THE INTERNET, AUTO-ACCOMPANIMENT SOFTWARE, AND SPECTRAL ANALYSIS IN UNDERGRADUATE VOICE LESSONS

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ABSTRACT

For eight weeks, eight undergraduate students experienced voice lessons with differing levels of technology integration. Data collected through teacher observations, student journals, and quantitative questionnaires aided both a comparison of the influence of each of the technologies on the attitudes of the participants and instructor and judgements regarding the feasibility and effectiveness of the technologies. The use of Internet Web pages proved effective as a visual reinforcement during lessons and as a resource for students outside of lessons. Auto-accompaniment software (SmartMusic by Coda Music Technology) was effective as a substitute for a human accompanist and as an aid to the learning process both in lessons and for individualized student practice. However, students performing with a human accompanist rather than the software rated the overall lesson experience more positively. Beginning students also found learning new pieces with the auto-accompaniment software frustrating. Spectral analysis and electroglottograph (EGG) readings were effective in increasing the motivation of students, serving as a vehicle to present factual information on the voice, and giving objective data on student improvement. However, they served little pedagogical purpose toward improving the students' singing, and the time spent on the spectral analysis process also hindered student preparedness for the final concert. General trends showed that the more technology that was used in the lesson, the more positive the students' reaction toward technology became. Since technology applied to voice lessons had a positive influence on student motivation, knowledge gain, and facilitation of communication within the voice lessons, voice teachers should work to gradually incorporate technology into their lessons. Teachers should take into account the increased time, skill, and special equipment necessary.

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INTRODUCTION

Few observers of modern society would deny that computer-centered technologies play a major role in our everyday activities. Given the ever-growing nature of the presence of technology in our lives, one might suppose that eventually technology would be integrated into virtually every aspect of our existence. The question remains, however, whether computer-based technology can be instilled in a meaningful way into all of our society. Certain human activities might not be adaptable to modern technologies.

Education is one human activity where the interpersonal roles of the teacher and student are essential to the learning process. Recent trends in education show that technology has become increasingly ingrained in the education of American students (National Center for Education Statistics, 1997). Many publications support the fact that music education has also been affected by modern technologies (e.g., Berz & Bowman, 1994, 1995; Higgins, 1991, 1999; Rudolph, 1996; Williams & Webster, 1996; York, 1999a, 1999b). The evidence suggests that music is an area that can be influenced by new technologies.

Because vocal music is intimately related to the human body, vocalists feel a personal identification with their instrument as a part of themselves, rather than as an outside entity that is manipulated to produce music. A bassoon or a piano can be interpreted as being a piece of technology, but the larynx of the singer is part of the human anatomy. Since the vocalist does not manipulate an object outside of him/herself, one might wonder whether singers might hold a bias against outside instrumentation.

The nature of the voice lesson is an intimate relationship between the teacher and the student. The tradition of singing has been passed down by word of mouth for centuries. Some teachers of voice have traditionally shown a bias against scientific method in the use of the voice lesson. This aversion to scientific method is increased with the presence of strange, untested technologies that find their way into the modern voice lesson.

Other teachers of singing are more open to technological aids in the voice studio. Teachers who have access to technology have found novel ways of incorporating the equipment into their practice routines. This study is an exploration of some of the technologies available to the voice professional. Technology was incorporated into the voice lessons of students over an eight-week period. The technology was an integral part of the lesson format as a supplement to hands-on teaching.

Background

A historical exploration of the ways teachers have used mechanical teaching aids in the past is essential for an understanding of the possibilities for the use of technology to teach voice. Additional information can be gleaned from an analysis of music education sources. (Please note that for the purpose of this review the term "technology" is presented in a general sense, including many teaching aids we would not consider as strictly technological today.)

History of Voice Technology

Before World War II, voice science and its application to the teaching of voice had not developed significantly (Von Leden, 1990). One of the first recorded attempts at using technology to aid in the understanding of voice production were made by Buzzoni in 1807. He invented what was to become the laryngeal mirror, and in a later evolution, the laryngoscope (Moore, 1937). The singing teacher Manuel Garcia made the most useful early applications of this technology. Attempts at laryngeal photography began in 1860 and evolved into today’s stroboscopic photography. These techniques were for the most part experimental and out of the reach of singing teachers. Most early research in the area of technology and the voice came from medical professionals and later from speech pathologists, rather than voice teachers.

Commentary on the use of technology for teaching singing appeared as the equipment developed. Although the first issue of The Bulletin of the National Association of Teachers of Singing (NATS) (Mowe, 1944) does not specifically address technology, the editors highlight the "serious obstacle" of the "geographic distribution of the members" (p. 2). The use of the technologies associated with the printed Bulletin were one way to overcome this geographical distribution. Although this use does not parallel today's information media, it is an early example of using communication technology to work around the challenges of the profession.

Early notice of the use of technology was accompanied by controversy over the philosophical basis behind the teaching of voice. The advent of scientific method and instrumentation led to a dichotomy of thought within the profession. Traditional views of voice pedagogy drew upon centuries-old traditions from Italian teachings (Bidoli, 1947), which incorporate the extensive use of imagery and imagination (Wilcox, 1945), rather than scientific method.

In 1953, Wollman articulated this dichotomy by dividing the philosophy into the categories of empirical, or those methods derived from experiential phenomena, and scientific, including the study of anatomy and acoustics (see Hisey, 1970). The scientific viewpoint gained acceptance in the 1940s. By 1948, the NATS "Fundamental Requirements for Teachers of Singing" contained a series on "Orientation Lectures on Physics and the Acoustics of Musical Sound" (National Association of Teachers of Singing, 1948, p. 8).

The advent of the scientific method in the study of voice had its detractors. In 1951, McLean supported a more spiritual approach to the teaching of singing with this statement:

> THE STUDY OF VOICE and vocal mechanism has degenerated from the quest of spiritual law and the utterances of eternal verities to a material, mental attitude based purely on the phenomena produced by a PHYSICAL INSTRUMENT ONLY, in like manner, with the automotive salesman, minutely describing the "entrails" of the newest car.
>
> The history of the world is a chronicle of discoveries of deeper laws than those produced from physical phenomena. . . . There remains an EXISTENT

> SOMETHING not included in our concept of mechanical movement. The fact is, we are dealing with a LIVING INSTRUMENT, not a dead one. Can an instrument which expresses the SPIRITUAL FORCES of man in action be measured by an earthly yardstick? (p. 7) [emphases supplied by McLean]

By the 1950s, technology had earned a permanent place in society. In 1953 Gilliand noted the prevalence of technology with the statement, "The presence of technological advancements found in many other walks of life has, to no small extent, become associated with the Fine Arts" (p. 7). A modern technician might view his statement as an acknowledgment that the so-called "new" technologies in the arts have been commonplace for at least the past 50 years. Gilliand goes on to meliorate the differences in the two philosophies by paying homage to the unseen forces which shape the singing process, "the belief in God constitutes one of the salient facets of our philosophy of teaching" (p. 7). However, he makes clear that the Divine represents only one portion of the process of the teaching of singing.

In the 1960s, the application of scientific voice study became better defined and more approachable to the voice teacher, but resistance still existed. Madsen (1965), while acknowledging the "mystery" associated with the teaching of voice, chided the profession for not following standard scientific principles such as continuous questioning of assumptions, sharing of ideas, and learning from peers. In contrast, scientific method came under fire from the profession as findings from controlled studies challenged the assumptions of long-held beliefs.

In 1968, Appleman found that 25% of NATS members supported voice science, while 25% rejected the process and would not support inclusion of voice science into the suggested foundations for teachers of singing (the remaining 50% were ambivalent). Despite advances in attitude toward voice science, Appleman still defined voice science and pedagogy as separate elements, and he reported issues of the profession concerning whether scholarship and knowledge of teaching methods actually aid vocal pedagogy. He divided voice professionals into disparate groups of scientists and "executionists."

As reliable studies began to appear, the profession took notice. However, with the exception of a 1952 article concerning the singer and television (Beier), articles on specific technologies (as opposed to a general support or denial of technology) were scarce. Research such as Taff’s 1965 acoustic study of vowel modification, Large’s (1968) study of acoustical measures of female chest register, and Smith’s (1970) investigation of electromyographic measurement of vibrato (cf. Michel & Grashel, 1980) gave concrete examples of voice science and vocal pedagogy.

Technology and Music Education

The broader body of music education has traditionally been more accepting of the use of music technology than voice educators have been. The use of what we would consider to be a computer as an aid to musical understanding began as early as 1949 (Bronson, 1949). One of the first references to music technology in the music education research literature was represented by an article by Jones (1957), who wrote:

> The artifacts of the society—television, electronic brains, radar, better printing and visual aids, automation, improved household appliances, new highways—will all have an effect not only upon the nature of education but also upon the problems that will face educational research workers. (pp. 21-22)

Although terms such as "electronic brains" and the potential use of radar for music research may seem quaint to the modern reader, Jones was prophetic in his prediction of the influence of technology upon the discipline of music education.

Even before high-speed modern computers, technological aids to music education came in many forms. In 1964, Shelter evaluated the use of available audio-visual media such as records, filmstrips, and school public address systems. Clever music teachers have found ways to use everything from the overhead projector (Debski, 1966) to films (Larsen,

1980) to enhance learning. Educators continue to use all manner of technology available, including video, to teach musical skills (Grashel, 1991).

One of the first articles in the music education literature that contained the word “computer” was published in 1965 (Roller). In the 1960s, the use of computers in education was associated with Programmed Instruction (PI). PI was based on the principles of behaviorist psychologists such as Thorndike and Skinner. These principles were first applied to teaching machines by Pressey in the 1920s (Hutcheson, 1967). In PI, teaching materials are broken down into small, graduated steps placed in a logical sequence, or "program." The program elicits a response from the student, who receives immediate reinforcement. The teaching machine is self-contained, so that the student can work at her own pace (Hutcheson, 1967; Ihrke 1962; Turpin, 1970; Rogers & Allmond 1970). In this period, experiments associated with technology almost exclusively fell into the PI category. Research concentrated on basic skills of musicianship (e.g., Carlsen, 1962; Deihl & Radocy, 1969; Ihrke 1964, 1971; Kuhn & Allvin, 1967a, 1967b; LaBach, 1964; Spohn, 1959; Wardenburg, 1969). One study in this period with application to singing is Kanable’s 1969 comparison of PI with classroom teaching of sight singing. (Kanable found no significant difference between the two methods.)

In the 1970s, Programmed Instruction using a computer was identified by the name computer-assisted instruction (CAI). CAI had not gained the respect of the profession as a whole, but proponents hoped that significant results would still appear in the future (Lincoln, 1969). Replicability was an important element of measurement of validity for the behaviorist-minded researchers (Deihl, 1971), and CAI offered the rare opportunity for almost exact replication of an experiment.

However, these techniques were beginning to expand the scope of what music educators could accomplish with technology beyond the still-ingrained atomistic mindset of the behaviorists (Deihl & Partchey, 1973). Although limited by cost and availability of technology, new techniques existed such as the use of light pens (Allvin, 1971) and the potential for information retrieval systems. The use of technology for information processing in music (e.g., Edwards, 1972; Lane, 1974) would set the stage for later developments applicable to today's Internet technology.

By the 1980s many in the profession were suggesting that music technology was "coming of age" (McGreer, 1984, p. 12). Many studies had found no significant difference or even a superiority of computer-based instruction over traditional materials (McGreer).

The use of computers to teach music was heavily influenced by the Programmed Logic for Automated Teaching Operations (PLATO) system designed at the University of Illinois at Urbana-Champaign (Hair, 1977). PLATO technology was incorporated successfully in Hoffstetter's Graded Units for Interactive Dictation Operations (GUIDO) system (Hoffstetter, 1981).

Nevertheless, the amount of research for the profession in general did not reflect the optimistic views about the value of technology. Stabler (1986) reported that articles on instructional technology in the Bulletin of the Council for Research in Music Education declined from 10% of all articles published from 1976 to 1980 to two percent from 1981 to 1985. The height of educational technology research in this particular publication was from 1963 to 1969, when 13% of the articles concerned instructional technology. The disillusionment with technology during this period including growing disenchantment with behaviorist principles behind the technology, prohibitive costs, steep learning curves for programming and use of the technology, and the inability of the technology to facilitate differing learning styles.

In the late 1980s and early 1990s, advancements in computer hardware would again create interest in technology as a vehicle for music instruction. In 1984, Apple Computers, Inc. released the Macintosh, which would revolutionize the way people interact with computers. The Macintosh featured the first widely available Graphical User Interface (GUI) (originally invented by Xerox-Palo Alto Research Center) which used the now-commonplace mouse and its point-and-click technology. The GUI is considered more intuitive and supportive of differing learning styles than the traditional line-entry model of earlier computer interfaces. Apple’s competitors soon followed suit with their own GUI interfaces.

In the 1980s, another technology known as Musical Instrument Digital Interface (MIDI) made it possible for the computer to communicate with an electronic keyboard. MIDI technology was incorporated into numerous CAI programs, and MIDI is standard in today’s electronic keyboard.

Interactive audio also showed potential for learning (Adams, 1990). Studies suggest that students learn better when they interact with technology in a meaningful way.

The use of technology in modern music education is so broad that a complete review of its applications is beyond the scope of this project. Many published texts go into detail on the possible uses of music technology for educators (Williams, 1992). Print resources include Williams' and Webster's (1996) overview of music technology and Rudolph's (1996) book specifically aimed at music educators. Many sources include resources aimed at music education organized around the National Standards (e.g., Piper, 1996; Rudolph, Richmond, Mash, & Williams, 1997). ATMI publishes a yearly catalog of music technology resources including books, software, hardware, publisher information, and contact lists (Murphy, 1999).

Specific Technologies

Investigation of all possible technologies for the teaching of voice is out of the scope of any research endeavor. Three technologies fundamental to the present study are discussed in detail here. These technologies include the Internet, spectral analysis, and auto-accompaniment software. In addition, a group of technologies that does not fit these categories, but was instrumental in research design, is also discussed.

Internet

One aspect of technology of interest to the profession has been the use of distance learning as applied to music education. Distance learning existed even before the spread of the Internet (Fonder, 1992; Hugedahl, 1984), as distance learning techniques are sometimes the only way that the geographically isolated student can access information on music (McMahon, 1985). The on-line communications and other advances with technology are also effective for use by the handicapped (Drake & Robinson, 1990). Distance learning has been proven effective when a teacher cannot be present (Wraggett, 1991).

Distance learning took on a new character beginning in 1989 when the international network of computers known as the Internet was made accessible to many without high-level technical knowledge through the World Wide Web (WWW). In 1993 the National Center for Supercomputing Alliance (NCSA) released the first widely available WWW browser called Mosaic. Mosaic allowed the user to navigate through the virtual "space" of the Web using simple techniques with a mouse. Web pages are reinforced with multimedia and graphical cues. In the modern vernacular, the terms Internet and Web have become synonymous.

The fact that one cannot turn on the television or open a magazine without being inundated with information about the explosion of the popularity of the Web and other aspects of technology-based education has not escaped music educators. The prevailing thought in the profession is that computer use will continue to increase (Nolan, 1994), and that music educators are committed to the integration of technology into the classroom (Glenn, 1990). Music teachers have taken notice of the phenomenon and the increased presence of technology in their schools. A recent survey by the National Center for Education Statistics (1997) found that in the fall of 1996, 65% of public schools in the United States had access to the Internet.

Although schools are dedicated to increasing Internet access for their students, doubts remain among practicing teachers as to whether the technology improves education. A recent survey showed that practicing teachers do not believe that the Internet improves children’s classroom performance, research abilities, or performance on standardized tests (Barber, 1997). Barber cites the lack of relevant and organized material as a major limitation of the Internet. Critics of the Internet would rather see the money spent on textbooks or other more traditional materials (Jackson, 1997). They compare the proven record of accomplishment of traditional materials with the unproved promises of the new technology.

In fact, the concern that technology might have a negative influence on music is as old as the technology itself (Kaegi, 1973). Many worry that the technological explosion may be turning us into a nation of spectators, rather than participants, in music (Elliot, 1990).

The Internet has taken the place of what many hoped interactive television (Rees & Downs, 1995) would accomplish. Some of the philosophy behind interactive technologies used by the hypertext documents of the WWW have been incorporated into the music classroom using multimedia (Mobley, 1996).

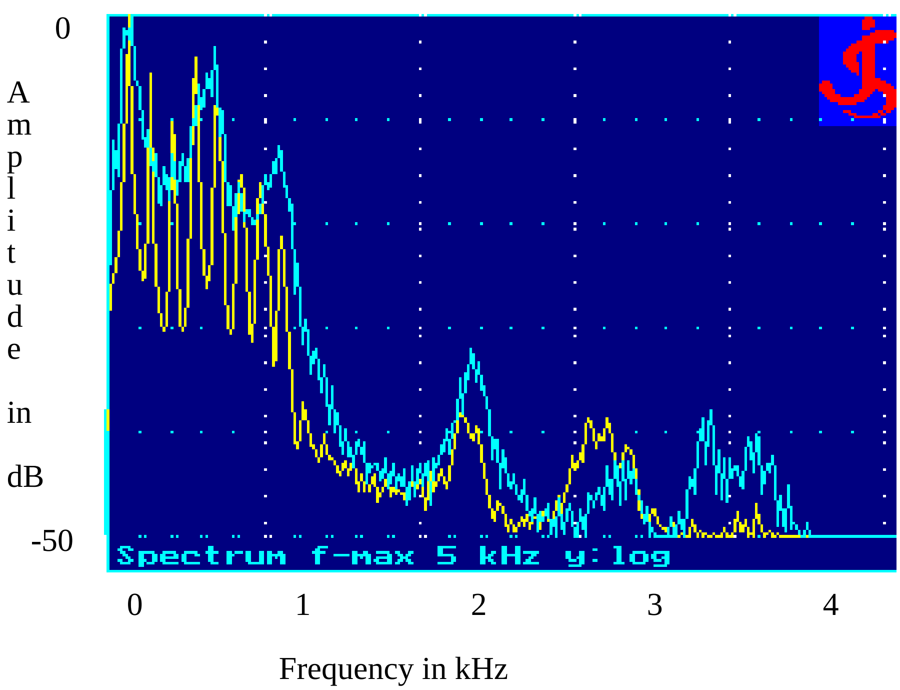
Web resources for vocalists are extensive (see Repp, 1995). One of the best resources for classically minded singers is the mailing list Vocalist (http://www.vocalist.org). Vocalist is a discussion group among voice users whose discourse is at a high level. Web sites have also been particularly useful for choral directors wishing to promote their choirs or provide information to their singers (Feiszli, 1998, 1999; Oglesby, 1998). Use of Web resources for singing has also drawn the attention of the popular press (e.g., Goodnough, 1997; Ingalls, 1995; Kingston, 1998; Pegararo, 1999; Strom, 1998; Valenti, 1993).

Spectral Analysis

Technology allows the voice scientist or teacher to investigate specific measures of voice production and to control the number of variables associated with a study. Because of the nature of scientific inquiry, phenomena which are difficult to measure, such as artistic expression, are often factored out of scientific voice investigation (Schutte, 1989). Of the myriad possibilities for voice measurement, those most accessible to the voice teacher must be safe, with no bodily invasive procedures, and affordable, without excessive specialized equipment. Some of the equipment to measure the activity of the larynx includes electroglottography and electromyography, which feature surface electrodes attached to the neck. Even more approachable are sonographic measures of the voice that can be taken with a microphone.

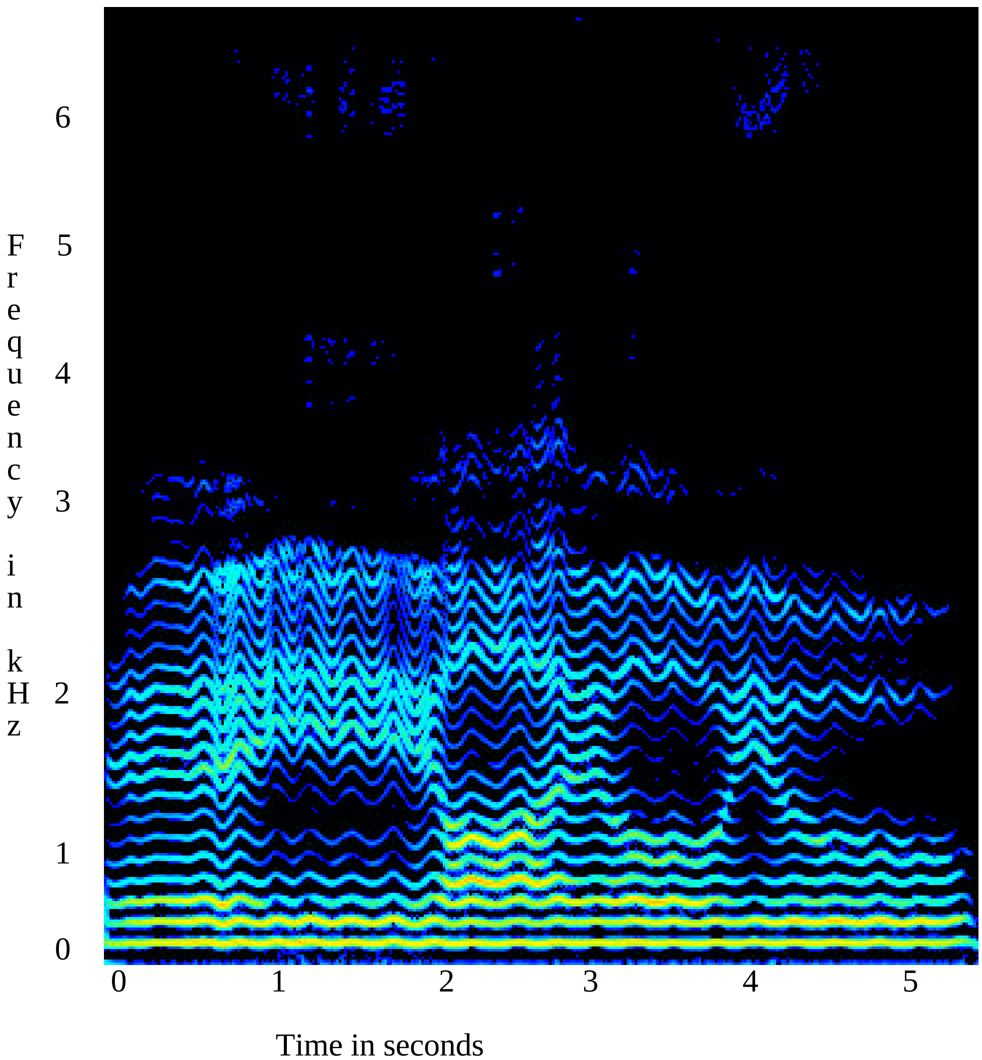
Whatever instrument measures the sound, the data can be analyzed by spectral analysis, or breaking the sound into its component parts. The term "spectral" analysis comes from the analogous function of a prism, which can break light into its component spectrum. Spectral readings are often graphed with amplitude on the vertical axis and frequency on the horizontal axis (see Figure 1.1), so that the power of portions of the voice spectrum can be observed (Titze, 1991).

Figure 1.1. Spectrograph of the [a] vowel. (Miller, Schutte, & Doing, 1996)



Another way of representing the voice is through a spectrogram, which produces readout with frequency on the vertical axis and time on the horizontal axis (see Figure 1.2) (Shorne, 1999). (Note that the terms spectrogram and spectrograph are used interchangeably in the literature; for this research the term spectrograph refers to the two-dimensional readout, and the term spectrogram refers to the readout which includes time as a variable.) The relative amplitude of the various frequencies is shown by an increase in the density of the reading (a darker color), or with a different color altogether (Miller & Franco, 1991). The spectrogram has the advantage of showing changes over time, such as changes in a vowel spectrum or wavy lines showing vibrato. Sometimes the three measurements of frequency, amplitude, and time are presented in a three-dimensional graph, or waterfall.

<u>Figure 1.2</u>. Spectrogram of sung vowels [e i a o u].



Central to the study of spectral analysis and the voice is the issue of formants. Formants are natural peaks in the spectrum of a singer's voice that do not occur at the larynx, but occur because of amplification of certain resonance bands of the vocal tract and attenuation of others. The trained singer can manipulate articulators to adjust the formants to produce differing tone qualities (Fox, 1984). Spectral analysis has shown the presence of a peak in the sound spectra of trained singers around 3000 Hz. This peak allows the singer to be heard over an orchestra (Schutte & Miller, 1983). A proficient singer can adapt the formant frequencies by manipulating the placement of the jaw, tongue, and resonating spaces (known as modifying the vowel) in order to produce a more resonant tone (Miller & Franco, 1991, 1992). Female singers are particularly proficient in modifying the tone to produce an increase in energy, and therefore amplitude and perceived volume (Cleveland, 1992, 1994b).

Spectral analysis allows the teacher of voice access to objective data on the tone of the student. The process has received a good deal of attention in the research literature, but clear strategies for the incorporation of spectral analysis techniques into the voice lesson are yet to be developed.

