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The effect of singing exercises on the tuning accuracy of middle school string students.

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THE EFFECT OF SINGING EXERCISES ON THE TUNING ACCURACY OF MIDDLE SCHOOL STRING STUDENTS

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By

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THE EFFECT OF SINGING EXERCISES ON THE TUNING ACCURACY OF MIDDLE SCHOOL STRING STUDENTS

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University of Nebraska, 2004

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The purpose of this study was to investigate the effects of singing exercises on the tuning accuracy of middle school string students. In addition, this study investigated what effects previous years of experience and previous tuning instruction had on the tuning abilities of middle school string students.

The study was conducted over a six-week period with beginning, intermediate and advanced string students enrolled in intact classes at a middle school (N=63). The experimental groups received in-depth training in the intervallic relationship of the strings and engaged in singing exercises utilizing these intervals. The control group was taught to tune by simple pitch-matching methods.

Data collected from the study indicated that there was no significant difference in the tuning accuracy of the subjects in either the experimental or control group. It was also found that prior tuning experience and years of playing experience had no significant impact on tuning accuracy.

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Chapter I

Introduction

The ability for students to tune their own instruments is a skill that is essential to their development as musicians. Because accurate tuning requires the detection of basic pitch discrepancies, it works to form the basis for solid intonation, giving students the capacity to transfer this pitch detecting ability from open strings to fingered notes.

Teaching students to tune is a subject that is often neglected by teachers until the high school level, leaving many string students without the ability to perform this vital task. In many elementary schools, string instruction consists of a "pull-out" program in which several beginning students meet simultaneously for instruction. These classes lack an equal complement of cellos and basses and the exercises, regardless of instrument, are often written in unison style. The task of managing beginning players includes intense and careful attention to posture, bow hold, basic technique, and music reading. These important beginning issues, coupled with limited class time, reduce the priority of mastering tuning skills.

Tuning is also difficult to teach at the elementary level because students lack both the physical strength and dexterity needed to tune accurately (Lamb, 1994). Furthermore, the understanding of intervallic relationships is an advanced concept both cognitively and aurally which many beginning students are not developmentally ready to process. With hurdles such as these, the task of teaching tuning often falls to the educators at the middle school program.

Middle school string programs differ greatly from their elementary counterparts. The larger class size requires students to adjust to playing in a full ensemble while performing independent musical lines. This adjustment, after time, helps students develop their sense of pitch discrimination, making middle school the logical placement for teaching tuning. Most middle school schedules, however, only allow for approximately 40 minutes of class time every other day. With such time restraints, the problem of finding the time to teach tuning is not alleviated. Also, current method and pedagogy books lack information on how to devise a systematic approach to teaching tuning. This leaves teachers with the daunting task of creating their own technique or allows them to simply ignore its importance.

As there are many ways to check the pitch of a string, electronic tuners and computers are often used by teachers as an easy solution. Though these devices seem useful, some research indicates that the utilization of these instruments has little effect on improving individual students' pitch discrimination (Glass, 1986).

Using relative pitch as a means for tuning, however, requires no extra equipment and benefits the development of musicians' tuning ability. Tuning by a relative pitch requires the student to first match their A string to a given A 440 Hz. After this is accomplished, the students tune the remaining strings in perfect fifths, relative to the original A. This tuning technique actively engages the student in the tuning process and may improve their pitch perception.

While there are no current method or pedagogy books that offer an efficient approach to tuning, there are many research studies that address the tuning issue. Many of these studies explore the use of audiation or internalization of musical sound

and its effect on pitch discrimination. Researchers have studied audiation and have defined it as an "inner hearing," specifically, the ability to perceive music when no aural stimulus (sound) is present. (Gordon, 1985; Gordon, 1999: Dalby, 1999). The best way to internalize pitch, some researchers say, is to sing the pitch. Examples of singing exercises which involve audiation have been tested as effective techniques to building relative pitch (Burnsed, 1990; Dalby, 1999).

The advantage of combining vocal exercises with instrumental lessons is that the students are given the opportunity to focus on pitch without being encumbered by the idiosyncrasies of their individual instruments or their personal technique (Dalby, 1999). Singing pitches before playing them on an instrument greatly intensifies the chances of tuning accurately.

Using audiation as a basis for instructing middle school students how to tune appears to be useful in many ways. By teaching the students to sing pitches, the teacher is enriching the musicianship of the student. Also, through vocal pitch training, string players may become more aware of the importance of intonation as individuals and as a group. Other research has been done to determine the effects of singing exercises on musical achievement, pitch accuracy, and instrumental intonation. Though this research indicates teaching pitch accuracy through vocalization is effective, there have been no specific techniques published for use in the classroom. Tuning is a basic task that every string player should become proficient at in order to improve both individual playing skills and group performance sound (Dunlap, 1989; Bennett, 1994: Schlacks, 1981).

Therefore, the purpose of the study is to determine the effects of singing exercises on the tuning accuracy of middle school string students. Specifically, this study sought to address and answer the following questions:

1. Do interval-based singing exercises improve tuning accuracy?
2. Does the number of years of playing experience affect the tuning accuracy of middle school string students?
3. Does previous tuning experience affect the tuning accuracy of students within each group?

Definition of Terms

The following definitions will provide clarity and promote a better understanding of selected terms used throughout the study.

