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The Effects of Structured Student Interactions on Musical Ability in a High School Orchestra Setting

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Abstract

This action research project looked at the potential effects of structured student interactions, such as peer-assisted learning and reciprocal peer tutoring, on student musical ability and understanding in a high school instrumental ensemble classroom. The study took place at a suburban high school in the Midwestern United States and included 45 students enrolled in a non-audition string orchestra. Qualitative and quantitative data was collected during three units that occurred in hybrid, online, and in-person learning settings during the COVID-19 pandemic. Quantitative data was obtained through scores on teacher-made pre- and post-assessments, while qualitative data was collected through field notes and student questionnaires. The data was put through statistical analysis to help determine growth. The study found mixed results. Structured student interactions have varying degrees of impact on student ability and understanding.

Keywords: music, orchestra, interactions, cooperative learning, peer tutoring, high school

Music itself is a difficult concept to define. In its simplest form, it is a combination of rhythms and pitches. However, music performance is much more than playing pitches and rhythms at the correct time. Instruments require specific technique in order to produce quality tone and fluidity of fine motor skills. Stringed instruments are notoriously difficult to excel on and call for students to learn with high attention to detail in the earliest of learning stages. Historically, novice musicians have learned to play their instrument by working with a master performer. In today's world, some students may have the opportunity to participate in private or semi-private lessons, but others have roadblocks that prevent them from receiving this support. When lessons are not possible, it falls on the ensemble instructor to ensure that students have a working knowledge of the technical skills needed for their instruments. High school performing ensembles often have high student-to-teacher ratios, which diminishes the teacher's ability to provide frequent, individualized feedback, especially during rehearsal when students are actively immersed in the music-making process. This feedback is vital as students engage in repetitive tasks that form neural connections. Without it, students are in danger of developing habits that significantly impair their ability to successfully perform advancing literature.

Learning can happen in many ways, but there are two significant theories that focus on how learning occurs through interactions. One is Vygotsky's Theory of Social Development. Vygotsky described the process of learning as "the co-construction of knowledge between the teacher and learners, or the learners and learners, which later becomes internalized by the learner through a series of transformations" (Vygotsky, as cited by Latukefu, 2009, p. 129). The other is the Social Learning Theory, developed by Bandura, which describes learning as a process of reciprocal communication and action. We observe the behaviors and attitudes of others and notice the outcomes of said behaviors (Bandura, as cited by Latukefu, 2009). Bandura

demonstrated that the physical and emotional environment where learning occurs could influence the quality and depth of learning in a tremendous manner (David, 2020b; Jellison, Brown, & Draper, 2015). According to these theories, learning does not occur in a vacuum; it is the product of multiple interactions and connections between everyone involved in the learning process.

Music classrooms, especially performing ensemble classrooms, are typically thought of as collaborative learning settings as students must function as one to successfully perform the repertoire. However, when one takes a closer look at the interactions within the room, it can be seen that teachers in these settings often control the learning goals and pacing as they act in the traditional role of the ensemble's conductor in preparation for public performance. Students are taught to follow the physical movements of the baton and the verbal instructions from the teacher. Providing students with the opportunity to engage in structured peer interactions, such as peer assessment and cooperative groupings, changes the traditional rehearsal structure and places the learning experience into the hands of the students. Based on this information, the following questions were explored: Can structured peer interactions be used in a music ensemble classroom to help develop and deepen understanding about content and improve facility with performance technique, even if the master teacher is seldomly involved in coaching and feedback? What effects, if any, do structured peer interactions have on student musical ability and understanding in a high school instrumental ensemble classroom?

Theoretical Framework

Upon recognizing the need to use peer-to-peer feedback and support, it was imperative to look more closely at the established learning theories that discuss how knowledge and skill acquisition occurs through communication and cooperation. Constructivism is a theoretical

model that states that people learn by actively constructing their knowledge by experiencing and interacting with the world around them (Constructivism, 2020). Vygotsky's Social Development Theory falls within this framework, as he further breaks it into three themes: social interaction, "The More Knowledgeable Other", and the Zone of Proximal Development (David, 2020a). Vygotsky hypothesized that children first learn through interpersonal relationships before they internalize the information, creating intrapersonal understandings. Collaboration with "The More Knowledgeable Other," another entity more proficient in a particular area than the learner, influences these social interactions (Vygotsky, as cited by David, 2020a). By connecting with the More Knowledgeable Other, students are able to fall into the Zone of Proximal Development, where learning occurs when they are challenged with a task that is too complex to be mastered through solo effort, but they can accomplish the task with guidance from others (Vygotsky, as cited by David, 2020a; Vygotsky, as cited by Latukefu, 2009).

While Bandura's Theory of Social Learning is not considered part of constructivism, it is closely related to Vygotsky's work. Vygotsky's theoretical focus is on knowledge acquisition, whereas Bandura's theoretical focus is on behavioral development. "Most human behavior is learned observationally through modeling: from observing others, one forms an idea of how new behaviors are performed, and on later occasions, this coded information serves as a guide for action" (Bandura, as cited by David, 2020b, para. 1). Being attentive to the demeanor, conduct, and outcomes of those behaviors allows children to learn by example, internalizing the knowledge before putting it to use. Like the modeling that occurred with the historical practice of master music teachers and apprentices, students can observe their peers' performances and behaviors to better understand their instrument and performance practices (Jellison, Brown, & Draper, 2015).

It was fitting to use Bandura's and Vygotsky's frameworks to guide the research for my action research project. Vygotsky's Theory of Social Development maintains that students must play an active role in the learning process, using reciprocal interactions to help foster growth and improve understanding (David, 2020a). Bandura's Theory of Social Learning states that the learning environment is an example of reciprocal determinism; it is both a product of and a contributing factor to student behavior (David, 2020b; Jellison, Brown, & Draper, 2015). Consulting these two theories enabled me to find relevant research, articles, and other materials in my quest to curate and develop learning strategies to use during the action research process to assess if structured peer interaction had any bearing on student musical ability and understanding.

Review of Literature

Formative Assessment

There are three types of peer interactions discussed frequently in the literature that demonstrate positive effects in improving student musical ability: formative assessment, peer-assisted learning, and peer tutoring and mentoring. Formative assessment is a multifaceted process that uses data to promote student learning by providing descriptive feedback from the teacher to the student and from the student to the teacher or other students through peer assessment. Students and teachers can then make informed decisions on where to place emphasis to better support individual progress (Chen, Lui, Andrade, Valle, & Mir, 2017; McMillan, 2018). As formative assessment occurs during the learning process, it is a low- or no-stakes method for students to give and receive descriptive feedback amongst one another (Chen et al., 2017). Students must have a clear understanding of what "good learning" entails, a working knowledge of technical music language to provide descriptive feedback, and the ability to focus peer

feedback on the task and not the characteristics of the individual learner (Chen et al., 2017; Latukefu, 2009; Valle, Andrade, Palma & Hefferen, 2016). Studies suggest that the discussion-reflection-revision cycle of peer-to-peer formative assessment aids students in strengthening their musical understandings by promoting metacognition (Brazeal, Brown, & Couch, 2016; Chen et al., 2017; Darrow, Gibbs, & Wedel, 2005; Latukefu, 2009; Johnson, 2015).

