The purpose of this study was to determine what factors contributed to bowed string students’ perceived tuning independence or perceived ability to tune their instrument without assistance. Eight hundred and twenty-six 6th through 12th grade string students participated in the study. Subjects were administered the Tuning Study survey form. Based on the findings from this study, it was found that grade level and/or years of study, intonation confidence, individual and class tuning procedures, type of reference pitch provided in tuning procedures, and private lesson study, contributed to students’ perceived tuning independence. In order to foster tuning independence, it is recommended that teacher intervention and feedback be provided to help develop students’ confidence in their ability to hear when a string is out of tuned, to provide procedures to help students develop pitch discrimination when tuning strings individually, that a reference pitch be provided from a student instrument and not one from a piano or electronic tuner, and that students be encouraged to study privately.

There are a variety of approaches to tuning a stringed instrument. The use of harmonics, beat elimination, double stops and pitch matching are generally the accepted methods of tuning. However, there has been little research that examines current practices for independent tuning instruction in string education. While many factors affect a students’ ability to independently tune their instrument accurately and confidently, choosing an appropriate tuning method for students is complicated by the instructional setting, classroom or private lesson procedures and varying student ability levels. String educators often find themselves asking questions like:
1. When should students start learning to tune independently?
2. What methods are most effective in helping students learn how to tune?
3. What tuning methods are most accurate?
4. How should a reference pitch be given?
5. What difficulties should be anticipated?
6. Do phenomena such as loudness and timbre affect a student’s ability to tune accurately?
7. Is there a learning sequence that corresponds to age or ability level?

**Beat Elimination**

“In the late 1950’s, Leeder and Haynie (1958), later followed by other music educators, began to advocate teaching a tuning procedure long used by piano tuners, physicists and some musicians” (Miles, 1972). This procedure is called the beat elimination process. Beating is the periodic rise and fall in loudness experienced when two simultaneously sounding tones are not quite in tune (Lathom-Radocy & Radocy, 1999). Tones that are closer in frequency beat at a slower rate. When the tones match frequency exactly, the beats are eliminated (Bartholomew, 1942). As two tones become further apart, the beat rate quickens until two distinctly separate tones are perceived.

Miles (1972) sought to determine whether beginning wind instrumentalists could be taught to tune using the beat elimination process. Subjects in this study consisted of 118 beginning wind players who were trained in the process of beat elimination over a five-month period. At the end of the training, Miles reported that every subject was able to recognize beats and tune a beat-free unison. Ninety-five percent of the subjects demonstrated the ability to play a perfect fifth free of beats, and eighty percent of the subjects were able to play a beat-free fifth in triad.

**Double Stops**

Beginning string students are often taught to hear the melodic and harmonic intervals of open strings in order to tune accurately. There has been no specific research exploring the use of double stops as a means of teaching accurate tuning. However, there have been
studies that explore the perception of melodic and harmonic intervals in relation to tuning and intonation. Musicians tend to enlarge larger intervals while diminishing smaller intervals (Terhardt, 1971; Rakowski, 1985). Papich and Rainbow (1937) found that string instrumentalists tended to overestimate the size of ascending intervals. While descending intervals are performed less accurately than ascending intervals (Forsythe, 1967; Edmonson, 1972), the opposite is true for ascending and descending scales (Madsen, 1966). Karrick (1998) reports that harmonic fourths, fifths, unisons and octaves are easier to tune than thirds and sixths.

**Pitch Matching**

Pitch matching is not only a basic musical skill, but also the foundation for teaching beginning string players how to tune. This method requires the student to listen to a reference pitch and match the respective open string to the given pitch. While some musicians are able to match pitch easily, others are not. The ability to match pitch is a physical and perceptual phenomenon (Seashore, 1938). Every sound vibration generates a specific number of oscillations in a given period of time. The rate of oscillation is called frequency, and is expressed in Hertz (Hz). Pitch is the primary function of frequency, and is the place a tone is perceived to occupy in a relatively fixed region of the musical scale (Lipscomb & Hodges, 1999). In general, the greater the frequency the higher the pitch, although not every change in frequency will be heard as a pitch change (Latham-Radocy & Radocy, 1999).

