classroom environment, I set tropical island pictures as the desktop display for the computer connected to the Smart Board. These pictures provided a welcome respite from the winter weather outside and helped set the tone for Set Theory Survivor.

A typical, fifty-five-minute class period during Set Theory Survivor opened with an update on the standing of tribes in the game. The “scoreboard” slide was displayed on the Smart Board while we listened to a brief musical work by the composer whose namesake tribe was currently in the lead. For instance, if the Bartók tribe was in first place, we listened to a piece by Bartók at the beginning of class. A list of the music played to celebrate leading tribes during Set Theory Survivor appears in table 4.3. I chose these pieces from a broader list of compositions by Bartók, Berg, Schoenberg, and Stravinsky that I compiled to represent a variety of genres and instrumentations from earlier and later portions of each composer’s oeuvre (see Appendix C). While the music played, I returned graded papers to the students. After addressing any questions regarding

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151 Our listening was not restricted to atonal works by these composers. I represented the breadth of each composer’s work as much as possible within the limited time available. These listening examples provided additional exposure to twentieth-century music while remaining independent of the content covered in class.

152 In the event that two tribes were tied for first place, each tribe placed one of their buffs in a bag for a drawing. I drew one of the buffs out of the bag (without looking while I did so), and we listened to music by the composer represented by that buff.
course content or upcoming assignments, I collected any homework assignment due that day before proceeding to the daily challenge.

Table 4.3. Music played to celebrate leading tribes during Set Theory Survivor.

<table>
<thead>
<tr>
<th>Challenge #</th>
<th>Leading Tribe</th>
<th>Music Played at Beginning of Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenge 1</td>
<td>Bartók &amp; Berg</td>
<td>Berg, <em>7 Frühe Lieder</em>, No. 3 “Die Nachtigall”</td>
</tr>
<tr>
<td>Challenge 2</td>
<td>Bartók</td>
<td>Bartók, <em>String Quartet No. 4</em>, IV (Allegretto pizzicato)</td>
</tr>
<tr>
<td>Challenge 3</td>
<td>Bartók</td>
<td>Bartók, <em>Szekely Folksongs</em>, No. 3 “Vekony cerna, kemeny mag”</td>
</tr>
<tr>
<td>Challenge 5</td>
<td>Bartók</td>
<td>Bartók, <em>Mikrokosmos</em>, Book 6, No. 142 “From the Diary of a Fly”</td>
</tr>
</tbody>
</table>

During the challenge, students worked together in their tribes to complete a worksheet covering material previously presented and practiced in class.153 I observed the progress of each tribe and answered questions as needed. Once tribes completed and turned in their copies of the challenge, I presented new material through a brief lecture interspersed with musical examples, opportunities for students to ask and answer questions, and practice exercises designed to give students hands-on experience with new materials and skills. At the end of the class period, I dismissed the students but remained

153 The challenge worksheets focused on written exercises, rather than listening exercises, so tribes could work at their own paces without distracting each other. While the overall emphasis of the unit was more computational than music-analytical, musical examples and aural reinforcement of course concepts were incorporated into the class lectures.
available to answer additional questions as they packed up. Later, I posted that day’s practice worksheets and corresponding answer keys on Carmen so students could complete any remaining exercises, check their work, and review for the next class. I also posted the daily challenge and its answer key on Carmen after class.

Throughout Set Theory Survivor, students completed a total of seven graded challenges and one ungraded reward challenge, spending a total of approximately 1 hour and 45 minutes completing challenges during the four-week unit.\(^{154}\) With the exception of Challenge 7, students completed each challenge with the other members of their tribes. A summary of the tasks included in each challenge appears in table 4.4. While most of the information contained in the table is self-explanatory, some additional observations are warranted. First, Challenge 4 appeared as part of a class-long interactive analysis engaging aspects of form, motive, pitch, texture, and dynamics in the fourth of Webern’s *Five Movements for String Quartet*. Given a notated septachord from this movement, students converted the pitch-class set to integer notation and found its normal form and prime form before calculating its interval-class vector. Second, because Challenge 5 served as a timely review for students following Spring Break, it focused on concepts that students learned relatively early in the unit. Third, students completed Challenge 7 individually in order to demonstrate their mastery of course material by completing a wide variety of exercises pertaining to transposition, inversional equivalence, prime form, and pitch-class invariance. Finally, the ungraded reward challenge followed Challenge 6 but preceded Challenge 7; this challenge helped students review set-theoretical

\(^{154}\) The challenges and their corresponding answer keys appear in Appendix A.
terminology by matching terms such as “Index Vector” and “Prime Form” with their visual representations. Tribes worked together to complete this challenge, then checked their answers against a provided answer key. The matching portion of the challenge was followed by a few brief exercises completed at the whiteboard. For each correct answer, a tribe earned a piece of chocolate candy; the total number of candies earned was divided among the members of that tribe.\footnote{The inspiration for this challenge came from a similar strategy presented by Burks (Burks, “Survivor Math,” 68).}

Because students were new to set-theoretical analysis, the challenge exercises focused primarily on skills from the lower and middle rungs of Bloom’s Taxonomy: remembering, understanding, and applying concepts.\footnote{Benjamin S. Bloom et al., \textit{Taxonomy of Educational Objectives: Cognitive Domain} (New York: McKay, 1956); Lorin W. Anderson and David R. Krathwohl, eds., \textit{A Taxonomy for Learning, Teaching, and Assessment: A Revision of Bloom’s Taxonomy of Educational Objectives} (New York: Longman, 2001).} However, peer tutoring within tribes helped students to engage higher levels of learning through analysis and evaluation as they explained concepts and processes to their peers and monitored each other’s progress during each challenge. Higher levels of learning were prominent later in the semester as students collaborated on a series of in-class composition exercises. These exercises culminated in an individually completed composition project that required students to synthesize what they had learned about pitch-class set theory in order to create original works of music. This emphasis on high-level learning through creative composition and analysis projects was an integral part of the core music theory curriculum at Ohio State.
Table 4.4. Tasks for in-class challenges.

<table>
<thead>
<tr>
<th>Challenge #</th>
<th>Tasks</th>
</tr>
</thead>
</table>
| Challenge 1 | • Convert pitch-class names from letters to integers  
• Perform calculations with modulo 12 arithmetic  
• Identify ordered and unordered pitch-class intervals  
• Calculate the normal form of pitch-class sets |
| Challenge 2 | • Determine transpositional equivalence  
• Transpose a pitch-class set |
| Challenge 3 | • Determine inversional equivalence  
• Invert and transpose a pitch-class set  
• Find the prime form of a pitch-class set |
| Challenge 4 | • Convert a notated septachord to integer notation  
• Find the normal form of this pitch-class set  
• Find the prime form of this pitch-class set  
• Calculate the interval-class vector for this pitch-class set |
| Challenge 5 | • Find the prime form of a pitch-class set  
• Determine transpositional equivalence  
• Invert and transpose a pitch-class set |
| Challenge 6 | • Find pitch classes that remain invariant under transposition (consult the List of Set Classes)\(^{157}\)  
• Determine which transpositions produce a specific number of invariant pitch classes  
• Complete a summation square for a pitch-class set and give the index vector  
• Determine which inversions of the pitch-class set produce specific numbers of invariant pitch classes |
| Reward Challenge (Ungraded) | • Match terms with their visual representations  
• Complete additional exercises at the whiteboard |
| Challenge 7 (Individual) | • Transpose a pitch-class set  
• Determine inversional equivalence  
• Find the prime form of a pitch-class set  
• Given a pitch-class set and its interval-class vector, determine which transpositions produce a specific number of invariant pitch classes  
• Complete a summation square for a pitch-class set and give the index vector |

\(^{157}\) The List of Set Classes appears in Appendix B.
Before beginning a challenge, students cleared their desks, except for writing utensils, as they would during a typical quiz. Each tribe sent one member to claim the tribe’s folder, dry-erase markers, and eraser from their place atop the piano. In addition to the survival supplies of staff paper and notebook paper, each folder contained enough copies of the current challenge for each member of the tribe. In order to claim the resources on behalf of the tribe, the designated member had to bring his or her buff to the front of the room and leave it, like a security deposit, on top of the piano in place of the resources. Buffs could be reclaimed when the resources were returned. Students worked together in their tribes to complete the assigned exercises. They were permitted to talk freely with the other members of their tribes during the challenge; additionally, I circulated the room to monitor students’ progress and answer questions. In order to allow sufficient time for peer tutoring, I avoided setting a strict time limit for the challenge. However, I did keep track of time and, when necessary, encouraged students to finish as soon as possible. Most challenges took 12–14 minutes for students to complete. Each student turned in a copy of the challenge labeled with the tribe’s name as well as the name of the person completing the challenge.

After class, I graded each copy of the challenge according to my answer key. Each student received an individual grade for the challenge; this grade became part of that student’s quiz grade for the course. The scores of each member of a tribe were

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158 The only exception was Challenge 1, for which students were permitted to consult their notes.

159 Grades for three challenges were averaged together to produce a grade given the weight of a single quiz. The only exception was Challenge 7, which was completed individually and constituted a full quiz grade. This challenge, the individual completion of which was announced at the beginning of Set
averaged together to form a “tribe score.” Throughout the game, tribes were ranked by means of their tribe scores; however, students’ grades were affected only by their own work. If a member of a tribe missed a challenge, the scores of the remaining members were averaged together to produce the tribe score. In the case of an excused absence, the absent student was excused from completing that challenge, and the tribe was not penalized for its absent member. If, however, the absence was unexcused, the absent student received a zero for that challenge (and therefore for that portion of the associated quiz grade). The scores of the remaining members were averaged together as usual, and the resulting tribe score was reduced by 1% for each unexcused-absent member. This system encouraged consistent attendance without penalizing tribes excessively for any absent members. The presence of a slight tribe-score penalty for unexcused absences encouraged students to act responsibly toward the other members of their tribes and to hold each other accountable for coming to class and engaging the material.

Conclusion

On the last day of Set Theory Survivor, students worked together in their tribes to complete the first of three in-class composition exercises. These exercises were not graded; rather, they served as preparatory activities leading up to an individually completed composition project at the end of the semester. Following this in-class exercise, the class watched the opening credits video as they did at the beginning of Set Theory Survivor. I followed the video with a verbal announcement of how close the tribe scores had been throughout the entire game, complimented them on their hard work and

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Theory Survivor, was designed to promote individual accountability for the course material. Each student received three quiz grades during Set Theory Survivor, for a total of 3.33% of his or her course grade.
achievement, and encouraged them to give themselves a round of applause. I then asked them to close their eyes briefly while I brought up the final scoreboard slide on the Smart Board. Similar in format to the previous scoreboards, this slide replaced the phrase “Now leading…” with “And the winner is…” and displayed the purple color of the winning Schoenberg tribe as its background (see figure 4.6). Directing students to open their eyes, I congratulated the winning tribe and called its members to the front of the room to receive their prizes.

Figure 4.6. Final scoreboard for Set Theory Survivor.

Once again merging the four tribes into a single class, we rearranged the semicircles of chairs into one large circle. Students still sat with members of their tribes, but they could now readily see and interact with all their classmates. I placed the piano bench, covered with clean buffs in every tribe color, in the middle of the circle to serve as
a table for refreshments: doughnut holes, chocolate candy, and juice.\textsuperscript{160} \textit{Survivor}-themed cups and napkins lent a festive air to our end-of-game celebration. While students enjoyed their refreshments, I facilitated a group discussion of Set Theory Survivor. These discussion questions appear in figure 4.7. Wrapping up the group discussion at the end of class, I played a recording of music by the winning tribe’s composer (Schoenberg) to conclude the game as students gathered their belongings and left the classroom.