Peer-Assisted Learning

Peer-assisted learning falls under the larger umbrella of formative assessment and is a collection of strategies designed to help students learn from one another. Key aspects are based on reading instruction, which lends itself to music instruction activities through the decoding of printed music (Walkup-Amos, 2020). Peer-assisted learning ties directly into Vygotsky's Zone of Proximal Development. The Zone of Proximal Development is the area where learning occurs for a particular student when they are challenged with a task that is too complex to be mastered through solo effort, but the student can accomplish the task with guidance from others (Vygotsky, as cited by David, 2020a; Vygotsky, as cited by Latukefu, 2009). Peer-assisted learning allows the teacher to apportion teaching and learning responsibilities amongst the students (Johnson, 2015). Students work in pairs or small groups that have been chosen by the instructor (Walkup-Amos, 2020). When grouping students, it is necessary to consider whether to arrange students in asymmetrical (novice/expert) or symmetrical (equal standing) groups (Johnson, 2017). Student behaviors, interests, strengths, weaknesses, and instruments or ensemble sections can also play a vital role in group formation (Thorius & Santamaría Graff, 2018).

Peer-assisted learning can be challenging to implement in the performing ensemble classroom as it breaks from the standard practice of rehearsal, where the director delivers all

information (Johnson, 2015). The director may choose to continue to be the person to introduce a new concept; however, peer-assisted learning provides an avenue for students to check comprehension and strengthen understanding (Johnson, 2017). The director must train students to participate in these scenarios, which takes more time and energy than preparing students to follow rehearsal norms (Darrow et al., 2005; Harris & Meltzer, 2015; Johnson, 2015). The director may find the time well spent as research has demonstrated that peer-assisted learning creates considerable gains not only in musical understanding and performance but also in student engagement and motivation (Jellison et al., 2015; Johnson, 2015). Allowing autonomy within the peer-learning groups is essential, as a 2003 meta-analytic review of peer-assisted learning interventions by Rohrbeck et al., (2003, as cited in Johnson, 2015) found that students were twice as successful in peer-assisted learning situations where they had control over rules for interaction with each other than when the teacher controlled those aspects.

Peer Tutoring and Mentoring

Peer tutoring and mentoring are a more specialized form of peer-assisted learning in which there is a difference in ability levels between cooperating students (Olaussen, Reddy, Irvine, & Williams, 2016). While symmetrical groupings have shown to increase student achievement, research indicates that asymmetrical groupings produce higher rates of growth (Johnson, 2017). Vygotsky described this in his theory of the "More Knowledgeable Other." The "More Knowledgeable Other" is simply another entity that has more expertise in a particular area than the learner (David, 2020a). When forming asymmetrical pairs, it is recommended to perform a pre-assessment to determine student ability and put students into ranked order. From there, one can pair the highest-ranking student with the student just under the median (Johnson, 2017; Thorius & Santamaría Graff, 2018). When using asymmetrical pairing, it is important to

have the lower-ranked student perform the task first and have the higher-ranked student act as the coach. Students then should repeat the process with roles reversed (Harris & Meltzer, 2015). Research has found that using reciprocal roles within asymmetrical groups further strengthens the effects of peer-assisted learning on achievement in the music classroom (Ginsburg-Block, Rohrbeck, & Fantuzzo, 2006, as cited by Johnson, 2015; Johnson, 2017). If triad grouping is necessary due to having an odd number of students, it is important to avoid including the learners with the lowest scores in that group as they will fare better with one-on-one attention (Harris & Meltzer, 2015).

Considering Students with Disabilities or Other Challenges

Peer tutoring is beneficial for both the mentor and the mentee. Students acting in the mentor role develop a higher understanding of the material as they must analyze and interpret it before delivering it to their peers (Darrow et al., 2005). The importance of reciprocal roles in peer tutoring is heightened by the finding that after participating in peer tutoring programs, students who are vulnerable, such as those with cognitive disabilities or low socio-economic status, have more considerable academic gains when compared to students without these vulnerabilities (Bowman et al., 2013; Johnson, 2017; Rohrbeck et al., as cited by Jellison et al., 2015). Darrow, Novak, Swedberg, Horton, & Rice (2009) cited numerous studies that found benefits in having at-risk or low-achieving students serve as mentors. Students demonstrated an improved attitude towards school, better social skills, and reduced attendance issues such as tardiness, truancy, and even drop-out rates. Literature references multiple studies indicating that students who hold a positive view of the learning environment are more likely to use learning strategies that promote conceptual understanding (Brazeal et al., 2016; Walkup-Amos, 2020). Asymmetrical reciprocal peer tutoring creates equitable relationships between students (Darrow

et al., 2005; Jellison et al., 2015; Latukefu, 2009; Thorius & Santamaría Graff, 2018), leading to a reduction of bias and an increase of self-confidence and musical skill (Darrow et al., 2009; Pettigrew & Tropp, 2006, as cited by Jellison et al., 2015). The environment created by the students in the group relates to the level of achievement (Bandura, as cited by Jellison et al., 2015).

Students labeled as "gifted and talented" often have needs that mirror the needs of students with disabilities and other vulnerabilities, making them “twice exceptional” (Abramo & Natale-Abramo, 2020). Gifted refers to a student who has a higher than average potential to achieve in one or more of Gagné's Aptitude Domains: Intellectual, Creative, Socioaffective, and Sensorimotor (Mcpherson, 1997). Talents develop when students are supported and provided with a structure that fosters the growth of aptitudes (Abramo & Natale-Abramo, 2020; Mcpherson, 1997). Due to the unique thought processes often experienced by gifted students, their potential may not always be apparent as it can be displayed or demonstrated in uncommon or divergent ways (Renzulli & Reis, as cited by Abramo & Natale-Abramo, 2020; Mcpherson, 1997). Peer-to-peer learning interactions can help provide the necessary support system to cultivate talent (Latukefu, 2009; Mcpherson, 1997).