Tuning Accuracy: Tuning accuracy in this study is defined as a pitch detected on a Korg Auto Chromatic Tuner that is within 5 cents sharp or flat of the target pitch.

Cents: Centihertz (cz) The division of musical pitches into 100 segments. 100 cz = 1 semitone.

Singing Exercises: The singing exercises in this study utilized pitches sung on the name of the note in descending and ascending patterns. These exercises were not designed to improve or emphasize vocal technique.

Chapter II

Review of Literature

A review of literature was completed for research pertaining to the topic. These studies will be organized according to the following categories: 1) pitch perception; 2) audiation; 3) singing and instrumental instruction.

Pitch Perception

Children develop basic pitch detection skills as early as three months and can detect differences in two pitches by the time they are six months of age (Campbell, Scott-Kassner, 1984). From that point on, the accuracy of pitch detection is effected both by the presence of musical training and by the social constructs in which the child is raised (Frances, 1988; Wallin, 1991). As a result, the pitch discrimination abilities between one student and another of the same age can be quite staggering.

Litke and Olsen (1979) researched the perception of pitch and how it is affected by age. The study called for 34 subjects in four different age groups, ranging from 4-5, 8-9, and 23-26 years of age. All subjects attended five training sessions at a hearing clinic. During these sessions, the subjects were introduced to an octave interval. The final test required the blindfolded participants to listen to two pitches, an octave apart. The test would then lower the higher pitch and the subjects were asked to return that pitch, using a dial, to its original octave placement. The researchers found that there were no initial age differences in the ability to perform the task. They also concluded that the important ability of pitch recognition could be learned and polished with careful instruction.

Even if a student has a well attuned sense of pitch perception, extraneous factors can affect the way they tune. For example, a students' ability to tune their instrument accurately can also be effected by the given tuning pitch. A study conducted by Benson (1995) reveals some peculiarities of the process of tuning. Eighty-five university students, 55 high school students, and 58 junior high students were recorded as they tuned to five different stimuli. These stimuli were oboe without vibrato, oboe with vibrato, and the pitch A at the following frequencies; 435 Hz, 440 Hz, and 445 Hz. The results of these recordings showed that university students' pitches deviated less than the other two groups. Benson concluded that brass players were the least accurate, while string players were the most accurate tuners. Furthermore, there was a tendency for string and brass instrumentalists to tune flat in relation to the stimuli. The most accurate tuning responses were gathered from the oboe vibrato and the A=435 Hz. This research suggests that a consistent and precise tuning pitch is very important when working with young students.

Because there are so many electronic and computer tuning devices readily available to the teacher and student, Glass (1986), researched the effects of these tools on students' pitch matching abilities. Seventy-four eighth graders from two junior high schools were the subjects for this study. The control group received no instruction, while the experimental group participated in the "Tuning Tutor" computer program for ten days. The control group was given the basic instructions to a game on "Tuning Tutor" and both groups were asked to play the game for the final post-test. Because utilizing an electronic device does not actively engage students in

the tuning process, the results of this study indicated that the computer program had little effect on the pitch discrimination ability of the subjects.

Audiation

Research indicates that the ability to discriminate pitch is greatly increased by the use of audiation. Audiation, a theory of music learning, was developed by Gordon to outline the process of gaining and refining musical knowledge. Gordon defines audiation as the ability of a person to "hear" or "understand" a musical idea without the presence of the related stimuli (Ables, Hoffer & Klotman, 1994; Colwell, 1992; Gordon, 1980).

Audiation, according to studies compiled by Gordon, is made up of five basic developmental stages. At the first level, or Aural/Oral Level, students imitate sounds without understanding their intrinsic meaning. For example, a teacher may clap a simple rhythm for the students to repeat. The second step brings students to the Verbal Association Level in which they are now able to attach labels to the rhythmic pattern they imitated in the first stage. Following that is the Partial Synthesis Level, where students are now capable of recalling familiar patterns of sound. At this stage, the teacher could present the students with several rhythmic patterns and expect them to sort and recall the differences between them. Reaching the Symbolic Association Level means students are now able to attach written symbols such as notes and rests to ideas learned in the first three stages. Finally, students arrive at the Composite Synthesis Level and gain the ability to comprehend and perform music from written symbols. Reaching this stage means a student is capable of performing a written piece of music without any other stimuli, it involves complete synthesis of all of the

previous stages and a concurrent comprehension of several music ideas (Gordon, 1980; Jordan-DeCarbo, 1986). Because basic audiation is easily attainable at the first level, it is an excellent tool for use in the instrumental classroom.

Audiation-based enrichment activities and their effect on wind players' musical achievements were researched by Frierson-Campbell (2000). This study involved 77 second-year wind and percussion students enrolled in intact elementary classes. Each class was randomly assigned and the treatment involved three instructors: two experimental and one control. While the control groups received basic instruction, the experimental group instructors utilized both vocal and instrumental activities that were based on audiation. These activities included rote singing of pitches both with and without instruments. Following the sixteen week treatment, the subjects were asked to perform three etudes taken from their everyday literature. These recorded performances were rated by three independent judges. The results of the post-test were analyzed to determine whether exposure to treatments predicted musical achievement. There was no significant difference in the musical achievement of the subjects.