Auto-accompaniment

One of the most exciting uses of voice-related technology that has become feasible in the recent past is the use of software as an accompanist. Since a piano accompaniment is standard in most voice lessons, teachers have had two choices. One, they must play the accompaniment for the student, a process which has the potential for distracting the teacher. Two, they must have the student hire an accompanist (if one is not supplied), which can lead to financial difficulty.

Questions remain about the musicality of using such technology in performance. Tarabella (1993) suggests that the interaction between the performer and the instrument "implies the existence of a Zenic unity [emphasis his] which starts at the deepest levels of will and creativity and leads to a set of biomechanic events which, transferred to a musical instrument, determines the global musical result" (p. 179). Schloss and Jaffe (1993) warn against the dangers of "too much" technology (p. 183). They remind us that part of the experience of the audience is intertwined with virtuosity, but they still conclude that the interaction of performers and technology can be a powerful combination. Research on recorded music (Price, 1995; Wapnick & Rosenquist, 1991) indicates that the presence of electronic timbres may not change listeners' attitudes toward the music presented.

Perhaps the natural aversion to the thought of computer accompaniment comes from models we have observed in the past. Few trained musicians would consider the cultural phenomenon of karaoke to be acceptable in a serious performance. Until recently, even the most advanced auto-accompaniment software, including Band-In-A-Box (Gannon, 1998), although far more adaptable to musical situations than simple karaoke, had no way to react to the performer. Another technology gaining acceptance for accompaniment practices is the Disklavier (Yamaha Corporation of America, 1999), which allows a standard piano to be played by a MIDI file. Truly interactive software was made available with the introduction of SmartMusic (formerly called Vivace) (Coda Music Technology, 1999).

Modern Uses of Technology

Voice science has advanced in scope and acceptance as technologies have become more accessible. In 1971, the Voice Foundation initiated its annual Symposium on the Care of the Professional Voice, which promoted an interdisciplinary approach to the study of voice care. With the publication of the Journal of Voice in 1987, a format existed for the presentation of voice science and the interdisciplinary nature of medical technology, acoustic instrumentation, and vocal pedagogy in the analysis of the professional voice. The instrumentation for the study of the voice then existed, and the experimental process had a historical basis upon which to draw. For the first time the experimenter did not need to devise methodology without prior example (Cleveland, 1994a). Cleveland reflects the growing acceptance with these comments:

> A few short decades ago, science received a bad name among the practical users of voice because they could not see that science was helping them at all. . . . Today, we are witnessing a greater trust from the singing teachers that science may have valid information to be shared in the studio and the education of teachers, as well. (p. 23)

NATS publications now feature regular articles on the use of technology and the voice (e.g., Simonson, 1999; Vaughn, 1999). A few articles on the use of technology in the choral classroom exist (e.g., Feiszli, 1998, 1999; Fleagle, 1979; Goessman, 1994; Oglesby, 1998; Platte, 1982; Skelton, 1988). Some articles on the use of video exist (e.g., Cleveland, 1989c), but many concern the appreciation of vocal music such as opera (e.g., Hostetter, 1979; Teter, 1995). Studies on voice are more likely to concern easily measurable phenomena such as intonation (e.g., Buck, 1991). Sataloff (1997) provides a compendium of scientific method in the study of voice.

Therefore, we see that technology has a long history of use in the teaching of voice, and a more thorough investigation in the music education community. A number of cutting-edge technologies are now available for the voice teacher to supplement lesson materials, including the three technologies under investigation in this study. By learning from the experiences of the past, we can best develop new pedagogies for the teaching of tomorrow.

Need for the Study

Although some research exists in the use of technology and voice, a need for a study that incorporates the technologies into voice lessons still exists. Freed (1991) notes that educators are increasingly asked to define clearly what they teach and how the lesson supports a firm technical foundation. Voice pedagogues (i.e., Reid, 1984; Rubin, 1988) call for a way to incorporate voice science and technology into voice training without sacrificing basic technique. A study such as this can provide reliable evidence and guidance to help voice teachers understand the techniques for incorporating technology into their teaching.

The researcher in computer technology must be careful not to enter the trap of straying from the social foundation of music. Being "more interested in the programming and internal workings of that ever more conspicuous electronic bag of tricks" (Kippen, 1992, p. 256) that encompasses music technology is that trap. The value of all the "charts, graphs, gadgets, and gismos in the studio" (Titze, 1986, p. 22) will not be solved until research is undertaken from the standpoint of someone trained in voice education rather than voice science (cf. Cleveland, 1988; 1989a, 1989b; Titze, 1985). Titze (1986) provided a metaphor of improvement in athletics brought about by an obsession with measurement and new technologies to keep track of the individual's progress. If this analogy does indeed carry over into the art of singing, then someone will have to measure and analyze the potential for influence of technologies in the voice lesson.

Despite the research cited in this document, existing studies specifically concerning singing and voice production are not prominent enough to make broad generalizations for the teaching profession. Therefore, I saw a need for the development of a study by a teacher of voice who could judge the influence of technology on voice lessons.

Purpose

The purpose of this study was to observe and measure the influence of technology during an eight-week series of voice lessons. Differences in attitude and teaching effectiveness were compared when students received differing levels of technology integration. The different technologies available to the voice teacher were then evaluated in order to suggest which technologies were feasible, and to provide research-based strategies for incorporating these technologies into the applied voice studio.

Design

(Note: A detailed report of the research design can be found in chapter 3). Participants in the experiment were selected from volunteer students at the University of Illinois. In the main part of the experiment, eight students received eight voice lessons of 45 minutes each, over a period of eight to ten weeks. The teacher was the same person as the investigator for this research. The use of auto-accompaniment software, spectral analysis of the voice, the Internet (specifically Web pages) as a tool for information gains, and electronic mail for communication were an integral part of the lesson format. The participants were divided into comparison groups that received varying levels of technology integration. Data gleaned from in-depth case studies were compared to determine feasibility and influence of the technology. A brief outline of the lesson procedure is listed below, and detailed lesson plans occur in chapter 3.

The first lesson highlighted the McClosky Technique for Vocal Relaxation (McClosky, 1978; McClosky & McClosky, 1975) and was supplemented by Web-based material developed for a previous experiment (i.e., Repp, 1997). Using the McClosky Techniques, the participants began to make therapeutic sounds as a basis for singing.

The second lesson, also supplemented by Web-based instructional materials, highlighted breathing and posture. The participants were also instructed as to proper speaking techniques and the relationship of speech and song. Simple singing exercises continued.

The third lesson was an introduction to spectral analysis and the EGG as a way to visualize voice production. Participants had the opportunity to view the spectral resonance readout produced by their singing (as measured by spectral analysis software) and the waveforms produced by their vocal folds (as measured by the EGG).

The fourth lesson began with the use of the SmartMusic (Coda Music Technology, 1999) software to aid in the voice lesson. The feature of the software that measures intonation was explored as an aid to pitch matching. The internal mechanism for warm-ups was used to perform simple singing exercises.

The fifth lesson continued exercises performed in previous weeks and served as an introduction to learning a song with the aid of the SmartMusic technology. The sixth lesson was a continuation of the process of learning the song begun in the fifth lesson. Each student learned one song, which was performed at an end-of-semester concert.

The seventh lesson was a follow-up session for the third lesson on tone production, and again highlighted the use of the EGG and the spectral analysis software. Students observed any changes that had occurred over the previous four weeks. Concepts such as singer’s formant and glottal closure were discussed in more detail within this lesson.

The eighth lesson was both a review of all the previous lessons and a preparation for the final concert. Half of the participants switched from the software accompaniment to a human accompanist at this point. The concert took place within two weeks of the final lesson, allowing all the students to complete the eight-week course of study. The concert was open to the public and was videotaped for future reference.

Research Question

To what extent did the use of varying levels of technology influence both the teacher's ability to provide a viable voice lesson and the participants' attitudes toward the process, and which combination of technologies was the most effective and feasible?

Sub-questions

1. How did students and teacher adapt to the use of auto-accompaniment software and its peripheral components

    a.) in rehearsal and

    b.) in performance situations,

    and did the transition from auto-accompaniment software to a human accompanist influence

    c.) student preparedness or

    d.) student attitudes?

2. Did the combination of World Wide Web pages and electronic mail as information sources

    a.) facilitate the day-to-day needs of the lesson structure?

    b.) Are such pages useful within lessons themselves, or simply as a tool for outside reference?

    c.) Were students exposed to on-line materials within the lesson more positively disposed toward technology?

3. Did spectral analysis and the EGG support voice lessons?

    a.) Were measurements of acoustical phenomena useful pedagogically?

b.) Did the process influence student attitudes?

c.) Was the time spent on such measurements worthwhile as compared to instruction that is more traditional?

All research questions were addressed by the analysis of weekly logs, observations, and test questions in the form of Likert-type responses.

Limitations

Due to the vast number of technologies available to the teacher, the scope of the project was limited to computer-based technologies readily available in the university setting. The uses of medical technologies that require specialized training and invasive application are not addressed. Technologies such as CAI, aural-skills software, music notation software, music sequencing software, and other music software were not specifically observed or analyzed in the experiment.

Because of the difficulty in judging student improvement, students were not rated or compared for singing proficiency. The technology was evaluated rather than the students themselves.

The intent of the spectral analysis process was to measure pedagogical concerns rather than to make scientific comparisons. Thus, the measurements presented in the graphs throughout are not meant to be as precise as might be expected in a quantitative use of the technology. In addition, some of the figures refer to a "darker line" and a "lighter line." Because a document of this nature is usually published through photocopies, the difference between these lines may not be apparent in the photocopies. The reader is encouraged to download a full-color copy from the Internet. In the color copy, the darker line is blue and the lighter line is yellow. The address is: (http://www-camil.music.uiuc.edu/Projects/tbmi/rrepp/lessons/reppdis.pdf).

Definition of Terms

Auto-accompaniment Software. The term auto-accompaniment software refers to interactive computer programs, which can substitute for the performers who traditionally play together with the soloist. The software used for this experiment was SmartMusic by Coda Music Technology (1999).

Closed Quotient (CQ). The relative amount of time the vocal folds stay closed during the phonatory cycle.

Formant. A band of frequencies in the spectrum of a voice that influences the characteristics of vowel sounds.

Fry tone. A tone produced by phonation of a low, rattling sound in the throat.

Fundamental Frequency (F_0). The amount of spectral weight within the voice at the fundamental frequency, or perceived pitch.

International Phonetic Alphabet (IPA). Pronunciation of phonated tones is reported using IPA symbols using brackets "[]". For example, the "u" sound in the word "music" would be reported as [u]. IPA symbols can be found in many sources including Wall, Caldwell, Gavilanes, and Allen (1990).

Internet. For the purposes of this study, the terms Internet-based, on line, Web, and similar terms refer to hypertext documents presented via the World Wide Web.

Jitter. Frequency perturbation within the voice.

McClosky Technique. For the purposes of this study, the phrases McClosky Technique for Vocal Relaxation, the McClosky Technique, or similar phrases refer to the six steps of relaxation taken from McClosky's 1987 writing (see appendix D).

Musical notes. Notes of the musical scale are notated with middle C reported as C4. Notes within the octave above middle C are notated with the note name and the numeral 4. Other notes are notated with numbers above or below 4 with a relationship of one octave for each unit. For example, the lowest line on the bass clef would be reported as G2.

Phonation. Any human activity producing sound with the vocal folds.

Shimmer. Amplitude perturbation within the voice.

Singer's ring (or singer's formant). An area of the sound spectrum around 3000 Hz produced by trained singers.

Spectral analysis. A mechanical process in which the various frequencies within the human voice are analyzed and presented through a graphical image on a computer screen.

Spectral weight. The relative amount of energy produced at a given frequency.

Organization

Chapter 1 contains information on the nature of the problem that I have chosen to investigate, what caused me to find this problem worthy of investigation, and why it is of importance to the profession. Chapter 2 contains a review of research literature relevant to the problem, and chapter 3 contains information relevant to the methodology of the project. Chapter 4 is a statement of the results of the study, while chapter 5 contains conclusions gleaned from the results stated in chapter 4. Appendix A contains permission letters and consent forms, and appendix B contains a report on the results from the 1998 pilot test for this study. Appendix C contains data collection instruments, including printouts of the Web-based forms and weekly journal questions. Appendix D contains printouts of the Web pages used throughout the study.

CHAPTER 2

RELATED LITERATURE

This chapter contains reviews of significant research literature that has relevance to the study. I begin with a historical framework of technology in voice and music education. Reviews of research that has specific influence on the present study are then categorized and summarized. The final section of the chapter is a summary of the items presented and a development of the rationale for the study as based on the literature reviewed.

Sundberg (1990) asks a question that is pertinent to the present study, "What's so special about singers?" (p. 107). He notes that singing is often avoided as a subject for research because the special nature of voice production makes general conclusions about applications of scientific research problematic. He answers his own rhetorical question by noting differences in the use of the singing voice compared to normal speech. In singing, breathing is more controlled, with greater subglottal pressure (the pressure of the air below the larynx). The singer must also have more control of phonation at the larynx, with less pressed phonation than in speech. Pitch and loudness are independent in singing. The trained singer also exhibits a peak in the sound spectrum known as the singer's formant, and singers can manipulate their sounds to produce more volume at important frequencies. The goal in singing is to make these parameters independent so that the performer can have maximum variation in voice nuance with a minimum of effort. Sundberg concludes that singers are indeed viable subjects for voice research.

Historical Framework

Voice research has a long historical background from which to gather information. In addition to the material presented in chapter 1, the following studies, which contain a rigorous scientific methodology, form a basis of the development of research in voice technology within the twentieth century. These trends will undoubtedly continue into the twenty-first century.

In his history of laryngeal investigation, Moore (1937) provides an early view of the scientific study of the voice (cf. Cooper, 1989, 1991). Early laryngeal investigation was more important to speech pathologists than singing teachers, but the techniques are applicable to both. Moore reviews the development of apparatus and summarizes the results from early experimentation. Development of the laryngoscope began in 1807 with Buzzoni, but the first "real success" (p. 267) was by the singing teacher Manuel Garcia, who used a dental mirror to view the larynxes of his students. Moore reviews improvements such as magnification, binocular viewing, photography, motion pictures, and stroboscopy. These early mechanical aids set a historical precedent for modern uses of technology in vocal pedagogy.

In his report on the evolution of the discipline, Von Leden (1990) provides a first-hand account of voice science in the middle part of the 20th century. According to Von Leden, before World War II little interest in scientific voice care existed. The medical community was more interested in surgical procedures than scientific investigation, while speech pathologists were more concerned with problems such as stuttering and articulation. The influx of scientists to America from Europe during and after the war included voice scientists such as Fröschels, Weiss, and Moses. Von Leden stresses the new interdisciplinary approach that occurred by the 1957 first International Voice Conference at Northwestern University.

In 1971, the Voice Foundation initiated its annual Symposium on the Care of the Professional Voice, which promoted an interdisciplinary approach to the study of voice care. The organization inspired many publications, including the Journal of Voice (Sataloff, 1997).

In 1994, Cleveland (1994a) concluded that the preceding 25 years had been the most productive period for the study of the singing voice. A survey of prominent voice scientists, voice teachers, and medical doctors helped to determine a consensus of the most significant findings concerning the singing voice and the most important advances in the research. Topics discussed include the singer's formant, vibrato, formant tracking, registers, subglottal pressure, singing synthesis, and voice classification as they relate to commercial singers, amateur singers, and classical singers. He found that technological developments that were specifically manufactured for voice research (such as real-time spectral analysis, stroboscopy, and inverse filtering) have enhanced the proficiency of the voice professional.

Cleveland also identified the most important contributors to the field. William Vennard was identified in the area of singing teacher research. Wilbur James Gould and Robert T. Sataloff created productive learning environments. Sundberg and Ingo Titze presented scientific contributions. In addition, Minoru Hirano contributed important medical contributions. The most significant development was an integration of divided groups of professionals into a common interest, with growing acceptance from teachers of voice.

Brewer (1989) constructed a descriptive matrix, which shows the interrelation of the unsolved problems, academic disciplines, and research tools pertinent to the profession. Of the 59 unsolved problems enumerated, the areas most pertinent to the present study are: voice training standards, the role of biofeedback, techniques of song preparation, and scientists' study of voice. Information exchange among physicians, singers, scientists, and teachers is cited as being important. Ease of transition stage to classroom was also highlighted.

Brewer identifies 36 disciplines that should work together in the study of voice. The disciplines most pertinent are acoustics, computer science, performing arts, and vocal pedagogy. He then factors in the research tools for voice science, including computers, software, artificial intelligence, electroglottography, speech synthesis, and information networks. (The Internet was not viable at the time of Brewer's writing, but the WWW would fit into this final category). The matrix Brewer produced is an organized way to chart the interrelationships among the various disciplines and technologies available.

Gould and Korovin (1994) comment upon the advances in voice research as reflected by the increase in the number of voice conferences and voice laboratories. Specific laboratory research includes advances in analyses of respiratory systems, laryngeal function, and visual analysis (stroboscopy). Acoustic analysis includes spectography and the use of modern recording techniques such as Digital Audio Tape (DAT). Applications of the computer, aerodynamic function, glottography, ultrasound, electromyography, supraglottal (x-rays and MRI to explore areas above the glottis), auditory function, and a combination of techniques allow for a quantitative analysis of the voice.

One of the most influential texts on the science and art of clinical care was edited by Sataloff (1997). This encyclopedic work contains articles by many contributors, who write on subjects such as history, basic science, clinical assessment, and medical applications of voice science. Although not specifically limited to technology, the work contains much insight on the use of mechanisms to study the voice.

The design, development, implementation, and evaluation of electronic technology to aid in the analysis and teaching of voice is of importance to voice professionals. Otto (1984, 1991) has prepared checklists of research articles containing descriptions of the use of mechanical and electronic research tools for the study of voice. Although the material presented is worthwhile, much of the instrumentation cited is out of the scope of this study.

The studies cited above provide proof that the use of technology has a long history and that it is of importance to the voice community. (Studies that are more specific will be presented later in this chapter.) However, the trend of many of the research studies is scientific in nature, and as voice teachers, we need to expand the scope of our literature review to provide models for learning.

Music Education

In addition to the research by voice professionals, important information from music education researchers forms a basis of the philosophical and methodological development of the present study. The music education literature has the advantage of the experience of practicing teachers rather than simply the viewpoints of scientists.

Higgins (1991) presents an overview of the research in music education technology, beginning with a discussion of the nature of technology as an art (Greek techne) of discourse (logos), or as a communication tool. A historical overview of the use of technology begins with Skinner's ideas of programmed instruction and then moves to early technologies examined at the Music Educators National Conference (MENC) 1965 conference on educational media. Early technologies included teaching machines, audio recordings, slides, filmstrips, and motion pictures. The shortcomings of television and video as instructional media are then examined.

The use of computers in music education has become notable since the late 1950s. One of the early efforts was the Programmed Logic for Automatic Teaching Operations (PLATO) at the University of Illinois at Urbana-Champaign. Also important was the establishment of the precursor of the Association for Technology in Music Instruction (ATMI), which began in 1975. Additionally, the advent of the microcomputer changed the field, and pioneers such as David Williams and his Temporal Acuity Products guided the profession toward what is available today.

Higgins also identified other technologies applied to music, including the oscilloscope, EEG, and Continuous Response Digital Interface (CRDI). Emergent technologies cited include sound synthesis, MIDI, and pitch extraction. Within his discussion of interactive media such as hypertext, CD-ROM, and laser disk, Higgins might have included the possibilities for on-line instruction if he had been more of a prophet.

Higgins also reviews research studies in the field, dividing the research into several categories including music fundamentals and ear training, music theory, instrumental music, conducting, creativity, testing, research modeling, and artificial intelligence. In his conclusions, he notes the lack of good research in the area due to poor research design, lack of treatment time, lack of expertise of experimenters, poor quality of treatment, and lack of internal validity of experiments.

Reasons for the poor research methodology include the rapid change in technology, the delay of acceptance in the classroom, and a traditionally narrow view of instruction. Reluctance to extend the research by applying new technology to old problems and the lack of qualified researchers also play a part. (Research in the area is often done by doctoral students with little experience.) He suggests future research follow the action research paradigm.

Unfortunately, although the technologies have evolved, Higgins conclusions on the state of research in the area remain consistent to the present. His suggestions and warnings have been taken into account in the design of this study.

Berz and Bowman (1994, 1995) also present a historical framework for research in music education. They propose that research has moved in a four-part cycle of research and development, adaptation for education, feasibility studies, and effectiveness studies. Emphasis in the field of music technology has been in the developmental phase. They break the history of music technology into four periods. Developmental (to 1965) had little research into pedagogical material. Mainframe (1965-1978) featured an emphasis on CAI and an influence of the PLATO system. Microcomputer/Traditional CAI (1978-1989) had CAI being developed and tested on personal computers such as the Apple II (1978) and the Macintosh (1984). Emerging Technologies has lasted from 1989 to the present. Three technologies the authors find particularly influential in the Emerging Technologies period are Hypermedia (including the WWW), Artificial Intelligence (which would contain auto-accompaniment software—an important feature of this study), and virtual reality.

Berz and Bowman also point out the debate over the validity of research studies that compare traditional teaching and computerized instruction. They suggest claims by these researchers could be due to a novelty effect or media advocacy as a bias for the investigators:

> To balance the present technocentric orientation, research should also address the broad issues of using technology in learning. Development and feasibility studies are needed, but researchers should also be encouraged to give more attention to ways of integrating technology into teaching/learning environments that result in optimal learning by each individual. . . . At this juncture, greater consideration should be given to the broad musical, educational, and technological contexts in which technology-based instruction is to be implemented, and more attention should be directed toward development of appropriate instructional models and practical teaching strategies. (p. 22)

The authors' call for consideration of these areas was considered in the design of my research method.

Music educators with an interest in technology have worked to adapt technology to the National Standards for Arts Education (Blakeslee, 1994) as developed by the Music Educators National Conference (MENC). Rudolph (1996) devised 143 teaching strategies to aid instructors using technology for music application. The fundamental Teaching Strategy #1 is, "Use technology to implement the National Standards as defined by MENC. Technology can be used to enhance all of the nine music standards" (p. 6). Teaching Strategy #2 is, "Establish the goals of the music curriculum. Then ask how technology can best serve the desired outcomes" (p. 9). Other sections of the 1996 book pertinent to this study are the chapters on "Intelligent Hardware and Software" (p. 141) and "Going On-line" (p. 233).

Rudolph, Richmond, Mash, and Williams (1997) suggest specific strategies for adaptation of technology to the National Standards. Most relevant to the present study is Content Standard #1, "Singing, alone and with others, a varied repertoire of music" (Blakeslee, 1994, p. 26). Student-centered activities suggested to comply with this particular standard include mechanisms to improve pitch and rhythm accuracy, using software to isolate parts for rehearsal settings, and searching the Internet for MIDI files.

Teacher strategies include using MIDI as an aid to accompanists and conductors. The authors also suggest using the Internet, specifically electronic mail, listserves, and chat rooms. Several of these suggestions were adapted into the present lesson plans.

Williams and Webster (1996) produced a compendium of applications of technology to music. Central to the philosophy behind the book is the Systems Perspective (cf. Reese & Davis, 1998), in which the people who use the computers and the tasks they perform are considered more important than the software and hardware used. Although not specifically tailored to singers, many sections of the book are apropos to the present study, including a section concerning acoustics and a section concerning on-line resources.

Geringer and Madsen (1987) called for an investigation of transfer between music research and the applied music setting. Questions discussed included benefits of systematic inquiry to the profession, the usefulness of theoretical models, and inadequate dissemination of research. Essays from students (n=100) who had taken research courses were compared to essays of students without the experience. Those with a research class were found better able to devise research projects relevant to applied music. The researchers found that methods of applied instruction are one of the least investigated aspects of musical instruction. Within the present study, research from both the applied literature and the music education literature join to form a basis for both scientific and pedagogical inquiry.

Examples of Technology Use

Having summarized the historical foundations upon which this project is based, I will now provide a review of literature that has applications that are more specific. Specific subjects discussed begin with the Internet and its influence on teachers. A discussion follows concerning the use of auto-accompaniment software and the interaction of man and machine in music making. Systems of voice measurement—including electroglottography (EGG) and spectral analysis—and the use of computer-based visualization in teaching music are discussed in the last part of the section.

Internet

Present-day educational researchers investigate the potential of the World Wide Web and other on-line sources as a platform for distance education. Fonder (1992) found that the use of distance learning for the presentation of music material to geographically isolated groups is not new, as music lessons by mail were a commonplace phenomenon in the past. The musical correspondence school flourished because of the popularity of amateur and semi-professional bands around the turn of the century and the scarcity of available local organized opportunities for study. Accomplished performers agreed that worthwhile material sent through the mail was superior to a poor teacher or no teacher at all, and in distance learning, incompetent classmates did not hinder the student.