Discussion and Gaps

Structured peer interactions show high potential for increasing gains for students in the performing ensemble classroom. Access to private instrument instruction is not always readily available, and financial barriers can make access even more difficult. Training students to use each other as instructional resources can provide the opportunity for all students to have frequent, individualized attention and feedback, especially in a classroom with a high student to teacher ratio. Acting in the teaching role can help students strengthen their understanding and

skills through metacognition. By fostering a supportive environment through feedback, students are more likely to be engaged in learning activities, leading to benefits such as a reduction of attendance issues and an increase in self-esteem. More research is needed at the secondary level, as many studies focused on the effects of structured peer interactions at the elementary level. More research is also needed to demonstrate if structured peer interactions have a lasting effect on skills and understanding.

Methodology

This action research study used student-generated artifacts, observational data, and inquiry data to achieve triangulation. Student-generated artifacts included quantitative data from physical performances and pre and post-assessment scores on teacher-made tests. Pre- and post-unit assessments were identical to help reduce the chance of confounding variables (Lock, Lock, Morgan, Lock, Lock, 2013). Qualitative observational data was collected through field notes during each structured peer interaction session. Students provided qualitative inquiry data by completing a survey at the end of each unit.

The population for this action research study was students at a suburban high school in the Midwestern United States. The sample included a total of 45 students enrolled in a non-audition string orchestra. While all students must complete arts credits, the orchestra was not a required class. Due to changes in enrollment and attendance, not all students were able to participate in every unit. See Table 1 for more information about the demographics. The data will be broken down within the results section for each unit to provide more details on the population represented. The study took place during the 2020-2021 academic year amid the COVID-19 pandemic and was a blend of hybrid, virtual, and in-person interactions. Students completed all activities synchronously.

Table 1
Student Demographics

	9th Grade (15)	10th Grade (15)	11th Grade (4)	12th Grade (11)	**Total**
Gender					
Female	7	9	2	5	23
Male	8	6	2	6	22
Ethnicity					0
African American	1	1	0	1	3
Asian American	2	3	0	0	5
First Nation	1	1	0	1	3
Latinx	2	2	1	1	6
White	9	8	3	8	28
Private Lessons					0
Current	2	1	1	0	4
Previous	4	5	2	7	18
Never	9	9	1	4	23
Years of Study					0
Less than a year	2	0	0	0	2
1 to 2 years	5	2	0	0	7
3 to 4 years	7	9	0	1	17
5 to 6 years	0	4	3	6	13
7 or more years	1	0	1	4	6

The first unit was based on identifying 33 different musical terms and symbols that appeared in the piece the ensemble was preparing for the state's high school league large group

orchestra contest. To determine prior knowledge before the unit started, students took a teacher-made test using a Google Form asking them to provide the meaning of each term or symbol. They were informed that the pre-test score would have no bearing on their grade, but they would receive credit for taking the test. The test was short-answer and did not include a word bank. Each correct response was awarded one point. A chart of the terms and symbols can be seen in Appendix A.

Students were in a hybrid setting at this point of the year, and those at home completed the assignment through Google Meet breakout sessions. The sessions were recorded. Students were placed in groups of three, determined first by their hybrid day (A or B) and then by their pre-assessment score. The groupings were asymmetrical, with all three students performing at different levels. To achieve this balance, the results were broken into three columns according to the score. The top students from each column were grouped together, followed by the students in the second spot, and so forth.

The terms and symbols studied in this unit are commonly found in orchestral literature, so all students needed to recognize and define them to create a cohesive and musically accurate performance. Before each learning session, the class explored the assignment using sample problems. The teacher fully demonstrated one example, and the ensemble completed the second example. The form provided the students with the terms and symbols, the pronunciations, and the definitions. Working together, students created a saying or a picture that would help connect the term or symbol with its meaning. Students were instructed to assign roles through a discussion prompt, such as determining who has the most pets or the longest middle name. Roles included: the person who would share the electronic document with others, the scribe, and the picture finder. Once in their online learning teams, students completed the assignment as a group

and submitted a single document. This process was conducted three times with eleven terms and symbols during each session. The fourth session had the students take the pre/post-assessment as a group, and they were encouraged only to use their previous work when no one in the group knew the answer. After the fourth session, students took the post-assessment individually during class. Once the test was complete, students filled out a questionnaire to give feedback on their experience working in their small groups.

Due to rising COVID-19 numbers, the district was fully online for all students during the second unit, which focused on key signature theory. Prior to the first session, students completed a teacher-made test using Google Forms. Students were aware that pre-assessment results would not affect their grades but that they would receive credit for completing the assessment. There were three sections to the test. Students were asked to provide the order of the seven sharps and seven flats found in Western notation key signatures. They then needed to identify the Major signatures from 5-flats through 5-sharps, followed by the third section that tested the relative minor key signatures using the same number of flats and sharps. Students were able to choose the name of the key signature through a drop-down menu. One point was awarded for each correct answer.

Students were grouped in dyads and triads according to orchestral section (e.g., Violin 1 or Violin 2) and then were homogenous by years of study as much as possible. With only three bassists and three violists, those groupings did not take years of study into consideration. Students were in distance learning and completed the assignment through Google Meet breakout sessions. The sessions were not recorded; however, I visited each group to take field observation notes without turning on my audio and camera. The first session asked students to complete a worksheet dealing with the theory regarding determining a Major key signature using sharps.

Students reviewed the sharped key signatures using digital flashcards during the second session. The third session required the students to complete a worksheet detailing the theory involved in identifying flatted Major key signatures. The fourth session used flashcards again, this time focusing on the Major key signatures with flats. The final session had students use their knowledge of Major key signatures learned in the previous lessons to determine the relative minor key signature. After the fifth session, students took the post-assessment individually during class. Once the test was complete, students filled out a questionnaire to give feedback on their experience working in their small groups.

The final unit of this action research study occurred after school returned to full in-person learning, and it focused on the physical performance of four different scales. The scales were based on the keys of the pieces being studied for the year's final concert: F Major, D harmonic minor, E natural minor, and D Major. Printed sheet music was teacher-created through the use of Finale Notation software. Scales were one to two octaves, and the range was determined for each orchestral section by the pitches encountered within the music. Fingering was provided for all shifts, but the positions were not marked. No fingering was provided for any pitches in first position except for the 4th finger extension in the viola F Major scale (see Appendix B for the score). The pre-assessment phase was done in person over two weeks with students sight-reading two scales per week. Students were not allowed to keep the scale sheet between testing sessions. They also were not given any information about their performance after testing. Like previous units, students were informed that their pre-assessment score would not affect their course grades.