Yarbrough, Karrick, and Morrison (1995) found the ability to match pitch is dependent upon the direction from which a particular tone is approached. Subjects that attempted to match pitch by approaching the tone from above tended to be sharp, while subjects that approached the tone from below tended to be flat. Early investigations of pitch matching ability indicated that poor pitch was the result of poor pitch discrimination, the ability to distinguish one pitch from another (Bentley, 1968; Pedersen & Pedersen, 1970; Zwissler, 1972). On the contrary, later research suggests that the two musical skills develop independently (Geringer, 1983; Chevellard, 1983; Solomon, 1993). Other physical attributes also have an affect on pitch perception (Latham-Radocy & Radocy, 1999).

The ability to match pitch can be compromised by varying the timbre and/or tone quality of a stimulus. Benson (1995) completed a study that compared the tuning accuracy of woodwind, brass and string instrumentalists in response to taped reference pitches played on an
oboe with vibrato, an oboe without vibrato and an electronically produced pitch. Subjects consisted of 198 students ranging in grade level from junior high to college. Significant differences were found among the tuning stimuli. The most accurate tuning results were achieved using a reference pitch generated by the oboe with vibrato, followed by the electronically produced reference pitch. Results of this study also indicated that the oboe stimuli produced more flat responses and the electronic stimuli produced more sharp responses.

These findings contradict an earlier study by Hayslett (1990). The purpose of this study was to examine the effect of three pitch sources on the ability of university band students to accurately tune their instruments. Reference pitches were generated from an oboe, tuba and electronic tuner. The results showed no significant differences in tuning accuracy among the three reference pitches. Results did indicate a decrease in tuning accuracy when the reference pitch was generated electronically.

Madsen and Geringer (1976, 1981) reported subjects often displayed difficulty in discriminating between tone quality and intonation. Later studies (Spradling, 1985; Ely, 1988) support these findings. Worthy (2000) found that tone quality conditions significantly affected pitch perception and performance. Sixty-four high school and college students were asked to participate in a study that included a perception and performance task. The perception task consisted of judging the tone quality and intonation of twelve pairs of tones. Subjects judged bright tones as being sharper in pitch, and dark tones as being flatter in pitch. For the performance task, half the subjects were asked to match pitch, while the other half were asked to match tone. Instructions to match pitch or tone quality separately had no significant effects.

The duration, as well as frequency, of a tone affects one’s ability to match pitch and discriminate between pitches. Fyk (1985) concluded that the accuracy of pitch matching is determined by the length of the tone, with lower tones needing to sound for a longer duration than higher tones. This is concurrent with earlier studies that have determined a tonal perception threshold of 60 ms for 50 Hz, and 10 ms for 1,000 Hz (Josephs, 1967; Piazza & Guilio, 1982).

A later study also by Fyk (1987) determined that training could affect one’s ability to match pitch accurately in a shorter duration of time. In this study, pre-test subjects were able to match the pitch of a stimulus tone within 8 cents of A4 (440Hz) in a duration of 96 ms. After training, subjects were able to match the same pitch within 4 cents at
a duration of 12 ms. A study by Klemish (1974) found no improvement in pitch matching after pitch discrimination training.

Instructor Feedback

Many researchers propose that the success or failure of a training program is dependent upon the type(s) of feedback received by the student. Smith (1995) and Brick (1983) investigated the effects of an aural-oral training program on students’ pitch discrimination and performance accuracy. Subjects from Smith’s study included 96 sixth-grade students randomly assigned to either one of four groups that received two twenty-minute sessions per week with the Pitch Master Machine, or one of four groups that performed the same tasks in class. Results of the study showed a significant improvement in the pitch discrimination and performance accuracy of students who were trained using the Pitch Master Machine. A similar study by Brick (1983) reported the same results.

Platt and Racine (1985) found that verbal and visual feedback improved tuning accuracy for complex tones, while Codd (1987) found visual cues to be more effective in improving tuning accuracy. Meyer (1994) also concluded that visual feedback was helpful in improving students’ tuning and pitch perception. In this study, a computer system was used to display immediate visual feedback while violin students tuned open strings or played scales and musical passages. The same results were found by Welch, Howard, and Rush (1989) in an earlier study that used real-time computer feedback to improve the pitch matching skills of vocalists. Salzberg and Salzberg (1981) found verbal feedback to have a minimal effect on the improvement of intonation in elementary string players. Jaroszewski (1992) determined that any feedback was preferable to none at all.