1. What are your overall impressions of Set Theory Survivor?
2. If another class wanted to play Set Theory Survivor, what suggestions would you give the teacher and students?
3. When you first heard that we would be playing Set Theory Survivor, what did you expect?
4. What surprised you about it?
5. What would you keep the same?
6. What would you change?
7. How many of you are currently enrolled in the twentieth-century music history course?
8. What did you think about listening to music by the leading tribe’s composer at the beginning of each class?
9. Do you have any other comments?

Figure 4.7. Questions for group discussion.

Building upon the discussion in the current chapter, I present the results of implementing Set Theory Survivor in the chapter that follows. In that chapter, I share my own observations of the game as well as those of my students. I also present and discuss student responses to pre-test and post-test questionnaires exploring their attitudes toward

\textsuperscript{160} Having refreshments in class was a rare treat; with the exception of the chocolate candy I supplied for the reward challenge, the Set Theory Survivor celebration was the first time I brought food to class for my students that semester.
post-tonal music, their self-perceived abilities to use set-theoretical analysis to study post-tonal music, and their views of Set Theory Survivor as a framework for studying pitch-class set theory. Finally, I discuss some limitations of the present study and suggest avenues for future research.
Chapter 5: Results of Set Theory Survivor

Introduction

Building upon the discussion in the previous chapter, this chapter presents the results of implementing Set Theory Survivor in the classroom. In this chapter, I share both my own observations of the game and those of my students. I also present and discuss student responses to questionnaires exploring their attitudes toward post-tonal music, their self-perceived abilities to use set-theoretical analysis to study post-tonal music, and their views of Set Theory Survivor as a framework for studying pitch-class set theory. Finally, I discuss some limitations of the present study and suggest avenues for future research.

Student responses to the pre-test questionnaire given at the beginning of the unit appear numerically in table 5.1 and graphically in figure 5.1; student responses to the post-test questionnaire administered at the end of the unit appear numerically in table 5.2 and graphically in figure 5.2.¹ Sixty-one of the fifteen students participating in Set Theory Survivor completed the pre-test questionnaire; similarly, thirteen students completed the post-test questionnaire. However, only twelve students completed both the pre-test and post-test questionnaires.² Percentages shown in tables 5.1 and 5.2 and in

¹ For the complete pre-test questionnaire, see Appendix D. For the complete post-test questionnaire, see Appendix E.

² Both questionnaires were administered during class; students who were absent on one or both of these days did not complete the associated questionnaire(s). Make-up questionnaires were not used
figures 5.1 and 5.2 reflect responses from all thirteen students who completed the respective questionnaires, but the graphs presented later in the chapter (figures 5.4 and 5.5) include only the responses of the twelve students who completed both questionnaires.

In order to facilitate visual comparisons among student responses to Likert-type questions on the pre-test and post-test questionnaires, results from tables 5.1 and 5.2 are presented graphically in figures 5.1 and 5.2. Figure 5.1 corresponds to table 5.1, and figure 5.2 corresponds to table 5.2. These figures are divided into segments containing two to ten questions each; each segment represents a single category from its corresponding table. Within each segment, questions are listed from bottom to top in the same order in which they initially appeared in tabular form.

*Attitudes toward Post-Tonal Music*

Students answered the open-response questions “What do you like the most about post-tonal music?” (Question 4) and “What do you dislike the most about post-tonal music?” (Question 8) on both pre-test and post-test questionnaires. When responding to the first of these questions on the pre-test, some students expressed dislike for post-tonal music (“I’m not a huge fan”); some described liking post-tonal works that maintain vestiges of tonality (“Sometimes the pieces that keep a little tonality are okay to listen to”); and some expressed appreciation for the new means of expression available in post-tonal music (“It allows for a more exotic way of interpreting different emotions or objects”). Dislikes mentioned on the pre-test included a perceived lack of structure (“It
sounds like random notes not music”), excessive dissonance (“The dissonance is interesting but I still like something I can hum. I like a little meaningful dissonance [Debussy] as opposed to Schoenberg”), and difficulty in performance (“[I]t is tricky to play”) and analysis (“It can be hard to decide what is going on so it can be hard to analyze”). The aspects of post-tonal music for which students expressed dislike on the post-test were similar to those on the pre-test; most of these comments focused on the perceived lack of structure and aesthetic inaccessibility of post-tonal music (“It sounds like random notes. I don’t think it’s pleasant to listen to”).

When asked on the post-test what they liked most about post-tonal music, nearly half the students (6 out of 13) mentioned the mathematical aspects of pitch-class set theory (“[I]t’s easy math & always has an interesting way to analyze it”). These responses contrasted with my initial expectation, based on the anxiety sometimes reported in the literature when students first encounter the mathematics of set-theoretical analysis, that students would be uncomfortable with the mathematical aspects of pitch-class set theory. Although some students commented during the unit that they were not good at math, the post-test responses imply that math anxiety was not a major issue for the class as a whole. Other students reported liking the “[a]llowance for creativity” in post-tonal music and “[t]he new methods of playing new instruments and the significance of each note played.”

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163 Eight students also identified math as the aspect of the unit on set theory that they liked most (post-test Question 17).

164 Further research would be needed to determine whether any students in the class did experience math anxiety when working with pitch-class set theory.
Table 5.1. Likert-type questions from pre-test questionnaire. The results indicate the percentage (rounded to the nearest 0.1%) of students who chose that response for the respective question; 1 = Strongly Disagree, 2 = Disagree, 3 = Slightly Disagree, 4 = Neutral, 5 = Slightly Agree, 6 = Agree, 7 = Strongly Agree. If two adjacent answers were circled, half the percentage was assigned to each answer.

### Learning and Working Preferences

| 1 | I like to learn about new techniques for analysis. | 7.7 | 0 | 0 | 23.1 | 38.5 | 23.1 | 7.7 |
| 2 | I prefer to complete assignments by myself. | 7.7 | 23.1 | 23.1 | 15.4 | 7.7 | 15.4 | 7.7 |
| 3 | I prefer to complete assignments with other people. | 0 | 0 | 0 | 23.1 | 46.2 | 23.1 | 7.7 |

### Attitudes toward Post-Tonal Music

| 6 | I appreciate the underlying structure of post-tonal music. | 15.4 | 15.4 | 7.7 | 19.2 | 26.9 | 15.4 | 0 |
| 7 | I like to listen to post-tonal music. | 23.1 | 23.1 | 15.4 | 0 | 15.4 | 23.1 | 0 |

### Experience with Set Theory and Ability to Perform Set-Theoretical Operations

| 5 | I have studied set theory before. | 53.8 | 23.1 | 7.7 | 0 | 7.7 | 7.7 | 0 |
| 9 | I can find the normal order of a pitch-class set. | 38.5 | 38.5 | 15.4 | 7.7 | 0 | 0 | 0 |
| 10 | I can find the prime form of a pitch-class set. | 46.2 | 38.5 | 7.7 | 0 | 7.7 | 0 | 0 |
| 11 | I can find the interval-class vector of a pitch-class set. | 46.2 | 46.2 | 7.7 | 0 | 0 | 0 | 0 |
| 12 | I can transpose a pitch-class set that is in normal order. | 30.8 | 23.1 | 15.4 | 7.7 | 23.1 | 0 | 0 |
| 13 | I can invert a pitch-class set that is in normal order. | 30.8 | 30.8 | 7.7 | 7.7 | 23.1 | 0 | 0 |
| 14 | I can invert and transpose a pitch-class set that is in normal order. | 30.8 | 30.8 | 15.4 | 7.7 | 15.4 | 0 | 0 |
| 15 | I can identify pitch classes that remain invariant under transposition. | 30.8 | 53.8 | 7.7 | 7.7 | 0 | 0 | 0 |
| 16 | I can identify pitch classes that remain invariant under inversion. | 46.2 | 46.2 | 7.7 | 0 | 0 | 0 | 0 |
| 17 | I am comfortable using set theory to analyze post-tonal music. | 53.8 | 30.8 | 7.7 | 7.7 | 0 | 0 | 0 |

### Engagement with Television Show *Survivor*

| 18 | I enjoy watching the television show *Survivor*. | 15.4 | 7.7 | 0 | 34.6 | 19.2 | 15.4 | 7.7 |
| 19 | I watch the television show *Survivor* regularly. | 46.2 | 23.1 | 7.7 | 15.4 | 0 | 0 | 7.7 |

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165 Question 5 appeared only on the pre-test questionnaire.

166 This question appeared as Question 5 on the post-test questionnaire.

167 This question appeared as Question 22 on the post-test questionnaire.

168 This question appeared as Question 23 on the post-test questionnaire.
Figure 5.1. Student responses to pre-test questionnaire. A, Learning and working preferences. B, Attitudes toward post-tonal music. C, Experience with set theory and ability to perform set-theoretical operations. D, Engagement with television show *Survivor*. 
Figure 5.1 (continued)

C.

Pre-Test: Experience with Set Theory and Ability to Perform Set-Theoretical Operations

![Bar chart showing student responses to questions about set theory and ability to perform set-theoretical operations.]

D.

Pre-Test: Engagement with Television Show Survivor

![Bar chart showing student responses to questions about engagement with the television show Survivor.]
Table 5.2. Likert-type questions from post-test questionnaire. The results indicate the percentage (rounded to the nearest 0.1%) of students who chose that response for the respective question; 1 = Strongly Disagree, 2 = Disagree, 3 = Slightly Disagree, 4 = Neutral, 5 = Slightly Agree, 6 = Agree, 7 = Strongly Agree. If two adjacent answers were circled, half the percentage was assigned to each answer.

<table>
<thead>
<tr>
<th>Learning and Working Preferences</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 I like to learn about new techniques for analysis.</td>
<td>0.0</td>
<td>7.7</td>
<td>7.7</td>
<td>7.7</td>
<td>38.5</td>
<td>38.5</td>
<td>0.0</td>
</tr>
<tr>
<td>2 I prefer to complete assignments by myself.</td>
<td>7.7</td>
<td>7.7</td>
<td>15.4</td>
<td>15.4</td>
<td>23.1</td>
<td>26.9</td>
<td>3.8</td>
</tr>
<tr>
<td>3 I prefer to complete assignments with other people.</td>
<td>0.0</td>
<td>0.0</td>
<td>23.1</td>
<td>15.4</td>
<td>38.5</td>
<td>7.7</td>
<td>15.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attitudes toward Post-Tonal Music</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 I appreciate the underlying structure of post-tonal music.</td>
</tr>
<tr>
<td>7 I like to listen to post-tonal music.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Experience with Set Theory and Ability to Perform Set-Theoretical Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 I can find the normal order of a pitch-class set.</td>
</tr>
<tr>
<td>10 I can find the prime form of a pitch-class set.</td>
</tr>
<tr>
<td>11 I can find the interval-class vector of a pitch-class set.</td>
</tr>
<tr>
<td>12 I can transpose a pitch-class set that is in normal order.</td>
</tr>
<tr>
<td>13 I can invert a pitch-class set that is in normal order.</td>
</tr>
<tr>
<td>14 I can invert and transpose a pitch-class set that is in normal order.</td>
</tr>
<tr>
<td>15 I can identify pitch classes that remain invariant under transposition.</td>
</tr>
<tr>
<td>16 I can identify pitch classes that remain invariant under inversion.</td>
</tr>
<tr>
<td>5 I am comfortable using set theory to analyze post-tonal music.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Engagement with Television Show Survivor</th>
</tr>
</thead>
<tbody>
<tr>
<td>22 I enjoy watching the television show Survivor.</td>
</tr>
<tr>
<td>23 I watch the television show Survivor regularly.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Perspectives on Set Theory Survivor</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 I learned a lot during the unit on set theory.</td>
</tr>
<tr>
<td>19 The “Theory Survivor” format made the unit on set theory challenging.</td>
</tr>
<tr>
<td>20 The “Theory Survivor” format made the unit on set theory enjoyable.</td>
</tr>
<tr>
<td>24 The “Theory Survivor” format made the unit on set theory interesting.</td>
</tr>
</tbody>
</table>