Initially, there were 24 students present for in-person instruction; however, some were absent from class any given day due to illness, needing to quarantine, or not opting to go into the

physical building. Seventeen students had enrolled in the district's online academy and were fully online during class time. The number of students in each program (in-person learning and online academy) fluctuated over the final unit as students were allowed to switch learning programs. Students were placed in dyads according to their orchestral section and then by seating arrangement. Due to contact tracing with COVID-19 protocols, students were limited to working with those in the neighboring seats. Triads were only used on days when absences left students without their assigned partners. Triads were avoided with the students with the lowest scores, as struggling students need one-on-one attention in peer-tutoring situations (Harris & Meltzer, 2015). Online students were included in the instruction, but data was not collected as there was no way to guarantee the baseline performance data. The updates to Google Meet no longer enabled me to record the breakout sessions for observation.

Students were directed to talk to each other to determine the key signature and then mark all non-taped finger placements, such as 1st finger extension, on their sheet music. I demonstrated the scale on my violin at 60 bpm before the first run-through to help acclimate the student's ears. I then switched to the piano to accompany the students on a louder instrument as they played. Groups were instructed to figure out who would play first and who would observe first through prompts, such as "the tallest student will play first." Student 1 played while student 2 watched the performance, keeping track of any issues. Two minutes were provided for student 2 to give feedback and help student 1 make adjustments. Student 1 played again, still accompanied by piano, while student 2 continued to inspect. Two more minutes were provided for instruction and feedback. This same process was repeated with student 2 playing and student 1 observing. The exercise concluded with all students performing the scale in unison.

Observational field notes were taken during learning sessions by watching from the podium/piano and circulating through the room when students worked cooperatively. This learning activity occurred four times, once for each scale. After the fourth session, students completed the post-assessment individually during class. They were allowed to use the sheet music they had marked during learning sessions. One point was awarded for each note that matched the printed pitch. Students were not penalized for using fingerings that differed from what was shown on the page. Once the post-testing phase was complete, students filled out a questionnaire to give feedback on their experience working in their small groups.

Analysis of Data

The data collected for this action research project was both qualitative and quantitative. Qualitative data came from observational field notes and post-unit student surveys. Student survey data was categorized through thematic analysis and coded accordingly. Quantitative data was obtained from identical pre- and post-assessments that the students completed on either end of the unit. The quantitative data points were analyzed through various t-testing procedures, such as testing for a difference in means in two samples and testing for a difference in means with paired data. The qualitative data was used in conjunction with the quantitative data with statistical analysis to compare specific subsets against the whole or one another.

Findings

This action research project attempted to determine what effects if any, structured peer interactions had on student musical ability and understanding in the orchestral classroom. Three different units were completed during the study, and each unit used distinct methods for grouping the participants. I compared the data for the whole class for pre and post-assessment scores, the difference in scores between students who participated in the peer interactions and the

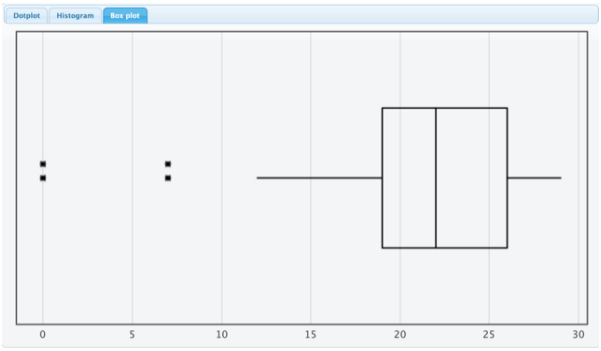
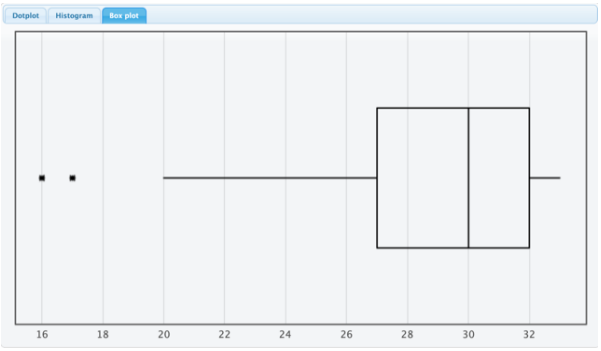
students who did not, and the levels of growth experienced within the grouping categories. I coded the responses provided by the students on the questionnaires they completed after each unit to provide a clearer picture of their experiences.

Terms and Symbols: Asymmetrical Grouping

Before proceeding with the qualitative data calculations, I determined if the Terms and Symbols Unit data was reasonably normally distributed (Figure 1) by using the boxplot function within StatKey, an online statistical analysis program. Due to the presence of outliers, I needed to remove the data from those students to proceed with calculations (Lock et al., 2013).

Figure 1

Terms and Symbols Box Plots

Pre-Assessment Data	Post-Assessment Data
	

The breakdown of the data for the 41 students with scores within the normal distribution can be seen in Table 2. The final column was calculated from the differences in the individual scores. There was an increase in both the mean and median, but analysis could help determine if the increase in scores was statistically significant (Lock et al., 2013).

The same assessment was administered before and after the terms and symbols unit, allowing for the Difference in Means with Paired Data t-Test. The null hypothesis was that the pre-test and post-test scores were the same, where the alternative hypothesis was that the pro-test score was higher than the pre-test score (Figure 2). Using a right-tail t-test found on StatKey,

with an alpha value of 0.05 and degrees of freedom at 40, I determined that the p-value was 0.000, enabling me to reject the null hypothesis. Students did make statistically significant gains from the pre-test to the post-test for the Terms and Symbols Unit.

Table 2
Terms and Symbols Pre and Post Assessment Data

Terms & Symbols (33 pts)	Pre-Assessment Data	Post-Assessment Data	Difference in Scores
Mean	22.4624	29.2927	6.8292
Median	23	31	6
Standard Deviation	4.5061	3.6827	5.4032

Figure 2
Calculation of the Difference in Means for Paired Data, Terms and Symbols

Hypothesis	Formula	Calculations
H_0: $\mu_{PreT} = \mu_{PostT}$ H_a: $\mu_{PreT} < \mu_{PostT}$	$t = \frac{\overline{x}_d}{s_d / \sqrt{n_d}}$	$\frac{6.8292}{0.8438}$ $t = 8.0934$

Through field-note observations, I kept data on the students who did not sign into their learning groups and also the groups that did not complete the assignment together. The data comparing post-assessment results separated by participation status can be seen in Table 3. Seventeen students did not participate in the activities. After generating box plots with the data, it was determined again that an outlier needed to be removed. While the students who participated in the group learning sessions had a slightly higher mean and median, further calculations needed to be made to determine if the difference was statistically significant.