Baggs (1971) set out to determine whether different sense stimuli would have an effect on students’ pitch matching abilities. Subjects were divided into four groups. One group was taught pitch matching by means of an audio only method, a second group by means of an audio-visual method, a third group by means of an audio-visual-kinesthetic method and a fourth group served as the control. A significant difference was found between the pre-test and post-test scores of students from all groups. However, students from the audio-visual-kinesthetic group had the most gain in scores. Studies by Yarbrough, Green, Benson, and Bowers (1991), and Jacobson (1998) found no significant relationship between kinesthetic stimuli and improvement of pitch discrimination. Jacobson (1998) hypothesized that the age of the subjects may have had an effect on the results.
Age and Tuning

While some researchers have found age to be a significant factor in the ability to tune and match pitch (Madsen, Edmonson, & Madsen, 1969; Fullard, 1968; Geringer, 1983), others have found no correlation between age and tuning ability (Litke & Olsen, 1979). The same mixed results are found in studies that investigated a possible relationship between musical experience and tuning or pitch matching ability. While Yarbrough, Morrison, and Karrick (1997) found no correlation between experience and pitch matching ability, Platt and Racine (1985), and Madsen, Edmonson, and Madsen (1969) reported a significant relationship between experience and pitch matching. Yarbrough, Morrison, and Karrick discovered that subjects who studied privately tended to match pitch more accurately than those who did not.

Tuning Preferences

Several studies indicate tuning preferences of string students tend to be sharp (Small, 1937; Papich & Rainbow, 1974; Geringer, 1976; Salzberg, 1980; Geringer & Witt, 1985; Sogin, 1989; Yarbrough & Ballard, 1990). Geringer (1978) attempted to see if students’ knowledge of their tendency to perform sharp would change their aural perception and performance. In this study, subjects performed a major scale. After performing the scale, half the subjects were randomly told that string players tend to perform sharp. Subjects were then asked to play the same scale a second time. Knowledge of the tendency did not affect the subjects’ intonational performances. A later study by Yarbrough, Karrick, and Morrison (1995) on the knowledge of directional mistunings yielded similar results.

Humming

Some educators believe pitch matching and tuning ability can be improved by humming the reference pitch previous to instrumental tuning. Bennett (1995) found that vocal instruction and humming did not improve the tuning accuracy of woodwind instrumentists.

The purpose of this study was to determine what factors contributed to bowed string students’ tuning independence or perceived ability to tune their instrument without assistance. Questions pertaining to students’ perceptions of their tuning ability, classroom tuning procedures, individual tuning procedures, and private teacher tuning procedures were considered as potential factors contributing to perceived student tuning ability.
Method

Eight hundred and twenty-six 6th through 12th grade string students participated in the study. There were 519 violin, 107 viola, 137 cello, and 63 double bass players in the sample. The sample breakdown by grade level was as follows: 6th grade (117), 7th grade (163), 8th grade (129), 9th grade (90), 10th grade (133), 11th grade (117), and 12th grade (77). The length of study on the various stringed instruments ranged from a low of .5 years to a high of 15 years. The average length of study was 3.8 years with a standard deviation of 2.5 years.

Subjects were administered the Tuning Study survey form. The Tuning Study survey form contained 14 questions. See the Appendix for the Tuning Study survey. Sub-question items were also included in questions #5, #6, #10, #12, #13, and #14. In addition to determining the stringed instrument the students played, their grade level, and the length of study they acquired on their instrument, subjects were asked to respond to questions pertaining to their tuning ability, classroom tuning procedures, individual tuning procedures, and private teacher tuning procedures.

The Tuning Study survey was developed and pilot tested prior to administration for this study. The survey was initially developed and pilot tested using a sample of 10 students. The survey was then revised and again pilot tested using a sample of 50 students from various grade levels who played either violin, viola, cello, or double bass. Based on information gathered from the second pilot testing, the survey was again revised before administration to subjects in this study. In a test-retest situation the Tuning Study survey was found to have a reliability of $r = .87$. Face and content validity were established through a review of the instrument by three professional string teachers. The teachers determined that the survey questions had both face and content validity.