Coan (1992) constructed a survey to determine the feasibility of using a computer network for music education research. The Pepper National Music Network was used as a basis for an on-line survey structured to determine the demographics of the group, the influence of the then-contemporary political and economic factors on the subject population, and the attitudes of the participants toward on-line delivery. Coan made a compelling case for the need of such research, as he was prophetic in his assumption that computer-mediated communication (CMC) would become more widespread, and potential for survey research using CMC was promising.

McCallum (1996) analyzed major issues in interactive technologies and their influence on the arts and arts management. Issues investigated include copyrights, emerging disciplines, performance venues, fundraising, marketing, and audience development. Projects analyzed included ArtsEdge, CyberClipper, and the work of Roger Dannanberg.

The popular media has embraced the possibilities for on-line instruction, and many sources for Web-based courses in music are beginning to appear, but the research community in music is yet to study adequately the potential of the trend. Therefore, I turn to other sources to provide information about on-line teaching.

Teachers and the Internet. Since the available literature on the Internet's influence on music teachers is so limited, literature on how general education teachers use the Internet provides useful information. Dupagne and Krendl (1992) compiled a review of literature pertaining to teachers' attitudes toward computers. Most of the literature is gleaned from self-administered surveys, although a few case studies exist. They found that overall, teachers express a positive view toward computers; however, a number of concerns exist including availability and lack of training. In general, attitude correlates highly with experience with computers, and teaching experience seems to have little influence. Studies on gender and computer use are inconclusive and suggest that gender differences may be based on experience with technology. The subject matter also taught correlates with attitude, with the technical subjects correlating more highly with attitude.

Several specific attitude scales were examined in the preparation of the survey questions (see appendix C). Woodrow (1991) compared four computer attitude scales (i.e., Gressard & Loyd, 1986; Griswold, 1983; Reece & Gable, 1982; Stevens, 1982). Ninety-eight preservice teachers were administered the four attitude scales simultaneously to measure reliability, dimensionality, and construct validity. The study divided questions into dimensions of computer anxiety, computer liking, and social and educational influence of computers. The tests differed on their relative weight assigned to each of the three areas in question.

Woodrow suggests short, efficient, and easy to administer questionnaires. To ensure reliability, strong evidence must exist that all of the scales are measuring the same attribute. Woodrow found that attitude is correlated with experience with computers, gender, and age. The study suggests a positive attitude for the subject group, but since the group had chosen to take part in a computer course, these findings cannot be generalized to the population at large. The tests were found highly reliable when compared with each other.

Gardener, Discenza, and Dukes (1993) also compared four measures of computer attitude (i.e., Ericson, 1987; Gressard & Loyd, 1984; Maurer & Simmonson, 1983; Raub, 1982). The researchers found that none of the tests was significantly more reliable than the others. Although none of the test questions from these studies appears verbatim in the present study, I examined the examples in order to present test questions that were similar, but more pertinent, to the present research.

In preparing the teaching materials for the present study, I was cognizant of the information teacher-educators felt that teachers should know about the Internet. George (1995) asks what information about the Internet should be taught to pre-service teachers. George felt that the Internet was coming to schools, but the schools may not have been ready, and undergraduate institutions were in the position to teach their student teachers about the Internet. An examination of the literature was used to determine how technology has been incorporated into the schools and the subsequent training of teachers, and conclusions from the findings indicate that teacher training is inadequate. The study helped to determine what pre-service teachers should be taught, finding discrepancies between what institutions believe their students should know about the Internet and skills of newly hired teachers. George suggests adding curriculum content including Internet literacy and integrating technology into the undergraduate curriculum.

Weber (1996) was also concerned with teacher preparation in an examination of the integration of technology, including the World Wide Web, into secondary teacher-education programs at a Midwestern university. Both qualitative and quantitative analysis of data, using three questionnaires that contained both open-ended and closed-response possibilities, provided statistical analysis to examine barriers toward use of the technology. Barriers included inadequate instruction, inadequate computer systems, and frustration. Weber found differences among learning style, gender, and academic major, but the majority of the participants reported a positive response. Recommendations included improving computer systems, providing training for faculty and staff, establishing classroom studios for hands-on experience, and requiring information regarding learning style and technology proficiency on admissions tests.

Savitt (1996) assessed whether cooperative learning techniques affected anxiety, performance, and attitude when preservice teachers used the Internet. The subject population was divided into a cooperative-learning group, which worked in teams, and an individualized group, while all other instruction was identical. A computer anxiety test given prior to and following instruction helped show that both groups experienced a reduction in anxiety with no significant difference in the scores for anxiety between the groups. However, a correlation existed between both factors of computer experience and anxiety and between factors of an individual's self-rating of anxiety and scores on the test for anxiety. A slight preference for working individually existed among members of both groups, and most participants were interested in continuing to learn about the Internet. He concluded that cooperative learning strategies had no effect on computer anxiety or performance and suggested hands-on experience to reduce computer anxiety.

Russett (1995) designed a study in part to evaluate the influence of Internet access on undergraduate students' attitudes toward educational technologies. The effect on student attitudes when telecommunications were present in a methods class was measured. The researcher compared the attitudes of students in a particular science-methods course with attitudes of the general population of two Midwestern schools' science methods courses. A pre- and posttest model was applied, and results led Russett to suggest that educational technologies must be incorporated into methods and curriculum courses, including practicum and student teaching. Although the students found the computer-mediated communication to be useful, attitudes toward the telecommunications varied with learning style and personal preference.

Wildish (1995) conducted six case studies concerning adults’ attitudes toward self-directed learning on the Internet. Each subject was given an open-ended interview before and after one hour of self-directed Internet exploration. People with serialist learning strategies had difficulty with the hypertext format of the Internet. Those with holistic learning strategies were better equipped to use the technology.

Experiences from these teachers and teacher educators were instrumental in devising models for lesson plans in the present study. Since one goal of this study was to provide strategies for the incorporation of technology into teaching environments, the exploration of the teacher-education research proved beneficial. General education teachers and researchers have studied the Internet enough to provide some guidelines on how to prepare teaching materials.

Auto-accompaniment Software

Another technology highlighted in the present study is auto-accompaniment software, in this case the SmartMusic system (formerly named Vivace) (Coda Music Technology, 1999). Three studies, all of which are centered on instrumental music, exist concerning SmartMusic/Vivace.

Ouren (1997) documented the influence of Vivace on the playing skills, musicality, and attitude of eight middle school students. Audiotapes from before and after a six-week interaction with Vivace showed an improvement in rhythm and musicianship as measured by impartial adjucation. The interaction with the software was found to elicit a positive reaction in musical responsiveness, a sense of accomplishment, and a feeling of success in preparation and performance.

Tseng (1996) investigated qualitatively the interaction of 10 college flute students with the Vivace system. Specific areas of concern were past experiences of performing and computers, the effect of Vivace on practice, and the reaction to Vivace as a teaching tool. Qualitative methods included observation, audio and video taping, and interviews. Case studies showed interest in using the software to teach musical understanding and composition, the importance of the role of the instructor, and the potential for the use of the software for beginners and adults. Participants agreed that the software aided in music learning, performance preparation, intonation, and stage presence, although some technical problems were encountered.

Sheldon, Reese, and Grashel (1998) investigated differences in performance quality among three groups of instrumental music education undergraduates, who received no accompaniment, live accompaniment, or digital accompaniment with SmartMusic. The participants prepared a solo piece for six weeks and then recorded their solo. Adjucation of the performances found no significant differences among the groups.

Although no studies on the use of intelligent auto-accompaniment for the voice exist, Wu (1997) explored the influence of karaoke, a technology with some common characteristics. He described the popular use of pre-recorded accompaniments in Taiwan and other Chinese cultures. The transformation of passive listeners into active participants in music allows for a musically creative role for leisure activity. Karaoke brings together modern technologies with the ancient Chinese philosophy of active participation in music. Other research published on the phenomenon of karaoke includes Mitsui and Hosakawa (1998) and Inoue and Hashimoto (1993).

Human/Computer interaction. The use of computers as an accompaniment device raises questions about the appropriateness of interaction between humans and machines in a musical setting. Borio (1993) reflected upon the appearance of electronic music in the 1950s and the need for a paradigm shift in the evaluations of the role of the new technologies. Some theorists felt the technology represented a dehumanization of music, while others anticipated the creative possibilities of the new media. Concepts included the relationship of the art object to its production technique, and a discussion of whether the artist is hindered in expression by the new technology. These debates helped to legitimize the use of electronic timbres in the music of the time.

Volume 22 of the Journal Interface is dedicated to the interaction between man and machine in live performance. In the editor’s introduction to the issue, Tarabella (1993) discusses the difference between the physiological activation of muscle reflexes to produce sound and the creativity that defines what is truly musical. Schloss and Jaffe (1993) continue the discussion by asking the rhetorical question of whether technology will be the demise of the performer. The authors warn against an excess of technology. They explore issues raised by interactive technologies by using various electronic sound sources in the preparation and performance of an improvisational piece. They conclude that such an interaction is viable if the performers take the time to become proficient in the technology.

Some researchers have investigated acceptability of electronic sound sources and classical music. Wapnick and Rosenquist (1991) investigated whether musicians would evaluate sequenced piano music differently than they would evaluate commercially available performances. Forty music majors rated examples of piano pieces performed by the two media. Sound quality of the sequenced examples was found superior to the professional excerpts, possibly due to poor recordings. No significant differences existed for ratings of technical merit, artistic merit, or overall impression.

Price (1995) attempts to answer the question of whether the increased familiarity with electronic timbres in modern music leads to a preference for the artificial timbres, and whether a preference is significantly different between musicians and non-musicians. Price compared the reactions of 69 undergraduate non-musicians with 34 persons holding at least a bachelor's degree in music. Treatment included a comparison of sampled acoustic timbres with sequences of synthesized sounds. The participants completed a survey instrument requesting demographic information, opinions on each of the six excerpts, and an identification of the performance instrument. Data from the study do not support the contention that non-musicians react more favorably to synthesized timbres, but the data may have been affected by the quality of the sound samples. Although the performances were identical, the ratings of both groups were more positive for the sampled timbre. The musicians had more negative reactions to the synthesized timbres than non-musicians, but tended to rate everything lower.

This research suggests that listeners prefer the quality of sequenced timbres over vinyl recordings, and that use of the electronic devices such as sequencers do not affect the perception of technical merit, artistic merit, or overall impression of the recordings. (No similar research of the kind exists using newer audio recording techniques.) These authors suggest that the use of artificial timbres and electronic methods of instruction deserve attention as a pedagogical vehicle. Although no studies suggest that the use of electronic media is superior to traditional instruction, at least the use of technology has not been proven inferior.

Systems of Voice Measurement

When designing teaching strategies for the use of spectral analysis in voice lessons, the teacher should be aware that a large number of systems of voice measurement exist. A comparison of these systems in the medical and speech pathology literature can provide models for the voice teacher. Although most of these systems are out of the scope of the practicing teacher because of prohibitive cost and specialized training necessary, an analysis of their possibilities and techniques is useful in determining pedagogical possibilities (cf. Bless & Baken, 1992; Hertegård & Gauffin, 1995; Large & Rothman, 1980).

Read, Bruder, and Kent (1992) provide an in-depth technical review of seven systems for acoustic analysis of the voice. At least 15 such systems exist presently, and the ability to choose the appropriate system is challenging because teaching applications require ease of use and an acceptable learning curve, while research applications require quantifiable data. Comparative literature aids teachers and investigators in choosing hardware, helps determine reliability and validity of instrumentation, and helps manufacturers in designing the next generation of hardware.

Other considerations discussed include cost, processing speed and memory, availability of peripheral devices, breadth of uses including pedagogical aspects, anticipated needs, compatibility with other systems, documentation, and technical support. The user interface has issues of types of display, efficiency, speed, compatibility of data formats, and ways to journalize data. Measurements discussed included spectral analysis, fundamental frequency (F_0) analysis, jitter, and shimmer. The researchers conclude that these systems deserve consideration, but differ greatly in how measurements are performed.

Titze (1994) called for standardization of acoustical voice analysis in order to educate, simplify, conserve time and effort, and certify results. Possible liabilities for standardization include oversimplification of the process (which limits the scope of research), prematurely adopting ambiguous or erroneous standards, and the problems in enforcing standards. Consensus may be possible in acoustic phenomena such as loudness or pitch, design of standardized test utterances, database formats, calibration techniques, and nomenclature.

Novák and Vokrál (1995) worked to establish such parameters of measurement for voice professionals. Because of the importance of healthy function for singers, they established a need to determine objective evaluation of future professionals. Outpatients (N=165) were divided into groups by age, gender, and voice type. Each participant was recorded reading a text, singing a song, and sustaining isolated vowels. Results showed significant differences in voice measurements among the voice classifications.

Radionoff (1996) investigated whether normal voice functions for trained singers differ from published voice norms. Acoustic, phonatory, and respiratory data were collected from 28 voice students and compared. The current norms for 59% of the measures were found to be in error when compared to this subject group. Radionoff concludes that normative data for singers needs to be collected from a large group so that accurate data can exist to aid in clinical study and pedagogical decisions.

Holmberg, Hillman, Percale, Guiod, and Goldman (1995) investigated how voice measurement techniques interrelated. They sought to determine which easily accessible measurements (such as acoustic analysis) could be substituted for measurements that are difficult to obtain. Twenty females with normal voices produced repetitions of the syllable [pæ] (as in the word pat) and the vowel sound [æ]. Intra-oral air pressure (measured by a catheter), sound pressure level, and EGG signals were measured. The study found that acoustical analysis could be substituted for more difficult to obtain data if prescribed formulations are taken into account.

Fritzell (1992) discusses another noninvasive method of voice measurement known as inverse filtering. This method produces a graphical representation known as a flow glottogram, which approximates the sound produced at the vocal folds. Data are taken through a microphone, and the formants present in the voice are filtered out by being fed back into the signal with a inverted phase shift. The technique provides relevant data on sound pressure level, regularity of vocal fold vibration, and closure of the larynx. The technique has not been widely accepted outside of research laboratories because of the need for instrumentation and expertise as well as the lack of a referential database of normative values.

Electroglottography (EGG). One of the first systems for analysis of the voice was known as electroglottography. Electroglottography to determine measurements of glottal closure was developed in the 1940s, and it became feasible in the 1950s. The device has the advantages of providing objective quantitative data that is free from the influence of supraglottal resonance (absorption of the vocal track and resonance from hard, bony structures) at a low cost and without invasive medical procedures. The device functions on the principle that since human tissue is a better conductor of electricity than air is, an electric current applied across the larynx will vary in resistance (impedance) as the vocal folds close. The electroglottogram usually consists of two small electrodes, which are placed on the neck on the sides of the larynx.

The instrument produces an electroglottogram, which measures the closure of the glottis over time. The EGG signal is much simpler than a spectral analysis of the voice and can be used to measure F_0 and perturbation measurements. Analysis of the EGG signal often takes place in a qualitative examination of the signal. Interpretation of the signal must include the knowledge that the EGG does not measure the degree of openness of the glottis, but the time the glottis is open.

Many authors have investigated electroglottographic research and the voice. Basken (1992) reported upon principles of the EGG, validity of its techniques, and recommendations for standardization of research in the area. Baken recommends the use of EGG as part of routine vocal assessment, but warns of validity questions when determining Closed Quotient (CQ) measurements (the relative amount of time the glottis stays closed).

Colton and Conture (1990) warn about the challenges of using the EGG in clinical studies. They begin with a thorough literature review with over 200 references concerning the EGG from its inception in 1940 to its present-day uses. Electronic interference in the EGG signal can arise from sources such as the automatic gain control (which boosts the signal to a usable level but also effects the waveform), the high pass filtering techniques (which help factor out changes in impedance which may occur due to the movement of extra-laryngeal tissues), and electronic noise (which may occur due to radio waves or other electronic interference). Procedural challenges can occur with variations in electrode placement, degree of contact with the skin, and movement during the recording process. Subject concerns include differences in gender and age of subjects as well as differences in speech patterns. Mucus strands or vocal fold vibration may also affect the signal. Many of these challenges occurred in measurement attempts within the present study.

Titze (1990) investigated the interpretation of the EGG signal by dividing the process into two stages. The transduction phase includes factors determined by the placement of the electrodes, such as how the signal is generated, processed, and demodulated. The modeling stage concerns interpretation of the waveforms. Experiments were conducted in a tank filled with electrolytic fluids made to approximate the conductivity of human tissue. Measurements were taken with changes in frequency of current, spacing, angle, size of electrodes, and the presence of a non-conducting gap. The experiments with these models help to explain the function of the EGG without the complexities of the human voice.

Alaska (1987) modeled the EGG signal to investigate potential in measuring vocal fold parameters and to explore its use for detection of pathology. EGG readings were taken under varied conditions. The model was able to simulate EGG readings of vocal fry, nodules, and the presence of mucus. New parameters were proposed for voice measurement and laryngeal pathology.

Spectral analysis. Another system of analysis used in the present study is generically called spectral analysis, but can contain many techniques within that umbrella term. Miller and Schutte (1990a) discuss the role of reinforcement from spectral analysis as applied to the singing voice. The authors query as to why, despite the established fact that formant tuning to enhance the voice has been proven to be effective, spectral analysis has not affected a greater influence on vocal pedagogy.

Miller's and Schutte's study builds on Sundberg’s (1973) work, which developed a method of supplying a non-harmonic sound source to determine the most efficient placement of the formant frequencies of individual singers. Sundberg used a neck-mounted sound-source to produce a continuous spectrum, but the authors felt that this method was not feasible for the voice teacher. Instead, they evaluated the effectiveness of ingressive airflow, fry tones, chromatic sweeping tones, and a wide trill to produce the spectra. Limitations to these methods include the use of techniques that are not natural to the singer and the experience required for interpretation. The use of fry tone is incorporated into the third and seventh lessons of the present study as a method of inducing a non-harmonic sound source to measure theoretical formant placement of the participants (see chapter 3).

Miller and Schutte (1990b) also investigated formant tuning in the singing technique of a professional baritone. They investigated the tuning of the first two formants relative to the fundamental frequency. Measurements from within the singer's vocal tract were measured with a catheter, rather than with a microphone.

Wilson (1982) developed another instrument to condition the singer’s ring, which appears around the fourth formant in the trained voice. (The singer’s ring allows a performer to project over an orchestra and is a component of a mature, professional voice.) The researcher took care not to measure the frequencies produced by a nasal sound, which fall into the same range as the singer’s formant and are often confused with ring by young singers (cf. Bailey, 1993).

Seventeen singers were divided into categories by gender, voice type, and race. (Because the machinery had been developed on Caucasian subjects, Wilson had an interest in determining characteristics for African-American participants.) Participants sang isolated vowel sounds with differing degrees of ring and nasality. The device was able to discriminate from among the different vocalized sounds. The presence of the singer's ring is important in the spectral analysis measurements within the present study.

Miller and Schutte (1983) investigated resonance patterns in a tenor singing the same pitch with different register characteristics. The term register refers to groups of pitches which have similar characteristics due to the intrinsic musculature used to produce the note (Miller, 1986; Randel, 1986)**.** Common examples include the chest register (voce di pettto), the head register (voce di testa) and the falsetto register (similar to a man imitating a woman’s voice). The researchers found a surprising similarity in the frequency balance of the registers.

Ågren and Sundberg (1978) investigated the differences between female altos and male tenors singing in the same range. Two altos and two tenors performed a folk tune in an anechoic chamber, and the results were analyzed through spectral analysis. The female voice was found to be higher in fundamental frequency content and with a greater distance between the third and fourth formants.

In their development of a computer-based biofeedback device, Rossiter and Howard (1996) considered real-time visual reinforcement for voice development of prospective professional voice users. The device contains user-configurable displays, color, the ability to combine parameters, and a user-controlled rate of information update. Measured phenomena included F_0, jitter, shimmer, and CQ. The system inputs data from a microphone and electrolaryngograph, and the data are then translated into user-controlled algorithms. The user can create new parameters, which are mathematical constructions of the original data, and GUI displays. The authors see a need for the study of high-end voice users such as singers, and cited research helps suggest that visual reinforcement strengthens the learning process. Garner and Howard (1997) and Pabon (1994) also investigated real-time voice display.

At the time of this publication, Nair (1999, in press) was in the process of publishing a book and accompanying CD-ROM containing strategies for the incorporation of spectral analysis technology into the voice studio. Anticipated chapters include information on acoustics, feedback in the voice studio, the spectrogram, and the EGG. The work seems promising, but was not included in the design of the present study because of the late publication date relative to this study.

Several studies exist on spectral analysis in other musical disciplines outside of the voice. Rees (1991) found that despite the increased attention on computer-aided learning, instrumental pedagogy had received little treatment because of limitations of computers, limitations of sound-processing technology, and limited software available to music teachers. Innovations such as MIDI had improved this situation in the previous five years before the study, but the development of effective sound-recognition systems was still beyond the reach of the educator. He suggested a system that would entail a careful examination and reduction of music through pitch extraction and sound spectrum analysis.

Pitch extraction techniques are notable because both spectral analysis software and auto-accompaniment systems must extract pitches from the dense sound produced by a human voice. Since their development in the 1960s, pitch extractors have improved significantly, but little research has taken place in pitch recognition for aural perception.

Rees explored pitch extraction for violin pedagogy, and discussed how the computer gathers and processes sound. The study was designed to determine the relationships among musical information processed by a computer-based sound analysis system and audiovisual records of a performer's response to specified musical assignments. The violin and the trumpet were studied on a series of musical tasks common to the performance of their particular instruments.

For each task, an audio-visual record was generated and the sound samples were processed into computer data. The audio and visual records were then compared against repetitions of individual players, against similar tasks with one variable changed, against the same task performed by different subjects, and against prior comparisons. Analysis of the audio, video, and graphical representation of the sound data revealed information on the relationships among the data recorded through each medium. Analysis of the sound spectra of tasks was more accurate than the human ear could recognize. Each player has distinct differences in sound spectra, and changes in playing technique produced similar changes in sound spectra.

The computer-based analysis of the sound spectrum produced information that can identify performance behavior. If this study were properly replicated, a database of performance attributes could be collected and used for pedagogical purposes. The potential for such a tool is still evolving.

Britt (1997) examined the effectiveness of visual reinforcement in trombone performance. Visual representation of amplitude, pitch, attack, release, and tone quality, combined with auditory reinforcement were included as factors in the study of 20 trombonists. The participants were divided into a control group and an experimental group that had access to the visual stimulus. The participants were asked to match a performance of a recorded professional model. All subjects showed an improvement. The author calls for this type of research to be repeated with vocalists.

Examination of the literature provided models of many systems of voice analysis. The various systems of voice analysis were examined, and the EGG and spectral analysis processes were incorporated into the lessons of the participants in the present study.

Other Uses of Technology

Many educators have developed technology that does not fall into the above categories, but was still instrumental in the design of the present study. One of the exercises in the present study involves pitch detection and tuning using the SmartMusic tuner. Welch, Howard, and Rush (1989) used real-time computer display to develop a computer-based system of providing reinforcement for pitch detection. A class of 7-year-old children (n=32) was divided into three groups. A control group received traditional instruction, an experimental group received the treatment of the software, and an interactive-experimental group received the treatment along with adult interaction. The two experimental groups recorded a significant improvement in pitch-matching ability as measured by electronic monitoring.

Rosenthal (1996) used a commercially available pitch-recognition software (Claire, 1996) in a case study of six high-school students and six music education majors. Areas of concern included pitch focus and pitch accuracy. Reinforcement in the form of voice comments, visual cues, and a computer-based voice profile were discussed, and reaction from the participants was consistently positive.

Each participant received an orientation to the software and then completed a minimum six (high school group) or 12 (college) 15-minute sessions with the software. Data were taken through a written file, which included a log of the student activity, and an electronic profile built into the software. Rosenthal reported that the technological requirements and the process of establishing a file for an individual were acceptable, and the intonation profile provided by the software could provide quantitative measures of long-term progress. Recommendations for success in using the software include supplementing instruction in vocal production, spending time with the subjects during the first session, being aware of computer crashes, maintaining a portfolio of printouts, and allowing the students to work in groups.

With the aid of technology-assisted visual and aural reinforcement in a choral setting, Simpson (1996) investigated the teaching of pitch accuracy. Subjects (n=69) were divided into three groups: a control group that received instruction from a teacher, a group that received the treatment, and a group that used technology within a teacher-guided setting. Statistical analysis showed no statistical difference among the three groups, leading the researcher to conclude that students who receive technology-based instruction in pitch accuracy perform equally as accurately as those receiving traditional instruction. (If the researcher had included another subject group that received no instruction at all in pitch accuracy, other relationships might have been more apparent.)

During the sixth week of lessons in the present study, students explored articulation and pronunciation with the aid of technology. A limited number of studies in the speech pathology literature served as examples of this process. An exhaustive review of the use of technology for speech pathology is out of the scope of this project; however, since the McClosky Technique for Vocal Relaxation began as a therapeutic method, speech pathology does have some bearing on the present research.