I compared two different groups, so it was appropriate to use the Two-Sample t-Test for a Difference in Means. The null hypothesis was that the two groups were equal, while the alternative hypothesis was that students who participated in the group learning sessions performed better than those who did not (Figure 3). Using a left-tail t-test available on StatKey, with the alpha value at 0.05 and degrees of freedom at 15, I determined that the p-value was 0.209. Since the p-value was larger than the alpha value, there was not enough evidence for me to reject the null hypothesis. The students who participated in the group learning sessions performed at the same level as the students who completed the assignments independently.

Table 3
Terms and Symbols Participation Data

Terms & Symbols (33 pts)	Did Not Participate	Participated
Number of Students	16	24
Mean	29.0625	29.9583
Median	29.5	31
Standard Deviation	3.6418	2.805

Figure 3
Calculation of the Difference in Means, Terms and Symbols Participation

Hypothesis	Formula	Calculations
H_0: $\mu_{DNP} = \mu_P$ H_a: $\mu_{DNP} < \mu_P$	$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$	$\frac{\text{-0.8958}}{1.0755}$ t = -0.8329

During the action research process, I had students grouped by ability based on their pre-assessment scores for this unit. I ran an analysis on the numbers of each subset of the low, medium, and high ranked students and compared the growth, which was calculated by subtracting each student's pre-assessment score from the post-assessment score. The numbers for

the data can be seen in Table 4. All students who completed both assessments are present. By completing additional t-Testing with a Difference in Means using a right-tail test in StatKey, I found that the students in the lowest and middle groups experienced similar growth with a p-value of 0.355. However, both of these groups demonstrated higher levels of growth than students in the highest group; the lowest-highest comparison test resulted in a p-value of 0.00031, and the middle-highest comparison test produced a p-value of 0.000023.

Table 4

Terms and Symbols Growth Data by Leveled Grouping

Terms & Symbols	Lowest Group Growth	Middle Group Growth	Highest Group Growth
Student Count	14	15	15
Mean	11.3571	9.8667	2.0667
Median	12.5	9	3
Standard Deviation	7.1533	4.1896	3.0814

One final set of calculations were completed for the qualitative terms and symbols testing data, which compared the growth of the students within each of the groupings split between if students did or did not participate in the group activities (Table 5). I compared the participation numbers to see if there was a difference in growth within each of the three groups by using a two-tailed t-test in StatKey. All of the t-tests had p-values higher than the alpha value of 0.05, meaning that all students within grouping categories had similar growth.

Table 5

Terms and Symbols Growth Data by Leveled Grouping and Participation

Terms & Symbols	Lowest Group Growth		Middle Group Growth		Highest Group Growth	
Participate	No	Yes	No	Yes	No	Yes

Count	6	8	7	8	5	10
Mean	14.6667	8.875	9.8571	9.875	0.8	2.7
Median	13.5	10	9	9.5	2	3
St. Dev	7.1181	6.5124	5.9841	2.1002	3.1145	3.0203

Thirty-one students completed a survey at the conclusion of the unit to give feedback on their experiences working in their small groups. When asked what they felt was most helpful about working in groups, 52% of students responded that they liked collaborating with others and having other minds to work with, 16% said the group work made the assignment fun, 10% said their partners helped keep them on track, and 13% said they did not feel the group activities were beneficial. Responses to "What Was Challenging About the Group Work?" included: unequal collaboration (45%), issues with online interactions (13%), and awkwardness (10%). 29% of students reported that they did not find anything overly challenging about the experience. After the group work, students said they felt like they understood the terms and symbols better (55%) and were better at socializing with their peers (10%). 13% of respondents did not feel that participating in the group learning activities improved their understanding of the terms and symbols. I used the student feedback to adjust the structure of the peer interactions in the subsequent units of Key Signatures and Scales.

Key signatures: Homogenous Grouping

Using StatKey, I determined there were no outliers in the data produced by the 36 students who completed both the pre and post-assessments for the key signature unit. I could proceed with statistical calculations using the data. The breakdown of the assessment data is described in Table 6. The null hypothesis was that the pre-test and post-test scores were the same, where the alternative hypothesis was that the pre-test scores were lower than the post-test

scores. The same assessment was administered before and after the key signature unit, enabling me to use the Difference in Means with Paired Data t-Test (Figure 4). With the alpha value at 0.05 and degrees of freedom at 35, I determined that the p-value was 0.000091 using a left-tail t-test accessed through StatKey. I could reject the null hypothesis. Student scores increased from the beginning of the unit to the end of the learning sessions at a statistically significant level.

Table 6
Key Signatures Pre and Post-Assessment Data

Key Signatures (40 pts)	Pre-Assessment Data	Post-Assessment Data	Difference in Scores
Mean	20.2778	31.6111	11.4865
Median	18	38	11
Standard Deviation	12.0466	11.5196	16.248

Figure 4
Calculation of the Difference in Means for Paired Data, Key Signatures

Hypothesis	Formula	Calculations
H_0: $\mu_{PreT} = \mu_{PostT}$ H_a: $\mu_{PreT} < \mu_{PostT}$	$t = \frac{\overline{x}_d}{s_d / \sqrt{n_d}}$	$\frac{11.3333}{2.708}$ $t = 4.1851$

Like the previous unit, some students and groups did not complete the assignments using the parameters outlined for the student interactions. The data comparing post-assessment results of non-participants and participants can be seen in Table 7. While 25 students did participate in the structured peer interactions, I discovered five data points were outliers. They had to be removed to create a normal distribution for the t-testing process. It was appropriate to use the Two-Sample t-Test for a Difference in Means since I compared two distinct groups. The null hypothesis was that the two groups performed at the same level on the post-assessment. The

alternative hypothesis was that the students who did not participate in the group learning scored lower than those who did participate (Figure 5). Students who participated in structured peer interactions obtained higher scores on their post-assessment than those who did not participate. Using 10 degrees of freedom with an alpha value of 0.05 and a t-test value of -2.9469, I found the resulting p-value of 0.0073.

Table 7
Key Signatures Participation Data, Post Assessment Scores

Key Signatures (40 pts)	Did Not Participate	Participated
Number of Students	11	20
Mean	25.4545	38.55
Median	33	38.5
Standard Deviation	14.7062	1.3169

Figure 5
Calculation of the Difference in Means, Key Signature Participation

Hypothesis	Formula	Calculations
H_0: $\mu_{DNP} = \mu_P$ H_a: $\mu_{DNP} < \mu_P$	$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$	$\frac{-13.0955}{4.4438}$ t = -2.9469

I opted to rerun the test without removing the outliers; eliminating those five student data points from the data excluded 20% of the population. Including the outliers in the calculations for the t-test produced -2.205. Using 10 degrees of freedom, this had a resulting p-value of 0.026, which is within the parameters for rejecting the null hypothesis. Even with including outliers, students who participated in the peer interactions had statistically higher scores on their post-assessment than their peers who did not participate. Completing the same test using growth

data (Table 8) resulted in a p-value of 0.022, demonstrating again that participating students outperformed those who did not participate.