Results & Discussion

Data were analyzed using t test, chi-square, and frequency distribution analyses. One t test for independent samples was computed between responses to question #5 “Can you tune your instrument without teacher assistance?” and question #3 “How long have you played your instrument?” Twelve chi-squares were computed, with one constant variable being the response (yes or no) to the question “Can you tune your instrument without teacher assistance?” with the other variable being responses to questions #1, #2, #4, #6, #7, #8, #9, #10, #11,
#13, #14, and #15 respectively. Frequency distributions were computed for sub-question items for questions #5, #10, #13, #14 and #15 as well as question #16. The following is a summary of these analyses.

**Analyses**

A discussion of the responses to question #5 will begin this section as it is fundamental to the subsequent t test and chi-square analyses. In question #5, students were asked if they could tune their instruments without teacher assistance. Of the 821 students responding to this question, 72% or 590 students, said they could tune their instruments without teacher assistance, while 28% or 231 students said they could not. Three follow-up subquestions were then asked of the students who said they could tune their instruments without teacher assistance.

First, students were asked how they rated their ability to tune their instruments. Of the students who said they could tune their own instruments, only 2% said they were “poor” at it, 23% indicated they were “fair,” the majority, 55%, stated they were “good” at tuning and the remainder, about 17%, reported their ability to tune as “excellent.”

Second, these students were asked if they found it physically difficult to tune because of sticking pegs, stiff or tight string adjusters, balancing the instrument in playing position, or coordination between bowing and making adjustments. Forty-five percent indicated difficulty tuning due to sticking pegs, 29% found stiff or tight string adjusters to be a problem, 13% said it was difficult to tune while balancing the instrument in playing position, and 17% found it difficult to tune due to coordination problems between bowing and making adjustments.

Third, these students were asked if they tuned using only pizzicato, only arco or a combination of both when tuning. Six percent said they used pizzicato only, 13% only used arco, while 81% indicated they used a combination of both pizzicato and arco.

One t test was computed. The independent variable for this t test was students’ responses to question #5 (yes or no) and the dependent variable was length of study students had on the instrument they were currently playing. A significant difference, t(814) = 12.47, p < .0001, was found between students' length of study and their perceived ability to tune without assistance such that students with 4.5 years of study were more often able to tune their instruments independently as compared to students with 2.25 years or less study.
The first of the 12 chi-squares computed was completed using the variables "What instrument do you play?" and "Can you tune your instrument without teacher assistance?" (question #5). No significant difference was found in the students' ability to tune their instruments with or without teacher assistance by the instrument they played (violin, viola, cello, or bass).

When looking at grade level and the ability to tune without assistance, a significant difference, \( \chi^2(6, N = 821) = 163.81, p < .0001 \), was found. Sixth and 7th grade students more often indicated they needed teacher assistance to tune as compared to 8th through 12th grade students. About 50% of the 8th grade students said they tuned themselves. The percentage of students who were able to tune themselves increased to 96% by the 12th grade.

Students were asked how they rated their ability to hear when a string was out of tune (excellent, good, fair, or poor). Of the students who said they could tune their own instruments, only 2% said they were "poor" at it, 23% indicated they were "fair," the majority, 55%, stated they were "good" at tuning and the remainder, about 17%, reported their ability to tune as "excellent." When a chi-square was computed with these replies and those to question #5, a significant difference, \( \chi^2(3, N = 820) = 121.17, p < .0001 \), was found in students' responses. Eighty-seven percent of the students who reported they were able to tune their instruments independently rated their ability to hear when their strings were out of tune as either good or excellent.

Students were to indicate whether or not their teachers had regular tuning routines. Seventy-three percent of the students indicated their teachers had a class tuning procedure as compared to 23% who said their teachers did not have a routine. When comparing these responses with question #5 responses, a significant difference, \( \chi^2(1, N = 820) = 5.59, p < .01 \), was found. In classes with tuning procedures, 73% of the students said they could tune themselves independently, while in classes without tuning routines only 58% of the students said they could tune without teacher assistance.

While no significant difference was found between students' tuning ability and the type of classroom routine used to tune, the most frequently used tuning routine was to provide a reference pitch for each string, beginning with "A." Over 50% of the students indicated that this routine was used. The second-most used routine was to tune the "A" strings and then tune the remainder of the strings without further reference pitches. About 45% of the students indicated this was used as the class tuning procedure. Finally, about 4% of the
students said the expected tuning routine was to tune individually before class began.