Michi, Yamashita, Imai, Suzuki, and Yoshida (1993) used visual reinforcement in the treatment of defective [s] sounds in six patients. Real-time assessment of the phonation was performed by one of the researchers and checked for reliability by the second researcher through recordings. Improvement was found in the experimental group that received the visual reinforcement.

Morawej (1997) developed a Web-based multimedia software kit called Fonetix, which incorporated interactive audio and video sources in teaching articulation. The software was designed to supplement the expertise of a speech pathologist and to allow patients to communicate with voice professionals over the Internet. Dechance (1994) developed an interactive HyperCard stack called Phoneticism 1.2 French Module to teach elements of diction.

Technology has also been used successfully to impart knowledge on voice-related issues. Teter (1995) investigated the effectiveness of the presentation of opera through the technological areas of video and audio. He set out to find ways of improving the knowledge base, attitudes toward opera, and commitment to attending live performances.

The study was centered on a chronological treatment of the history of opera. One group viewed presentations of opera in video or laser disk format, complete with subtitles. The other group listened to audio performances and read printed versions of the translations of the text. The groups were given pre- and posttests designed to measure attitude and knowledge. In addition, both groups were asked to write an essay to measure their ability to verbalize their understandings. Simpson found that both the audio and video formats were effective methods of instruction, as both groups reached similar cognitive gains. Surprisingly, the group that listened to the recordings showed a higher attitude increase than the group watching the videos. However, cognitive gains for the video group exceeded those of the audio group, and the video group stated that they were more likely to attend future performances.

Ester (1992) compared computer-assisted instruction to traditional lecture for vocal anatomy taught to undergraduate music students with differing learning styles. Taking into account grade point average and learning style (as measured on the Gregorc scale), Ester divided students from undergraduate choral ensembles into experimental and control groups. He found a significant interaction between learning style and preferred instructional approach. Abstract learners performed better with the traditional lecture, while concrete learners performed equally well with traditional and computer-assisted instruction.

Ester (1994) also developed a HyperCard stack called Hyper Vocal Anatomy to teach laryngeal anatomy to undergraduate music majors. He cited the growing interest in voice science and the importance of understanding vocal anatomy in the study of voice. Contents of the stack were focused on names, locations, and functions of vocal anatomy, and users were given the choice of sequential or random order of presentation. Examination of the program took place with a written assessment and a Likert-type scale reaction to the program, and formative evaluation and field testing mechanisms took place before the implementation of the study. The subject group showed a significant gain in knowledge as compared to a lecture group, and the program was an effective tool for teaching anatomy.

Freeman, Syder, and Nicolson (1996) designed a multimedia tutorial for students of voice therapy. The tutorial linked a transcript window to a digitized video recording of a diagnostic interview with a voice-disorder patient. The software contained guidance, assessment tasks, and commentary. Users were able to rewind, fast forward, and skip to different parts of the interview as needed—traditional video would make this process tiresome at best.

The authors state that in clinical training, few speech therapists have extensive experience working with voice disorders. Multimedia presented an opportunity for the student to view an interaction with a therapist and client and to highlight the clinical decisions. Students collected data on abusive behaviors of the patient, and students were able to develop skills in a controlled environment. An analysis of the development of the program has been incorporated into the teaching of nursing and medicine, including further courses and workshops. Cost and time management were found to be consistent with preparation of traditional materials, but the authors stress that such a tutorial is not considered a substitute for face-to-face contact with clients.

Schneider, Schwartz, and Fast (1993) devised a computerized, telephone-based stress management program which was presented to the public via an "800" telephone number. The treatment was similar to the Internet-based material in that it was available to a large number of people 24 hours a day and essentially free of charge.

The program also included elements of interactivity: Callers could interact with the system through touch-tone responses. The recordings were worded in an effective manner for a large number of callers, and could be individualized for any particular caller. The authors found that the treatment was most effective when the messages were personalized to the individual caller. When the messages contained homework assignments, the callers were more likely to call back. Effective treatment was judged by the attitudes toward the treatment and the likelihood that the participants would use the suggestions for relaxation. Data were taken by a self-reported survey.

Use of microphones is prevalent in many of this project's technologies, including both spectral analysis and auto-accompaniment. The effect of microphones in classical music has also been an important topic of research for musicians interested in technology (e.g., Coleman, 1988; Fuchs, 1965; Price & Sataloff, 1988; Titze & Wihholz, 1993).

Many researchers have devised ways of using technology as an aid to the teaching process. In addition to the knowledge gleaned from reading the research above, my personal research has also added to the design of the study.

Preparatory Research

The present research has grown out of four previous studies. In 1995, I completed an investigation of the various voice-research sources available on the Internet. In addition to Internet exploration, I used a series of interviews to determine voice users' attitudes toward Internet resources. I found considerable interest about technology, but also discrepancies. The influence of technology is felt in college music departments across the nation, but voice departments are often unwilling to embrace the technology. The information about how vocalists use the Internet resources has been incorporated into the present study.

In 1996, I designed a quasi-experimental study n the influence of WWW pages dealing with Technology-Based Music Instruction (TBMI). The focus of the project was the dissemination of information for pre-service music educators wishing to increase knowledge of TBMI. The format of the report was WWW documents made available publicly. From the positive reaction in both the direct observation of the participants and the questionnaires, I concluded that the project was successful in its stated purpose of presenting information to music education students. The knowledge I gained from the design of the Web pages helped in the design of the teaching materials used in the present research.

In 1997, I completed a report of the extent which the attitudes of pre-service music teachers were affected by an Internet-based presentation of the McClosky Technique for Vocal Relaxation. Specific areas of concern were the attitudes of the subject group toward the McClosky Technique and educational technology, and how teaching experience, experience with technology, and vocal training correlate with each of these areas. An evaluation of the presentation as an acceptable representation of the McClosky Technique and a discussion of how Web pages could be designed to improve attitudes were also included. The experiment contained both quantitative and open-ended techniques in a descriptive paradigm.

The participant group was chosen from an undergraduate course in choral methods for instrumental majors. The participants were exposed to the McClosky Technique through a series of WWW pages which included demonstrative video clips, text, and graphics. The participants completed an on-line questionnaire concerning the effectiveness of the technique.

Quantitative analysis led to the conclusion that the pages had affected a small increase (.18 on a seven- point scale) ($N=28$, $p=.057$) in the mean scores measuring attitudes toward educational technology. Correlation among predetermined factors through a Spearman Rho technique did not yield expected results ($\alpha \leq .05$, $N=28$). Attitude toward technology had a moderate correlation with response to non-technical areas of the experiment.

The respondent group felt that computers were important to music education, but some doubts existed as to whether the computer could teach something as intimate as the McClosky Technique. The Web pages and testing measures designed in the 1997 study serve as the first set of data collection instruments for the present study.

Repp, Reese, Meltzer, and Burrack (1999) (cf. Burrack, Meltzer, Reese, and Repp, 1998) studied the effect of a set of WWW pages. We found that exposure to the Web pages produced a positive effect on the attitudes, knowledge gain, and people-centered mindset of the participants, who were practicing music educators. Again, Web materials and data collection methods have been incorporated in the present study.

In the fall of 1998, I pilot tested the present study. Results from the pilot test are published separately (Repp, 1999a), and reproduced in appendix B.

Summary

Having presented a historical basis for this research and examples that have bearing on the present study, I will now summarize the studies and show how they influenced the direction of my investigation. I will develop a rationale by drawing upon the philosophical, psychological, scientific, and pedagogical issues raised in the literature.

I began this chapter with a brief summary of the historical use of instrumentation and the voice. Although many of the technologies we use today are new, the process of using instrumentation as an aid to scientific study and pedagogy has been documented for years. Although the instruments such as the laryngoscope will not be available for this study, a review of the development of voice instrumentation has been helpful in developing the philosophical basis of the experiment. As the technology has improved, the breadth of application to the singing voice has brought about growing acceptance by voice teachers.

Some of the philosophical arguments were more fully presented in chapter 1, where I was able to draw upon the general literature rather than the research-based literature summarized in this chapter. The history showed a dichotomy of thought in the profession between those with a belief in the scientific study of voice and those with a more traditional approach gleaned from centuries of tradition. The question was proposed as to whether the intimate nature of the voice as a part of the human body would be a hindrance to the incorporation of outside apparatus. The use of technology is a modern addition to a pedagogical process that has existed for centuries. Although a thorough discussion of the history of voice pedagogy is out of the scope of this paper, the traditions were considered as part of the philosophical basis of the project.

Much of the philosophical basis of the paper has been drawn from the music education literature, where philosophical, psychological, and pedagogical issues are more clearly defined than in the limited research in applied music. Music education has been more open to innovation in the realm of technology, and the research base reflects that acceptance. A historical framework was established. The present-day uses of technology can better be understood through an examination of the growth in the use of technology from its early behaviorist principles, through a more constructivist phase, to today's multifaceted, often utilitarian uses. The research in music education is assumed appropriate to the applied music setting.

Careful attention has been paid to the problems associated with computer research in music as noted by Higgins (1991) and Berz and Bowman (1994, 1995). This study is more than simply a development of a series of lessons on the computer. Broad issues concerning the learning environment, individual differences, and instructional models were considered in the design. Because of the concerns raised about experimental studies that were so limited in scope that they proved to have no practical significance, this study was designed with a broader, more descriptive mindset.

Although a detailed discussion of learning theory, educational psychology, and their application to technology is not included in this paper, issues concerning the history of pedagogical theory were considered in the development of the project. The philosophical basis for this project was influenced by those educators who have chosen to use the MENC National Standards as a basis for their pedagogy (e.g., Rudolph, 1996; Rudolph, Richmond, Mash, and Williams, 1997). The National Standards are assumed to be an effective basis for a broad-based approach to the teaching of music and the most important trend in the profession today. Additional philosophical and pedagogical influence has been modeled on Williams and Webster (1996), particularly the "systems approach," which places the person using the computer as the most important part of the system. The systems approach was modified and clarified by Reese and Davis (1998).

This project is an examination of the influence of the integration of technology into the applied lesson, and three areas of technology are studied in depth. The Internet, specifically the Web, is assumed to have a meaningful educational influence that will continue to grow. Although the Internet is a relatively new phenomenon, other aspects of distance learning have been taking place for years in correspondence schools, on television, and among other technologies. Special attention has been paid to the Internet’s influence on teachers’ attitudes. In general, the research shows teachers’ attitudes toward technology to be positive, with reservations about its implementation.

Perhaps the most intriguing potential use of technology in the applied voice setting is intelligent accompaniment software. Several studies have shown that the most widely used of this type of software, SmartMusic (formerly Vivace), has had a positive influence on the learning of instrumentalists. No studies yet exist on the use of auto-accompaniment software for the voice, but because of the necessity of an accompanist in the voice studio, the potential is meaningful.

Many writers have stated an aversion to the use of computers in the presentation of classical music. Some worry that the use of technology will dehumanize the music or lead to a nonmusical result, as in the popular karaoke phenomena. However, in the realm of performance of new music, the practice of a performance with a tape of electronic music has become commonplace. Some recent studies suggest that the use of electronic timbres do not necessarily affect the reception of the music.

Many systems of voice analysis have been developed in the medical field. Unfortunately, these systems have limited application to the voice studio because of cost, availability, and need for expertise in research and interpretation. Pedagogical applications have not been standardized because most studies have either concerned patients with damaged voices or concerned norms taken from the general population, rather than the "vocal athletes" who are singers. Several systems of voice analysis were examined, but two were discussed in depth because of their potential in the voice studio. This potential is enhanced by reasonable cost, availability, and learning curve.

The EGG has a long history of use in the study of voice. Because the procedure is noninvasive, no special medical training is necessary—as would be the case with the laryngoscope. The waveform produced by the EGG is relatively simple to interpret, so that the voice teacher need not rely on databases of norms that do not apply to the singer. The equipment is not expensive when compared to many of the voice analysis systems available.

Spectral analysis is another method of voice research that is approachable to the average teacher. To use the technique, a teacher needs only readily available hardware such as a microphone and a computer. Software for spectrographic analysis can be obtained at minimal cost, with some applications available as freeware (Simonson, 1999). Pedagogical applications include using the display of the spectrogram to make the singer aware of the voice's natural resonance, which can be exploited to produce a more refined tone. Researchers have determined that by shaping the articulators to affect the formants, the singer can tune the voice to produce a more efficient sound.

Many researchers have used computer displays to provide visual stimuli to enhance the learning process. These applications vary from the more traditional uses of multimedia for teaching knowledge-based material to systems that provide real-time reinforcement for the mastery of techniques such as pitch detection. Many studies have suggested that computer-based instruction is as effective in teaching basic skills as traditional instruction is; other studies suggest that a combination of technology and hands-on teaching is appropriate. These applications served as a model in the development of this research.

A system that relied solely on the computer as the teacher was taken out of consideration for this project; instead, the technology is used a tool to aid the instructor. If technology is to become an integral part of the applied voice setting, it must be integrated into the existing framework of vocal pedagogy.

The present study has grown directly from the four studies I undertook between 1995 and 1998. In 1995, I determined the presence of an interest of voice professionals for technological information. Together with Reese, Burrack, and Meltzer, I experimented with presenting material to music educators via the Internet in 1996 and 1998. In 1997, I presented a voice relaxation technique on the Internet and determined reactions to the technique and the presentation. The present study is a direct outgrowth of what I have developed in these explorations.

In this chapter, I have reflected on the available scientific research that reflects on the problem. I presented a historical overview of the use of technology in voice research and music education, supplied examples of studies that have influenced my reasoning, and provided a discussion on the philosophy, psychology, and pedagogies that have influenced me.

CHAPTER 3

METHODOLOGY

This investigation falls in the descriptive research paradigm, featuring a case-study approach to the collection of data. Data collection measures, including student journals, teacher observations, and student questionnaires, will be discussed in detail later in this chapter. The methodology was influenced by literature that suggests broad issues of learning be investigated within the context of teaching models (Berz & Bowman, 1995). Higgins (1991) cited other problems with research in technology such as lack of treatment time and a reluctance to apply technology to traditional methods. Higgins also suggests an action research paradigm for future research. These considerations have been addressed in the design of this study, which occurs in the naturalistic setting of voice lessons.

Participants

An invitation to participate in free voice lessons was posted on flyers on various campus locations and posted on relevant Internet newsgroups. Those interested in the lessons replied by telephone or e-mail, and they were put into a pool of potential participants. Once a pool of people willing to take voice lessons was established, I gave each prospective participant an e-mail questionnaire to determine their voice type, voice experience, level of comfort with technology, and willingness to participate in the experiment (see appendix C). I attempted to find participants with a broad range of experiences, because a heterogeneous group was preferable to determine broad trends within the results. From the initial interviews, I chose eight students to receive voice lessons augmented by technology. The participants had enough of a level of familiarity with technology to use the Web and electronic mail for personal journals. Since the study took place over most of a college semester, and college students are generally pressed for time, I asked that the prospective participants communicate a willingness to take part in a long-term study.

Because the participants were volunteers, the study may not be generalizable to the general population because of well-established norms of volunteer groups (Gall, Borg, & Gall, 1996). Volunteers were deemed acceptable to the experiment because of the real-world similarity between those who are participants in the study and those who actually take voice lessons. (The study of applied voice is rarely a requirement, even in music schools.) The use of unmotivated subjects, coupled with the Institutional Review Board's requirement that all subjects be able to withdraw at any time, would have produced undue pressure on the small size of the sample group. The use of volunteers reflects real-world experiences because some intrinsic motivation is assumed a part of successful voice training. I minimized the possible source of volunteer bias from the sample by choosing a broad-based group with varying degrees of technology experience and voice experience.

All members of the participant group received instruction from the same teacher. (I was both the teacher and the experimenter.) Care was taken to observe whether changes in measurable phenomena were due to the presence of technology or by the influence of the instructor. Quantitative data also served as a check for experimenter bias.

The process did not include the most advanced students as subjects. Because voice majors at the University all take lessons with a voice professor and the University does not allow students to participate in additional lessons with another instructor, access to voice majors was not possible. Teaching students concurrently with another instructor would also affect the data since the students would be receiving instruction that could affect the data; therefore, the participants were chosen from the remaining population.

Procedures for use of human subjects were cleared through the University Institutional Review Board. All participants were made aware of their rights. Rights included, but were not limited to, the anonymity of results, the ability to drop out of the research at any time, and the right to receive the results of the experiment (see appendix A).

Internal Sub-groups

In order to provide comparisons among the participants, the groups were exposed to differing levels of technology. Half of the students received voice analysis through spectral measures, and the other half received lessons that are more traditional. Those students who did not have voice analysis worked with a human piano player at the last lesson and performed with the piano player at the concert. The other students performed with the aid of the SmartMusic software (Coda Music Technology, 1999). Of special importance was comparing the challenges of transferring to the human accompanist after practicing with the software and the challenges of using the software in a performance situation.

Half of the students received voice lessons with World Wide Web pages used to clarify concepts and skills and to provide graphical representation of the material under study. The other half received the same lessons without the use of the computer assistance. The students who did not receive the activities with the Web pages still had access to the pages outside of class time. This selection of participants overlapped the division between those using the voice analysis software, so that the groups were divided as follows: Group A had voice analysis software, Web pages, and software accompaniment. Group B had voice analysis software, no Web pages, and software accompaniment. Group C had no voice analysis, Web pages, and human accompaniment. Group D had no voice analysis, no Web pages, and human accompaniment (see Table 3.1). Each group contained one person of each gender. Participants are identified by pseudonym throughout to protect anonymity.

Table 3.1

Breakdown of Participant Group

Group	A (n=2)	B (n=2)	C (n=2)	D (n=2)
Treatment				
Voice analysis	yes	yes	no	no
Web page	yes	no	yes	no
Accompaniment	software	software	human	human
Gender				
Male	Mark	Jack	Kevin	Tony
Female	Brenda	Jane	Tina	Linda

Setting

The experiment took place in two studios at the University. One studio was equipped with an electronic keyboard and a computer that has the SmartMusic auto-accompaniment system installed. The other studio had both a computer with sound analysis software installed and an Electroglottograph (EGG) (a device to measure the opening and closing of the glottal folds) available. For the appropriate groups, two of the eight lessons took place in the studio with the analysis equipment. In addition, participants had access to the University's music computer labs, where they were able to access the Web and use electronic mail, and the students had the opportunity to use the SmartMusic system independently.

Instructional Materials

A series of lessons were produced. Each of these lessons was supplemented with at least one of the technologies highlighted in this study: the Internet, SmartMusic, or the EGG/spectral analysis. Appropriate lesson materials remained on line so that the student might refer to these later.

Lesson Plans

I now describe the eight lessons used, the final concert, and alternate lesson plans for control groups.

Lesson 1

The first lesson began with introductions. I started by giving the student a brief overview of what the series of lessons would entail, including a description of the technologies to be used and the weeks I planned to use them. I also gave a brief explanation of the concert at the end of the semester, with an emphasis on the fact that the concert would be informal. I explained what would be expected from the participant, including a description of journalizing procedures through e-mail and Web forms.

I then familiarized myself with the student by having her summarize the questions that were asked in the initial questionnaire to which they had responded by e-mail. I took the opportunity to glean information that may not have been apparent from the e-mail text, and I began to evaluate the participant's speaking voice so that I could guide future lessons. I confirmed the fact that the student was willing to spend the required amount of time needed for the research, and I gave the student the opportunity to ask questions.

I then gave the student the presurvey (see appendix C) in paper form. I asked if she would be comfortable filling out a form like the printout on the Web. If the student reported being uncomfortable with a Web form, I gave her a brief primer on the use of Web forms.

The informational part of the lessons began at this point, with Web pages used (for the appropriate groups) to illuminate points and provide graphical support to the lesson (see appendix D). The first week's lesson concerned the McClosky Technique for Vocal Relaxation (McClosky, 1978). As each area of relaxation was achieved, a different Web page with supporting materials was accessed. After the material was presented, I had the student recall the six areas of relaxation (see appendix D) from memory and work through the steps so that I could be sure she had understood and could remember the exercises.

After the initial exposure to the technique, I began each student vocalizing. Since the needs of each student varied at this point, having Web pages to support this portion of the lesson would have been counterproductive. Students began by making high, light, falling glissando sounds to initiate a healthy onset of the voice (McClosky, 1978). We worked through the McClosky areas of relaxation while making this most basic of sounds. Then the consonant [m] was added to the sound [hamamamam] to work on relaxation while the articulators were functioning. Finally, different vowel modifications such as [mimemamomu] were used to determine if the use of vowels added tension to the voice. In each of these exercises, the six steps of relaxation from the McClosky Technique were used as testing points.

At the end of the lesson, I made for the improvement of the student's speaking voice. Suggestions were individualized, but usually included tips on raising the speaking pitch, adding support, and avoiding of vocal fry. I gave the student the opportunity to ask questions, and prepared her for the next lesson on breathing.

Lesson 2

The second week's lesson began with a discussion of the questions asked through the e-mail questionnaire during the intervening week. I commented on the student's responses so that he would know that I valued his opinions and to expand and clarify points discussed. I made sure to let him know that the suggestions made in the past had been put into effect for this week's lesson. For example, in the pilot test, some participants had noted that the text was too small to read in the first week's lesson, so I made the text larger the second week, with fewer words. Next, we reviewed the McClosky Technique. I asked the students to go through the technique while speaking aloud and to show me how they had practiced.

In the main informational portion of the lesson, we began a topic on posture and breathing. I made the student aware that the most important element of singing is breathing, and good breathing comes from correct postural alignment. Web pages were used to highlight the areas of postural stability upon which I wished the student to concentrate: The feet should be shoulder-width apart, with a firm foundation. The student should feel that he could move easily in any direction. Knees should be slightly bent, and the muscles of the thigh needed to be developed to keep the knees bent. Hips should be rotated forward to straighten out the lower back. I tested the student against a corner of a door or a wall to determine if he could keep the lower back straight. If this area proved problematic, as with people who stand with a curved spine, I introduced other exercises to straighten the back.

A good deal of emphasis centered on proper placement of the rib cage. I had the student stand with his back against a wall with his knees bent and hands above the head. When the student brought the arms down, the ribs should have remained in an expanded condition. The head should have been level, with eyes forward. After I had finished introducing postural elements, I had the student recall the elements of posture that had been presented.

In the next part of the lesson, I introduced breathing, again with the support of the Web pages (see appendix D). The first exercise had the student learn to take a breath "diaphragmatically." I explained the differences among breathing "clavicularly" (with the chest), with the intercostal muscles (ribs), and the diaphragm. The exercise consisted of exhaling all of the air from the body and then releasing the muscles to allow the air to come in naturally, without "trying" to take a breath.

Once proper inhalation had been established, the student worked on exhalation by taking a relaxed breath and then slowly exhaling while producing the [s] sound. I encouraged the student to feel their ribs so that the rib cage did not collapse. I emphasized keeping the McClosky areas relaxed so that the student learned to do the work with the abdominal muscles. I also timed each student and made him aware that this exercise would be used as a test to determine progress throughout the semester.

Once proper breathing had been established, I warmed up the student’s voice by reviewing the techniques for producing healthy phonation starting with a light sigh, and then adding layers of complexity. In order to establish a healthy onset and release of the sound, I introduced two exercises. The first began with a long [h] sound that became a sung tone slowly, without a glottal stroke. Once the student could produce a healthy onset, an exercise to work on releases was introduced: five short tones followed by a descending five-tone scale (sol fa mi re do) were used (Miller, 1986).

I then established the beginnings of a legato voice by introducing the concept of a siren on the five-note scale. I encouraged the student to use the siren to remove any glottal stroke between changing tones. At this point in the lesson, some students were out of time. If I had remaining time, I worked on exercises that seemed beneficial to the individual student.