Table 8
Key Signatures Participation Data, Growth

Key Signatures Growth	Did Not Participate	Participated
Number of Students	11	25
Mean	1.1818	15.8
Median	-1	20
Standard Deviation	19.1667	12.803

Students were primarily grouped by years of experience for this unit, so I broke down the data to show growth. As I only had one student who was in the "Less Than One Year" category due to a different student dropping the class, I did not include that column in the table. Table 9 displays the data by years of experience. Completing the t-Test for Difference in Means between all groups produced p-values ranging from 0.208 to 0.473, and all were higher than the alpha value of 0.05. I could not reject the null hypothesis that each group experienced equal growth.

Table 9
Key Signature Growth Data by Years of Strings Performance Experience

Key Signatures	1-2 Yrs: Growth	3-4 Yrs: Growth	5-6 Yrs: Growth	7+ Yrs: Growth
Number of Students	6	15	10	4
Mean	7.5	10.8667	11.5	15.75
Median	18	6	14.5	16
Standard Deviation	20.8878	14.101	20.625	7.3655

After the conclusion of the key signature unit, students fill out an opened-ended questionnaire to provide insight into their experiences with peer interactions. Thirty students

completed the form, and 53% responded that asking others for help was the most valuable part of the group activities. 17% said it was helpful to use others to check work and understanding, and 13% felt working in groups made the material more fun. When asked to describe what they did not enjoy, 23% of the responders indicated that they did not find anything they did not like about working in groups. For the remaining responses, unequal collaboration (33%) was the most common reason for not enjoying the group activities, followed by not having the option to work alone (17%), feeling forced to socialize (7%), and describing the experience as awkward (7%). Unequal collaboration (20%) was a theme that showed up again when asked what was challenging. Other challenges included feeling comfortable asking for help (13%) and socialization (7%). Students reported feeling more confident with the key signature theory (40%), collaboration skills (13%), general social skills (10%). 13% of students responded that they did not feel like they improved any skills due to peer interactions. I used student feedback from the key signature unit to influence the design of the work completed during the final segment of the action research project that focused on scale performance.

Scales Performance: Grouping by Seating

Four different scales were studied during the scale performance unit. For ease of data analysis, students were assigned a score resulting from the combined pre-assessments scores and another score that was the sum of all post-assessment scores. Fifteen students were able to complete all of the assessments, and there were no outliers in the data, so I was able to commence the statistical analysis without delay. The breakdown of the data for the assessments, plus the data for the differences between each student's scores, can be seen in Table 10. Using an alpha value of 0.05, 14 degrees of freedom, the t-Test for a Difference in Means in Paired

Data, and StatKey, I concluded that the p-value was 0.0000021. I could reject the null hypothesis for the alternative hypothesis that students had a higher score on the post-assessment (Figure 6).

Table 10
Scales Performance Pre and Post-Assessment Data

Scales (116 pts)	Pre-Assessment Data	Post-Assessment Data	Difference in Scores
Number of Students	15	15	15
Mean	89.8	106.2667	16.4667
Median	85	106	16
Standard Deviation	14.1481	9.3844	8.7739

Figure 6.
Calculation of the Difference in Means for Paired Data, Scales Performance

Hypothesis	Formula	Calculations
H_0: $\mu_{PreT} = \mu_{PostT}$ H_a: $\mu_{PreT} < \mu_{PostT}$	$t = \frac{\overline{x}_d}{s_d / \sqrt{n_d}}$	$\frac{16.4667}{2.2654}$ $t = 7.2688$

My field observation notes included data on the students who did not actively work with their partner(s) while completing the scale exercises. The data comparing post-assessment results for this scenario can be seen in Table 11. The p-value after calculations and testing was 0.033, which shows that students who participated in the peer interactions had a higher post-unit score (Figure 7).

Table 11
Scales Performance Participation Data

Scales (116 pts)	Did Not Participate: Post Score	Participated: Post Score
Number of Students	5	10
Mean	101.6	108.6

Median	103	109
Standard Deviation	10.5499	8.3293

Figure 7
Calculation of the Difference in Means, Scales Performance Participation

Hypothesis	Formula	Calculations: Diff. in Means, Participation
H_0: $\mu_{DNP} = \mu_P$ H_a: $\mu_{DNP} < \mu_P$	$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$	$\frac{-5.3091}{2.1181}$ $t = -2.5065$

As grouping was determined by a seating chart and students were not paired due to any previously selected data, I did not look at calculations for students by years of playing or pre-test performance. However, I opted to run an additional test that showed the growth experienced by the participation subsets. That data is displayed in Table 12. Using the t-Test for a Difference in Means, with an alpha value of 0.05, four degrees of freedom, and a right-tailed test in StatKey, I found the resulting p-value of 0.244. The null hypothesis that students experienced equal growth between the two groups could not be rejected.

Table 12
Growth Data by Scales Performance Participation

Scales Unit	Did Not Participate: Growth	Participated: Growth
Number of Students	5	10
Mean	13.8	17.8
Median	15	19.5
Standard Deviation	10.1833	8.23

I provided a final reflection opportunity after the scales unit and 14 students completed the questionnaire. The following themes were present in the responses regarding what was most

helpful about peer interactions: deepening understanding through collaboration (57%) and asking for help (43%). When asked to describe what, if anything, they were able to improve on as a result of working with another student, 57% reported feeling more confident with scale theory and subsequent finger placement. 14% said they improved their shifting skills, and 7% felt they improved their social skills. A new theme that emerged with this unit was the issue of pacing. 14% of students reported pacing was a part of what they did not like about the group activity, and 21% said pacing was a challenge when completing the partner work.

Comparing Unit Growth

Three different units were covered, each with its own structured peer interaction format, with students demonstrating growth from the pre-assessment to the post-assessment. To compare the student growth in each unit (Table 13), I used a two-tailed t-Test for a Difference in Means. I found the following p-values: 0.212 (Terms & Symbols and Key Signatures), 0.168 (Key Signatures and Scale Performance), and 0.0032 (Scale Performance and Terms & Symbols. There were similar levels of growth from the first unit to the second, and the second to the third. Students experienced a different level of growth during the final unit than they did during the first unit.