A significant difference $\chi^2(6, N = 821) = 160.79$, $p < .0001$, was found between students' perceived tuning ability and the device used to provide a reference pitch for class. Students who felt they were able to tune their instruments most often indicated that a student instrument was used for tuning, while students who felt they were not able to tune their instruments most often indicated that a piano, electronic tuner, or no reference pitch at all was used. The most common device used to provide a reference pitch for class tuning was a student instrument (56%), followed by a piano (33%), an electronic tuner (22%), a tuning fork or pitch pipe (9%), and a pitch from a CD disk (3%). Seven percent of the students indicated that a reference pitch was not normally given.

When asked if it took them a long time to tune their instruments (always, frequently, sometimes, or never), students' perceptions of how long it took them to tune differed significantly, $\chi^2(3, N = 817) = 56.90$, $p < .0001$, by their perceived ability to tune their instruments independently. Students who reported they did not require tuning assistance thought they tuned much faster than students who required tuning assistance. Seventy-nine percent of the students who tuned without assistance said it "never" took them long to tune while only 21% of those who needed help tuning said it "never" took long to tune. Conversely, 75% of the students who needed help tuning said it "always" took them a long time to tune while only 25% of the students who tuned without assistance said it "always" took a long time to tune.

Students were asked how often teachers assisted them in tuning (always, frequently, sometimes, or never). There was a significant difference, $\chi^2(3, N = 820) = 201.28$, $p < .0001$, in the frequency of teacher assistance in tuning by students' perceived ability to tune their instruments. Only 16% of the students who said they could tune by themselves also said they were frequently or always assisted with their tuning, while over 66% of the students who said they could not tune without teacher assistance said they were frequently or always assisted by a teacher.

In a similar question, students were asked if their teachers monitored or checked the accuracy of their tuning. There was a significant difference, $\chi^2(3, N = 819) = 11.33$, $p < .01$, in teachers' monitoring of students' tuning accuracy by students' perceived ability to tune their instruments. Forty-seven percent of the students who could tune their instruments indicated that their teachers frequently or always checked
their tuning while 59% of the students who could not tune their instruments said their teachers frequently or always checked their tuning.

Students responded (always, frequently, sometimes, or never) to the question: "Does your teacher have you sing or hum pitches as part of the tuning process?" There was no significant difference between students who felt they could or couldn't tune with teacher assistance by the frequency at which their teachers asked them to hum or sing pitches as part of the tuning process. Only about 10% of the students said they frequently or always hummed pitches as part of the tuning process. Nearly 70% said they never hummed as a tuning routine.

Regardless of the tuning procedure used, students were asked if they thought they could accurately tune with the routine used. There was a significant difference, $x^2(2, N = 819) = 36.45, p < .0001$, in the students' perception of tuning accuracy and tuning routine by their perceived ability to tune their instruments. Eighty-four percent of the students who could tune without assistance also said they could tune accurately in class with the routine used. For those students who responded that they needed tuning assistance, only 66% said they could tune accurately when using the class tuning routine. For those students who said they did not feel they could accurately tune with the routine used in class, one additional question was asked of them. They were asked what would help them tune more accurately. Fifty-five percent of these students thought that no practicing of music during tuning could help them tune more accurately, 40% stated that more teacher instruction on how to tune would improve their tuning, 36% stated that a longer reference pitch was the key to more accurate tuning, 34% believed that softer tuning by all students was important, 33% said that more frequent checking of individual tuning and that a louder reference pitch would be beneficial to tuning efforts, while 3% thought a softer reference pitch could help them tune more accurately.