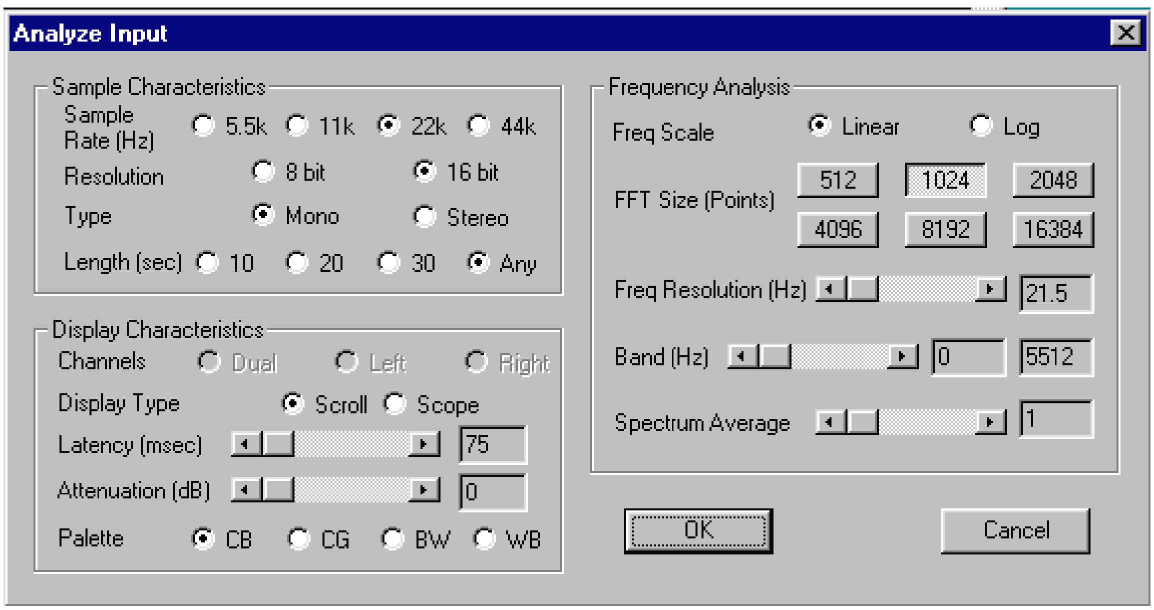
Lesson 3

I began the third lesson with a review of the e-mail responses and a discussion of the Web survey from the previous week (see appendix C). If the student told me she had not performed the McClosky Technique the day of the lesson, I took the time to reinforce the habit. I then asked the student to review the postural and breathing exercises from the previous week. I introduced new breathing exercises, such as an exercise which consisted of breathing in for four counts, holding the lungs open for four counts, and exhaling for four counts (Miller, 1986). The count then increased until the student seemed uncomfortable. We then reviewed the onset and legato exercises from the week before. Additional exercises were introduced at this point as indicated by the responses of the student. Because of both the large variety of exercises employed and the differences in individual singers, a summary of the exercises here would not be possible.

The third lesson was an introduction to the use of spectral analysis in the voice. However, since some of the students did not receive spectral analysis, the lesson sequence was adjusted for this group. During the third lesson, the comparison group received extra instruction in breathing, posture, and phonation. Extra vocalization exercises were employed as needed by the individual. These students did not begin to work on repertoire any earlier than the other group. Thus, the comparison during the final concert would be valid because all groups would have worked with the repertoire for the same amount of time. This group was introduced to the tuner function and warm-up function of the SmartMusic software, as described in the fourth lesson plan.

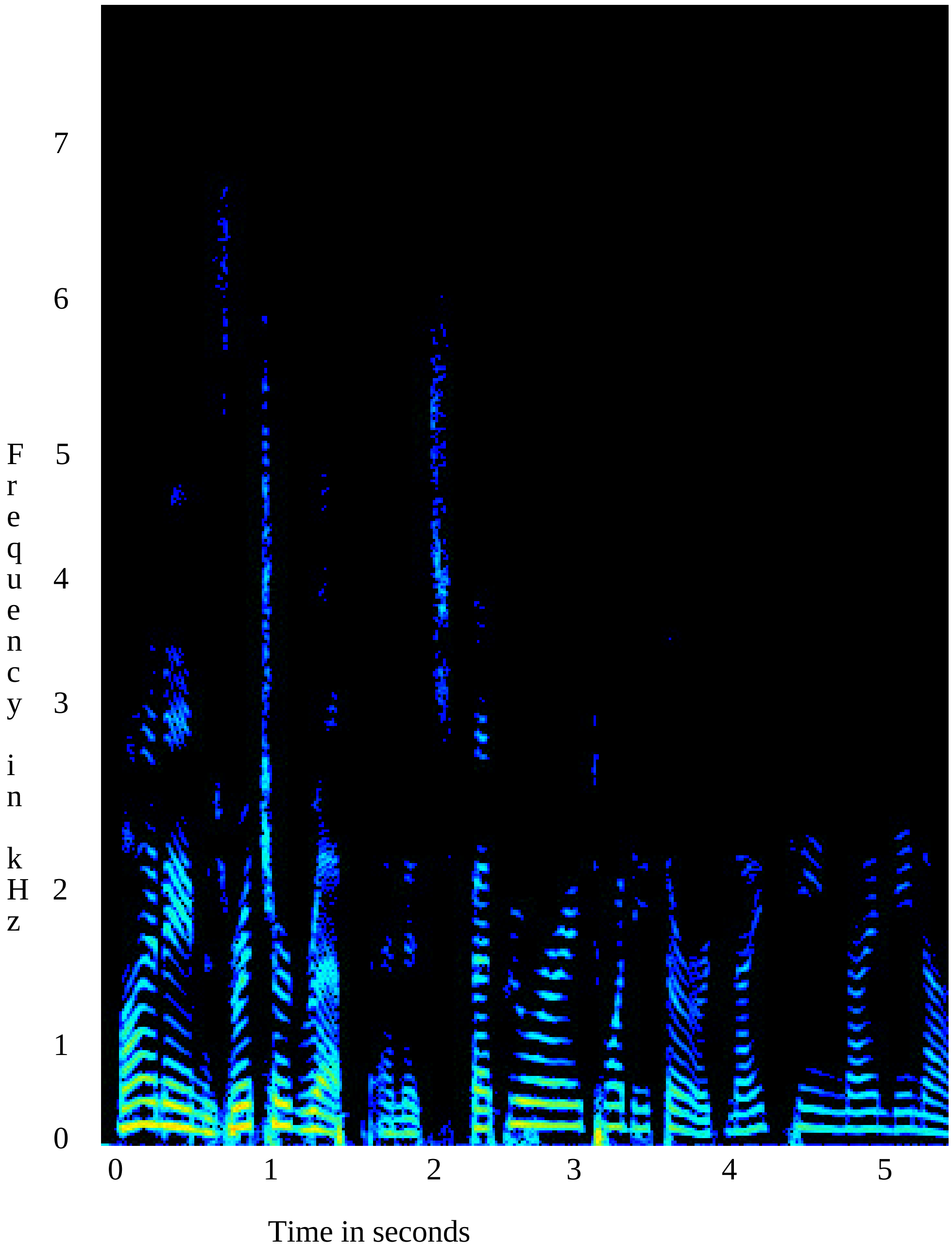
For the spectral analysis group, I begin with the voice measurements once the student's voice was thoroughly warmed up. The first part of the voice measurement was through spectral analysis. The software Spectrogram 4.2 (Shorne, 1999) was calibrated as shown in Figure 3.1.

Figure 3.1. Calibration of Spectrogram 4.2 software.



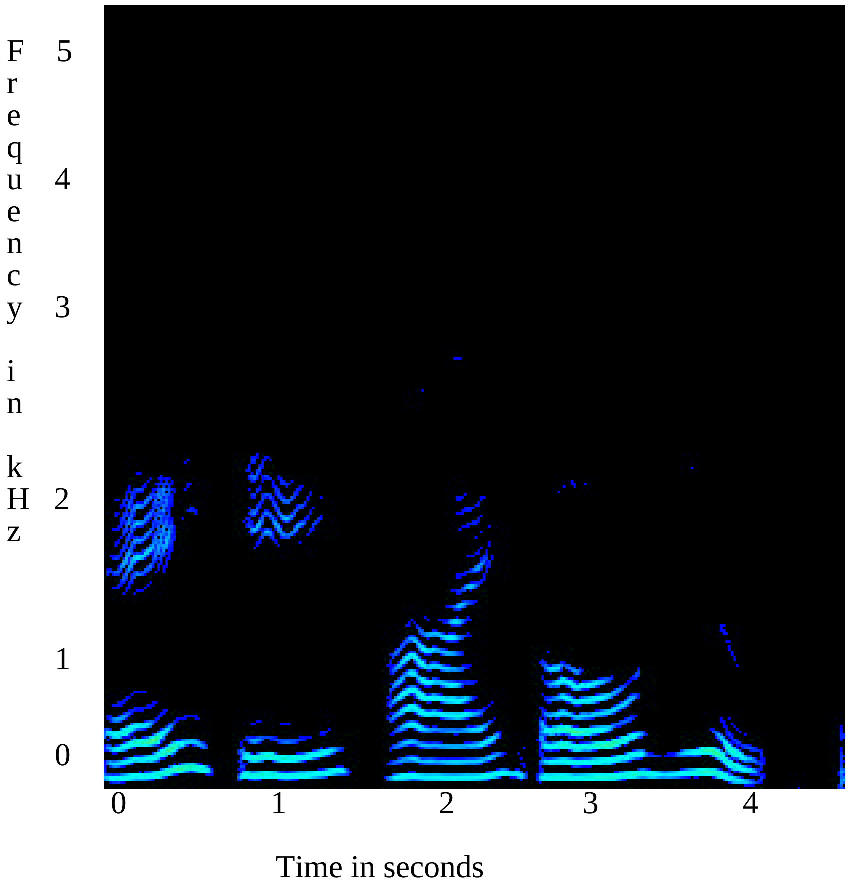
In order to have the student become acclimated to the system, I showed her the computer screen and had her sing into the microphone. I explained that the graph of the voice contained three dimensions (see Figure 3.2). On the horizontal axis was time, which was easily seen. The vertical axis was frequency. I then explained to the student that her voice was not made up of one frequency, but a series of frequencies, as shown by the horizontal lines on the graph. The third dimension was the color of the lines, measuring amplitude, or the relative weights of each part of the sound spectrum. I introduced the concept of formants (attenuation and absorption of resonance peaks) and showed the student the different formants for different vowels.

Figure 3.2. Spectrogram of spoken "My name is . . . and today's date is . . ."



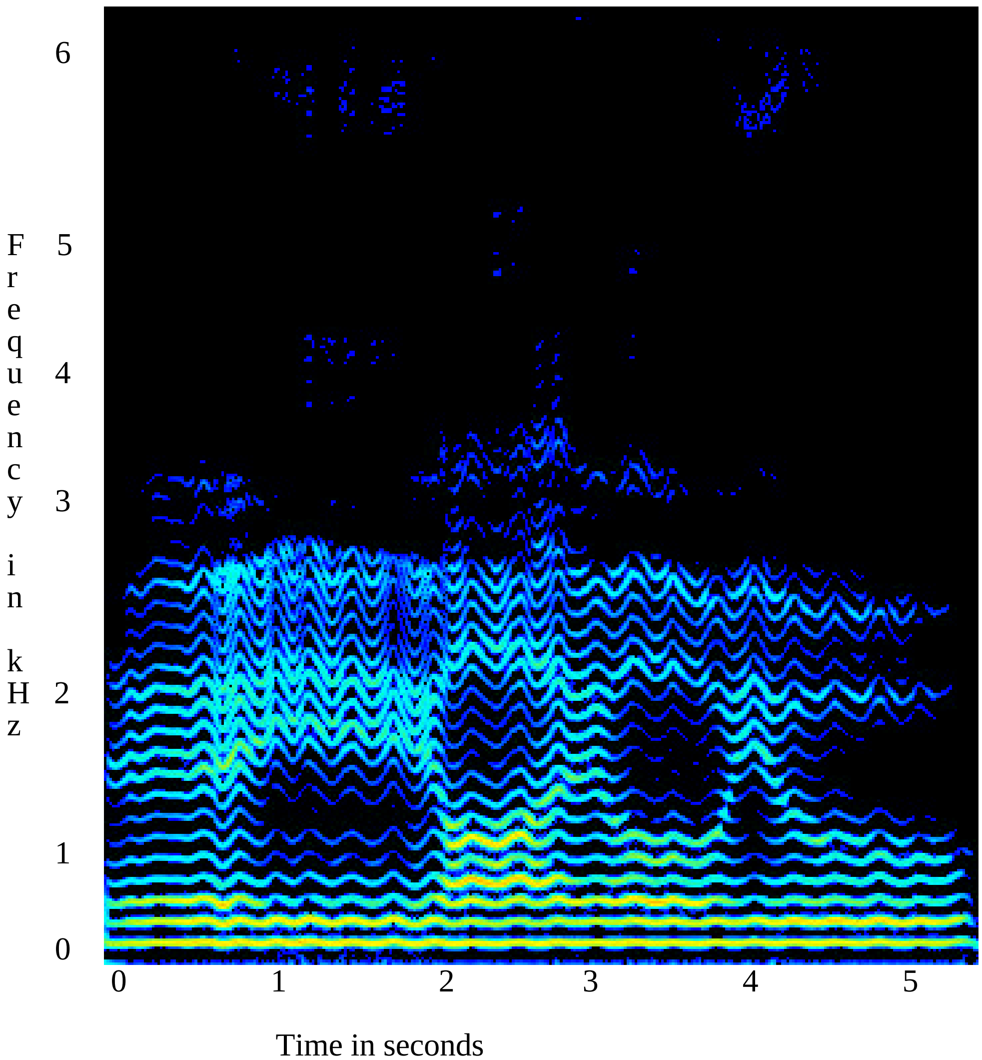
At this point, we began to take measurements. I had the student speak the phrases "My name is . . . and today's date is . . ." into the microphone (see Figure 3.2). The phrases were recorded and then played back with the accompanying graphical reinforcement. Any comments by the student or instructor were noted. The student then went through the same process speaking the vowels [e i a o u] (see Figure 3.3).

Figure 3.3. Spectrogram of spoken vowels [e i a o u].



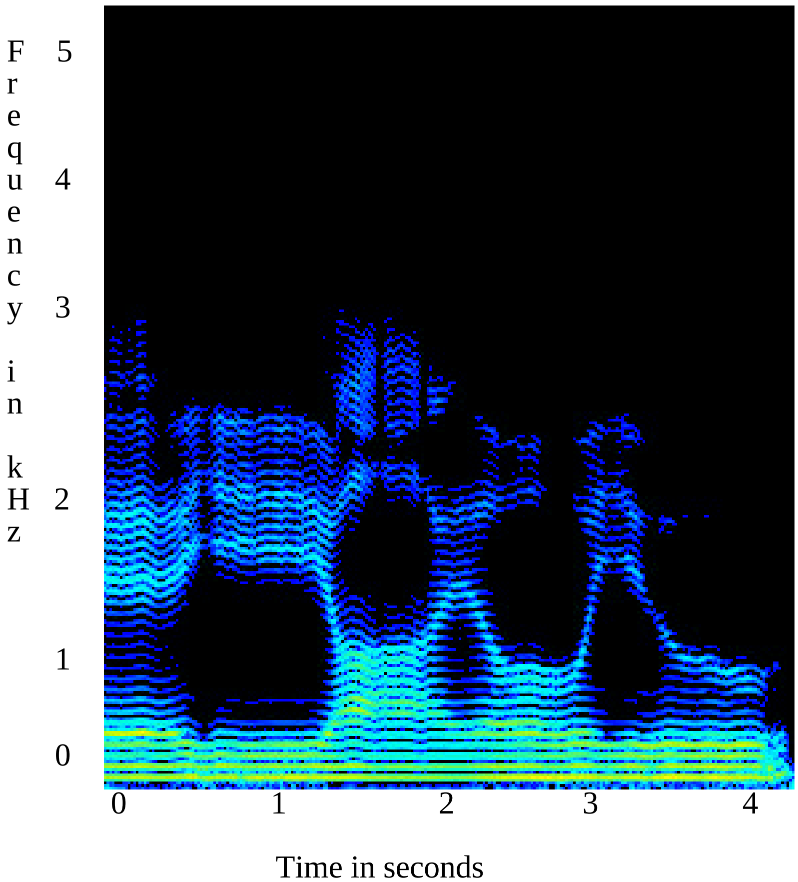
After the student was made aware of the readout from his speaking voice and he had heard the files being played back through the computer, we then discovered together the spectral readings from his singing voice. We began by singing the vowels [e i a o u] in the middle of the student's range. Since I was attempting to compare the readout of several students, I had the male students sing on the pitch F3 and the female students sing the pitch F4. Figure 3.4 is a reading from a trained male singer.

Figure 3.4. Spectrogram of singing [e i a o u] in the middle range.



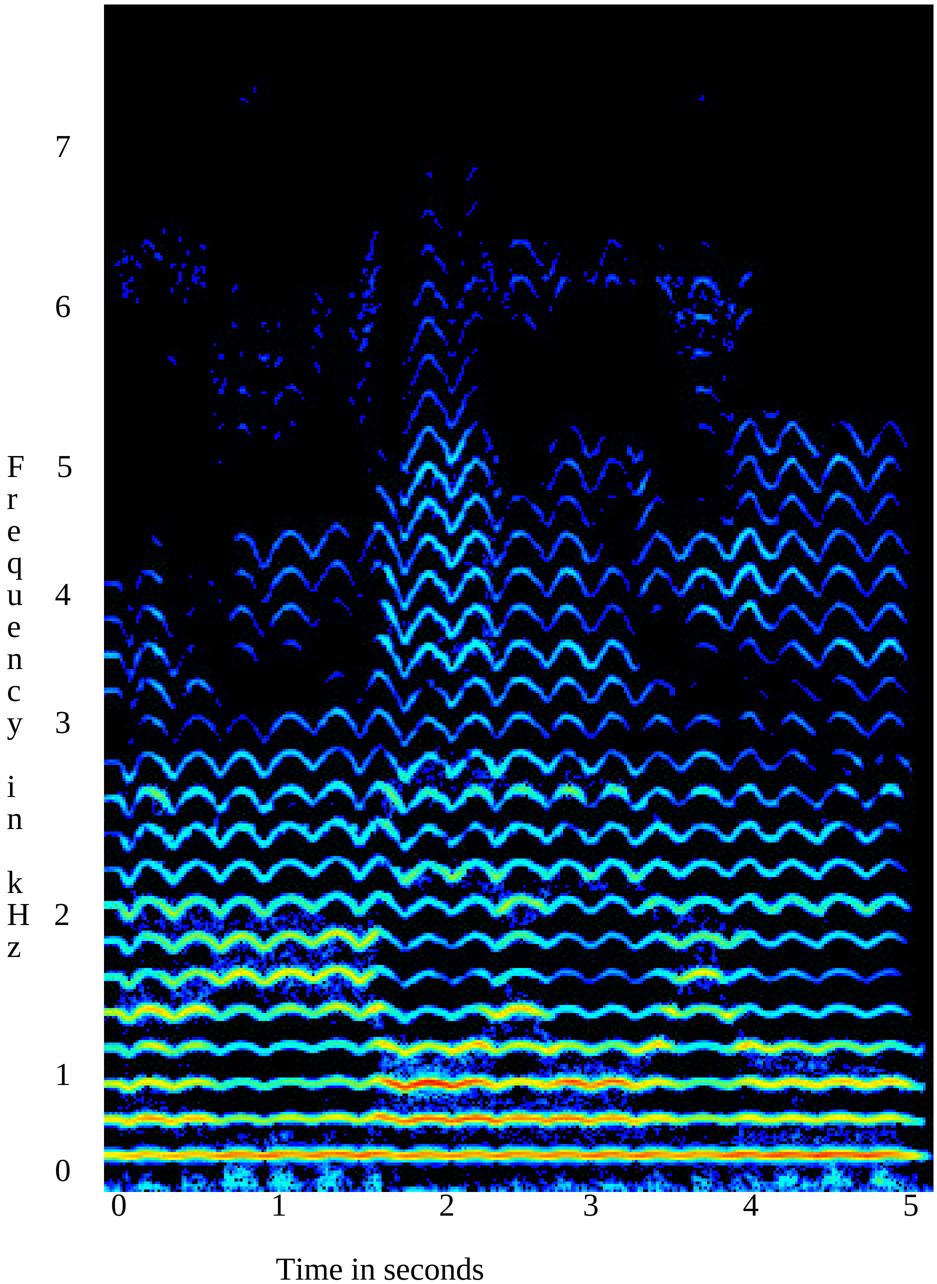
We then discussed the student’s readings, explored factors such as the singer's formant, and investigated how this area appeared in the readout. Then we repeated the procedure on the pitch F2 for men and F3 for women. Since not all students could sing these pitches comfortably, the pitches were adjusted upwards as necessary to find a low note in the student's comfortable range. Figure 3.5 shows the spectrogram from a trained male singer.

Figure 3.5. Spectrogram of singing [e i a o u] in the low range.



The process was repeated on an F4 for men and an F5 for women. Again, if these pitches were not comfortable for the student, then a lower pitch was substituted. The student was shown how at this lower range, the distance between the lines on the screen was greater because the lines represented integer multiples of the fundamental pitch. Most students found that readout from their higher range was not as strong as readout from their lower range. Figure 3.6 is readout from a trained male singer.

Figure 3.6. Spectrogram of singing [e i a o u] in the high range.

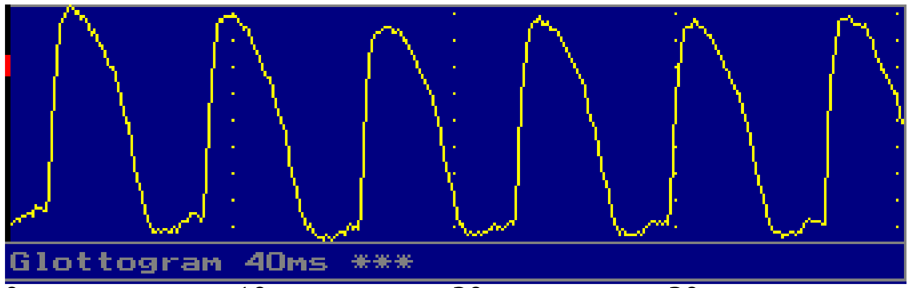


As this point, the student was introduced to the EGG analysis. I allowed the student to become acquainted with the software and showed him an ideal reading taken from Miller and Schutte (1990a). Two electrodes were placed on either side of the larynx and a very slight current passed through the larynx. As the vocal folds opened and closed, the electric current varied through the neck, and the differences were displayed on the computer screen in a periodic wave (see Figure 3.7).

Figure 3.7. EGG reading. (Miller, Schutte, & Doing, 1996)

Open

Closed



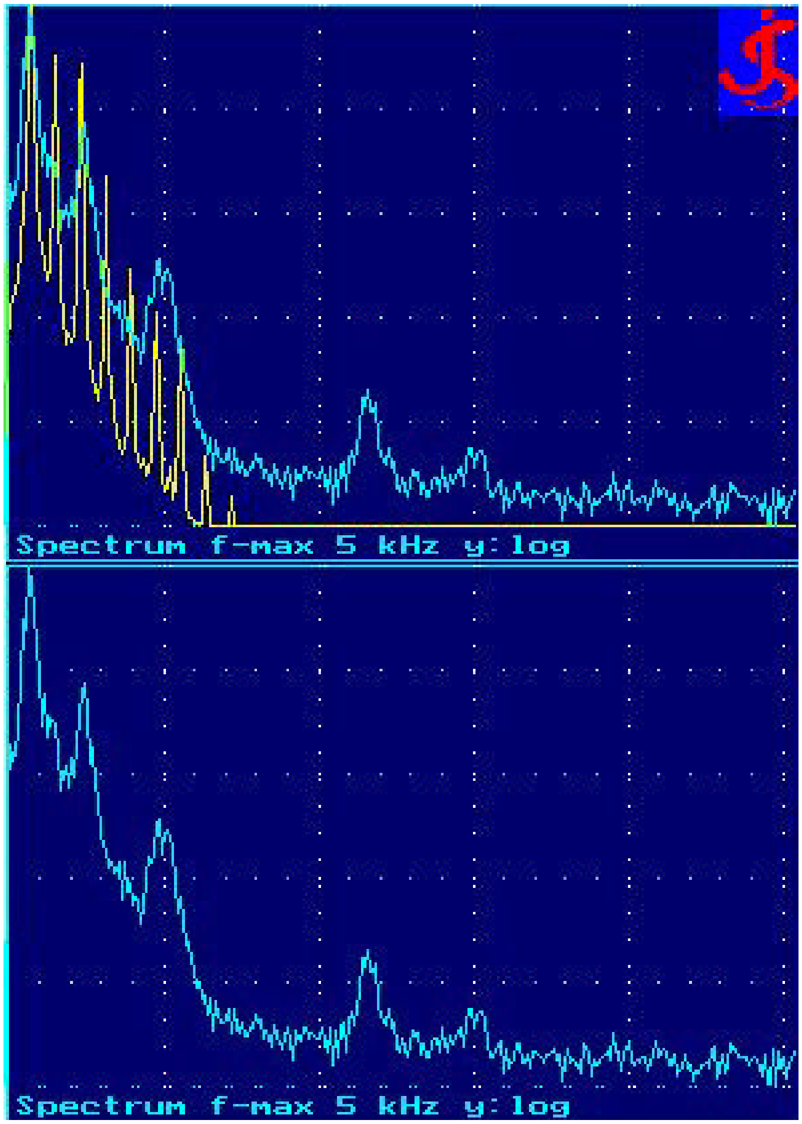
0 10 20 30 40

Time in milliseconds

Additionally, a different type of spectral analysis was taken. This analysis was a snapshot in time, with frequency on the horizontal axis and amplitude on the vertical axis (see Figure 3.9). The formant frequencies can be clearly seen.