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169 This question appeared as Question 17 on the pre-test questionnaire.
170 This question appeared as Question 18 on the pre-test questionnaire.
171 This question appeared as Question 19 on the pre-test questionnaire.
172 The questions in this category appeared only on the post-test questionnaire.
Figure 5.2. Student responses to post-test questionnaire. A, Learning and working preferences. B, Attitudes toward post-tonal music. C, Experience with set theory and ability to perform set-theoretical operations. D, Engagement with television show *Survivor*. E, Perspectives on Set Theory Survivor.
Figure 5.2 (continued)

C. Post-Test: Experience with Set Theory and Ability to Perform Set-Theoretical Operations

D. Post-Test: Engagement with Television Show Survivor
Contrary to what I anticipated, no significant differences appeared in the pre-test and post-test responses of students to Question 6 (“I appreciate the underlying structure of post-tonal music”) or Question 7 (“I like to listen to post-tonal music”). It is worth noting, however, that each student was able to identify on the post-test some aspect of post-tonal music that he or she liked; this was not the case for two students on the pre-test.¹⁷³

**Student Perspectives on Set Theory Survivor**

News of Set Theory Survivor spread quickly; the day after I announced the game in class, I ran into a former student who mentioned that one of my currently enrolled students had told him about the “tribes” that we were using in class. About a week later, one of the students in another class I was teaching asked if we would be playing Survivor

¹⁷³ Eleven of thirteen students were able to identify on the pre-test an aspect of post-tonal music that they liked.
in that class, too. When I informed him that we would not, he pointed out that one of his classmates (who was also enrolled in my theory class) already had “one of those bandanna things” (i.e., a buff), implying that it would be convenient for us also to incorporate the game into our class.

While only one student mentioned watching *Survivor* regularly on the pre-test questionnaire (Question 19), several students expressed some level of enjoyment in watching *Survivor* (7.7% strongly agreed, 15.4% agreed, and 19.2% slightly agreed with Question 18). Upon my initial announcement of Set Theory Survivor, several students showed their familiarity with *Survivor* by referring to specific elements of the show such as buffs, survival supplies, and alliances. The greatest enthusiast in the class—the same student who called *Survivor* “the greatest game show of all time” in the pre-test additional comments—drew points of comparison between our activities and those of contestants on *Survivor*. For instance, when I distributed buffs to the class, this student asked if I could throw the buffs to them like the host does on *Survivor*.

The opening credits video helped to build excitement and set the tone for the unit. Its debut on the first day of Set Theory Survivor was greeted with laughter, light applause, and requests for an encore. At the next class, students informed their classmates who had been absent that they had missed the “fun opening video.” Their description of the video as “fun” persisted nearly a month later when I played the opening credits just prior to announcing the winning tribe. During this screening, some students spontaneously cheered when pictures of their tribe’s composer appeared.
Students’ perceptions of Set Theory Survivor as fun were reflected in their open-response comments on the post-test questionnaire. When asked to write any additional comments they had, one student wrote, “It was fun! I liked it a lot,” while another student remarked, “Nice idea with how the unit was set up.” A third student described Set Theory Survivor as “fun” and “enjoyable” during the group discussion at the end of the unit. As I anticipated, an overwhelming majority of students believed the game-like format of the unit was enjoyable. When responding to post-test Question 20 ("The ‘Theory Survivor’ format made the unit on set theory enjoyable"), 30.8% of students strongly agreed, 53.8% agreed, 7.7% slightly agreed, and 7.7% were neutral regarding this question. Similarly, all students who completed the post-test questionnaire believed “[t]he ‘Theory Survivor’ format made the unit on set theory interesting” (38.5% strongly agreed, 23.1% agreed, and 38.5% slightly agreed with Question 24). Student responses to Question 19 (“The ‘Theory Survivor’ format made the unit on set theory challenging”) varied widely (7.7% strongly agreed, 38.5% agreed, 15.4% were neutral, 7.7% slightly disagreed, 15.4% disagreed, and 15.4% strongly disagreed). The breadth of these responses may reflect differing perspectives on what constituted a challenge. On the one hand, working together with one’s peers reduced the pressure of retaining concepts and applying skills individually; however, the positive interdependence built into the tribes made each student partially responsible for the success of other tribe members. One student made this perspective explicit by writing the following comment next to Question 19: “[Y]ou had to work hard for you and your group.”

\footnote{One student also commented, “I really enjoyed the Survivor experiment!” on the end-of-semester course evaluation.}
Outcome of the Game

Harnessing the collective intelligence of their tribes, students performed very well on the challenge worksheets.\textsuperscript{175} The grades of each member of a tribe were averaged together to produce a tribe score. Tribe scores for each challenge appear in table 5.3. The score of each tribe on the most recent challenge was averaged together with that tribe’s scores on previous challenges to produce a cumulative tribe score (cumulative tribe scores appear in table 5.4). Relative rankings of the four tribes throughout the unit were based on these cumulative scores, and the tribe that finished the unit with the highest cumulative score was declared the winner.\textsuperscript{176}

In table 5.4, the score of the leading tribe after each challenge appears in bold. While the Bartók and Berg tribes tied for first place after the first challenge, the Berg tribe lost ground after the second challenge, leaving the Bartók tribe to enjoy a winning streak spanning five more challenges. Not until the final, individually completed challenge did the Bartók tribe give way to the Schoenberg tribe; after occupying second place for Challenges 3–6, the Schoenberg tribe earned the highest tribe score (by a decisive 8%) on the individually completed Challenge 7, bypassing the long-leading Bartók tribe to win the game by a margin of 0.9%.

\footnotesize{\textsuperscript{175} For a detailed description of the challenges and a sample challenge, see Chapter Four. Complete copies of the challenges and their corresponding answer keys appear in Appendix A.}

\footnotesize{\textsuperscript{176} Besides contributing to the tribe scores that determined the outcome of the game, students’ individual grades on the challenges were incorporated into their quiz grades for the semester in order to encourage them to take the challenges seriously. While the actual performance of students on the challenges was not the focus of this study, a single-factor Anova revealed that the final cumulative challenge scores did not differ significantly from tribe to tribe.}
Table 5.3. Tribe scores during Set Theory Survivor.

<table>
<thead>
<tr>
<th>Challenge #</th>
<th>Bartók</th>
<th>Berg</th>
<th>Schoenberg</th>
<th>Stravinsky</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenge 1</td>
<td>100</td>
<td>100</td>
<td>98</td>
<td>99</td>
</tr>
<tr>
<td>Challenge 2</td>
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<td>Challenge 4</td>
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<td>99</td>
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</tr>
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<td>Challenge 5</td>
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<td>100</td>
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</tr>
<tr>
<td>Challenge 6</td>
<td>94</td>
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<tr>
<td>Challenge 7</td>
<td>88</td>
<td>88</td>
<td>96</td>
<td>80</td>
</tr>
</tbody>
</table>

Table 5.4. Cumulative tribe scores during Set Theory Survivor.

<table>
<thead>
<tr>
<th>Challenge #</th>
<th>Bartók</th>
<th>Berg</th>
<th>Schoenberg</th>
<th>Stravinsky</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenge 1</td>
<td>100</td>
<td>100</td>
<td>98</td>
<td>99</td>
</tr>
<tr>
<td>Challenge 2</td>
<td>100</td>
<td>99</td>
<td>99</td>
<td>99.5</td>
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<td>99.7</td>
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<td>Challenge 4</td>
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<td>Challenge 6</td>
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<tr>
<td>Challenge 7</td>
<td>97.4</td>
<td>96.4</td>
<td>98.3</td>
<td>95.4</td>
</tr>
</tbody>
</table>

The Bartók tribe’s lengthy tenure as the leading tribe may partially be attributed to attendance: although the Bartók tribe occasionally had an absent member during a challenge, all of these absences were excused. On the other hand, each of the other three tribes accumulated two unexcused absences, in addition to excused absences, during the course of the game. As described in the previous chapter, each unexcused absence
resulted in a 1% deduction from the tribe score for that challenge. Nonetheless, the cumulative scores of all four tribes remained extremely close throughout the entire competition. Indeed, the first- and last-place scores for Challenges 1–4 were separated by only 1%. It was, as I told students on more than one occasion, “anybody’s game.” The prolonged success of the three-member Bartók tribe and the eventual victory of the four-member Schoenberg tribe demonstrate that it is possible for tribes of different sizes to have similar chances of winning. Furthermore, the initial ranking of tribes did not predict the order in which tribes would rank in the game Set Theory Survivor.

<table>
<thead>
<tr>
<th>Tribe rankings before Set Theory Survivor</th>
<th>Tribe rankings after Set Theory Survivor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bartók</td>
<td>1. Schoenberg</td>
</tr>
<tr>
<td>2. Stravinsky</td>
<td>2. Bartók</td>
</tr>
</tbody>
</table>

Figure 5.3. Tribe rankings before and after Set Theory Survivor. Rankings before Set Theory Survivor were based on the cumulative course averages of the students in each tribe following the midterm examination. Rankings after Set Theory Survivor were based on the cumulative average performance of each tribe on Challenges 1–7.

As seen in figure 5.3, none of the tribes retained their original rankings at the end of Set Theory Survivor. Instead, the tribes initially ranked first and fourth (Bartók and Berg, respectively) each moved one place closer to the middle (Bartók 1→2; Berg 4→3) while
the other two tribes (Stravinsky and Schoenberg) crossed paths as they each moved two places toward the outer boundaries of the tribe rankings (Stravinsky 2 → 4; Schoenberg 3 → 1). This thorough redistribution of tribe rankings suggests that the initial grouping of students yielded tribes that were evenly matched, providing all tribes with similar chances of winning the game.

Responsibility toward Fellow Tribe Members

Many students exhibited a sense of responsibility toward the other members of their tribes. In addition to attending class regularly—even on the Friday before Spring Break—they expressed concern for their fellow tribe members when absences were unavoidable. Notifying me of an illness-related absence, one student requested, “Tell my survivor group I’m sorry I couldn’t make it.” When a concert tour required several students to miss two consecutive classes, one of these students expressed hope that her absence would not affect her tribe’s score, and another student took the initiative to e-mail the other members of her tribe to inform them of her upcoming absence. Concern for the well-being of one’s fellow tribe members was also evident in the classroom; on one occasion, I heard a student asking a fellow tribe member about the status of a problem he had mentioned earlier that week. A student who received a low grade on the individually completed Challenge 7 apologized to the other tribe members for bringing down their tribe score. Another student, who openly displayed her tribe spirit by keeping her buff tied to her backpack on days when we did not have class, said that she was very proud of
her tribe. During the group discussion at the end of the unit, one student mentioned feeling pressure to “do well for my team.”¹⁷⁷

As anticipated, the positive interdependence built into Set Theory Survivor also sparked constructive peer pressure. One student, as mentioned in the previous chapter, was frequently absent from classes during the first half of the semester. Since he missed my initial class announcement and the grouping of students into tribes, I met with him individually to explain the format of the unit. When he arrived for our meeting, he said that he had encountered two classmates who acquainted him with the premise of Set Theory Survivor and “told [him] that [his] life was about to change.” One of the classmates assigned to his tribe was especially insistent that he come to class. Impressively, he rose to the occasion and even arrived early for the next class. His attendance during the Set Theory Survivor unit was much more consistent than it had been previously, and he expressed care for his tribe by bringing his buff to class when the member who normally used her buff to claim the tribe’s materials was absent. The process of working with the other members of his tribe appeared to aid his comprehension of course material. Toward the end of the game, he expressed pride that he was now able to complete most of a challenge without assistance from his tribe.