Singing and Instrumental Instruction

Several studies have been conducted to examine the effects of vocal exercises on the achievement of instrumental students (Bennett, 1994; Dunlap, 1989; Schlacks, 1981). One such study, by Schlacks (1981), investigated the use of vocal exercises in the instrumental classroom and how it affected the students' ability to accurately perform intervals. This study was comprised of three experimental groups and one

control group from four high schools. School A received training on vocalization and playing of intervals, school B received training on vocalization of intervals, school C received training on the playing of intervals, while school D engaged in normal rehearsal. The researcher utilized the Music Achievement Test No. 3 "Pitch Recognition" and the Watkins-Farnum Performance Scale (Forms A and B). Furthermore, the researcher designed an interval performance test that measured the accuracy of each interval. Scores from both pre-test and post-test were analyzed for variance of gain or difference. All three experimental groups experienced positive gains in the skill of pitch accuracy when compared to the control group. The researcher concluded that interval performance was greatly enhanced by the addition of vocal interval training to normal classroom procedures.

Other research that involves singing exercises and instrumental performance includes a study done by Dunlap (1989). In his research, Dunlap randomly assigned 92 beginning fifth-grade band students from four intact elementary band classes to the control and experimental groups. This fourteen week study required subjects in the experimental group to: 1) sing rhythmic patterns on a single pitch using rhythmic syllables; 2) sing melodic patterns from instrumental songs using solmization syllables; and 3) sing instrumental songs with lyrics. The control group received only traditional instruction. Following the treatment, the subjects were judged in five areas: 1) vocal accuracy; 2) melodic ear-to-hand coordination; 3) melodic aural-visual discrimination; 4) instrumental performance; and 5) sight-reading skills. From these five criteria, Dunlap found that there was a positive correlation between the treatment and the subjects' vocal accuracy and melodic ear-to-hand coordination. This study

suggests that singing and solmization training on beginning instrumentalists may be an effective teaching strategy to help develop melodic ear-to hand skills and pitch accuracy in beginning instrumental students.

Bennett (1994) conducted research on the effects of simple vocalization on the intonation of wind players. Ninety-five junior high and high school students participated in the study. The subjects first took the Advanced Measures of Music Audiation test designed by Edwin Gordon, followed by the pre-test designed by the researcher. The pre-tests and the post-tests were comprised of nine isolated pitches with three pitches from the low, middle, and upper registers for the subjects to perform on their primary instrument. The subjects then took part in four instructional periods designed to improve intonation through the use of vocal exercises. Following the treatment, the post-test was administered. The results indicated that there was no significant improvement in intonation due to the addition of vocalization exercises to instrumental rehearsals. Bennett suggests that the development of accurate intonation could be aided by a longer period of instruction and in-depth training.

One of the considerations of this study addresses the physical restrictions of the middle school voice. Many researchers have studied the changing voice of adolescents and how it affects singing ability. One such study by Moore (1995), investigates the adolescent male voice as determined by age. Moore found that the mean age of boys with changed voices was between 12.8 and 13.2, causing difficulties in singing on pitch, as well as a restricted range in middle school. Another study, by Bottoms (1995), researched the female adolescent voice. Bottoms concluded that 63% of adolescent females used breathy vocal sounds when singing.

These findings indicate that middle school students are likely to have some difficulty in vocal pitch matching and accuracy depending on the range of the music and the degree of voice change they have encountered.

Summary

The previously cited compilation of research studies shows that there are many consistent findings in the realm of pitch perception. It is agreed, for the most part, that pitch perception is a learned skill that can be affected by the musical training a child receives and also by the social environment in which the child is raised. Gordon suggests through his theory of audiation that pitch perception and musical understanding is also a developmental process reached through a series of stages. It is clear then, that student pitch detection and differentiation skills can be honed through careful and well-planned training.

A few general assumptions can be made about students at the middle level. They include the conjecture that the students will be physically developed enough to: 1) hear and perceive pitch, and 2) operate the tuning equipment on a given string instrument. Reaching these criteria, however, is not enough to ensure accurate tuning abilities. Research indicates that most students at the middle level have trouble singing on pitch, producing a true tone, and hearing the octave transfer that will be needed for some instrumental ranges. It is with these considerations in mind that this study was conducted.

Chapter III

Methodology

The purpose of this study was to investigate the effects of singing exercises on the tuning accuracy of middle school string students. The researcher also took years of playing experience and tuning experience into consideration when compiling the data for the study. Specifically, the questions addressed in this study were:

1. Do interval-based singing exercises improve tuning accuracy?
2. Does the number of years of playing experience affect the tuning accuracy of middle school string students?
3. Does previous tuning experience affect the tuning accuracy of students within each group?

Design and Analysis

An intact group comparison design was selected to investigate the questions addressed in this study. It is acknowledged that some weaknesses are inherent in this type of design; specifically, that the groups may not be equivalent. For the scope of this study there was some variation in class size, playing experience, and age. Because little research or pedagogy exists in the area of tuning accuracy for string students, this design may be an initial step for identifying further channels of study in this area.

Statistical ANOVA and Chi-Square tests were utilized to determine differences in tuning accuracy between the control and experimental groups.

Measurement Instruments

Tuning Mechanism Assessment

Because comprehension and understanding of the basic mechanics of tuning is essential to the outcome of the study, each subject was required to tune the A string of their primary instrument to the given A=440 Hz before any pitch matching lessons occurred. A violin, viola, and cello were provided for this first test and a Korg Auto Chromatic Tuner was used to determine the pitch of the string. Students that struggled with this activity were given special instruction to ensure their success in the continuing study.