I then began the analysis procedure designed by Miller and Doing (1996). While holding the mouth in an [e] vowel, the student phonated on a glottal fry (a growling sound produced in the throat). Since the vocal fry was an inharmonic spectrum, the vocal tract resonated with the formant frequencies particular to that individual. A snapshot of these formant frequencies was taken and placed in the lower left of the computer screen (Figure 3.8). The student then sang the same vowel into the microphone. A snapshot of the sung vowel was then compared to the idealized formants produced by the fry tones. If the student was phonating efficiently, the peaks of these two graphs should have matched (Miller, Schutte, & Doing, 1996).

Figure 3.8. Theoretical versus actual readout on an [a] vowel.



The process was then repeated with the other vowels (see Figures 3.8-3.11). Screen reproductions were taken to have available for comparison with measurements to be taken later in the semester.

Figure 3.9. Spectrographic snapshot of the [e] vowel.

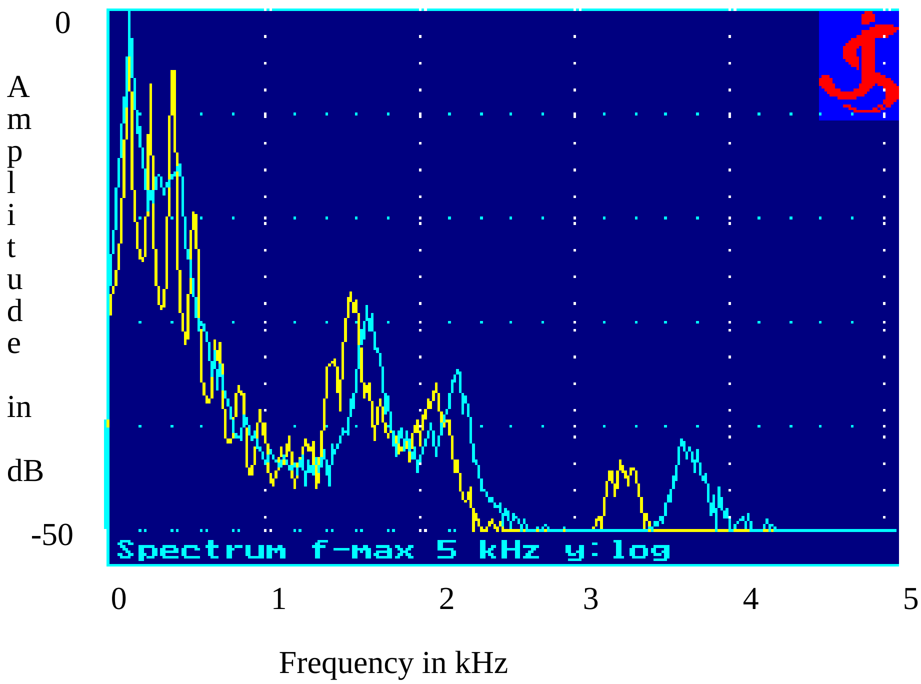


Figure 3.10. Spectrographic snapshot of the [i] vowel.

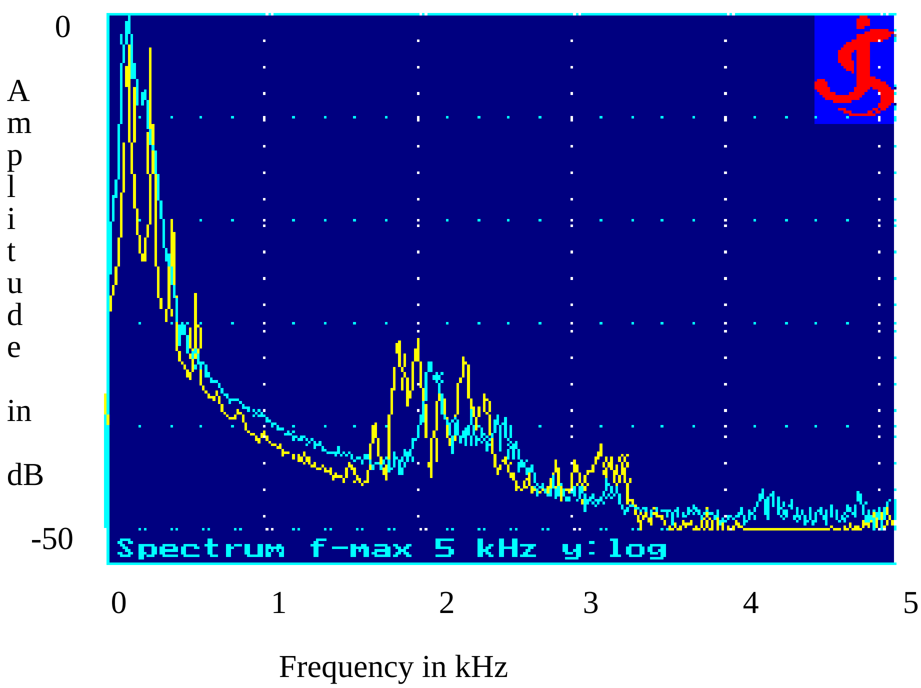


Figure 3.11. Spectrographic snapshot of the [a] vowel.

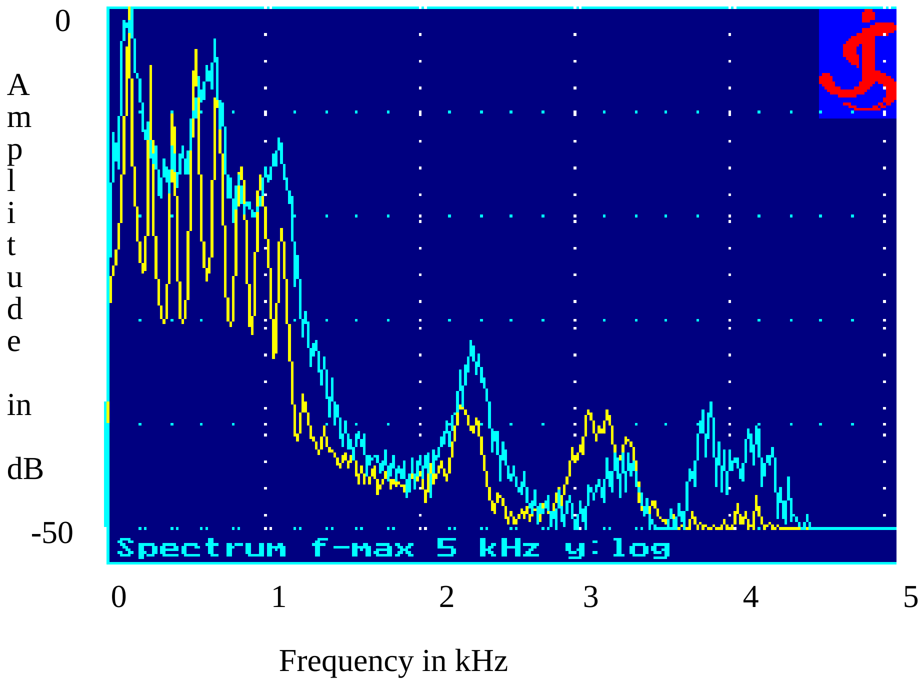


Figure 3.12. Spectrographic snapshot of the [o] vowel.

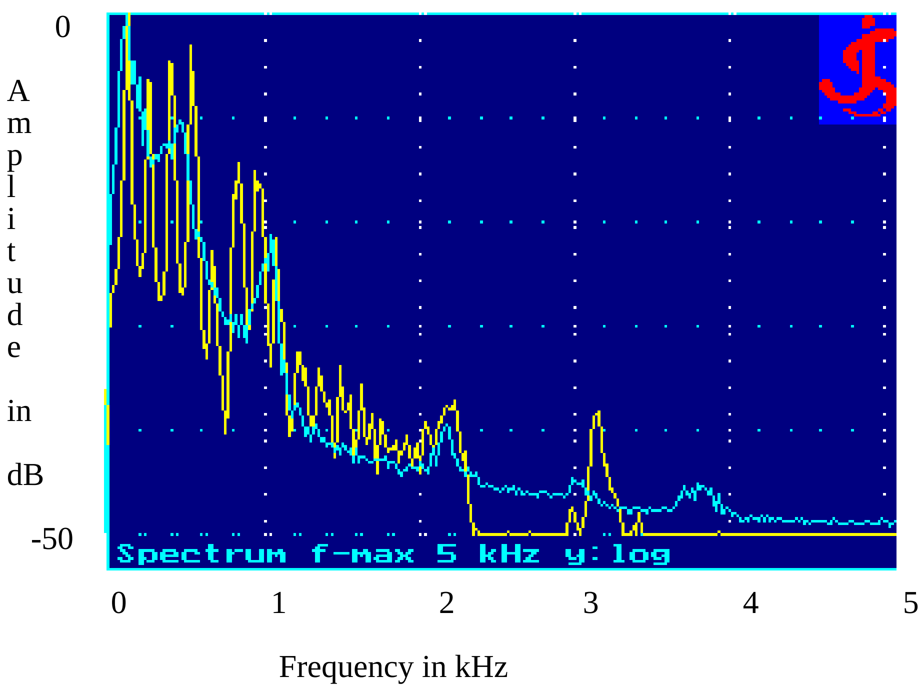
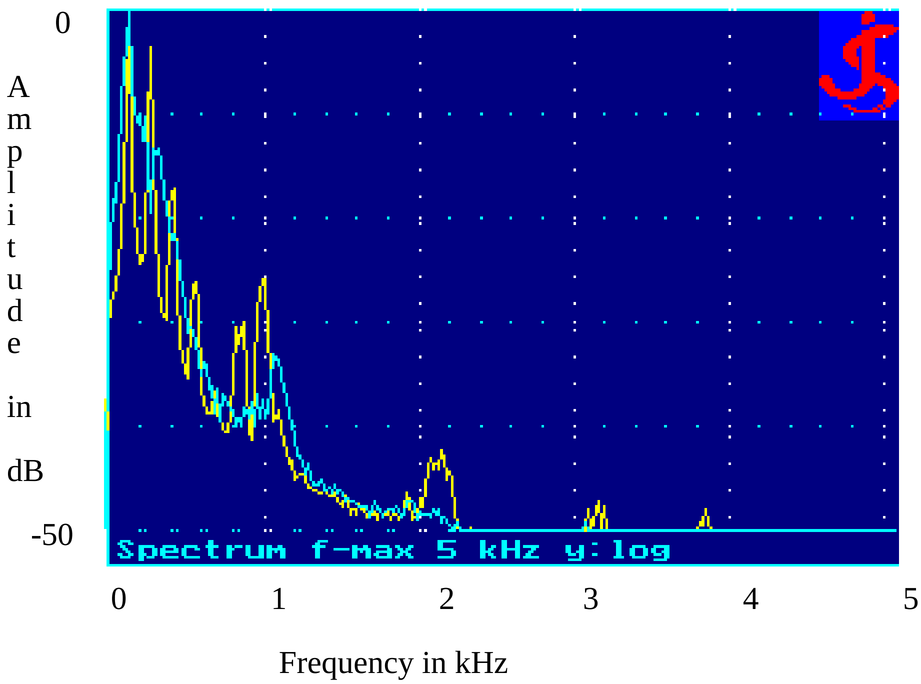


Figure 3.13. Spectrographic snapshot of the [u] vowel.



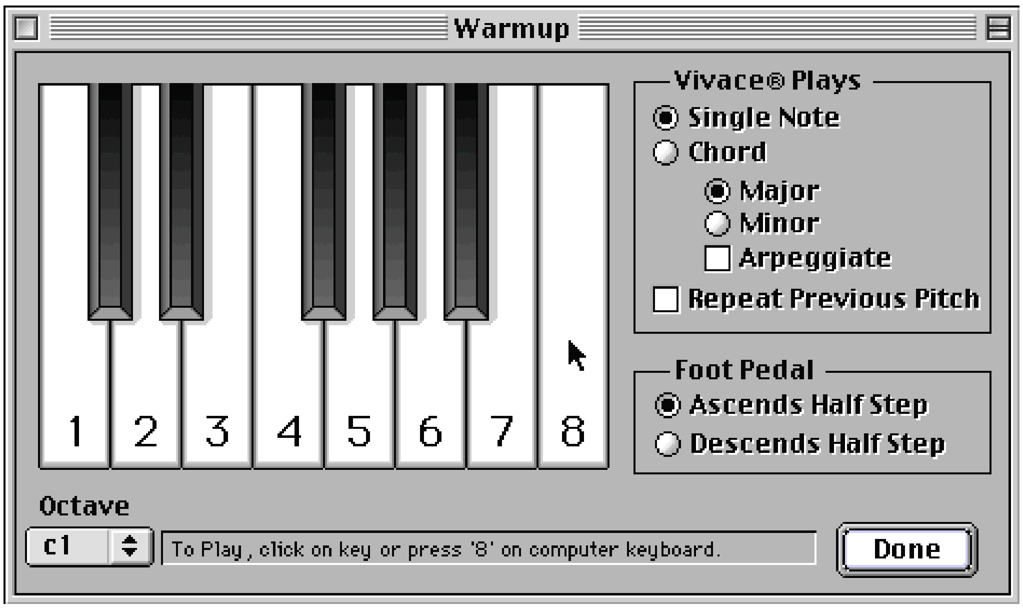
Experimenting with improving the tones produced took up any remaining time in the lesson. Use of the McClosky Techniques was particularly effective in producing spectral weight in the area of the spectrum known as the singer's ring (about 3000 Hz). The ring was shown by the darker colors on the readout in the place that corresponds to this area of the spectrum.

Lesson 4

The fourth lesson began with a discussion of the previous week's activities with the voice analysis equipment. I asked the students for their reactions, and if their responses were positive, I asked them whether they had enjoyed the experience because of the novelty, or because they had learned about their voices from the reinforcement. I also attempted to ascertain whether they had understood the technical portions of the lecture.

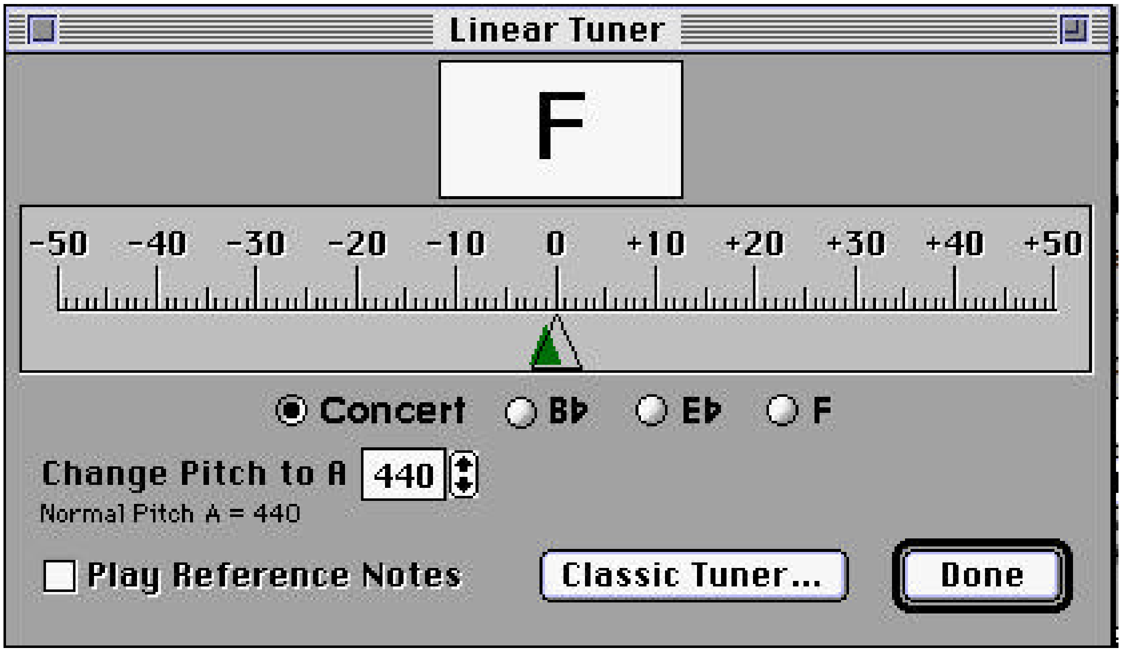
If the student had not yet warmed up that day, we began with a short review of the McClosky Technique and some phonation exercises. We reviewed breathing and performed some breathing exercises as determined by the needs of the individual. The next 10 minutes were spent on vocalises, including those presented earlier. If the individual had not yet learned the messa di voce exercise (a gradual crescendo and decrescendo on a single tone), I made sure we worked this centuries-old technique. During the vocalises, I used the warm-up feature of SmartMusic. The warm-up feature had the option of playing ascending single notes or chords when the foot pedal was depressed or when the mouse was clicked on the keyboard graphic on the screen (see Figure 3.14).

Figure 3.14. Warm-up function of SmartMusic.



After the exercises, the students used SmartMusic's built-in tuner to explore intonation. The student began the exercise with a reference note supplied by the software. The tuner displayed a straight line with an arrow in the middle and segments on the line which represent the distance from the correct pitch and the pitch the singer produced in cents (100 cents = a whole step). As the singer produced a tone, a triangle that represented the singer's pitch appeared on the line. As he saw the deviation from the ideal reading, he could move the triangle left or right to match the pitch. When the pitches matched, the triangle turned green (see Figure 3.15).

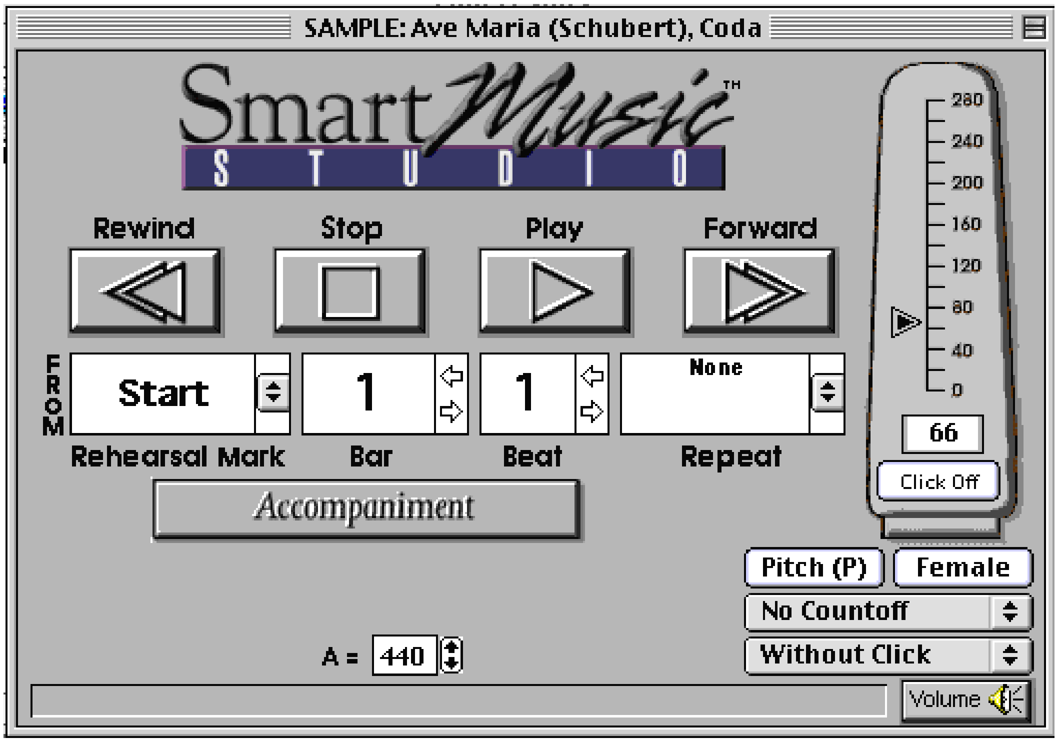
Figure 3.15. Tuning feature of SmartMusic.



Once the student had learned to match the reference tone, I turned off the reference note and allowed the student to match the pitch without aural reinforcement. Once the student could match single pitches, I had him work on five-tone scales. The software automatically adjusted the measured pitch to the student's and displayed the name of the pitch in a box above the scale. We then worked on scale patterns and determined which scale degrees were consistently out of tune.

I then introduced the student to the SmartMusic system. We began without undue explanation by singing through Burleigh's arrangement of "Swing Low, Sweet Chariot." I began the music and had the student listen to the introduction to the song. When the singer's entrance occurred, the software waited for the student to begin singing. The student sang the first pitch into the microphone, and we noted how the software responded.

Figure 3.16. Accompaniment feature of SmartMusic.



The rest of the lesson familiarized the student with the SmartMusic system so that she would be able to access the system on her own. I first explained the procedure of obtaining the key to the practice room. I then shut down the computer and sound system and guided the student in setting up the equipment. The student learned to boot the computer, power on the monitor, power on the Vivace module, and power on the amplifier. The student was instructed how to insert the microphone and power on the battery—and then warned to turn the battery off when not in use.

The student then launched the SmartMusic system without my guidance. The use of key-disks to access the different songbooks and ways to eject and replace the disks were explored next. Once the student could access the song, she explored features such as transposition and tempo changes. The rest of the lesson was an exploration of the songs available on the SmartMusic system (see appendix D). The student chose songs she knew, and sang alone. The student was encouraged to use the system during the week to find songs she might like to sing at the concert.

Lesson 5

At the beginning of the fifth lesson, I asked the student whether he had the chance to use the SmartMusic system during the last week, and if he had experienced any technical difficulties. If the student had used the equipment, I discussed the different parts of the system (including the warm-up feature, the intonation strip, and the song accompaniment) and asked which parts were the most beneficial in practice.

I then began breathing, warm-up, and vocalization exercises as determined by the needs of the individual student. At this point in the lesson sequence, each student received individualized instruction, so a summary of the individual exercises used is impossible.

We then further explored the tuner as a tool for intonation and ear training. Each student used the tuner to explore individual pitches and five-note scales from the previous week, and then patterns that are more complex were introduced. I began by having the student sing major, minor, diminished, and augmented triads, and then other patterns as dictated by the ability of the individual. We discussed which patterns and notes drew the student out of tune and worked with those patterns.

Next, the student used the SmartMusic accompanying feature to learn a song. If the student had found a song that I deemed acceptable for pedagogical purposes, we began with the student's choice; if the student had discovered no acceptable song, I began with a song I chose. I had the student sing through the piece on his own, allowing the student to finish at least a major portion without interruption. When I was sure the student had been introduced to the song as a holistic body, I taught him my methods of learning a piece.

First the student established proper rhythmic support for the song by counting out, without accompaniment, the rhythms of the song. I employed the widely used patterns of "1 e & a, 2 e & a . . ." as an introduction. The student then counted out his particular piece articulating only rhythmic units that appear in the piece. For example, the opening line to "Caro mio ben" (Caldara) would be articulated "3   4 a 1." I had him chant in a spoken pitch on the rhythms of the song, and then he sang the notes of the piece while articulating the rhythms on numbers. SmartMusic accompaniments served as an aid in keeping rhythmic pulse.

Once correct rhythm had been established, I reiterated the need for a legato line in the piece. (Note that any music that did not lend itself to legato singing had been eliminated at the beginning.) I then had the student sing portions of his piece on a single vowel sound (the choice of vowel was dependent on the needs of the individual) while the use of legato line was stressed. When the student had established a legato line, I had him add the [l] consonant between each note. I stressed the fact that the line underneath the [l] should remain legato and the [l] sound should be a very slight, forward placed "liquid" sound.

Once the student had established correct use of a single consonant, I had him learn to isolate the vowels of a song. We spoke the text of the piece together without consonant sounds, for example "Credimi almen" would be pronounced [e i i:a e]. Once the student could speak the text without consonants, I had him sing the song using only the vowel sounds. Again, a legato line was stressed, and the student was warned against using a glottal stroke between the notes as the vowel changed. The SmartMusic accompaniments again provided for a musical setting. The student was instructed to work on his songs without any consonant sounds during the following week. Class Web pages contained a summary of the tips on learning a song (see appendix D).

Lesson 6

The sixth lesson began with a discussion of how the software had helped the student in learning the piece. Since no new software had been introduced or would be introduced in the rest of the lesson sequence, interview questions concerned how the students' growing familiarity with the software was helping them in learning the voice techniques. I hoped that the use of the technology would become transparent, so that the student might concentrate on the use of the voice. I asked the students whether they were continuing to use the software available, and which parts they found most effective. I was also interested in whether they continued to access the class Web pages. I had included links to sites outside of the normal class environment, including the site for the Vocalist mailing list (http://www.vocalist.org), one of the best Internet resources for singers.

We then went through a sequence of steps designed to incorporate consonant sounds within a bel canto style. Using material published by McClosky (1985), we explored individual vowel and consonant sounds, determining which consonants produced tension in the McClosky areas (tongue, swallowing muscles, larynx . . .). Since lesson time did not allow for the exploration of all consonant sounds, students were encouraged to return to the Web pages to discover their individual trouble spots. Elements of proper speaking, including optimum speaking pitch and the importance of breath support while speaking, were again emphasized.