¹⁷⁷ This student and at least one other student still had their buff[s] tied to their backpacks more than three weeks after the conclusion of Set Theory Survivor (i.e., until the end of the semester). A third student had his buff tied to his instrument case three weeks after the conclusion of Set Theory Survivor. Each of the three students mentioned here represented a different tribe.

¹⁷⁸ This student still described Set Theory Survivor as enjoyable.
**Peer Tutoring**

Peer tutoring was integral to Set Theory Survivor. While working in their tribes, students regularly asked each other questions, provided explanations, and compared their answers on practice worksheets and challenges. Instead of the quiet, tense atmosphere that is all too common when students take a quiz, challenges sparked lively conversations and camaraderie among students. In general, the highest-achieving student in each tribe assumed the role of leader (although no tribe leaders were designated) early in the game by taking the initiative to provide explanations to the other members of their tribes.\(^ {179}\) However, tribe members took on more equal roles as the game continued, with explanations coming from more than one member of each tribe and the higher-achieving students also receiving help from other members of their tribes. Students explicitly asked their fellow tribe members if they understood the skills required for the challenge and supplied explanations when needed. Additionally, students sometimes rose from their desks and moved to stand or sit by different members of their tribes in order to facilitate giving or receiving these explanations. By the third challenge, tribes functioned almost independently; I remained available to answer questions, but the tribes usually had matters well in hand. The efficacy of collective knowledge within each tribe was especially evident in contrast to the confusion and greater need for my help that arose during Challenge 6 when class attendance was at its lowest point of the unit (six students were absent, primarily due to a required concert tour). With one or two members absent from each tribe, I frequently circulated the room to answer student questions. The

\(^ {179}\) I did not structure tribes’ intragroup interactions in any specific way, nor did I assign particular roles to the members of each tribe.
combination of increasingly challenging content and lower tribe efficacy contributed to somewhat lower scores for each tribe on Challenge 6 (see table 5.3).

During the group discussion, students commented favorably on working with their peers throughout the learning process. One student identified “a more open dialogue” resulting from Set Theory Survivor, while another student described the game as a “bonding experience” that formed connections within the class. This student explained that she had never spoken with one of the other members of her tribe prior to Set Theory Survivor; however, their work together in class now extended beyond the classroom to collaboration on homework assignments.

**Student Learning**

Students reported considerable learning during the unit covered by Set Theory Survivor; this report was consonant with my expectations prior to the unit. When responding to post-test Question 18 (“I learned a lot during the unit on set theory”), 30.8% of students strongly agreed, 61.5% agreed, and 7.7% slightly agreed (see table 5.2). Few students had previous experience with set theory; only two students agreed or slightly agreed with pre-test Question 5 (“I have studied set theory before”). As demonstrated by their questionnaire responses, the self-perceived ability of students to perform specific set-theoretical operations increased over the course of the unit. Figure 5.4 shows mean responses to Likert-type questions appearing on both the pre-test and

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180 The positive bonding of tribe members during Set Theory Survivor was one of the anticipated outcomes of the game. However, contrary to my initial expectation, no statistically significant difference emerged in students’ learning and working preferences from pre-test to post-test.

181 Such collaboration was both permitted and encouraged in this course.
post-test. In the case of a question that is numbered differently on the post-test than on the pre-test, the graph refers to that question by its number on the pre-test.\footnote{For instance, Q17 includes pre-test Question 17 and post-test Question 5; Q18 includes pre-test Question 18 and post-test Question 22; and Q19 includes pre-test Question 19 and post-test Question 23. All other questions shown on this graph were numbered identically on the pre-test and post-test.}

Questions 9–16 assessed the self-reported ability of students to perform specific set-theoretical operations; for example, Question 10 asked students to respond to the statement “I can find the prime form of a pitch-class set.” As seen in the graph in figure 5.4, the mean response of students increased from pre-test to post-test by 4.2 points or more on a 7-point scale (in several instances, from Disagree to Agree) for every question pertaining to students’ ability to perform set-theoretical operations (Questions 9–16). Their overall growth in capability and confidence is reflected in the marked increase from pre-test to post-test in mean responses to Question 17 (“I am comfortable using set theory to analyze post-tonal music”). The graph in figure 5.4 reveals that the mean differences in student responses to Questions 9–17\footnote{Q9: I can find the normal order of a pitch-class set. Q10: I can find the prime form of a pitch-class set. Q11: I can find the interval-class vector of a pitch-class set. Q12: I can transpose a pitch-class set that is in normal order. Q13: I can invert a pitch-class set that is in normal order. Q14: I can invert and transpose a pitch-class set that is in normal order. Q15: I can identify pitch classes that remain invariant under transposition. Q16: I can identify pitch classes that remain invariant under inversion. Q17: I am comfortable using set theory to analyze post-tonal music.} were statistically significant; the confidence intervals associated with the pre-test and post-test mean responses to these questions do not overlap.\footnote{Data analysis comprised paired t-tests with the Bonferroni correction for multiple tests ($\alpha = 0.05/16 = 0.003125$) and 95\% confidence intervals.}
Figure 5.4. Pre-test and post-test mean responses. Open circles represent pre-test means, while filled circles denote post-test means. Each mean is accompanied by a 95% confidence interval.

The significance of the mean differences for Questions 9–17 also appears in the graph in figure 5.5, inasmuch as the confidence intervals for these questions do not cross zero. Figure 5.5 also includes the differences (represented by small gray dots) in individual student responses from pre-test to post-test. By plotting the individual differences as well as the mean differences, figure 5.5 displays the variability among student responses.
Figure 5.5. Pre-test and post-test mean differences. Differences are represented by open circles, each of which is accompanied by a 95% confidence interval. The small gray dots indicate individual student responses, revealing the variability among these responses.

Several factors may have contributed to this variability in student pre-test and post-test responses as reflected by the varying sizes of the 95% confidence intervals across the questions (see figure 5.4). Focusing on Questions 9–17, the questions for which differences in mean student responses were statistically significant, Questions 12–14 show the most variability in student responses to the pre-test. These questions respectively address the self-reported ability of students to transpose, invert, or invert and transpose a pitch-class set.\(^{185}\) As mentioned earlier, only two students had prior experience with pitch-class set theory; however, students had studied motivic transformations—including transposition and inversion—in their previous core music

\(^{185}\) Q12: I can transpose a pitch-class set that is in normal order. Q13: I can invert a pitch-class set that is in normal order. Q14: I can invert and transpose a pitch-class set that is in normal order.
theory courses. Students’ familiarity with these terms may have led some of them to exhibit more confidence in their ability to perform transposition and inversion operations than they displayed in response to questions containing less-familiar terminology. On the post-test, Questions 15–17 showed the most variability in student responses. Questions 15 and 16 referred to the most recently learned of the specific set-theoretical operations addressed on the questionnaire: identifying pitch classes that remain invariant under transposition or inversion.\textsuperscript{186} Having had a shorter amount of time to reinforce these skills than those previously learned, different rates of student learning may have given rise to the variability seen among student responses to Questions 15 and 16. Finally, student responses to Question 17, which encompassed a wide range of skills learned during the unit, were understandably varied according to students’ individual perceptions of their ability to apply the tools of set-theoretical analysis.\textsuperscript{187}

Comments during the group discussion highlighted the important role daily challenges played in facilitating student learning. One student said she liked the “constant reinforcement” provided by daily challenges. Another student explained, “I was kind of surprised that we had to have a challenge on something that we learned just the class before. Like I wasn’t expecting that, I guess—which I was annoyed with at first, but I feel like it kind of made me go home and actually look at my notes and make sure I knew it before I came to class.” The comment of a third student summed up the general consensus; when asked what she would keep the same if playing Set Theory Survivor

\textsuperscript{186} Q15: I can identify pitch classes that remain invariant under transposition. Q16: I can identify pitch classes that remain invariant under inversion.

\textsuperscript{187} Q17: I am comfortable using set theory to analyze post-tonal music.
again, she responded, “The daily challenge[s]. They were annoying, but they helped.” In
addition to the benefits of the daily challenges to their own learning, one student, a music
education major, found it helpful to see that there is more than one way to teach; Set
Theory Survivor inspired her to consider “more interesting ways to share information
with kids.” Thus, the impact of Set Theory Survivor on student learning has the potential
to go beyond the learning of participants themselves to influence the learning of students
who will someday be taught by participants in Set Theory Survivor.

Discussion

One of the greatest strengths of this study is the authentic educational setting in
which it took place. Participants in Set Theory Survivor came from a small, intact class of
students with a variety of strengths and weaknesses, and the absence of students due to
required travel for a concert was not uncommon in a course designed for music majors.
The day-to-day operation of the study was subject to the demands of the course schedule
as well as the pedagogical needs of the students. I regularly revised upcoming challenges
in order to address student needs and manage the course schedule effectively.

The primary limitations of this study are the small sample size and the absence of
a control group. With only fifteen students participating in the study (and twelve students
completing both pre-test and post-test questionnaires), the response of an individual
student has a greater impact on the results than it would if the sample size was larger.
Furthermore, without data from a control group, there is no way to determine how much
of the statistically significant increase in student learning can be attributed to normal
instruction and how much can be attributed to framing the course unit with Set Theory
Survivor. Nevertheless, the combination of the instruction provided and the framing of the unit as a pedagogical game did prove effective in facilitating student learning as demonstrated by the statistically significant results presented in figures 5.4 and 5.5. As previously discussed in this chapter, students unanimously believed the Set Theory Survivor framework made the unit interesting, and 92.3% of students believed this framework made the unit enjoyable. Thus, introducing pitch-class set theory via the game Set Theory Survivor enhanced the experience of students in the course. A third possible limitation of the study is the potential for confirmation bias because I served as instructor, researcher, and analyst. However, I remained open to finding results different from those I anticipated on the basis of my literature review, and my multifaceted role in the study facilitated the smooth integration of this study into the fabric of the course.

Future research could investigate the effects of Set Theory Survivor in greater detail by comparing a class taught in a traditional manner to a class incorporating Set Theory Survivor. In order to avoid the potential problem of teacher effect, both classes should be taught by the same instructor. Elements of the pre-test and post-test questionnaires could be modified to explore working relationships among tribe members and to assess the familiarity of students with elements of Survivor regardless of whether or not they have watched the television show.

When asked what they would keep the same and what they would change about Set Theory Survivor, students offered a variety of insightful comments during the group discussion. They wanted to keep the primary elements of the game—the daily challenges, the competition, and the tribes—in place. Although students liked the idea of listening to
music by the leading tribe’s composer, they also expressed a desire to hear more music
by other composers, whether those of the other tribes or composers unrelated to any
tribe. They also requested more application of pitch-class set theory to musical
examples. In order to make challenges more exciting, they suggested physical games,
such as a race to write something on the board. Finally, students suggested either giving
tribes the ability to vote members out or rearranging tribes through a merge at some point
in the game in order to minimize the impact of tribe members with less consistent
attendance. Most of these suggestions would be relatively simple to implement; however,
any modifications to tribal membership during the game would have to be made
cautiously in order to avoid devaluing the contributions of lower-achieving students or
undermining the developing cohesion of each tribe.