Post-Test

Following the six-week instructional period, a post-test was administered that required each subject to tune the strings of their primary instrument. To reduce the chance of error due to a wide variety of instrument makes and styles, one instrument of each kind was provided by the instructor. The instruments were carefully tuned the same way for each subject in order to increase the validity of the research findings. The A and D strings of the violin were tuned flat while the G and E were tuned sharp. On the viola, the A and G were tuned sharp and the D and C tuned flat while the A and D of the cello were sharp and the G and C, flat. The pitch direction of the strings was determined by random assignment.

The post-test, designed by the researcher, awarded each subject up to four points. An initial point was given to each subject who could tune the A-string of the instrument to a given pitch of A=440 Hz. An additional point was awarded to each of the other three strings if tuned accurately in relation to the given A. The subjects

were given four minutes to complete the task of tuning their instrument before the pitches of each string were checked for accuracy.

A Korg Auto Chromatic Tuner was used to check each string tuned by the subject after the test was completed. An error margin of 5 cents sharp or flat was given to allow for temperature changes and instrument type. To avoid an initial loss of all points, the researcher tuned the A-string if the student could not, allowing the student to attempt tuning the other strings in perfect fifths.

Singing Exercises

Appendix A is a copy of the exercises used during the instructional period of this study. These exercises present a general format, variations in both rhythm and interval direction were made as needed.

Subjects

The subjects for this study were 63 string students from intact classes at a middle school. These subjects were enrolled in six separate classes: three beginning-level, two intermediate-level and one advanced-level string class. The classes were randomly assigned. The experimental group contained 29 subjects, eight from a beginning class, eight from an intermediate class, and thirteen from an advanced class. The beginning students in the control group numbered sixteen and the remaining eighteen subjects were at the intermediate level. The subjects were students who played the violin, viola and cello. Because the string bass is tuned in perfect fourths; students who play the bass were excluded from this study.

Procedures

Upon receiving approval from the Institutional Review Board at the University of Nebraska at Omaha, intact classes were assigned to experimental and control groups.

The treatment for this study was a six-week program of instruction (Fifteen, 40-minute classes). The instruction for the first week of the study was identical for both the control and experimental groups to teach the mechanics of tuning. Ideas presented within this first week included the discussion of pitch and how the tightness and the size of each string determine its sound. Subjects were allowed to experiment with the tuning equipment on an instrument belonging to the school to reduce the fear of harming their own strings. After the initial week of instruction, the tuning mechanism assessment was given to ensure that students could satisfactorily operate the equipment need for tuning.

The subjects in the control groups, after the preliminary training, were given a limited amount of guidance on tuning. The instructor limited the amount of time spent on tuning to a few minutes at the beginning of class. The subjects in the control groups were provided with information on the interval relation between the strings but were encouraged to tune by pitch matching. The exact pitch of each string was played on an electronic keyboard for students to tune to in their octave.

The following five weeks of instruction for the experimental group consisted of in-depth training on the interval of a perfect fifth. A piano keyboard was used to show the subjects a visual representation of the interval. The instructor demonstrated different examples of tuning on each instrument, asking the students to listen for the

perfect fifth. Subjects were also asked to identify and sing the perfect fifths in the well-known song, "Twinkle, Twinkle Little Star". Following this initial training, students began to learn new singing activities utilizing this interval.

The singing activities designed for the experimental groups involved both ascending and descending intervals of a perfect fifth. Each day of interval instruction began with five minutes of singing exercises involving the perfect fifth interval. Because all string instruments tune the A-string first, the descending perfect fifth from the A to the D was the first interval learned. The subjects used a given A=440 Hz stimulus to tune their A strings and were then asked to tune the D-string in relation to the original A, using the singing exercise. Though the descending perfect fifth interval is used for the majority of tuning, violinists were required to tune an ascending perfect fifth from their A to E-string.

The exercises were taught by rote and sung with the name of each string to reinforce the location of these intervals on the instrument. Because many students at the middle school level experience voice change, all five pitches used were placed in a comfortable singing range and not in direct relation to the octave of the actual pitch. Though this placement of the pitch relied on the octave transfer abilities of the subjects, it provided a better opportunity for accurate interval singing.

The final stages of the instruction involved more difficult singing examples, using all the perfect fifth intervals and both ascending and descending patterns. The students were given an exercise at the beginning of each session, followed by an A=440 Hz. They were then given time to tune their instruments as trained.

The post-test for both groups required the subject to tune the strings of their major instrument as provided by the researcher. An A=440 Hz was given to begin the test and each subject had four minutes to complete the task of tuning all four strings. The data was collected using a Korg Auto Chromatic Tuner and the test awarded one point for every correctly tuned string.

Time of the Study

The study was completed during the 2003-2004 academic year. Preliminary writing took place during the Fall semester of 2003 and data collection and final editing occurred during the Spring semester of 2004. Data were analyzed and reported, and conclusions, along with educational implications, were determined during the 2004 Summer semester.

Chapter IV

Results

This study was conducted to determine the effects of singing exercises on the tuning accuracy of middle school string students. Furthermore, the study investigated the accuracy of tuners as affected by years of previous playing experience and self-reported tuning experience.