Once individual consonant sounds were established, the student repeated sentences designed to highlight specific consonant sounds. For example, the sentence "A coward weeps and wails with woe when his whiles are thwarted" (McClosky, 1978, p. 51) highlights the use of the [w] sound. Students were encouraged to work with any sentences not covered in class later in their practice time.

Students then explored the text of their pieces without the musical context. First, the student spoke the text of her song, discovering which text elements led to tension in the McClosky areas. The student then explored the poetry inherent in the text by speaking as if she were reading a poem, with an emphasis on the aesthetic sense of the text. If the students were singing in a foreign language, I made sure they were aware of the meanings of each individual word.

The student then began to transfer the spoken text into song by non-rhythmic chanting of the text on a single pitch. The text was then spoken or chanted on a single pitch using the rhythm of the song. Once the student was aware of how the text could be translated onto a single pitch, we reviewed the work from the previous week by having the student sing the piece on vowel sounds only. When proper legato singing had been established, the student sang the song with text, noting which notes brought about tension in the McClosky areas. These tips were summarized on the class Web pages (see appendix D)

Once a healthy manner of singing the song had been established, I emphasized that the most important element of singing is the sense of the aesthetic—the bond between the singing voice and the feelings of the singer and audience. We sang the song with an emphasis on how the poetry and the music came together to make a meaningful whole.

Lesson 7

The seventh lesson began with a discussion of the previous week's use of the SmartMusic system to learn the students’ individual piece. I ascertained whether the software was being used effectively. I also judged how I might best prepare the students for our final lesson on the following week.

I then vocalized each participant to the point where I was sure the data were taken from a fully warmed-up voice. No new exercises were introduced. At this point, I repeated the procedures from lesson 3 (including EGG and spectrographic data) for the appropriate comparison groups. The results of each student were compared with the previous results, including recordings and graphical representations. Once the data had been taken, each student was asked to explore readings taken while performing exercises. We ascertained which exercises were effective in bringing out the singer’s ring.

If any time remained in the lesson, we went through the student’s piece to determine what needed to be practiced in the intervening week. Rehearsal of the piece was hindered by the fact that the accompaniment software was not installed in the studio that housed the spectral analysis software.

With the group that did not receive spectral analysis, we began to prepare for the following week's lesson, which would incorporate a change to the human accompanist. Activities described in the lesson 8 plans were begun early for this group in order that they would have extra time to become accustomed to the human accompanist.

Lesson 8

The eighth lesson was a preparation for the final concert. The group that received spectral analysis undertook a separate procedure from the comparison group. After a brief discussion concerning the effectiveness of the follow-up lesson with the spectral analysis software, each student warmed up as needed. The student rehearsed the piece in as natural a setting as possible—I attempted to allow the student to sing through the entire piece at least twice during the lesson. Troublesome passages were isolated and rehearsed, and the uses of aesthetic elements were highlighted. The student was made aware of techniques that would make the piece more interesting, including the use of a contrived character for the student to act out, and the use of phrase shaping. I also highlighted facial gymnastics to help with expression and stressed the philosophy that the "work" was now done, so now was the time for the student to "have fun." I also discussed other issues including dress and some methods for minimizing any possible stage fright.

Half of the participants prepared for the final concert with their new, human accompanist. First, I allowed the singer and accompanist to become accustomed to each other by having them play though the piece without interruption. After asking the student and accompanist for their comments on the initial performance, I went through any notes I might have taken on my reactions. Then I worked out trouble areas within the piece and allowed myself to interrupt when needed. Finally, at the end of the lesson, I again allowed the performers to practice without interruption. The student and I then returned to the practice room to discuss the experience alone. I attempted to ascertain the differences between the software and the human accompanist, whether they felt uncomfortable with another person in the room, and whether they preferred human or software accompaniment.

Final Concert

The final concert was a public presentation of the students' accomplishment as well as an opportunity for further study. A concert program (see appendix D) contained the name of the pieces to be played, the names of the larger work from which the piece is taken, the names of the performers and accompanist, and the birth and death dates of the composer. The concert took place in a performance area within the School of Music, which had both a suitable piano and sound system. Pieces accompanied by the SmartMusic system were interspersed with pieces accompanied by a human accompaniment. The concert was videotaped for further evaluation. The students themselves were not judged—the effectiveness of the technology in a performance setting was the focus of the analysis.

Data Collection and Analysis

Data were collected in a variety of ways. The data collection process was broken into two categories: open-ended and closed-response. Open-ended data taken from weekly student logs, teacher observation, and spectral analysis results (for the appropriate comparison groups) were analyzed in a case-by-case manner. Results presented in chapter 4 contain analyses for each individual case and a follow-up section containing observed trends. Closed-response data came from questionnaires administered to students five times during the semester. Trends from the comparison of open-ended and closed-response data lead to the conclusions presented in chapter 5.

Open-ended Data

Three types of open-ended measurements helped to form general conclusions about the students reactions to the process. First, participants completed weekly journals in response to questions asked via e-mail. The questions asked can be found in appendix C. Second, I made careful observations of the participants throughout the process. Audiotapes of the lessons and videotape of the final concert served as an aid to my memory. Third, readout from spectral analysis of appropriate subjects served as a method of judging the progress of individual students. Although the process was technical and produced objective results, I include the spectral analysis in the open-ended results because the graphs were analyzed through observation rather than statistical procedures.

Weekly Logs

The initial questionnaire helped determine that the members of the participant group fell within acceptable parameters. Those chosen for the experiment were undergraduates of traditional college age, with an intermediate amount of singing experience, a willingness to use the computer, and a willingness to spend the necessary time to produce a journal.

Each week's questions contained a report of the amount of time the student practiced and the relative amount of practice time spent on exercises compared to the amount of time spent on songs. The comparative percentages were used to determine if the students continued with the important breathing and relaxation exercises throughout the semester.

The questions given to the student after the first week contained an effort to ascertain whether the Web pages on the McClosky Technique served as an effective presentation. Students were asked whether the pages were effective within the lesson (for those students who had exposure to the pages during the lesson) and outside the lesson. Of particular importance was the reaction to the pages of the students who had the pages in the lesson as compared with the reactions of those who did not have the support within the lesson. The students were also asked for input on how to improve the pages and their use within the lesson.

Some questions from the second week were similar to those from the first week, but concentrated on the pages on breathing and relaxation. Additional questions were asked concerning the on-line survey, which had been completed by the students by this point.

Questions from the third week were different for the two comparison groups. I designed questions for the spectral analysis group to help determine if the students learned from the spectral analysis software. Of particular importance were whether the student understood the process and whether the process had more than simply a novelty effect. Those students who did not take part in the spectral analysis received more generalized questions concerning the SmartMusic system.

Since all students received similar activities during the fourth, fifth, and sixth weeks, separate questions were not necessary for the different groups. These questions determined the relative effectiveness of the SmartMusic system’s warm-up exercises, the tuner as a tool for pitch accuracy, and the accompaniment feature. The relative effectiveness of external Web links was also judged.

Questions from the seventh week’s log were similar to the third week's in that the groups received radically different lessons. The eighth week’s questions concerned the participant’s feelings of preparation for the impending concert and the students' reactions to the switch to a human accompanist.

After the concert, the participants were asked to complete a final questionnaire. The final questions were an attempt to glean reactions to the concert, the use of the SmartMusic as accompaniment compared to the human accompanist, and reactions to the entire process. In addition, participants reported on their attitudes toward each of the individual technologies and their components.

Analysis of logs. I produced a content analysis of each of the weekly responses. Data were analyzed in two separate ways. First, the data from each particular student were analyzed for changing patterns from week to week as described above. Individual patterns became known when these data were compared to the weekly observations. Secondly, the answers from each individual question were amassed without identification of the individual and compared. Trends from the weekly observation became apparent as the data were compared to presurvey data and alternative activity group data.

Observations

I kept a weekly log of observations of each of the students. Logs were compiled from the viewpoints of the experimenter and the teacher (in this case, the same person playing two simultaneous roles). Each lesson was audiotaped, and the final concert was videotaped to provide support for my memories of the process. The data from observation are presented together with the analysis of logs to produce observable trends.

Spectral Analysis

Analysis of the spectral analysis and EGG data was individualized for each student. Of particular importance to the spectral analysis was whether the student understood the factual material presented on the acoustics of voice. Readings of individuals helped to show conditioning of the singer's formant and relative efficiency of vowel placement. Data from the second reading helped to demonstrate individual improvement. Because of the developing nature of the voices, no attempt was made to compare the sound spectra of individuals to the spectra of either other students or professional singers.

Quantitative Data

Three sets of questions were designed to provide quantitative, closed-response data for comparisons with the questionnaires and observations. Copies of the survey mechanisms can be found in Appendix C.

The first set of surveys was originally designed for an experiment in 1996. I devised a pre- and postsurvey for the presentation of the same Web pages viewed during the first lesson. In the present study, these surveys took place at the beginning of the semester and after the first lesson. The presurvey requested demographic information as well as information concerning vocal training, experience with technology, teaching experience, and attitudes toward educational technology. The postsurvey measured reaction to the McClosky Technique, a report of the number of times the student incorporated the technique, the reaction to the pages, and the questions from the first survey concerning attitudes toward educational technology. I computed t values in addition to the descriptive data.

The second set of on-line surveys was originally designed by Miller and Doing (1996) when devising a method to test the VoceVista (Miller, Schutte, & Doing, 1996) software to facilitate the singers' register changes. Queries were divided into general questions on the effectiveness of the equipment and effectiveness of individual portions for the students' own singing, the singing of others, and teacher effectiveness. Other questions helped toward a judgment of whether the students understood the process.

Data from the present study were compared to the results from the original study to determine differences between the reaction of the students in the present study to the reactions of the students of Miller and Doing. Comparable results would indicate that the process in the present study was genuine and the experience of the present group of students is comparable to the experience of the group in the original study.

The third set of surveys quantifies the relative effectiveness of the different parts of the SmartMusic software, including the tuning feature, the warm-up feature, and the accompaniment feature. The presurvey took place in the sixth week of the semester, and the postsurvey took place at the end of the semester. In the intervening time, one of the comparison groups had the opportunity to rehearse and perform with a human accompanist. Thus, the data from the two groups showed differences in the attitudes of those students using the software more or less frequently.

At the end of the semester, a survey was administered to judge reactions of the students for the entire semester. I added questions on the final survey that had been asked in the first survey to determine changes among the different groups over the entire semester. The survey also contains questions on each of the particular software or hardware packages used throughout the semester. The questions are presented twice, with one asking for the reaction to the technology used within lessons and one asking for the reaction for the technology used outside of lessons. These questions shed light on the pilot-test premise that the technologies are more useful to students in their personal practice than they are in the lessons. The reactions to each of the technologies were then placed in rank order, so that the relative effectiveness of each of the technologies could be compared. In addition to the questions on the technology, other questions meant to help judge the students' attitude toward the entire process were added to chart the attitudes throughout the semester. Specific added questions included their preparedness for the final concert, attitude toward the McClosky Technique for Vocal Relaxation, and additional questions from the first survey.

Synthesis

The conclusions presented in chapter 5 are a synthesis of the open-ended and quantitative data. Because of the small sample size, the quantitative results may not fulfill the tests of statistical significance, but they are useful as a check for experimenter bias and as an aid to prove conclusions gleaned from the observation process.

CHAPTER 4

RESULTS

Chapter 4 contains the results of the study. The chapter is divided into two major sections. The first section contains open-ended data gleaned from student journals and instructor observations. The second section contains quantitative results taken from the surveys completed by participants throughout the experience.

Cases

This section contains case studies for the individuals involved in the research. First, the experiences and observations of each individual are presented. The cases are then summarized for trends.

Individual Cases

Each individual in the study completed weekly questionnaires to determine his or her reactions to the experience. In addition, I interviewed students during lessons to clarify information they presented in journals. This sub-section also includes my observations on a week-by-week basis throughout the series of lessons and the final concert. Each participant's summary is broken into the sections regarding demographic information, lesson reactions and observations, concert reactions and observations, summary of their final journals, and a final summary.

Mark

Demographic information. Mark was an 18-year-old freshman math and computer science major. He had already experienced a significant amount of voice training, including voice coaching at two separate institutions, three years of high school chorus, participation in college choirs, and musical theater experience. At the time of the experiment, he sang in a choir and had a chorus role in a musical. He expressed an interest in practicing a musical theater number for use as an audition piece. He initially characterized his voice type as a bass. He also had a good deal of musical experience outside of voice training, including 14 years of piano, percussion in the high school pep band, honor bands, and work on native-American flute.

Mark reported that he had significant computer experience, so working on the Web would not present difficulty. He had worked with BASIC, QBASIC, HTML, and JAVA programming languages, and had knowledge of various word processors, databases, spreadsheet programs, games, MIDI devices and software, hardware components, and the Internet. He had easy access to a computer, and was willing to commit the time to the experiment.

Lessons. During the first lesson, I used the Web pages as a support device. He did not look at the computer screen much, but he was able to recall the techniques in the proper order. Despite his definition of his voice as a bass, I believed at the first lesson that he was definitely a baritone or higher. When I tested his speaking pitch, his most healthy sounds came from Ab3 to Db4, so I felt he might have been a tenor or high baritone.

During the first week of practice he reported, "I went through the entire McClosky Technique at least once every day, and some days two or three times. I would do some of the exercises before chorus rehearsal or before [the musical] rehearsals." Concerning the use of the Web pages at home, he stated, "I really only accessed the Web page twice during the week just to check something, so, I didn't stay long. . . . I used them only a few times, because I remembered everything I was supposed to do." When asked about the use of the pages in the lesson he stated, "They were effective in supporting what was being said. The use of images and diagrams to further explain what was being done was effective." He had no suggestions for improvements to the pages. He felt that the McClosky Techniques were awkward, but thought they would be effective in the future.

During the second lesson, Mark reiterated that he had been using the Web pages at home, but that they had not been as effective as they had been in the lessons, since he already knew the steps by heart. His jaw was loose, so I assumed he had indeed worked with the McClosky Technique, but since he was suffering from a cold, I did not use my usual tactile exploration to test the areas of the face for tension. I did observe some laryngeal tension. His posture was acceptable, except for a tendency to collapse the ribs. When I tested his breathing, he was able to sustain an [s] sound for 20 seconds. Because of his cold, I did not have him vocalize extensively. I also noticed that he had difficulty initiating tones without a harsh glottal attack.

In the responses from the second week, Mark reported that he was incorporating the principles into his practice and daily life:

> When in musical rehearsals, or chorus rehearsals, and a lot of times simply when it crossed my mind, I would work on my breathing technique, keeping my chest open, and expanding my stomach only. It was odd how many times I was just walking to class, or sitting in class, or just watching TV, I would remember and correct myself. [My tendency is] still to breathe high in my chest, but I'm working on, and getting more comfortable breathing lower. . . . Simply because I'm always around people, most of the time is taken by the massaging and breathing exercises. However, I've made sure to do the sighing, and different sounds.

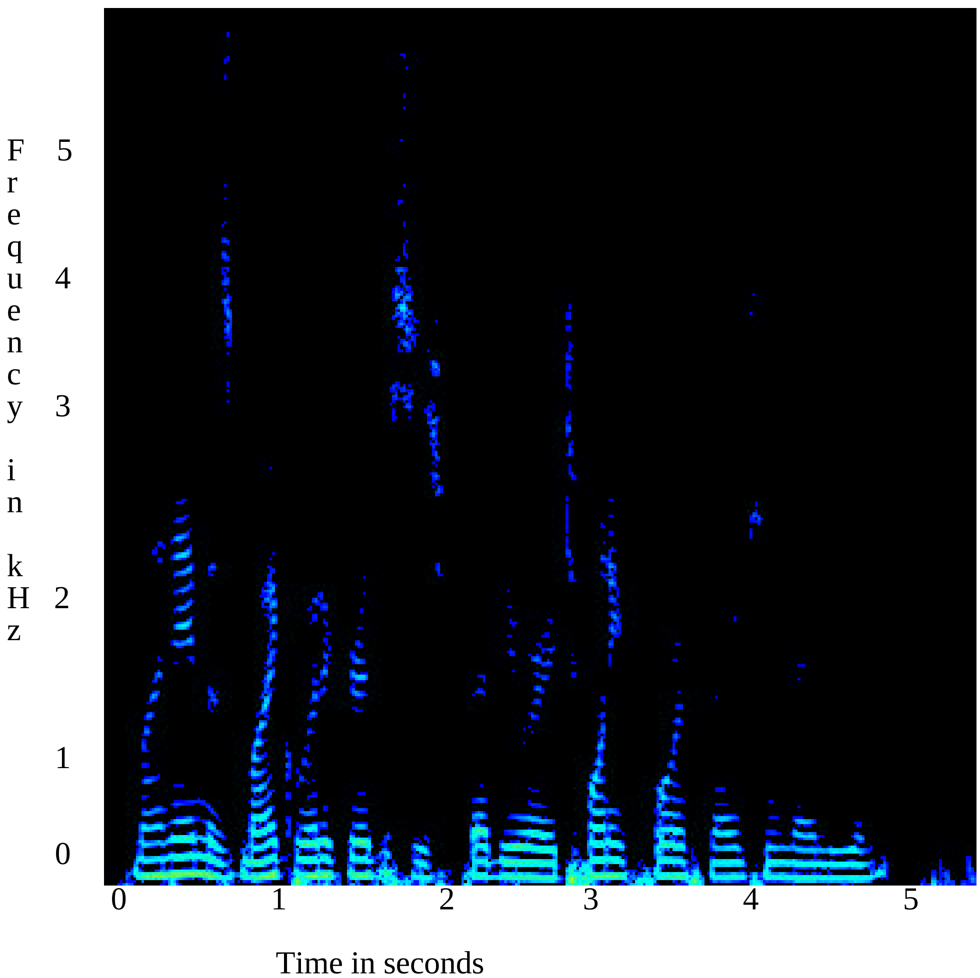
He continued to find the Web pages effective, "Like in the first lesson, the diagrams on the pages were helpful to see specific details of what we were doing. It helped explain internally what was going on." He also had some suggestions he had not mentioned the week before, "Maybe, since there are ways to add sounds and sound files to Web pages, you could record WAV [sound] files giving examples of the sound we're supposed to make. For example, on the McClosky Techniques, have available a recording of the sighing and the different sounds." He found the Web pages more helpful this week because the information on breathing and posture had been more useful to him.

He again commented about the improvements in his breath support, "[Before taking voice lessons] I wasn't using my breath correctly when I was singing. I've always taken deep breaths high in my chest, not using my diaphragm."

He had mixed feelings about using on-line surveys instead of e-mail journals. The Web form was less appealing to him when compared with his e-mail journals because he wanted to expand on his answers and there was no place on the form:

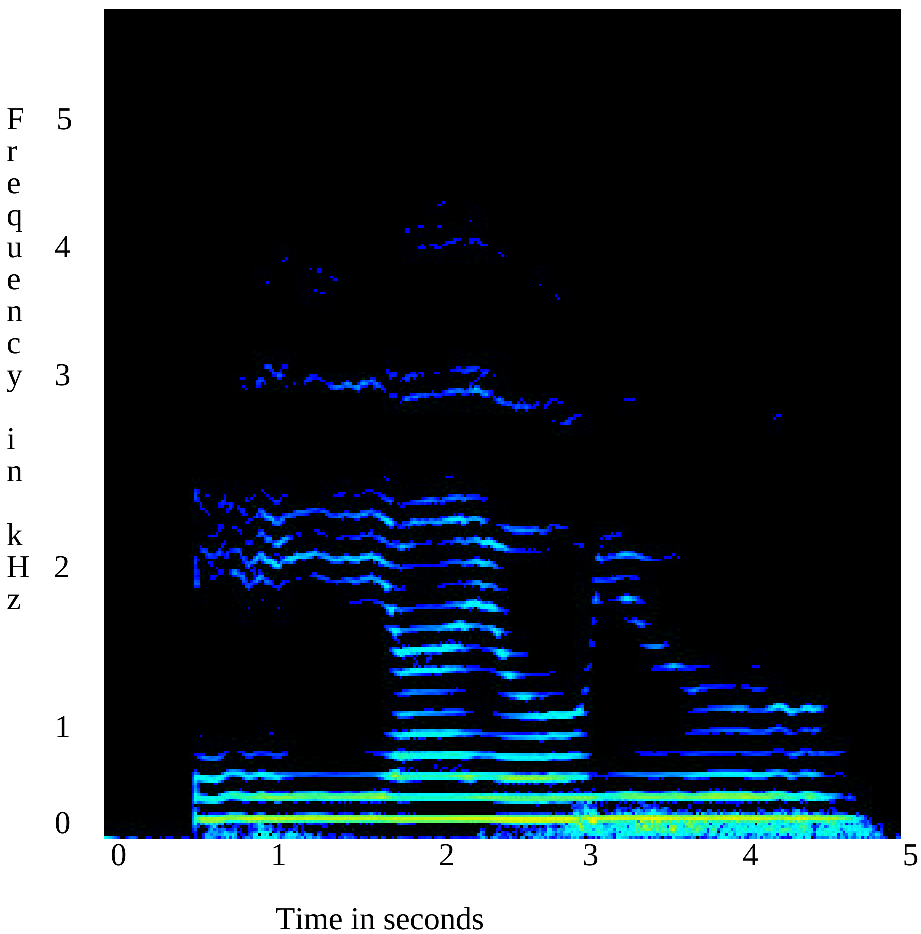
> With quite a few of the questions, I wasn't sure how to answer to best relay how I felt about the topic in question. For some I would have liked to have explained myself a little better than just checking a number between 1 and 7. . . . I liked the on-line survey, except that I would have liked to explain myself a little more. E-mails allow for this.

Figure 4.1. Week 3 spectrogram of Mark saying "My name is . . ." (Shorne, 1999)



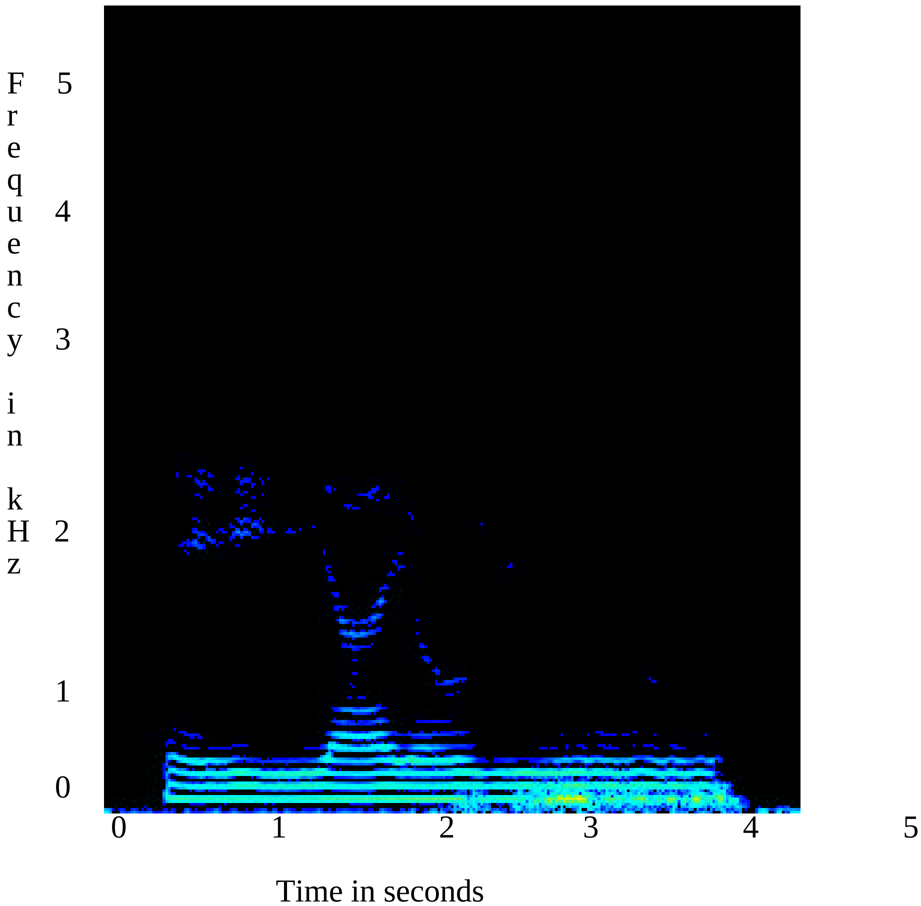
Mark was still suffering from cold symptoms during the third lesson, so I was unable to test the limits of his voice. He said he had been working on the breathing exercises and his breathing had improved. He sustained an [s] sound for 29 seconds, an improvement of nine seconds. When we began the spectral analysis process, readings on the time-based spectrogram were beneficial. He seemed to understand my explanations of the sound spectrum and asked no questions. He thought his own initial readings looked "thin" (see Figure 4.1), possibly because he was comparing them to mine. When we began to measure his singing voice, initial readings taken on the notes F3 in the middle of his range (see Figure 4.2) showed a still developing voice without much upper partial content.