As an instructor, I was satisfied with how Set Theory Survivor unfolded in the
classroom. The learning of both higher- and lower-achieving students was enhanced by
working with their peers and explaining concepts to each other. Students enjoyed the
process of learning about pitch-class set theory while working with their fellow tribe
members toward the goal of winning a non-academic prize, and they remained actively
engaged with the course material throughout the unit. The engagement of students
reflected both the motivated self-interest (i.e., wanting to win the game) identified by
Slavin and the group cohesion identified by Johnson and Johnson as effective forces of

188 For a list of the “leading tribe” music played during Set Theory Survivor, see Chapter Four.

189 We did examine some pieces of music, but the emphasis of the unit was more computational
than music-analytical. This emphasis was due largely to the brevity of the unit. The in-class music
listening that began each class period supplemented our analysis of pieces such as the fourth of
Webern’s Five Movements for String Quartet and Webern’s setting of Wie bin ich froh!.
cooperative learning. Additionally, Set Theory Survivor proved invaluable in boosting energy levels during the mid-semester doldrums. While my workload increased due to preparing and grading a challenge for almost every class period, I was pleased with the responsibility and camaraderie I saw among my students, and I enjoyed teaching this challenging unit via the framework of a pedagogical game. I would highly recommend Set Theory Survivor to other music theory instructors.
Chapter 6: Conclusion

Fresh from several semesters of tonal music theory, undergraduate students bring tonal ears and expectations to their study of atonal music. When confronted with a musical world in which tonal expectations are frequently thwarted, students may experience confusion or frustration which may, in turn, hinder them from fully embracing the rich analytical potential of pitch-class set theory. Therefore, one of the greatest challenges for undergraduate students encountering pitch-class set theory for the first time is the unfamiliarity of the entire enterprise: a body of music whose departure from tonality necessitates a new collection of analytical tools. Students may find it difficult to internalize a broad new set of terminology and operations and to differentiate accurately between such concepts as transpositional and inversional equivalence or between the normal form and prime form of a pitch-class set.

Other challenges are inherent to set-theoretical analysis. For example, pitch-class space—as opposed to pitch space—relies upon enharmonic and octave equivalence. These equivalence classes enable analytical connections among seemingly diverse elements of the musical surface; however, their reductive nature also obscures potentially interesting facets of pitch and register. Accordingly, the most effective applications of pitch-class set theory make full use of the powerful analytical tools afforded by enharmonic and octave equivalence while still considering noteworthy elements of pitch space.
In spite of these challenges, undergraduate music students can benefit in multiple ways from engaging pitch-class set theory in the core curriculum. Some benefits are direct, while others are indirect. By way of illustration, I recall visiting a café on a beautiful spring day. Looking out the full-length window from the corner table where I sat, all I could see directly was a small strip of concrete and another tall window, diagonally joined to the first. Reflected high in the second window was the spring day in all its glory: a clear blue sky with golden sunshine streaming down upon trees newly covered in bright green leaves. These sights were no less beautiful because they appeared indirectly; indeed, the very unexpectedness of seeing them reflected there rendered them all the more memorable. In a similar fashion, both direct and indirect benefits of studying pitch-class set theory can enhance the preparation of undergraduate music students for their future careers.

The most obvious direct benefit of studying pitch-class set theory concerns students who choose to specialize in music theory or composition. Because pitch-class set theory forms the basis of a prominent body of work within theory and composition, these students should be prepared to engage set-theoretical analysis and composition in their own work as well as in professional interactions with colleagues. Students who become performers, conductors, and teachers of atonal repertoire from the twentieth century also benefit directly from engaging this analytical system: their initial study of pitch-class set theory lays the foundation for lifelong learning as they read about, perform, and teach this repertoire. Conversely, students’ exposure to the repertoire and concepts associated with pitch-class set theory may pique their interest and inspire them to engage this body of
music more deeply in the future. Straddling the boundary between direct and indirect benefits, exposure to pitch-class set theory affords students a deeper understanding of some compositional aspects of a seminal period in music history. This insider’s perspective, as it were, can help students better apprehend the reactions and eventual syntheses that shaped the face of art music in the early twentieth century and beyond. While this knowledge may most directly benefit those students who specialize in musicology, it also forms an essential component of a thorough education for musicians of all specializations.

Several important indirect benefits may also accrue to students through their study of pitch-class set theory. As previously noted, atonal music may seem (in the words of Peter Silberman) like a “foreign language” to many undergraduate music students. While this simile neatly encapsulates the initial challenge of introducing students to atonal repertoire, it need not be a negative one. The experience of learning a second language is widely acknowledged as a beneficial means of enhancing one’s communication skills while fostering an awareness of, and appreciation for, diversity among cultures. Indeed, many students seek out such transformative experiences by studying abroad as part of their college education. Why should such opportunities for intellectual and personal growth not also be afforded to undergraduate music students? Indeed, twentieth-century atonal music provides an ideal venue for a virtual “study abroad” experience; while the vast majority of students have grown up listening to tonal

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190 Peter Silberman, “Post-Tonal Improvisation in the Aural Skills Classroom,” *Music Theory Online* 9, no. 2 (July 2003): [1]. For a brief description of Silberman’s pedagogical strategies, see Chapter One.
music in various classical or popular genres, fewer students enter undergraduate music programs with extensive—or, in some cases, any—prior experience listening to or performing atonal music. Thus, students have the opportunity to expand their horizons from early encounters with this repertoire to a working knowledge of its basic structural properties—to start from the outside and find a way in. Instructors also play an important part in this journey of discovery as they nurture the curiosity of students, model “disciplinary” ways of thinking about music like a theorist, and help cultivate students’ music-analytical acumen.

Other indirect benefits of studying pitch-class set theory extend beyond the field of music. In his presentation on alternative career options for graduate students in the humanities, Jim Grossman identifies four skill areas that—while sometimes not explicitly taught in graduate programs—contribute to professional success both inside and outside the academy. These four areas include presentation skills, collaboration, basic quantitative skills, and intellectual self-confidence. Arguably, these skills are also important for undergraduate music students who may work in a variety of capacities (performing, teaching, etc.) throughout their careers. Aspects of all four areas appear in Set Theory Survivor. Through peer tutoring, students simultaneously practice collaboration and strengthen their presentation skills as they learn to explain concepts and analytical procedures concisely in the supportive environment of their tribe. Although the computational aspect of Set Theory Survivor involves only simple mathematical operations, it nonetheless refreshes students’ knowledge of basic quantitative skills and

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191 Jim Grossman, “Graduate Education and Career Horizons in the Humanities” (lecture for the Graduate School, The Ohio State University, Columbus, OH, February 17, 2015).
reinforces the importance of accurately following the proper sequence of steps (i.e.,
invert first, then transpose) when solving analytical problems. Finally, the milieu into
which students without previous exposure to atonal music are thrust is precisely the type
of setting that spurs students along the road to intellectual self-confidence as they master
new tools for music analysis while confronting an unfamiliar repertoire.\textsuperscript{192}

In light of the potential challenges and benefits of teaching and learning pitch-
class set theory as a vehicle for post-tonal music analysis, both instructors and students
may welcome a pedagogical approach that fosters active learning and builds peer
communities within the enjoyable context of a pedagogical game. With a thorough
grounding in the literature of music theory pedagogy and general education, Set Theory
Survivor provides just such an approach. The first three chapters of this dissertation
review pertinent sources from the literature. Chapter One examines problematic aspects
of teaching post-tonal music analysis—most notably, the dissonance of atonal music and
the overtly mathematical features of pitch-class set theory—and explores strategies
designed to address one or more of these potential difficulties. Chapter Two presents
foundational aspects of cooperative learning and constructive competition; these
seemingly disparate strands of educational theory unite in intergroup competition, the
organizing force behind Set Theory Survivor. Finally, Chapter Three explores a wide
variety of pedagogical games from music theory as well as other disciplines, introduc

\textsuperscript{192} Grossman describes intellectual self-confidence as the ability to say, “I don’t know anything
about that. Give me twenty-four hours, and I’ll figure it out.” The high concentration of new analytical
techniques associated with pitch-class set theory provides many opportunities for students, assisted by their
instructors, to develop this type of confidence.
several of my own theory and aural-skills games, and discusses antecedents of Set Theory Survivor.

Chapter Four details the implementation of Set Theory Survivor as a research study conducted with fifteen music majors enrolled in a sophomore-level theory course at The Ohio State University. During Set Theory Survivor, students worked together in three- or four-person tribes to complete in-class challenge worksheets and expand their understanding of set-theoretical analysis through peer tutoring. Tribes were composed heterogeneously with regard to achievement and were balanced so each tribe had a similar chance of earning the highest cumulative score and thereby winning the non-academic prize of a modest gift card for each member of the tribe. Game-like elements designed to promote student engagement included a customized logo and an opening credits video combining *Survivor* theme music with photographs of the prominent twentieth-century composers (Schoenberg, Bartók, Stravinsky, and Berg) for whom the tribes were named.

Chapter Five presents the results of this study via discussions of student comments, instructor observations, and student responses to open-ended and Likert-type questions on pre-test and post-test questionnaires. Data analysis for the Likert-type responses consisted of paired t-tests with the Bonferroni correction for multiple tests and 95% confidence intervals. As shown by the data from this study, the learning of students increased in a statistically significant way during the four-week unit covered by Set Theory Survivor, and the vast majority of students found Set Theory Survivor interesting and enjoyable.
The success of Set Theory Survivor rests on a tripartite synthesis of cooperative learning, constructive competition, and a pedagogical game. Removing or minimizing any of these necessary components would undermine the pedagogical effectiveness of Set Theory Survivor. For instance, without cooperative learning, students would be left to navigate the complexities of pitch-class set theory without the camaraderie of fellow tribe members who, bound together by positive interdependence, share explanations, strategies, and social support as they work toward the common goal of understanding pitch-class set theory and the hope of winning a non-academic prize. Switching from intergroup to interindividual competition might also increase the pressure felt by students and endanger the constructiveness of the competition. Finally, a vital part of the connection to the show *Survivor* would be lost without the metaphor of tribal membership.

If, on the other hand, the element of constructive competition was removed, the underlying social motivation that supports cooperative learning in Set Theory Survivor would disappear. Without the competition, there would be no need to tabulate tribe scores because there would be no prize to win. If the prospect of earning tribe scores did not prompt students to put forth their best effort and to facilitate the efforts of their peers, the positive interdependence of students—so necessary to the success of cooperative learning—would decrease sharply. Additionally, the analogy to *Survivor* would break down entirely in the absence of competition.

Suppose the pedagogical game itself was removed. At that point, Set Theory Survivor would revert back to Robert Slavin’s pedagogical method STAD (Student
Teams-Achievement Divisions). Although this pedagogical method has much to commend it, the connection to popular culture through Set Theory Survivor—which provides a “selling point” for students reluctant to engage set-theoretical analysis—would be lost. Furthermore, the social cohesion aspect of cooperative learning in this activity would suffer without the sense of shared identity facilitated by group names and colors, and students would most likely perceive the course unit as less enjoyable without the framework of Set Theory Survivor. Hence, all three core elements of Set Theory Survivor—cooperative learning, constructive competition, and a pedagogical game—are vital to its success as a pedagogical strategy.

Set Theory Survivor combines the expertise and efficacy of instructor-presented lectures and active student involvement in a series of cooperative, small-group activities. Forging communities that work toward the common goal of understanding pitch-class set theory, students provide each other with valuable academic and social support in their tribes throughout the learning process. The hope of winning a non-academic prize simultaneously increases student motivation through constructive intergroup competition and frees students to help other members of their tribes without fear of potentially negative effects on their grades. By providing a novel and enjoyable approach to a subject that often sparks student resistance, Set Theory Survivor presents a valuable tool with which to enhance the pedagogy of pitch-class set theory.