The first question sought to research the effects of vocal exercises on the tuning accuracy of string students. Table 1 and 2 show the mean tuning accuracy score as determined by instrument. A two-by-three analysis of variance (ANOVA) was used to determine the tuning accuracy of each group by instrument. The results show that there was no significant difference ($p=<.01$) in the tuning accuracy of either group.

Table 1

Tuning Accuracy by Instrument

Group	Instrument	Mean	Std. Deviation	N
Experimental	Violin	2.6316	1.0116	19
	Viola	2.4000	1.8166	5
	Cello	2.6000	1.1402	5
	Total	2.5862	1.1501	29
Control	Violin	2.4091	1.3683	22
	Viola	3.0000	1.1952	8
	Cello	2.7500	1.2583	4
	Total	2.5882	1.3054	34

Table 2

Tuning Accuracy by Instrument

ANOVA

Source	Type III Sum of Squares	df	Mean Square	F	p.
Group	.319	1	.319	.200	.657
Instrument	.402	2	.201	.126	.882
Group Instrument	1.662	2	.831	.521	.597

In addition to analyzing tuning accuracy by instrument, a Chi-Square Test of Independence was used to analyze the tuning accuracy of each individual string. Again, there was no significant difference in the results of either group. Tables 3 through 7 show the mean tuning accuracy scores by individual string.

Table 3

Tuning Accuracy by String

A-String

Group		Incorrect	Correct	Total
Experimental	Count	11.0	18.0	29
	Expected Count	10.6	18.4	29
Control	Count	12.0	22.0	34
	Expected Count	12.4	22.0	34
Total	Count	23.0	40.0	63
	Expected Count	23.0	40.0	63

Table 4

Tuning Accuracy by String

D-String

Group		Incorrect	Correct	Total
Experimental	Count	9.0	20.0	29
	Expected Count	8.7	20.3	29
Control	Count	10.0	24.0	34
	Expected Count	10.0	23.7	34
Total	Count	19.0	44.0	63
	Expected Count	19.0	44.0	63

Table 5

Tuning Accuracy by String

G-String

Group		Incorrect	Correct	Total
Experimental	Count	11.0	18.0	29
	Expected Count	11.5	17.5	29
Control	Count	14.0	20.0	34
	Expected Count	13.5	20.5	34
Total	Count	25.0	38.0	63
	Expected Count	25.0	38.0	63

Table 6

Tuning Accuracy by String

E-String

Group		Incorrect	Correct	Total
Experimental	Count	6.0	13.0	19
	Expected Count	6.5	12.5	19
Control	Count	8.0	14.0	22
	Expected Count	7.5	14.5	22
Total	Count	14.0	27.0	41
	Expected Count	14.0	27.0	41

Table 7

Tuning Accuracy by String

C-String

Group		Incorrect	Correct	Total
Experimental	Count	4.0	6.0	10
	Expected Count	3.6	6.4	10
Control	Count	4.0	8.0	12
	Expected Count	4.4	7.6	12
Total	Count	8.0	14.0	22
	Expected Count	8.0	14.0	22

The second research question addressed students' years of experience and their effect on tuning accuracy. Table 8 and 9 show the mean tuning accuracy score as determined by years of playing experience. A two-way analysis of variance (ANONVA) was applied to the data. This test showed that there was no significant correlation between the number of years experience and a students' ability to tune. The playing experience of the subjects in this study ranged from .5 to 4.5 years.

Table 8

Tuning Accuracy and Years of Experience

Group	Experience(Years)	Mean	Std. Deviation	N
Experimental	0.50-2.00	2.6667	1.1882	18
	2.50-4.50	2.4545	1.1282	11
	Total	2.5862	1.1501	29
Control	0.50-2.00	2.5385	1.1983	13
	2.50-4.50	2.6190	1.3956	21
	Total	2.5882	1.3054	34
Total	0.50-2.00	2.6129	1.1741	31
	2.50-4.50	2.5625	1.2936	32
	Total	2.5873	1.2265	63

Table 9

Tuning Accuracy by Years of Experience

ANOVA

Source	Type III Sum of Squares	df	Mean Square	F	p.
Group	4.861	1	4.861	.003	.956
Experience	6.384	1	6.384	.041	.841
Group Experience	.316	1	.316	.201	.656

The third research question addressed the issue of previous tuning experience and its effect on tuning accuracy. Previous tuning experience in this study was self-reported by the subject with no measure of the amount or quality of training received. Table 10 and 11 display the mean tuning accuracy score as determined by previous tuning experience. A two-way analysis of variance (ANOVA) was used to establish the effects of previous tuning experience on the tuning accuracy of the subjects. The results show that there was no significant difference between the two treatment groups.

Table 10

Tuning Accuracy and Previous Tuning Experience

Group	Previous Experience	Mean	Std. Deviation	N
Experimental	Yes	2.3333	1.2111	6
	No	2.6522	1.1524	23
	Total	2.5862	1.1501	29
Control	Yes	2.4000	1.3416	5
	No	2.6207	1.3205	29
	Total	2.5882	1.3054	34
Total	Yes	2.3636	1.2060	11
	No	2.6346	1.2372	52
	Total	2.5873	1.2265	63

Table 11

Tuning Accuracy by Years of Experience

ANOVA

Source	Type III Sum of Squares	df	Mean Square	F	p.
Group	2.784	1	2.784	.002	.967
Training	.655	1	.655	.417	.521
Group Training	2.167	1	2.167	.014	.656

Chapter V

Discussion of Results and Conclusions

The purpose of this study was to determine the effect of singing exercises on the tuning accuracy of middle school string students. In addition, this study sought to investigate the effects of both previous playing experience and tuning experience on tuning accuracy.