Table 13
Unit Growth

Unit Growth	Terms & Symbols	Key Signatures	Scale Performance
Student Count	44	36	15
Average	7.6818	11.3333	16.4667
Median	8	14	16
Standard Deviation	6.4295	16.2481	8.7739

Other Demographics

I collected data on the students regarding gender identity, ethnicity, lesson participation, and grade level. While I did not use these elements to form groups, I was still able to look at the growth of each of these identifiers within the three units. That data is shown in Tables 14 - 17. There were potential outliers in any category where the mean and median differed. Running calculations with data that includes outliers can increase the variance measure, which decreases the t-value, therefore affecting the resulting p-value. I was unable to find any statistically significant differences when comparing subgroups within each unit.

Table 14
Growth by Gender Identity

	Terms & Symbols		Key Signatures		Scales	
Gender	Female	Male	Female	Male	Female	Male
Count	23	21	20	16	7	8
Mean	6.5652	8.9048	11.05	11.6875	14.4286	18.25
Median	6	8	14.5	11.5	15	20.5
St. Dev.	5.4425	7.3	17.9692	14.37924	8.2433	9.377

Table 15
Growth by Ethnicity

	Terms & Symbols		Key Signatures		Scales	
Ethnicity	BIPOC	White	BIPOC	White	BIPOC	White
Count	16	28	12	24	4	11
Mean	7.3125	7.8929	6.75	13.625	16.25	16.5455
Median	7.5	8	9.5	15	15	19
St. Dev.	6.183	6.6686	20.7063	13.4255	9.5	8.9818

Table 16
Growth by Grade Level

	Terms & Symbols				Key Signatures				Scales			
Grade	9	10	11	12	9	10	11	12	9	10	11	12
Count	15	15	4	10	12	13	3	8	6	4	3	2

Mean	9.4	8.467	3.5	5.6	8.333	9.539	19.667	15.625	18.167	18.25	12	14.5
Median	9	9	3.5	7	13.5	3	26	17	21	15.5	7	14.5
St. Dev.	6.045	6.937	1.291	6.835	17.706	16.626	18.339	13.606	10.343	5.582	12.288	6.364

Table 17
Growth by Lesson Participation - students with any experience with private instruction

	Terms & Symbols		Key Signature		Scales	
Lessons	Yes	No	Yes	No	Yes	No
Count	22	22	18	18	11	4
Average	7.5909	7.7727	11.6667	11	15.0909	20.25
Median	8	5	18.5	7.5	16	18.5
St. Dev.	4.8566	7.8129	16.1209	16.8348	9.3	6.702

Conclusions and Recommendations

Answering the question of, “What effects, if any, do structured peer interactions have on student musical ability and understanding in a high school instrumental ensemble classroom?” proved to be difficult, and the data analysis left me with more questions than answers. Students demonstrated high levels of growth from the pre-assessment to the post-assessment in every unit. Focused contact with the subject matter could contribute to the increase in performance. I attempted to break it down further by comparing the final assessment scores between students who did and did not participate in the group learning activities. While the analysis did provide more insight and even looked promising in demonstrating a positive effect, it didn’t truly get to the heart of the matter. It became clear to me that I needed to compare growth.

The terms and symbols data indicated that students who did participate in the peer interactions experienced similar growth to those who did not participate. Per recommendations from Johnson (2017) and Thorius & Santamaría Graff (2018), I used asymmetrical groupings for this unit and examined the performance of each student grouping. Students in the middle and

lowest level groups had more significant growth than those in the highest group, but that was expected since the students who scored the highest on the pre-assessment had less room to grow. When I compared participants versus non-participants within each ranked group, there was no difference in the growth. It appears that working in small groups had no impact on student achievement in this particular unit.

I am thankful that I was able to complete multiple units during my action research project, as the key signature unit data demonstrated that students who worked with their partners had higher levels of growth than students who worked independently. The difference in outcomes between the units made me question if the subject matter impacted the effectiveness of the learning strategy. Key Signature Theory is more difficult to grasp than the memorization of terms and symbols. It is possible that a larger number of students found themselves in the Zone of Proximal Development because the subject matter was challenging. I do not want group work to feel like busywork, so I aim to continue using structured peer interactions when the materials and concepts require a higher level of thinking.

As I looked closer at the data for the key signature unit, it was interesting to find that while students who participated in group activities had more growth and higher post-assessment scores, they also tended to start with higher pre-assessment scores. Some students responded to the questionnaires that it was difficult to ask for help because they didn't want others to think they were "stupid." There is potential that students who have lesser established musical foundations are more likely to avoid group activities because of the risk of demonstrating ineptitude. Rather than basing grouping solely on years of playing or achievement, I should also consider student confidence and rapport. If a student is more comfortable with their group members, could I increase their likelihood of participating in the cooperative activities?

I am concerned that the type of testing questions influenced assessment outcomes. Eight students (six non-participants and two participants) had lower scores on their key signature post-assessments, with growth numbers ranging from -1 to -29. While there were five students with negative growth numbers in the terms and symbols unit, the range was only -2 through -5. The terms and symbols unit used a short answer format assessment without a word bank. The key signatures unit's assessment had a drop-down menu; students could have had lucky guesses. It is also possible that the students with negative growth used outside resources while completing the pre-assessment but not the post-assessment. We were fully online for this unit, so monitoring students during testing was impossible other than using the locked mode on the Google Form Quiz. Locked mode prevented students from opening other tabs or applications while completing the quiz, but I could not control if a student used another electronic device. Google warned me if a student closed the form and re-opened it. I was alerted only once, and that particular student did have a growth score of -5. Moving forward, I will complete prior knowledge testing where monitoring is possible and will reduce guessing errors by not providing potential answers.

Like the key signature unit, students who participated in the scale performance peer interactions fared better on the post-assessment than those who did not participate, but the overall growth for either group was statistically similar. The students who participated in group learning started with higher pre-assessment scores and therefore ended with higher post-assessment results. Besides feeling uncomfortable demonstrating a lack of prior knowledge, what other factors could contribute to the students with lower starting scores opting out of the cooperative learning experience?

One must view the scales unit data with some caution as the data pool was small. Only 15 students were able to complete the entire pre- and post-assessment, but that does not mean that all 15 students were present for each learning opportunity during the unit. Due to numerous reasons, including illness, quarantining, and high-stakes testing, such AP courses and standardized testing make-up, very few students fully participated in the group work. I worry that the assessment scores were affected by nerves as students were not used to playing for me or anyone else outside of their household. The scales unit started shortly after returning to the classroom for the first time in four months. Some students hadn't been in the school building for nearly a year after opting into online-only instruction in the fall and switching to in-person learning when it became available. Students played individually for me, and many verbally expressed how stressful it was right after their performance. Having more in-person practice could have made a difference in testing outcomes.