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Appendix A: Challenges and Answer Keys
**CHALLENGE 1**

**Integer Notation**

<table>
<thead>
<tr>
<th>Pitch-Classes</th>
<th>Integer Notation</th>
</tr>
</thead>
<tbody>
<tr>
<td>D#</td>
<td>G#</td>
</tr>
<tr>
<td>Gb</td>
<td>F</td>
</tr>
<tr>
<td>Ab</td>
<td>Bb</td>
</tr>
<tr>
<td>C#</td>
<td>E</td>
</tr>
<tr>
<td>F#</td>
<td>Db</td>
</tr>
<tr>
<td>A</td>
<td>G</td>
</tr>
</tbody>
</table>

**Mod 12 Arithmetic**

1. Write the equivalent integer in mod 12.

| 21 | 17 | 12 | 14 | 29 | 15 | 13 | 18 | 25 | 16 |

2. Perform the calculations and write the results in mod 12.

<table>
<thead>
<tr>
<th>7+6</th>
<th>10+9</th>
<th>9+8</th>
<th>5+11</th>
<th>11+4</th>
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<tr>
<td>2-8</td>
<td>6-11</td>
<td>4-11</td>
<td>8-10</td>
<td>1-9</td>
</tr>
</tbody>
</table>

**Ordered vs. Unordered Interval-Classes**

<table>
<thead>
<tr>
<th></th>
<th>Ordered</th>
<th>Unordered</th>
</tr>
</thead>
<tbody>
<tr>
<td>G# → Bb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Db → F#</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B → E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C → F#</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D → A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bb → Gb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F → Db</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Rotation and Normal Form/Order**

1. Convert each set into integer notation.
2. Rearrange into ascending order.
3. Calculate all possible orderings through rotation.
4. Calculate normal form.

Set: E, Bb, Db, F

Normal Form: Normal Form:

Set: G#_C#_D_E_G

Normal Form:
### CHALLENGE 1

#### Integer Notation

<table>
<thead>
<tr>
<th>Pitch-Classes</th>
<th>Integer Notation</th>
<th>Pitch-Classes</th>
<th>Integer Notation</th>
</tr>
</thead>
<tbody>
<tr>
<td>D#</td>
<td>3</td>
<td>G#</td>
<td>8</td>
</tr>
<tr>
<td>Gb</td>
<td>6</td>
<td>F</td>
<td>5</td>
</tr>
<tr>
<td>Ab</td>
<td>8</td>
<td>Bb</td>
<td>10</td>
</tr>
<tr>
<td>C#</td>
<td>1</td>
<td>E</td>
<td>4</td>
</tr>
<tr>
<td>F#</td>
<td>6</td>
<td>Db</td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>9</td>
<td>G</td>
<td>7</td>
</tr>
</tbody>
</table>

#### Mod 12 Arithmetic

1. Write the equivalent integer in mod 12.

<table>
<thead>
<tr>
<th>21</th>
<th>17</th>
<th>12</th>
<th>14</th>
<th>29</th>
<th>15</th>
<th>13</th>
<th>18</th>
<th>25</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>5</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>6</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

2. Perform the calculations and write the results in mod 12.

<table>
<thead>
<tr>
<th>7+6</th>
<th>10+9</th>
<th>9+8</th>
<th>5+11</th>
<th>11+4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>2·8</td>
<td>6·11</td>
<td>4·11</td>
<td>8·10</td>
<td>1·9</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>5</td>
<td>10</td>
<td>4</td>
</tr>
</tbody>
</table>

#### Ordered vs. Unordered Interval-Classes

<table>
<thead>
<tr>
<th>Ordered</th>
<th>Unordered</th>
</tr>
</thead>
<tbody>
<tr>
<td>G# → Bb</td>
<td>10 - 8 = 2</td>
</tr>
<tr>
<td>Db → F#</td>
<td>6 - 1 - 5</td>
</tr>
<tr>
<td>B → F</td>
<td>4 - 11 = -7 = 5</td>
</tr>
<tr>
<td>G → F#</td>
<td>6 - 7 - 1 - 11</td>
</tr>
<tr>
<td>D → A</td>
<td>9 - 2 = 7</td>
</tr>
<tr>
<td>Bb → Gb</td>
<td>6 - 10 - 4 - 8</td>
</tr>
<tr>
<td>F → Db</td>
<td>1 - 5 - 4 = 8</td>
</tr>
</tbody>
</table>
Rotation and Normal Form/Order
1. Convert each set into integer notation.
2. Rearrange into ascending order.
3. Calculate all possible orderings through rotation.
4. Calculate normal form.

Set: E-Bb-Db-F
1. 4, 10, 1, 5
2. 1, 4, 5, 10
3. 1, 4, 5, 10 (10 - 1 = 9)
4. 5, 10, 1 (13 - 4 = 9)
   10, 1, 4, 5 (17 - 10 = 7)
4. Normal Form = [10, 1, 4, 5]

Set: G#-C#-D-E-G
1. 8, 1, 2, 4, 7
2. 1, 2, 4, 7, 8
3. 1, 2, 4, 7, 8 (8 - 1 = 7)
2, 4, 7, 8, 1 (13 - 2 = 11)
4, 7, 8, 1, 2 (14 - 4 = 10)
7, 8, 1, 2, 4 (16 - 7 = 9)
8, 1, 2, 4, 7 (19 - 8 = 11)
4. Normal Form = [1, 2, 4, 7, 8]
Name: \hspace{2cm} Tribe:

**CHALLENGE 2**

**Transposition**

- Determine whether the pairs of Normal Form sets are transpositionally equivalent. If yes, provide the transpositional operator.

<table>
<thead>
<tr>
<th>Normal Form sets</th>
<th>Transpositionally equivalent?</th>
<th>Index Number (T_N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[2,4,7]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[9,10,9]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[8,10,11,1]</td>
<td>[2,4,5,7]</td>
<td></td>
</tr>
</tbody>
</table>

- Perform the required transposition on the following Normal Form set.

<table>
<thead>
<tr>
<th>Normal Form set</th>
<th>Transposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>T_{10} [0,2,4,5,8]</td>
<td></td>
</tr>
</tbody>
</table>
Name: KEY

Tribe:

CHALLENGE 2

Transposition

- Determine whether the pairs of Normal Form sets are transpositionally equivalent. If yes, provide the transpositional operator.

<table>
<thead>
<tr>
<th>Normal Form sets</th>
<th>Transpositionally equivalent?</th>
<th>Index Number (Tn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[2,4,7]</td>
<td>[9,10,0]</td>
<td>No</td>
</tr>
<tr>
<td>[8,10,11,1]</td>
<td>[2,4,5,7]</td>
<td>Yes</td>
</tr>
</tbody>
</table>

\[
a) 9 \quad 10 \quad 0 \\
 2 \quad 4 \quad 7 \\
7 \quad 6 \quad 5
\]

\[
b) 2 \quad 4 \quad 5 \quad 7 \\
8 \quad 10 \quad 11 \quad 1 \\
6 \quad 6 \quad 6 \quad 6
\]

- Perform the required transposition on the following Normal Form set.

<table>
<thead>
<tr>
<th>Normal Form set</th>
<th>Transposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>T_{10} [0,2,4,5,8]</td>
<td>[10, 0, 2, 3, 6]</td>
</tr>
</tbody>
</table>

\[
b) 0 \quad 2 \quad 4 \quad 5 \quad 8 \\
10 \quad 10 \quad 10 \quad 10 \quad 10 \\
10 \quad 0 \quad 2 \quad 3 \quad 6
\]
CHALLENGE 3

Inversion

- Determine whether the following Normal Form sets are inversionally equivalent. If yes, provide the index number.

<table>
<thead>
<tr>
<th>Normal Form sets</th>
<th>Inversionally equivalent?</th>
<th>Index Number (If Any)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1,2,3,7]</td>
<td>[10,2,3,4]</td>
<td></td>
</tr>
</tbody>
</table>

- Perform the required inversion/transposition on the following Normal Form set.

<table>
<thead>
<tr>
<th>Normal Form set</th>
<th>Inversion/Transposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁:1 [1,3,6,9]</td>
<td></td>
</tr>
</tbody>
</table>

Prime Form

Provide the prime form for the following Normal Form set.
1. (Put set in normal form.)
2. Transpose the set so that the first element is 0.
3. Invert the original, normal-form set and repeat steps 1 and 2.
4. Compare the results of step 2 and step 3; whichever is more packed to the left is prime form.

<table>
<thead>
<tr>
<th>Normal Form</th>
<th>Step Two</th>
<th>Step Three</th>
<th>Prime Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>[11,2,6]</td>
<td>Inversion of original</td>
<td>Normal Form</td>
<td>Transposition</td>
</tr>
</tbody>
</table>

Bonus: What common musical structure is represented by the prime form of this set?
Name: KEY

CHALLENGE 3

Inversion

- Determine whether the following Normal Form sets are inversionally equivalent. If yes, provide the index number.

<table>
<thead>
<tr>
<th>Normal Form sets</th>
<th>Inversionally equivalent?</th>
<th>Index Number (T₃θ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1,2,3,7]</td>
<td>Yes</td>
<td>T₃θ</td>
</tr>
<tr>
<td>[10,2,3,4]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AIS for [1,2,3,7]: 1,1,4
AIS for [10,2,3,4]: 4,1,1

1+4=5
2+3=5
3+2=5
7+10=17=5

- Perform the required inversion/transposition on the following Normal Form set.

<table>
<thead>
<tr>
<th>Normal Form set</th>
<th>Inversion/Transposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁₁,₁ [1,3,6,9]</td>
<td>[2,5,8,10]</td>
</tr>
</tbody>
</table>

Original: [1,3,6,9]
Inversion: 11,9,6,3
Normal Form: [3,6,9,11]

\[
\begin{array}{cccc}
3 & 6 & 9 & 11 \\
11 & 11 & 11 & 11 \\
\end{array}
\]

\[
\begin{array}{c}
2 \\
5 \\
8 \\
10 \\
\end{array}
\]

Prime Form

Provide the prime form for the following Normal Form set.
1. (Put set in normal form.)
2. Transpose the set so that the first element is 0.
3. Invert the original, normal-form set and repeat steps 1 and 2.
4. Compare the results of step 2 and step 3; whichever is more packed to the left is prime form.

<table>
<thead>
<tr>
<th>Normal Form</th>
<th>Step Two</th>
<th>Step Three</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inversion of original</td>
<td>Normal Form</td>
</tr>
<tr>
<td>[11,2,6]</td>
<td>[0,3,7]</td>
<td>[1,10,6]</td>
</tr>
</tbody>
</table>

Bonus: What common musical structure is represented by the prime form of this set?
The minor triad (Note that this prime form represents both the minor triad and the Major triad.)
Webern, *Five Movements for String Quartet*, IV, m. 6 (2nd Violin)

Convert the following set to integer notation, put the set in Normal Form, and calculate the Prime Form of the set.

![Musical notation](image)

**Interval-class Vector**

Calculate the interval-class vector for the set whose Prime Form you just found.

1. Calculate the intervals formed with the first note and each subsequent note in set.
2. Repeat the procedure with all of the notes except for the last one.
3. Add up all of the occurrences of each type of interval.
4. Show results in this format: [012111]. (In this example, there are no instances of ic1; there is one instance of ic2; etc.)

<table>
<thead>
<tr>
<th>Set</th>
<th>ICV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Name: KEY

CHALLENGE 4

Webern, *Five Movements for String Quartet*, IV, m. 6 (2nd Violin)

Convert the following set to integer notation, put the set in Normal Form, and calculate the Prime Form of the set.

\[
\begin{array}{ccccccc}
\flat & \natural & \flat & \natural & \sharp & \natural & \flat \\
\end{array}
\]

[NOTE: Show additional work throughout these exercises.]

Integer notation: 0, 4, 6, 11, 1, 7, 10

Normal Form: [10, 11, 0, 1, 4, 6, 7]
Transposed to begin on 0: (0123689)

Inversion of original, normal-form set: 2, 1, 0, 11, 8, 6, 5
Normal Form of inversion: [11, 0, 1, 2, 5, 6, 8]
Transposed to begin on 0: (0123679)

Compare (0123689) with (0123679). The first five entries (and the last entry) are the same in both cases. The second-to-last entry breaks the tie: 7 is smaller than 8, so (0123679) is the Prime Form.

**Interval-class Vector**

Calculate the interval-class vector for the set whose Prime Form you just found.