The study was conducted over a six-week period with 63 beginning, intermediate and advanced string students enrolled in intact middle school string classes. The experimental groups received in-depth training in the intervallic relationship of the strings and engaged in singing exercises utilizing these intervals. The control group was taught to tune by simple pitch-matching methods.

Data collected from the study indicated that there was no significant difference in the tuning accuracy of the subjects in either the experimental or control group regardless of previous playing or tuning experience.

Discussion of Results in Relation to Research Questions

1. *Do interval-based singing exercises improve tuning accuracy?*

The results of this study show that there was no significant difference in the tuning accuracy scores of the experimental or control group. The factor that most influenced the outcome of this study revolved around the issue of the middle school voice. Because singing is not perceived as a typical activity in an orchestral rehearsal, many of these students seemed to be inhibited in performing the singing exercises. A large part of their hesitancy was due to having to perform in front of their peers. For many of these students, group singing had not been experienced since

their elementary music classes. Male students, in particular, tended to fear the activity of singing due to change in voice. Because students were so preoccupied with the act of singing aloud, it may have inhibited their ability to cognitively process the intervallic relationships required for accurate tuning. Furthermore, with more attention to vocal technique, vocal accuracy, and a longer period of study, it is suggested by the researcher that singing exercises may have a more significant impact on tuning accuracy.

2. *Do the number of years of playing experience effect the tuning accuracy of middle school string students?*

The data analysis of this study indicates that the number of years playing experience does not effect the tuning accuracy of middle school string students. This suggests that even though students may possess pitch discrimination skills; the current techniques in string pedagogy are not addressing the tuning issue.

3. *Does previous tuning experience affect the tuning accuracy of students within each group?*

The results of this study suggest that previous tuning experience has no significant impact on tuning accuracy. The subjects' experience was a self-reported result; therefore, there was no measure of the quality or quantity of this experience. A more detailed investigation into the past experience of the subjects may have yielded different results.

It is interesting to note that while there was no significant difference between groups, students who reported having prior tuning experience had an overall lower mean score on the post-test than those who reported having no tuning experience. It

may be that students who reported having prior training perceived themselves as "proficient tuners" and therefore were not fully invested in the singing exercises. The fact that those students who reported no prior experience had a higher overall mean score may indicate that interval-based singing exercises are an effective tool for teaching tuning.

Conclusions

Overall, the findings of this research indicate that singing exercises have little affect on the tuning accuracy of middle school string students. The present study also indicates that the years of playing and previous tuning experience have little affect on the tuning accuracy of middle schools string students.

Three factors that seem to have had the most significant impact on the results are: 1) the issue of the middle school voice; 2) a lack of challenging pitch perception activities in pedagogy; and 3) a lack of any systematic approach to teaching tuning in pedagogy. Past research shows that a students' ability to perceive differences in pitch will not strengthen unless cultivated by continuous and focused training. It is therefore suggested by the researcher that an inclusion of pitch perception activities in current string pedagogy may yield higher accuracy scores for each student as they progress from year to year.

Though the overall results show no significant difference in the tuning accuracy of the subjects, they do indicate that any specific and consistent training in tuning makes a considerable difference in a student's ability to tune accurately.

Discussion in Relation to Past Research

The results of this study, like similar studies executed by Litke and Olsen (1979) and Frierson-Campbell (2000) show that pitch relation can be learned and refined with careful training. The student's ability to recognize pitch differences was greatly enhanced in both the experimental and control group. Studies by Schlacks (1981) and Bennett (1994) also show findings consistent with the results of the current study. Both studies used vocalization in the experimental group and like this study, no significant gains were found, though it was suggested that a longer period of instruction may have improved the results of the experimental groups.

Also concurrent with the present study were the results of research by Bottoms (1995) and Moore (1995). Both studies suggested that middle school students had difficulty singing on pitch and producing a pure tone due to extraneous physical and psychological factors. If students are unable to vocalize intervals accurately, it may be assumed that the vocal exercises would have little positive impact when transferred to instrumental tuning.

Implications for Music Education

Because a lack of tuning strategy has been identified in string pedagogy, this study aims to present a change in strategy that may help foster more accurate tuners. In studying the results of the final test by string, the research reveals that the D-string is the most accurately tuned of all individual strings. A quick glance through many beginning string books will show that the first notes a student may learn to finger and read on the staff take place on the D-string. Subsequent pages of literature are also based in the key of D. Perhaps method books should be designed with a varied use of

keys from the beginning. The use of aural training on all four strings at the beginning level would also seem beneficial to the development of pitch memory on all strings.

As students grow and become more independent as musicians, it is important that they are both confident and capable tuners. This requires an in-depth approach to teaching tuning that is easily used in independent daily practice. Because students may not have pianos or electronic tuners at their disposal, the ability to tune in perfect fifths with the use of vocalization is a valuable and inexpensive asset to help them tune without teacher guidance.