A chi-square was computed, $x^2(3, N = 817) = 61.76, p < .0001$, with the variable response to the question "Do you tune before each practice rehearsal?" by students' responses to the question "Can you tune your instrument without assistance?" A significant difference was found such that 76% of the students who felt they could tune by themselves said they tuned before each practice session, while 51% of the students who said they could not tune without assistance indicated they tuned before each practice session. Additional information was gathered when students were asked "If you tune before practicing what do you use for a reference pitch?" and "What routine do you use
for tuning?” Fifty-five percent of the students said a piano, 24% an electronic tuner, 10% a tuning fork or pitch pipe, and only 3% of the students said they used a pitch from a CD disk for a reference tuning pitch before practicing. Twenty-one percent of the students indicated they normally didn't use a reference pitch to tune before practicing. A majority of students (67%) used harmonics to tune their instrument at some point, 47% used both individual strings and double stops together, and 21% used individual strings to tune. Note: students could respond to more than one item and thus the percentages total more than 100.

A significant difference, $x^2(1, N = 807) = 23.45, p < .0001$, was found between students' perceived ability to tune independently and private study. Over 82% of the students who studied privately indicated they could tune without assistance, while only 66% of the students who did not study privately reported they could independently tune their instruments. Several follow-up questions were then asked of those students who indicated they studied privately.

Subjects were asked if their private teachers assisted them in tuning. Of the students who studied privately, 48% of the students who felt they could tune themselves said they were assisted in tuning by their private teachers while 90% of the students who said they could not tune their instruments were assisted in tuning by their private teachers. This difference was significant, $x^2(3, N = 283) = 37.18, p < .0001$. Of the 48% that said they were assisted in tuning, 35% said their teachers took their instruments and tuned them, 25% indicated that they bowed the strings and their teachers adjusted the pegs and/or string adjusters, 35% said they adjusted the strings and their teachers helped them identify which were in or out of tune, and 43% reported they tuned the best they could and their teachers checked and/or retuned their instruments as necessary. Devices used for pitch reference by private teachers were reported as follows: a piano (51%), the private teacher's instrument (40%) an electronic tuner (27%), a tuning fork or pitch pipe (4%), and a pitch from a CD disk (less than 1%). Seven percent of the students said their private teachers did not normally use a reference pitch for tuning.

**Summary**

The purpose of this study was to determine what factors may contribute to tuning independence among middle and high school students. While this study focused on students’ perceptions of their ability to tune independently, there are several interesting findings
that were similar to those of other researchers. It must be kept in mind when looking at this study and other studies in this area that the current study assessed the perception of tuning independence. Two of the findings that were addressed in the current study were age as delineated by grade level and experience.

Madsen, Edmonson and Madsen (1969), Fullard (1968), and Geringer (1983) found age to be a significant factor in the ability to tune and match pitch, while Litke and Olsen (1979) found no correlation between age and tuning ability. Findings from this study were similar to those of Madsen, Edmonson & Madsen; Fullard, and Geringer. The number of students who reported they could tune independently increased as they progressed through the grade levels, and this could be considered a function of age, since students in higher grades tend to be older than students in lower grades, or of experience especially if it is assumed that the higher the grade the longer a student may have played an instrument. Yarbrough, Morrison and Karrick (1997) found no relation between pitch matching ability and experience, while Platt and Racine (1985), and Madsen, Edmonson and Madsen (1969) found such a relationship. The findings from this study were similar those of Racine & Madsen, Edmonson & Madsen, and Platt. Students with 4.5 years of study were more often able to tune their instrument independently as compared to students with 2.25 or less years of study.

A relationship between pitch discrimination and tuning was found in this study. Pitch matching requires the student to listen to a reference pitch and match a respective open string. While some musicians are able to match pitch easier than others, the task is fundamental to teaching string tuning. The skill of pitch discrimination must have been developed for pitch matching to occur. Bentley (1968), Pedersen and Pedersen (1970), and Zwissler (1972) found that poor pitch was the result of poor pitch discrimination while Geringer (1983), Chevellard (1983), and Solomon (1993) suggested that the two musical skills developed independently. In this study it was found that students who had higher confidence in their ability to hear when a string was out of tune also were more likely to be able to tune their instruments independently.

While researchers have not specifically explored the use of double stops as a means of teaching tuning, Terhardt (1971), Rakowski (1985), Papich & Rainbow (1937), Forsythe (1967), Edmonson (1972), and Madsen, (1966) found that the perception of the intervalic relationship differs among musicians when tuning. Karrick (1998)
found that harmonic fourths, fifths, unisons and octaves were easier to tune than thirds and sixths. In this study it was found that a majority of students used harmonics to tune their instruments when they were not in a class situation. Fewer students used a combination of tuning using individual strings or double stops, while the least frequently used approach was to tune an individual string using a reference pitch. It should be noted that cello and bass players generally use harmonics to tune while violin and viola players generally do not rely on harmonics to tune. Given this tendency, it may have been possible that some students checked “harmonics” without understanding what the term meant and thus affected the outcome of this question on the survey.