I appreciated learning what students liked and disliked about the group learning experience. The majority of students indicated that they enjoyed working with others and felt it helped them increase their musical understandings and performance abilities. The number of students who thought that structured peer interactions were helpful is enough to convince me to keep these learning situations in place. The biggest drawback was when students did not participate equally (or at all) in their groupings. I strongly feel that having more in-person time so I can circulate the room would help cut down on this particular issue. It was easier for students to opt out of online-only instruction because they could disappear with a simple click of a button.

I found it interesting that students demonstrated similar growth from unit one to unit two and again from unit two to unit three. However, there was a difference in development from unit

one to unit three. I believe this difference comes from students becoming more accustomed to the processes. Everything seemed to take an extraordinary amount of time this year, from establishing classroom norms to building rapport to preparing music for concerts due to the COVID-19 pandemic. It makes me question if the data may have been affected by the on-and-off nature of the 2020-2021 academic year. Could there have been a different outcome with the terms and symbols unit if students had not been in a hybrid learning situation? What would the data tell me if more students had been present for testing and unit implementation for scales performance?

I feel that I demonstrated that structured student interactions can influence the amount of growth experienced in the orchestral classroom but that this type of learning experience does the most good when students are faced with material that is not easily grasped through solo efforts. It is more beneficial to use cooperative learning for units, skills, and repertoire that require students to stretch to keep the experience valuable and worthwhile.

More research needs to be done to determine the long-term effects of structured peer interactions. Do students who participate in group learning activities retain information better over time? Earlier I hypothesized that the difficulty of the material could play a role in the effectiveness of cooperative learning. Determining when one should implement collaborative learning is another aspect that should be studied further. Finally, more research needs to occur focusing on the social and emotional benefits or drawbacks of group learning in the music ensemble setting.

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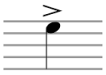
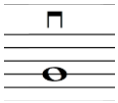
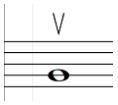
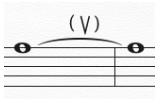
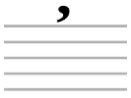
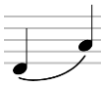
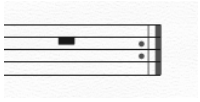
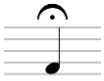
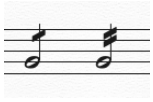
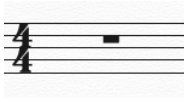
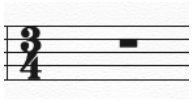
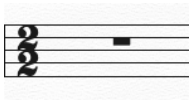
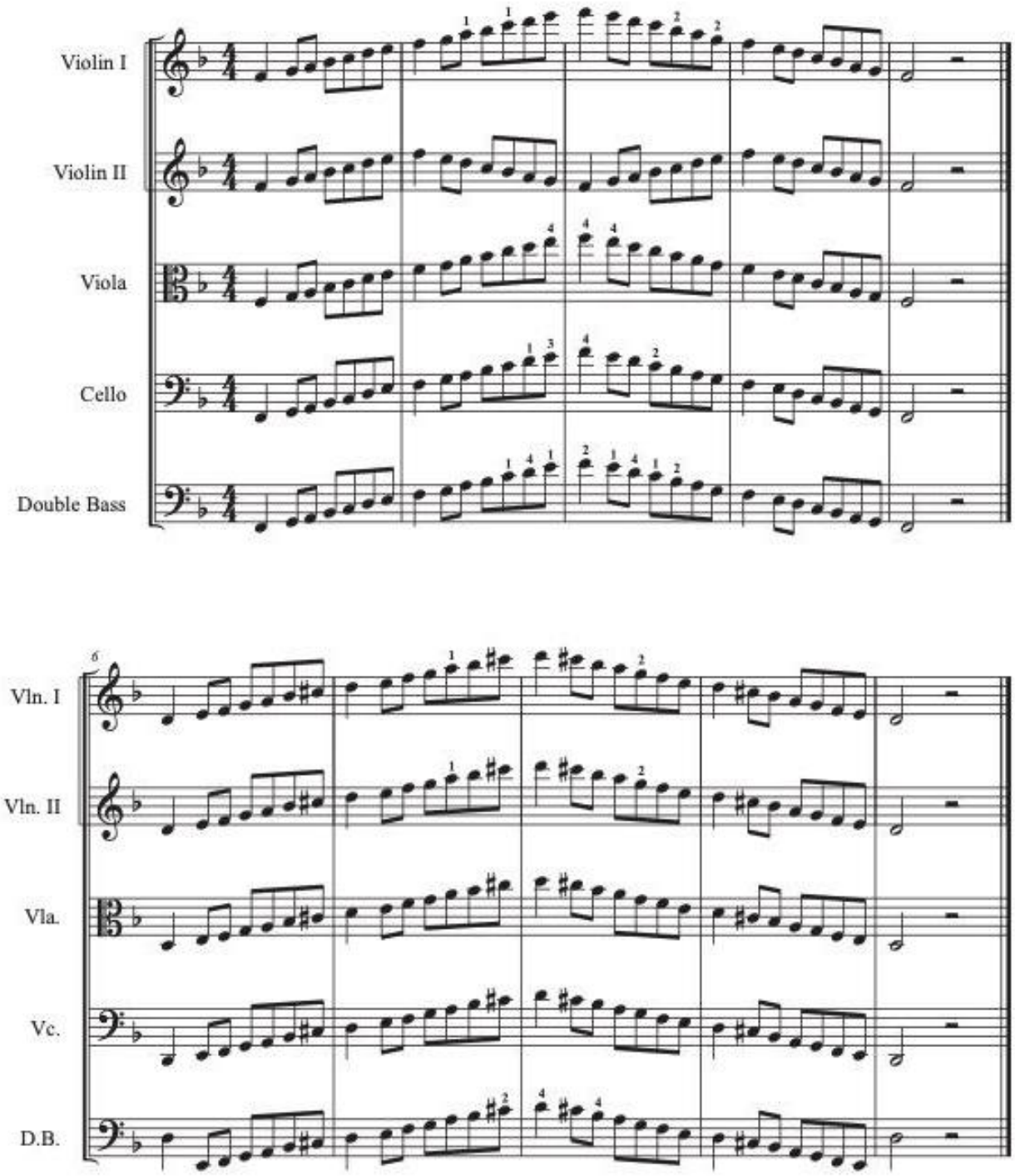
Appendix A
Unit 1: Terms and Symbols

Session 1	**Session 2**	**Session 3**
p		Tutti
mp		Tempo I
mf		Allegro
f		Largo
ff		*rit.*
		
	*pizz.*	
cresc.	*arco*	
dim.	*marcato*	
sub.	*al Fine*	
div.	*2x only*	

Score

Appendix B

Scales Based on Spring Repertoire



Appendix B