The National Standards for Music Education (2001), state that a students' ability to sing alone and with others should be the first priority of music educators. Vocalizing as part of everyday instruction in the instrumental classroom may be an effective way to teach pitch perception, intervals and most importantly, it is a pathway to creating well-rounded musicians.

Implications for Future Study

Though the results of this study were not statistically significant, it is suggested that the study be replicated with a longer period of training. The students were not given a sufficient amount of time to become confident with their voices and with a longer instructional period, the experimental group may have shown significant gains.

It is also suggested that this study be done with a larger, more varied selection of students. Though this study utilized students from the beginning through advanced level in both groups, the average number of years experience was significantly higher

in the control group. With a wider selection of students, the results may indicate a more precise view of tuning accuracy based on method.

Another recommendation for researchers is to replicate this study at the elementary level. Because most elementary schools have mandatory music classes, the students are still in the practice of singing in a class at least once a week. This would eliminate problems with confidence as well as many of the hurdles of voice change at the middle level.

While the results of this study show that interval-based singing exercises have little effect on the tuning accuracy of middle school string students, it is clear that there is a need for a systematic approach for teaching tuning. The alarming lack of tuning skills in students from the elementary through high school level shows that current pedagogy is not sufficiently fulfilling this need. Because basic tuning skills are the foundation of a students' development as a musician, it is essential that new pedagogical methods are devised and researched to address this growing need.

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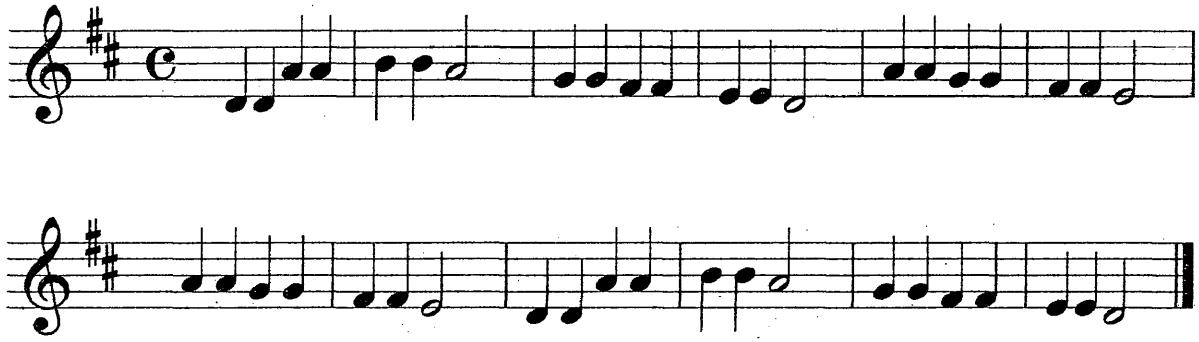
Appendix A:

Singing Exercises

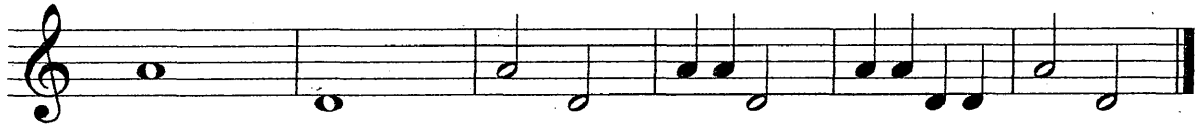
Lesson 1

"Twinkle, Twinkle Little Star"