It was also found that class tuning routines significantly contributed to students’ ability to tune independently. There was no significant difference in tuning independence by the type of the routine used. The most regularly used tuning routine was to tune each string individually from a reference pitch beginning with the “A” string. This was closely followed by the approach in which an “A” was given as a reference and the students completed tuning the other strings without a reference pitch.

Bennett (1995) found that vocal instruction and humming did not improve the tuning accuracy of wind instrumentalists. Results from this study tend to support Bennett’s findings. There was no significant difference between students who could or couldn’t tune independently by the frequency at which their teachers asked them to hum or sing pitches as part of the tuning process.

Fyk (1987) studied tuning speed as it was affected by training. While Fyk found that tuning speed could be increased by training, Klemish (1974) found no improvement in pitch matching after pitch discrimination training. While not directly related to these findings, a relationship was found in this study between tuning speed and tuning independence. Students who perceived they could tune independently generally reported that it did not take them a long time to tune, while students who perceived they were not independent tuners thought it took them a long time to tune. Independent tuners who thought they could tune faster, also perceived themselves to be more confident about their tuning accuracy in a class situation as compared to students who thought they were not independent tuners.

The ability to match pitch using various timbre and/or tone quality stimuli has been investigated by Benson (1995) and Hayslett (1990). While their results differed, both reported that a reference pitch generated electronically, did not necessarily produce accurate tuning.
Hayslett found a significant decrease in tuning accuracy when the reference pitch was generated electronically and Benson reported that the electronic stimuli produced more sharp responses. A similar finding was noted in this study such that students who indicated they were able to tune their instruments most often said that a student instrument was used to provide the class tuning reference pitch, while the students who said they were not able to tune their instruments most often indicated that a piano, electronic tuner, or no reference pitch at all was used in the class tuning procedure. Based on these results, it would be suggested that electronic tuners be avoided for tuning purposes and that a student’s instrument be used for reference pitch tuning purposes.

Yarbrough, Morrison and Karrick (1997), indicated that subjects who studied privately tended to match pitch more accurately than those who did not. Their findings were supported by this study. Over 82% of the students who studied privately stated they could tune without assistance, while only 66% of the students who did not study privately indicated they could independently tune their instruments.

Based on the findings from this study it would seem that the following factors may contribute to perceived tuning independence among middle and high school students:

Grade Level: The number of students who perceived they could tune independently increased as they progressed through higher grade levels.

Years of Study: Students with 4.5 years of study were more often thought they were able to tune their instrument independently as compared to students with 2.25 years or less study years of experience.

Intonation Confidence: Students who had higher confidence in their ability to hear when a string was out of tune also were more likely to report that they were able to tune their instruments independently.

Individual Tuning: Students who perceived themselves as independent tuners more often used harmonics to tune their instruments than using individual strings or double stops.

Class Tuning: Students who perceived themselves as independent tuners more often were in classes in which the most regularly used class tuning routine was to tune each string individually from a reference pitch beginning with the “A” string.
Humming: Humming or singing pitches as part of a class tuning process did not seem to affect student’ perceived ability to tune independently.

Tuning Speed: Students who thought they could tune independently generally indicated that it did not take them a long time to tune, while students who reported they were not independent tuners reported it took them a long time to tune.

Reference Pitch: Self-reported independent tuners most often said that a student instrument was used to provide the class tuning reference pitch, while the self-reported non-independent tuners most often indicated that a piano, electronic tuner, or no reference pitch at all was used in the class tuning procedure.

Private Instruction: Over 82% of the students who studied privately responded that they could tune without assistance, while only 66% of the students who did not study privately indicated they could independently tune their instruments.

While age and years of study may certainly have an impact on perceived tuning independence, the findings of this study also point to the idea that other factors may assist students in their development of tuning independence. Students must develop a high degree of confidence in their ability to hear when a string is out of tune. Teacher intervention and feedback are excellent vehicles to accomplish this task. It is recommended that teachers provide consistent student tuning feedback assessment that can help students develop confidence in hearing when a string is out of tune or in tune.