1. Calculate the intervals formed with the first note and each subsequent note in set.
2. Repeat the procedure with all of the notes except for the last one.
3. Add up all of the occurrences of each type of interval.
4. Show results in this format: [012111]. (In this example, there are no instances of ict; there is one instance of ic2; etc.)

<table>
<thead>
<tr>
<th>Set</th>
<th>ICV</th>
</tr>
</thead>
<tbody>
<tr>
<td>0123679</td>
<td>434343</td>
</tr>
</tbody>
</table>

See work shown on next page.
<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>0123679</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>123679</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>23679</td>
<td>1</td>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3679</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>679</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>79</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL:** 4 3 4 3 4 3

**ICV:** [434343]
Name: 

CHALLENGE 5

Prime Form

• Find the Prime Form of the Normal Form set [9,10,11,3]. Show your work.

Transposition

• Determine whether the pair of Normal Form sets is transpositionally equivalent. If yes, provide the transpositional operator. Show your work.

<table>
<thead>
<tr>
<th>Normal Form sets</th>
<th>Transpositionally equivalent?</th>
<th>Index Number ($T_N$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[10,1,2,5]</td>
<td>[5,8,9,0]</td>
<td></td>
</tr>
</tbody>
</table>

Inversion

• Perform the required inversion/transposition on the following Normal Form set. Show your work.

<table>
<thead>
<tr>
<th>Normal Form set</th>
<th>Inversion/Transposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_{3,1}$ [0,2,5]</td>
<td></td>
</tr>
</tbody>
</table>
CHALLENGE 5

Prime Form

- Find the Prime Form of the Normal Form set \([9,10,11,3]\). Show your work.

  1. (Put set in normal form.)
  2. Transpose the set so that the first element is 0.
  3. Invert the original, normal-form set and repeat steps 1 and 2.
  4. Compare the results of step 2 and step 3; whichever is more packed to the left is prime form.

<table>
<thead>
<tr>
<th>Normal Form</th>
<th>Step Two</th>
<th>Step Three Inversion of original</th>
<th>Normal Form</th>
<th>Transposition</th>
<th>Prime Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>[9,10,11,3]</td>
<td>[0,1,2,6]</td>
<td>[3,2,1,9]</td>
<td>[9,1,2,3]</td>
<td>[0,4,5,6]</td>
<td>(0126)</td>
</tr>
</tbody>
</table>

Transposition

- Determine whether the pair of Normal Form sets is transpositionally equivalent. If yes, provide the transpositional operator. Show your work.

<table>
<thead>
<tr>
<th>Normal Form sets</th>
<th>Transpositionally equivalent?</th>
<th>Index Number (T_N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[10,1,2,5]</td>
<td>Yes</td>
<td>7</td>
</tr>
</tbody>
</table>

\[
\begin{array}{cccc}
5 & 8 & 9 & 0 \\
- & 10 & 1 & 2 & 5 \\
7 & 7 & 7 & 7 \\
\end{array}
\]

AIS for [10,1,2,5]: 3,1,3
AIS for [5,8,9,0]: 3,1,3

Inversion

- Perform the required inversion/transposition on the following Normal Form set. Show your work.

<table>
<thead>
<tr>
<th>Normal Form set</th>
<th>Inversion/Transposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.d</td>
<td>[0,2,5]</td>
</tr>
</tbody>
</table>

Original: [0,2,5]
Inversion: 0,10,7
Normal Form: [7,10,0]
Transposition: [0,3,5]

\[
\begin{array}{ccc}
7 & 10 & 0 \\
+ & 5 & 5 & 5 \\
\hline
0 & 3 & 5 \\
\end{array}
\]
CHALLENGE 6 (Requires a List of Set Classes)

**Invariant tones under transposition**

- For set (0247), how many pitch classes remain invariant under T+?

- What transpositions produce the maximum number of invariant pitch classes for set 4-12?

**Invariant tones under inversion**

- Create a summation square for the following set (0247), give the index vector, and answer the accompanying questions.

Summation square:

Index vector:

- What inversions produce the maximum number of invariants?

- How many invariants are produced by these inversions?

- What inversions produce no invariants?
**CHALLENGE 6 (Requires a List of Set Classes)**

**Invariant tones under transposition**

- For set (0247), how many pitch classes remain invariant under $T_7$?
  
  2

- What transpositions produce the maximum number of invariant pitch classes for set 4-12?
  
  $T_5, T_9$ and $T_6$

**ICV:** [112101]

Recall that the number of invariants under a given transposition for interval classes 1–5 and 7–10 is equal to the number of occurrences in the set’s interval-class vector. However, the number of invariants under a given transposition for interval class 6 is equal to twice the number of occurrences in the set’s interval-class vector (see Notes on Set Theory – Part 4).

**Invariant tones under inversion**

- Complete a summation square for the following set (0247), give the index vector, and answer the accompanying questions.

**Summation square:**

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>2</th>
<th>4</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>9</td>
<td>11</td>
<td>2</td>
</tr>
</tbody>
</table>

**Index vector:** $<1,0,3,0,3,0,2,2,1,2,0,2>$

- What inversions produce the maximum number of invariants?
  
  $T_2I, T_4I$

- How many invariants are produced by these inversions?
  
  3 invariants each

- What inversions produce no invariants?
  
  $T_1I, T_3I, T_5I, T_{10}I$
Reward Challenge: Match the term in the left-hand column with its representation in the right-hand column.

<table>
<thead>
<tr>
<th>Summation Square</th>
<th>$T_N I$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Form</td>
<td>[111120]</td>
</tr>
<tr>
<td>Index Vector</td>
<td>(0237)</td>
</tr>
<tr>
<td>Prime Form</td>
<td>[2,4,5,9]</td>
</tr>
<tr>
<td>Forte Name</td>
<td>0 2 3 7</td>
</tr>
<tr>
<td></td>
<td>0 0 2 3 7</td>
</tr>
<tr>
<td></td>
<td>2 2 4 5 9</td>
</tr>
<tr>
<td></td>
<td>3 3 5 6 10</td>
</tr>
<tr>
<td></td>
<td>7 7 9 10 2</td>
</tr>
<tr>
<td>Interval-Class Vector</td>
<td>$T_N$</td>
</tr>
<tr>
<td>Inversion operation</td>
<td>4–14</td>
</tr>
<tr>
<td>Transposition operation</td>
<td>(&lt;1,0,3,2,1,2,1,2,0,2,2,0&gt;)</td>
</tr>
</tbody>
</table>
Reward Challenge: Match the term in the left-hand column with its representation in the right-hand column.

- Summation Square
- Normal Form
- Index Vector
- Prime Form
- Forte Name
- Interval-Class Vector
- Inversion operation
- Transposition operation

Tables:

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>2</th>
<th>3</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>9</td>
<td>10</td>
<td>2</td>
</tr>
</tbody>
</table>

\[ T_N \]

\[ T_{NI} \]

\[ \langle 1,0,3,2,1,2,1,2,0,2,2,0 \rangle \]
Name:  

Tribe:  

CHALLENGE 7

Transposition
• Perform the indicated transposition operation. Show your work.
T: [8,9,11,1]

Inversion
• Determine whether the following pair of Normal Form sets is inversionally equivalent. If yes, provide the index number. Show your work.

<table>
<thead>
<tr>
<th>Normal Form sets</th>
<th>Inversionally equivalent?</th>
<th>Index Number (T_{NI})</th>
</tr>
</thead>
<tbody>
<tr>
<td>[4,5,7,9]</td>
<td>[6,8,10,11]</td>
<td></td>
</tr>
</tbody>
</table>

Prime Form
• Find the Prime Form of the Normal Form set [8,9,11,1]. Show your work.
Invariant tones under transposition

- What transpositions produce two invariant pitch classes for set (0135)?

ICV: [121110]

Invariant tones under inversion

- Complete a summation square for set (0135) and give its index vector.

Summation square:

Index vector:
Name: KEY

CHALLENGE 7

Transposition

- Perform the indicated transposition operation. Show your work.

\[ T_3 \{8,9,11,1\} = \{1,2,4,6\} \]

\[
\begin{array}{cccc}
8 & 9 & 11 & 1 \\
5 & 5 & 5 & 5 \\
\hline
1 & 2 & 4 & 6
\end{array}
\]

Inversion

- Determine whether the following pair of Normal Form sets is inversionally equivalent. If yes, provide the index number. Show your work.

<table>
<thead>
<tr>
<th>Normal Form sets</th>
<th>Inversionally equivalent?</th>
<th>Index Number (TN1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[4,5,7,9]</td>
<td>Yes</td>
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<td>[6,8,10,11]</td>
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\( \text{AIS for } [4,5,7,9]: 1,2,2 \)
\( \text{AIS for } [6,8,10,11]: 2,2,1 \)

\[ 4 + 11 = 15 = 3 \]
\[ 5 + 10 = 15 = 3 \]
\[ 7 + 8 = 15 = 3 \]
\[ 9 + 6 = 15 = 3 \]

Prime Form

- Find the Prime Form of the Normal Form set [8,9,11,1]. Show your work.

1. (Put set in normal form.)
2. Transpose the set so that the first element is 0.
3. Invert the original, normal-form set and repeat steps 1 and 2.
4. Compare the results of step 2 and step 3; whichever is more packed to the left is prime form.

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<th>Step Two</th>
<th>Step Three</th>
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<td>Inversion of original</td>
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<td>[8,9,11,1]</td>
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Invariant tones under transposition

- What transpositions produce two invariant pitch classes for set (0135)?

ICV: [121110]

$T_2$ and $T_{10}$

Invariant tones under inversion

- Complete a summation square for set (0135) and give its index vector.

Summation square:

\[
\begin{array}{cccc}
0 & 1 & 3 & 5 \\
0 & 0 & 1 & 3 & 5 \\
1 & 1 & 2 & 4 & 6 \\
3 & 3 & 4 & 6 & 8 \\
5 & 5 & 6 & 8 & 10 \\
\end{array}
\]

Index vector: $<1.2.1.2.2.3.0.2.0.1.0>$
Appendix B: List of Set Classes
Displaying complementary set classes across from one another, the following list presents all the set classes containing three to nine pitch classes (trichords through nonachords). Columns one and seven provide Forte names for the respective sets. Columns two and six show the prime forms of these sets, while columns three and five give their interval-class vectors. Finally, column four (center) shows the respective degrees of transpositional and inversional symmetry for each set.

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**HEXACHORDS**

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Appendix C: Selected Repertoire for In-Class Listening
The following list contains nine compositions each by Bartók, Berg, Schoenberg, and Stravinsky. The works of each composer, which are listed chronologically, were chosen from both earlier and later portions of that composer’s oeuvre with attention to breadth of genre and instrumentation. In light of the limited class time available, most selections listed here are less than five minutes long; however, in the case of some works (such as the movement from Berg’s Violin Concerto), only part of the selection would be played in class. An asterisk (*) denotes pieces played prior to the Set Theory Survivor unit.