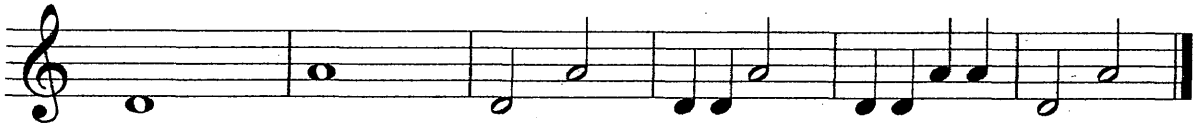


Lesson 2 and 3

Descending A to D

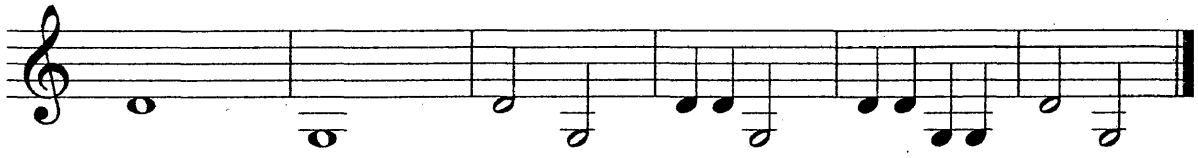


Ascending D to A

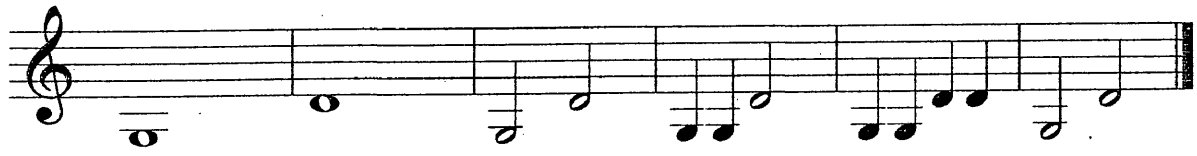


Lesson 4 and 5

Descending D to G

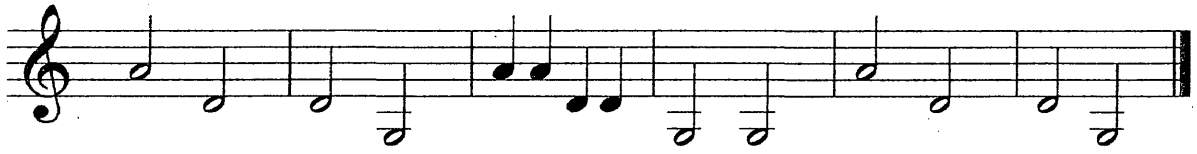


Ascending G to D

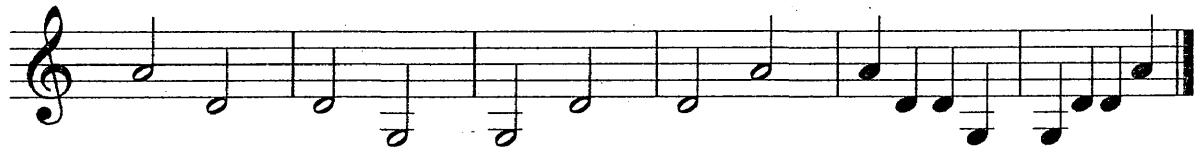


Lesson 6 and 7

Descending A, D, and G

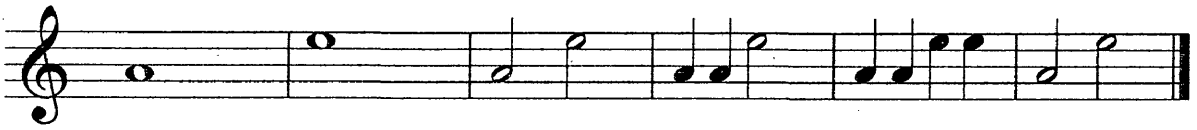


Descending and Ascending A, D, and G

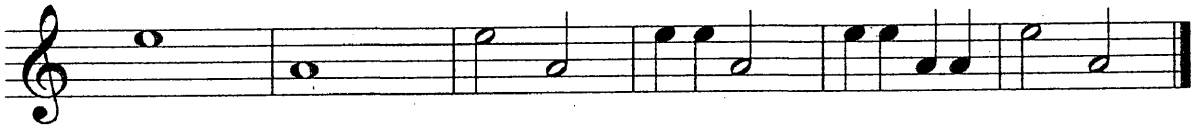


Lesson 8 and 9

Ascending A to E

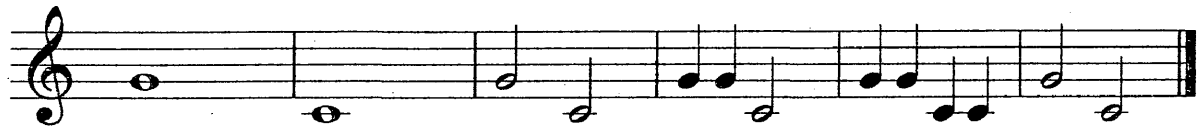


Descending E to A

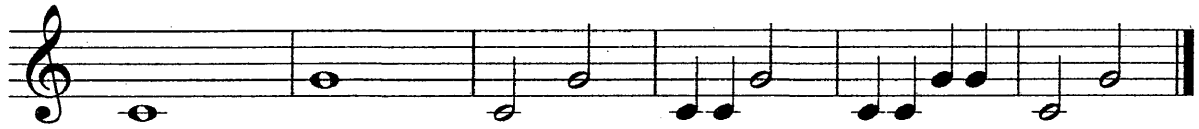


Lesson 10 and 11

Descending G to C

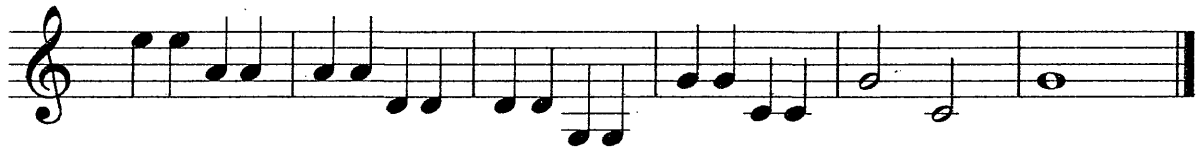


Ascending C to G

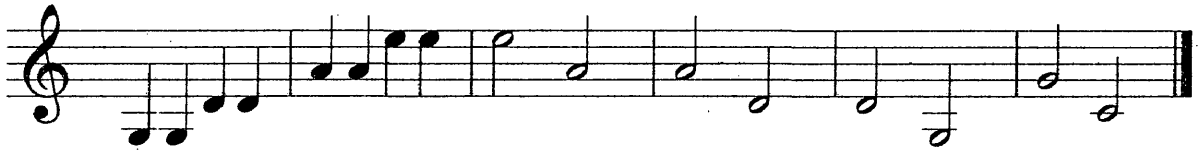


Lesson 12 and 13

Descending E, A, D, G, and C



Ascending E, A, D, G, and C



Descending and Ascending E, A, D, G, and C