Effective individual and classroom tuning procedures must also be implemented to help create independent tuners. It is suggested that students be taught to use harmonics and double stops to tune their instruments, specifically in regard to the cello and bass players, as well as use procedures to help develop pitch discrimination when tuning each string individually from a reference pitch. The most effective reference pitch seems to be one that is provided from a student instrument and not one from a piano or electronic tuner. Additionally, the process of humming or singing pitches as part of a class tuning process does not appear to contribute to the students’ tuning independence.

Students who believe they are independent tuners not only report to tune with greater speed, but they also request less teacher assistance. With an ever increasing number of independent tuners in each
classroom, the teacher can focus tuning assistance energies to those who are still developing their tuning independence skills. In addition to providing constructive tuning feedback assessment, using the most effective device to provide reference tuning pitches, and adapting a constructive tuning procedure in which a variety of techniques are demonstrated and reinforced, the string teacher should encourage each student to study privately, as private lesson study has been found to be related to the development of perceived tuning independence.

Additional research is needed to further study the way string students develop tuning independence. This study has provided a survey of common practices in string tuning factors as they relate to student’s perception of tuning independence. It is recommended that research be conducted in which tuning independence be studied through observation and assessment of operational criteria to determine the relationship between students’ perception of tuning independence and observed tuning accuracy.

References


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**Seashore, C.E. (1938).** The psychology of music. New York: Dover.


Appendix

Tuning Independance Survey

1. What instrument do you play?
Violin Viola Cello Bass

2. What grade are you in? ______________

3. How long have you played your instrument? _________ year(s)

4. How would you rate your ability to hear when your strings are in tune or out of tune?
poor fair good excellent

5. Can you tune your instrument without teacher assistance?
yes no

5a. If yes, How would you rate your ability to tune your instrument?
poor fair good excellent
5b. Do you find it difficult to physically tune the instrument because of

1. instrument balance:
   yes no
2. sticking pegs:
   yes no
3. stiff or tight string adjusters:
   yes no
4. coordination between bowing and making adjustments
   yes no

5c. How do you tune?
   ___ pizzicato only
   ___ arco only
   ___ pizzicato and arco

**Classroom Procedures**

6. What tuning device is used as a reference pitch in class? (check all that apply)
   ___ piano
   ___ electronic tuner
   ___ student instrument
   ___ pitch from a CD disk
   ___ tuning fork or pitch pipe
   ___ a reference pitch is not normally given.

7. Does your teacher assist you in tuning your instrument?
   always frequently sometimes never
8. Does it take you a long time to tune your instrument?
always frequently sometimes never

9. Does your teacher use a regular system or routine for tuning the class?
yes no

9a. If yes, What system or routine is used to tune the class?
___Strings tuned in sequence beginning with “A”.
___“A” strings tuned, students complete remainder of tuning.
___Students expected to tune individually before class begins.
___Other – Explain

_____________________________________________________________________

10. Does your teacher use singing as part of the tuning process?
yes no

11. Does your teacher monitor or check the accuracy of your tuning?
yes no

**Individual Procedures**

12. Do you tune before each practice session?
yes no

13. Do you tune to a reference pitch?
yes no
13a. If yes, What do you use for a reference pitch? (Check all that apply)
   ___piano
   ___electronic tuner
   ___pitch from a CD disk
   ___tuning fork or pitch pipe

14. Which system or routine do you use when tuning? (Check all that apply)
   ___ Individual strings
   ___ Individual strings and double stops
   ___ Harmonics
   Private Teacher Procedures

15. Do you study privately?
   Yes No

15a. Does your private teacher assist you in tuning?
   Yes No

15b. If yes, what system does your private teacher use to help you tune: (Check all that apply)
   ___ Individual strings
   ___ Individual strings and double stops
   ___ Harmonics

16. Does your private teacher provides a reference pitch for tuning?
   Yes No
16a. If yes, what does he/she use for the reference pitch? (Check all that apply)

___ piano
___ electronic tuner
___ his/her instrument
___ pitch from a CD disk
___ tuning fork or pitch pipe

Thank you for completing this survey!