**Bartók:**

- *Bluebeard’s Castle*, BB 62 “Fourth Door: The Secret Garden”
- *Allegro Barbaro*, BB 63
- *String Quartet No. 3*, BB 93, I (Prima parte: Moderato–Attacca)
- *String Quartet No. 4*, BB 95, IV (Allegretto pizzicato)
- *44 Duos for 2 Violins*, BB 104, Vol. 4, No. 38 “Forgatos”
- *Mikrokosmos*, BB 105, Book 4, No. 101 “Diminished Fifth”*
- *Mikrokosmos*, BB 105, Book 6, No. 142 “From the Diary of a Fly”
- *Szekely Folksongs*, BB 106, No. 3 “Vekony cerna, kemeny mag”
- *Music for Strings, Percussion and Celesta*, BB 114, III (Adagio)

**Berg:**

- *7 Frühe Lieder*, No. 3 “Die Nachtigall”
- *Piano Sonata*, Op. 1
- *5 Altenberglieder*, Op. 4, No. 1 “Seele, wie bist du schöner”
- *Passacaglia*
- *4 Stücke*, Op. 5, No. 1 (Mäßig)*
- *3 Orchesterstücke*, Op. 6, No. 1 (Präludium)
- *Lyric Suite*, I (Allegretto gioviale)
- *Lulu Suite*, II (Ostinato: Allegro)
- *Violin Concerto*, I (Andante–Scherzo)

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194 Having nine compositions by each composer provided enough selections to cover the piece played prior to the Set Theory Survivor unit, one “wildcard” listening example chosen through a blind drawing among the four tribes’ buffs, and leading tribe music for all seven challenges.
Schoenberg:

- *String Quartet No. 2*, Op. 10, IV “Entrückung”
- *3 Stücke*, Op. 11, No. 3 (Bewegt)*
- *Das Buch der hängenden Gärten*, Op. 15, No. 5 “Saget mir, auf welchem Pfade”
- *5 Stücke*, Op. 16, No. 3 “Chord-Colors”
- *6 Kleine Klavierstücke*, Op. 19, No. 1 (Leicht, zart)
- *Herzgewächse*, Op. 20
- *Pierrot Lunaire*, Op. 21, Part I, No. 3 “Der Dandy”
- *2 Stücke*, Op. 33a
- *De profundis* (Psalm 130), Op. 50b

Stravinsky:

- *Le sacre du printemps*, Part I
- *L’Histoire du soldat*, Part II, No. 1 (Tango)
- *Concerto for Piano and Wind Instruments*, I (Largo–Allegro)
- *Octet*, II (Tema con Variazioni)
- *The Firebird Suite* (1945 version), Ic (Variations)
- *Septet*, II (Passacaglia)
- *Canticum Sacrum*, “Surge, aquilo”
- *Epitaphium* *
- *The Owl and the Pussycat*
Appendix D: Pre-Test Questionnaire
For each of the following statements, circle the answer that best represents your response. Do not circle more than one answer. Thank you for your participation!

1. I like to learn about new techniques for analysis.

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2. I prefer to complete assignments by myself.

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3. I prefer to complete assignments with other people.

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Write your response to the following question.

4. What do you like the most about post-tonal music?

Circle a single answer for each of the following statements.

5. I have studied set theory before.

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6. I appreciate the underlying structure of post-tonal music.

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161
7. I like to listen to post-tonal music.

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Write your response to the following question.

8. What do you dislike the most about post-tonal music?

Circle a single answer for each of the following statements.

9. I can find the normal order of a pitch-class set.

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10. I can find the prime form of a pitch-class set.

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11. I can find the interval-class vector of a pitch-class set.

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12. I can transpose a pitch-class set that is in normal order.

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13. I can invert a pitch-class set that is in normal order.

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14. I can invert and transpose a pitch-class set that is in normal order.

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15. I can identify pitch classes that remain invariant under transposition.

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16. I can identify pitch classes that remain invariant under inversion.

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17. I am comfortable using set theory to analyze post-tonal music.

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18. I enjoy watching the television show Survivor.

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19. I watch the television show Survivor regularly.

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Please write any additional comments that you have.
Appendix E: Post-Test Questionnaire
For each of the following statements, circle the answer that best represents your response. Do not circle more than one answer. Thank you for your participation!

1. I like to learn about new techniques for analysis.

   
   
   
   1 strongly disagree  
   2 disagree       
   3 slightly disagree 
   4 neutral       
   5 slightly agree 
   6 agree       
   7 strongly agree

2. I prefer to complete assignments by myself.

   
   
   
   1 strongly disagree  
   2 disagree       
   3 slightly disagree 
   4 neutral       
   5 slightly agree 
   6 agree       
   7 strongly agree

3. I prefer to complete assignments with other people.

   
   
   
   1 strongly disagree  
   2 disagree       
   3 slightly disagree 
   4 neutral       
   5 slightly agree 
   6 agree       
   7 strongly agree

Write your response to the following question.

4. What do you like the most about post-tonal music?

Circle a single answer for each of the following statements.

5. I am comfortable using set theory to analyze post-tonal music.

   
   
   
   1 strongly disagree  
   2 disagree       
   3 slightly disagree 
   4 neutral       
   5 slightly agree 
   6 agree       
   7 strongly agree

6. I appreciate the underlying structure of post-tonal music.

   
   
   
   1 strongly disagree  
   2 disagree       
   3 slightly disagree 
   4 neutral       
   5 slightly agree 
   6 agree       
   7 strongly agree

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7. I like to listen to post-tonal music.

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Write your response to the following question.

8. What do you dislike the most about post-tonal music?

---

Circle a single answer for each of the following statements.

9. I can find the normal order of a pitch-class set.

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10. I can find the prime form of a pitch-class set.

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11. I can find the interval-class vector of a pitch-class set.

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12. I can transpose a pitch-class set that is in normal order.

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15. I can identify pitch classes that remain invariant under transposition.

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Write your response to the following question.

17. What aspect of the unit on set theory did you most like?

Circle a single answer for each of the following statements.

18. I learned a lot during the unit on set theory.

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</table>
19. The “Theory Survivor” format made the unit on set theory challenging.

   1  2  3  4  5  6  7
strongly disagree slightly disagree neutral slightly agree agree strongly agree

20. The “Theory Survivor” format made the unit on set theory enjoyable.

   1  2  3  4  5  6  7
strongly disagree slightly disagree neutral slightly agree agree strongly agree

Write your response to the following question.

21. What aspect of the unit on set theory did you most dislike?

Circle a single answer for each of the following statements.

22. I enjoy watching the television show Survivor.

   1  2  3  4  5  6  7
strongly disagree slightly disagree neutral slightly agree agree strongly agree

23. I watch the television show Survivor regularly.

   1  2  3  4  5  6  7
strongly disagree slightly disagree neutral slightly agree agree strongly agree

24. The “Theory Survivor” format made the unit on set theory interesting.

   1  2  3  4  5  6  7
strongly disagree slightly disagree neutral slightly agree agree strongly agree

Please write any additional comments that you have.
Appendix F: IRB Approval Letter
March 12, 2015

Protocol Number: 2015B0054
Protocol Title: AN INVESTIGATION OF STUDENT PERCEPTIONS OF SET-THEORETICAL ANALYSIS AND POST-TONAL MUSIC PRESENTED IN A GAME-LIKE CONTEXT, David Clampitt, Angela Ripley, Music
Type of Review: Initial Review— Expedited
IRB Staff Contact: Michael Donovan Email: Donovan.6@osu.edu; Phone: 614-292-6950

Dear Dr. Clampitt,

The Behavioral and Social Sciences IRB APPROVED BY EXPEDITED REVIEW the above referenced research. The Board was able to provide expedited approval under 45 CFR 46.116(b)(1) because the research meets the applicability criteria and one or more categories of research eligible for expedited review, as indicated below.

Date of IRB Approval: March 6, 2015
Date of IRB Approval Expiration: March 6, 2016
Expedited Review Category: 6, 7

In addition, the research was approved for a waiver of documentation of the consent process.

If applicable, informed consent (and HIPAA research authorization) must be obtained from subjects or their legally authorized representatives and documented prior to research involvement. The IRB approved consent form and process must be used.

Changes in the research (e.g., recruitment procedures, advertisements, enrollment numbers, etc.) or informed consent process must be approved by the IRB before they are implemented (except where necessary to eliminate apparent immediate hazards to subjects).

This approval is valid for one year from the date of IRB review when approval is granted or modifications are required. The approval will no longer be in effect on the date listed above as the IRB expiration date. A Continuing Review application must be approved within this interval to avoid expiration of IRB approval and cessation of all research activities. A final report must be provided to the IRB and all records relating to the research (including signed consent forms) must be retained and available for audit for at least 3 years after the research has ended.

It is the responsibility of all investigators and research staff to promptly report to the IRB any serious, unexpected and related adverse events and potential unanticipated problems involving risks to subjects or others.

This approval is issued under The Ohio State University’s OHRP Federalwide Assurance #00006378. All forms and procedures can be found on the OHRP website – www.orhp.osu.edu. Please feel free to contact the IRB staff contact listed above with any questions or concerns.

Michael Edwards, PhD, Chair, Behavioral and Social Sciences Institutional Review Board
Appendix G: Online Informed Consent Form
Online Informed Consent Form

This form appeared on the Music 3422 Carmen page as a single-question survey. Although this Carmen page was shared by several sections of the course, the survey was only available to students who were enrolled in Angela Ripley’s section of the course.

Survey title: “Study Participation Consent”

Text:

Please read the following information carefully.

This semester, our section of Theory IV (Music 3422) will take part in a research study that uses a game-like format for classes during one 3 – 4 week unit in the middle of the semester. This study, which is being conducted by Angela Ripley, is supervised by Dr. David Clampitt, a member of the faculty here at OSU.

The purpose of the study is to examine how the game-like format affects student perceptions of the topics covered in this unit. We anticipate that the benefit of this research will be to contribute to music theory instructors’ understanding of how students perceive these topics and to offer a possible way to teach the topics.

During this unit, the format of which is loosely based on the television show Survivor, you will work together with your classmates in small groups, or “tribes,” to complete worksheets called “challenges.” These challenges are similar to the worksheets typically used in this course. Your tribe will compete with other tribes to see which tribe can earn the highest cumulative score on the challenges by the end of the unit. No one will be voted out of their tribe during the game.

Each member of the winning tribe will receive a $13 gift card as a non-academic prize. To ensure that each tribe has an equal chance of winning the prize, your educational records for this course will be accessed in order to check your cumulative course grades.

The challenge worksheets that you complete will be graded individually, and these grades will become a part of your quiz grade for the semester. Your grade in the course will be determined by your individual work, and will not be affected by the outcome of the game.

As a part of the research, you will complete two paper questionnaires, one at the beginning of the unit and the other at the end of the unit. Your responses will be kept confidential and will not affect your grade in the course. Class activities may be videotaped to facilitate more accurate collection of data. This video footage will not be shared with anyone outside the research team.

Participation in this study is voluntary. If you do not wish to participate in this study, you may move to a different section of Theory IV. You may also choose to withdraw from the study at any time without penalty or loss of benefits to which you are otherwise entitled. Because the curriculum is closely coordinated across sections, your progress in the course will continue smoothly even if you move to a different section later in the semester. Additionally, because another section of the course meets at the same time as this one, your class schedule will not keep you from withdrawing from the study if you so choose. The other section is open, and under no circumstances will a student who wishes to move to that section be closed out of the section. Changing sections is not equivalent to moving to a different course.
If you agree to participate in this study, select the answer “Yes, I agree to participate in this study.” If you do not agree to participate in this study, select the answer “No, I do not agree to participate in this study.” Click “Submit,” then confirm your submission by clicking “Yes” when asked if you are sure that you want to submit the survey.

Thank you for your time and consideration.

Contact Information:

Angela Ripley  
Graduate Student, School of Music  
The Ohio State University  
Columbus, OH 43210  
USA  
Phone: X-XXX-XXX-XXXX  
Email: (Email address)

The faculty supervisor for this research project is:

Dr. David Clampitt  
School of Music  
The Ohio State University  
Columbus, OH 43210  
USA  
Phone: X-XXX-XXX-XXXX  
Email: (Email address)

You may contact Dr. Clampitt with questions or if you feel you have been harmed as a result of your participation.

For questions about your rights as someone taking part in this study, you may contact Ms. Sandra Meadows in the Office of Responsible Research Practices at X-XXX-XXX-XXXX or X-XXX-XXX-XXXX. You may call these numbers to discuss concerns or complaints about the study with someone who is not part of the research team.

Answer choices:

○ Yes, I agree to participate in this study.

○ No, I do not agree to participate in this study.