Figure 4.2. Week 3 spectrogram of Mark singing [e i a o u] in the middle range.



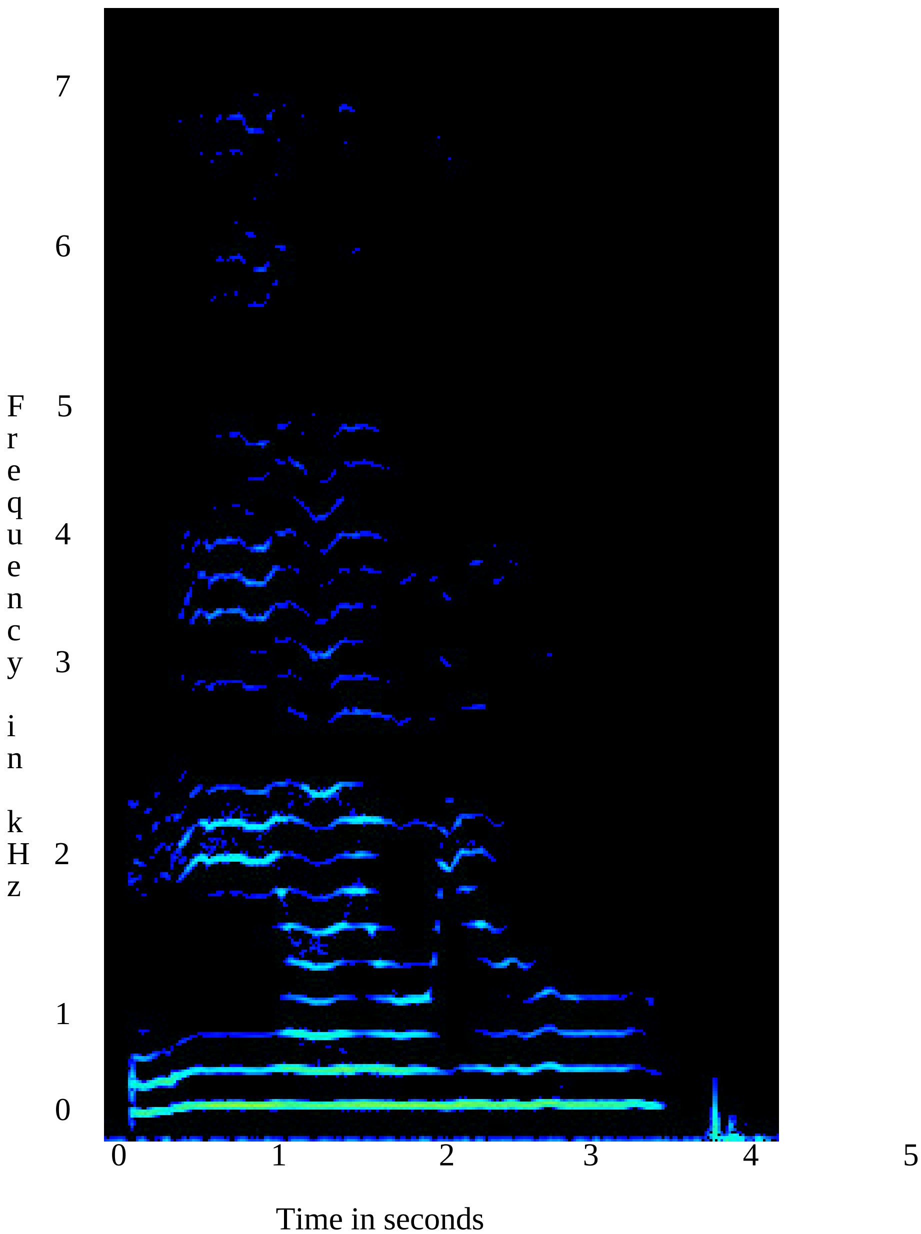
Because Mark was unable to sing the F2 that had been planned for the reading of his low voice, I took readings while he was singing Ab2 (Figure 4.3). Readout showed that he was constricting his voice to negotiate pitches that were unnaturally low for his tenor voice.

Figure 4.3. Week 3 spectrogram of Mark singing [e i a o u] in the low range.



We measured Mark on D4 in his high range (see Figure 4.4). While he was singing his high notes, I was both able to show the relative lack of strength in his upper range and show the potential for improvement. His upper range was much more productive in the parts of the vocal spectrum I was attempting to promote (the singer's formant).

Figure 4.4. Week 3 spectrogram of Mark singing [e i a o u] in the high range.



When we took spectral snapshots of Mark's voice, I was able to show how he was producing a more efficient tone with selected vowels. Readings (Miller, Schutte, & Doing, 1996) from his forward vowels [e] and [i] (see Figure 4.5 and Figure 4.6 respectively) matched well with the readings from the fry tone.

Figure 4.5. Week 3 spectrographic snapshot of the [e] vowel for Mark

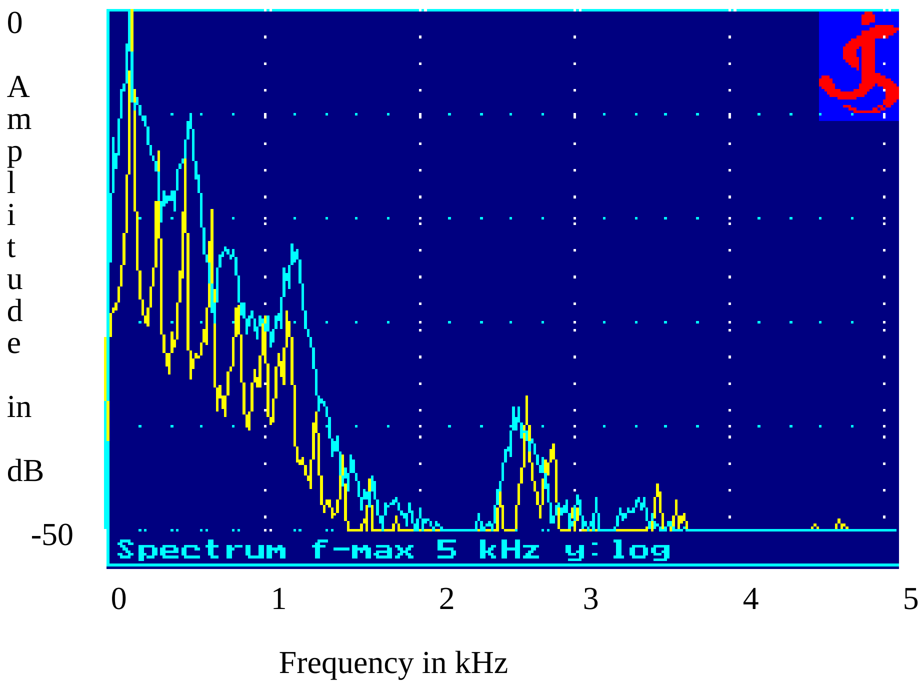
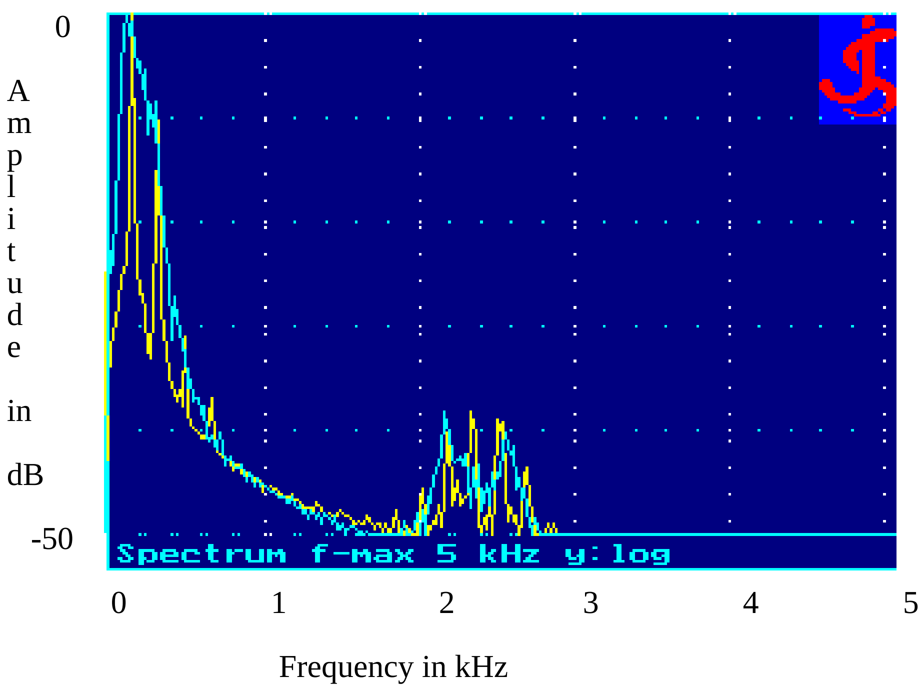


Figure 4.6. Week 3 spectrographic snapshot of the [i] vowel for Mark.



The back vowel [a] showed a good match between the two readings (see Figure 4.7).

Figure 4.7. Week 3 spectrographic snapshot of the [a] vowel for Mark.

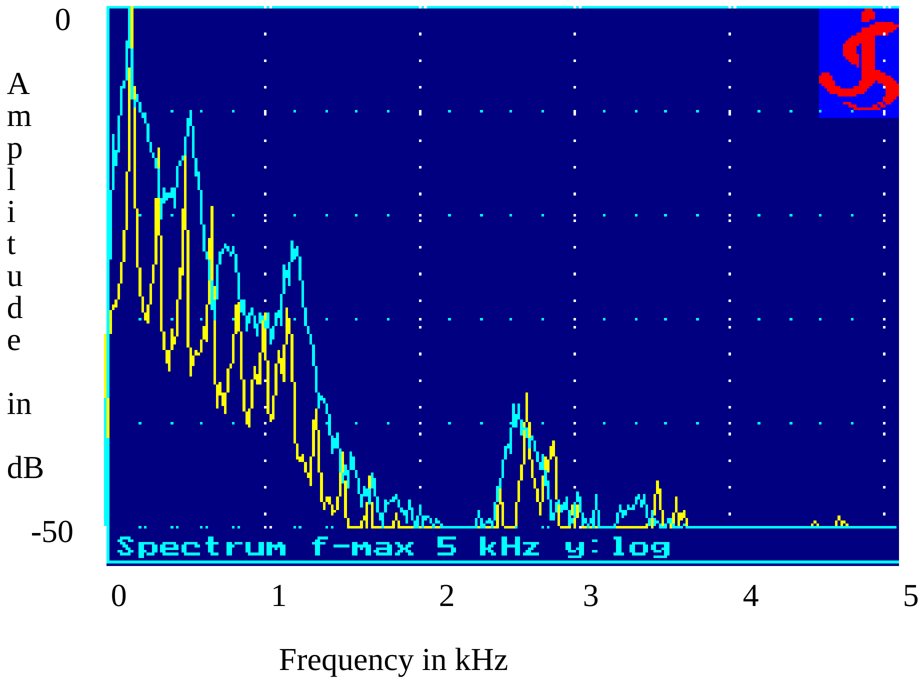
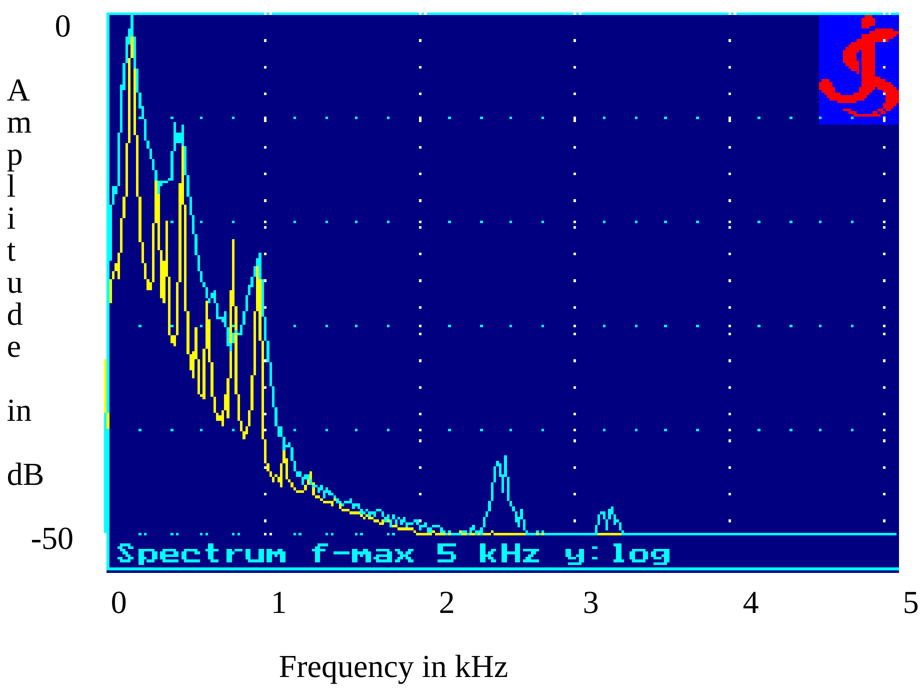
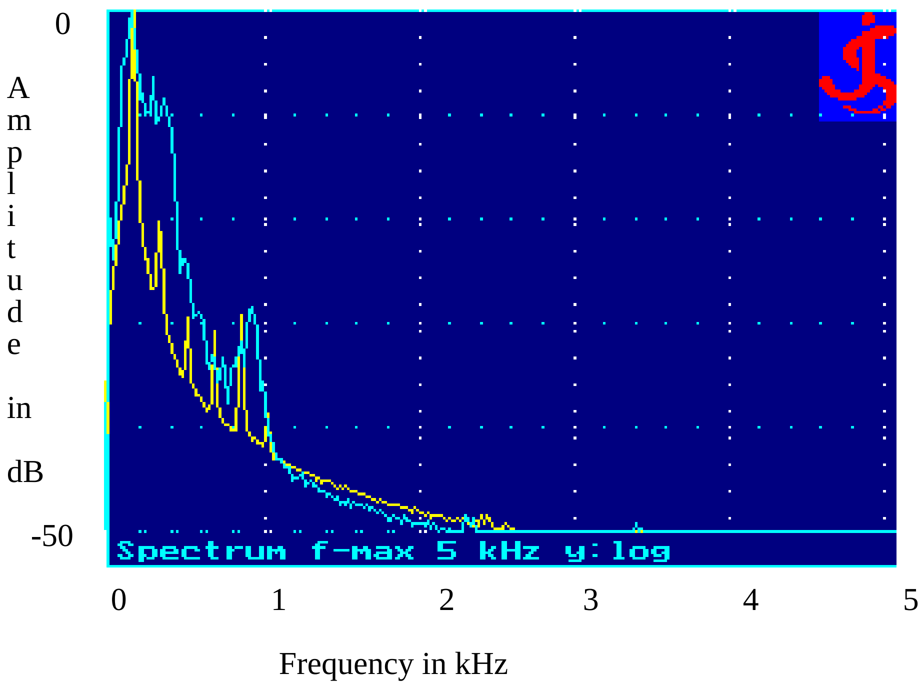


Figure 4.8. Week 3 spectrographic snapshot of the [o] vowel for Mark.



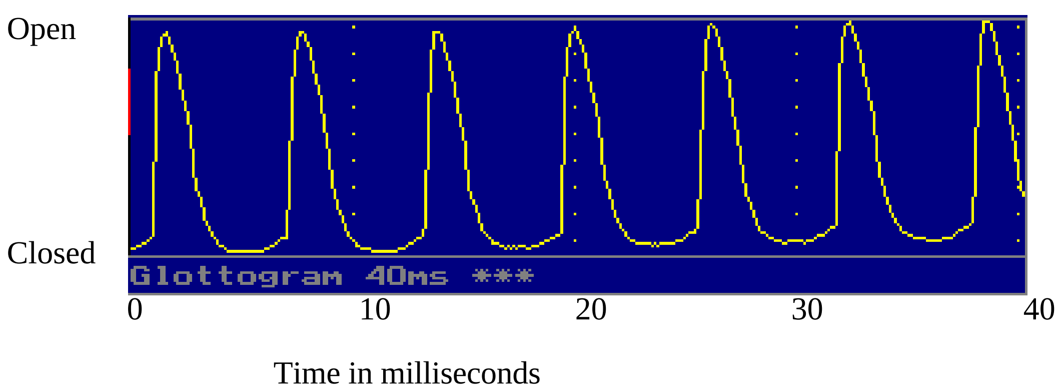
However, the back vowels [o] and [u] (see Figure 4.8 Figure 4.9 respectively) did not match the resonance peaks around the important singers' ring, at about 3 kHz.

Figure 4.9. Week 3 spectrographic snapshot of the [u] vowel for Mark.



These vowels are naturally lower in these higher formants, but Mark's voice was even darker than was necessary. I was successful in establishing the waveform on the EGG reading for Mark (Figure 4.10). I was able to explain the periodicity of the opening and closing of the vocal folds, but the reading was not strong enough to make an acceptable closed quotient reading.

Figure 4.10. Week 3 EGG reading for Mark.



In the third week's journal, Mark indicated that he was continuing the exercises, mostly in his everyday life, but he spent most of his time singing with his choir:

> [I am] still getting over my cold, [so] I didn't do the singing exercises Monday or Tuesday of last week. However, I did the relaxing and breathing exercises every day whenever possible. The McClosky Techniques usually take about 10 to 15 minutes to do, but the breathing exercise is a continuing thing throughout my day. Sometimes, I'll just catch myself breathing incorrectly and adjust to doing it right. . . . I didn't sing much last week, except in University Chorus rehearsal. Counting these practices, I would say approximately 25% is exercises and the rest is actual singing.

He had positive reactions to the use of the voice analysis software, "I really enjoyed the lesson. I think analysis of this type has incredible potential in vocal teaching. I found it very interesting." He also had a good grasp of the technical side of the process, "I've taken physics classes that cover sound waves and the like. Actually applying this knowledge to my vocal learning was interesting." He also indicated he appreciated having the graphics on line.

At the fourth lesson, Mark still had cold symptoms, but he was singing well enough to proceed. Because the lesson was his first exposure to the SmartMusic software, I had to allow time for the added explanations necessary. The tuning software intrigued him, and some minor difficulties in matching pitch existed, but I was unable to use the tuner as much as I might have preferred because I wanted to leave adequate time for the accompaniment. He seemed to understand my explanation of all of the functions of the software, and his initial singing with the software went well. He was able to boot the computer, launch the software, and access the features without much prompting. He had some questions about the Macintosh system, but I believe he could have answered his own questions in my absence.

In the fourth week’s responses Mark reported working with the McClosky Techniques every day, but only "did significant singing" on three days, and he was not able to use the practice room with the SmartMusic system. When he practiced, he spent about 75% of the time singing songs and 25% working with vocalises. Although he had not used the SmartMusic system, he felt he had a "good grasp" of the software and enjoyed using it in lessons, "I really like using that software. It's helpful for a bunch of reasons. You can set it up for your own personal ability, (or lack thereof.) You can get your first pitch. It waits for you to sing. It allows for your own personal style, (ritards, etc.)."

During the fifth week's lesson, Mark again reported that he had not gotten the chance to use the practice room that week, so I was unable to judge whether the introduction to the SmartMusic software had been effective. Because he had been trained as a percussionist, he was able to perform the rhythm exercises with little instruction from me. On his initial sing through "The Impossible Dream" (Leigh and Darion) I noticed he was singing some portions of the song as it is traditionally performed rather than as notated in the written music. I pointed out the places where he had learned rhythms incorrectly. The SmartMusic software's pitch button was not effective in showing him the notes and rhythms he was missing, so I was forced to use the piano keyboard to help him find certain notes. He was able to isolate and sing the vowels of the song without much difficulty.

In the fifth intervening week, Mark had noticed a change in his practice habits:

> Although it was Spring Break, I did the McClosky Techniques and singing exercises almost every day, (approximately 10 out of the 13 days between lessons for 25 to 30 minutes each time). I approach things a little differently now, in terms of out-of-lessons practicing. More of my time doing these exercises is when I'm rehearsing for Joseph or in University Chorus, and I catch myself doing something wrong. I'll check to see if my Adam's apple is moving too much, or if my jaw is tight, or if my swallowing muscles are tense, or if I'm breathing wrong, and I correct it. . . . When I include University Chorus and Joseph rehearsals, it averages to about 20% warm-up/exercises and the rest singing.

Because this practice week coincided with Spring Break, he did not access the practice room. He still had excellent comments on the SmartMusic system from the

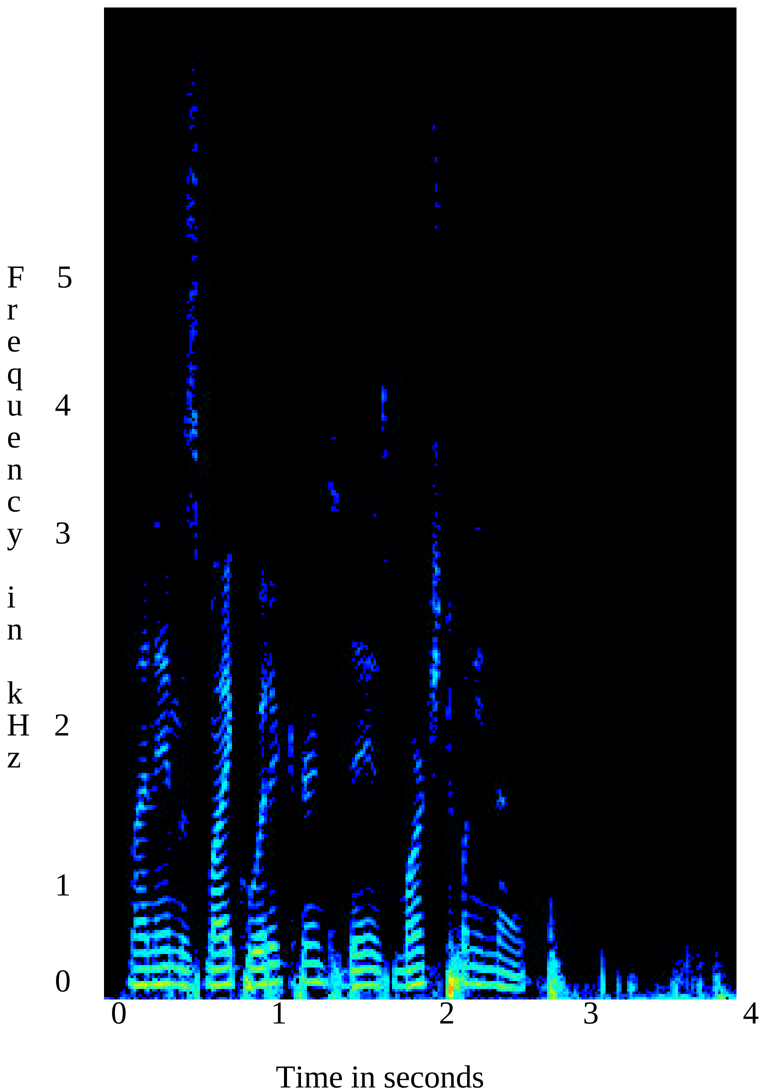
previous week's practice, "I was very impressed with the program, especially the fact that it will wait until you're ready and can adjust to your changes in tempo in some locations. It also really helps to be able to pause it and get your next note, and change the pitch, and even the key that the music is in." He also appreciated having the class material on line, "It was nice to be able to look at it to remember what was gone over in the lesson, specifically, being able to look at the order in which to do things, and how to approach the song."
He had also adjusted well to the new exercises, such as isolating the vowels, "It comes pretty easy when you think of it as not making any consonant sounds, as almost baby talk. (I even tried singing only vowels during one church hymn.)"

At the sixth lesson, Mark reported that he had still not gotten into the practice room, but that he had worked on isolating the vowels on his own at home. I noted that his nasal-consonant [m]s and [n]s could show more presence, and his [l] sound was too guttural. When we ran through his piece, I noticed a few note discrepancies. Articulation challenges included the tendency to close the diphthong on the [a:i] vowel combination. He also had a tendency to strain on high loud notes.

During the sixth week Mark reported singing for about seven hours, including a one-hour session in the practice room, but only about 10 minutes per day on vocalises. His only comments on the practice session had little to do with the software and more to do with the practice room itself, "I'm a little more comfortable in the smaller space. I'm still a little wary about other people being able to hear me in the hall as I'm experimenting with things." He appreciated the use of the Web for informational purposes because of the large amount of information that had been presented in the lesson, "[The Web pages] were helpful, because I don't think there is any way I'd remember all the consonants. I could probably get most, but I know I'd forget something. Using the Web pages, I know I don't miss anything."

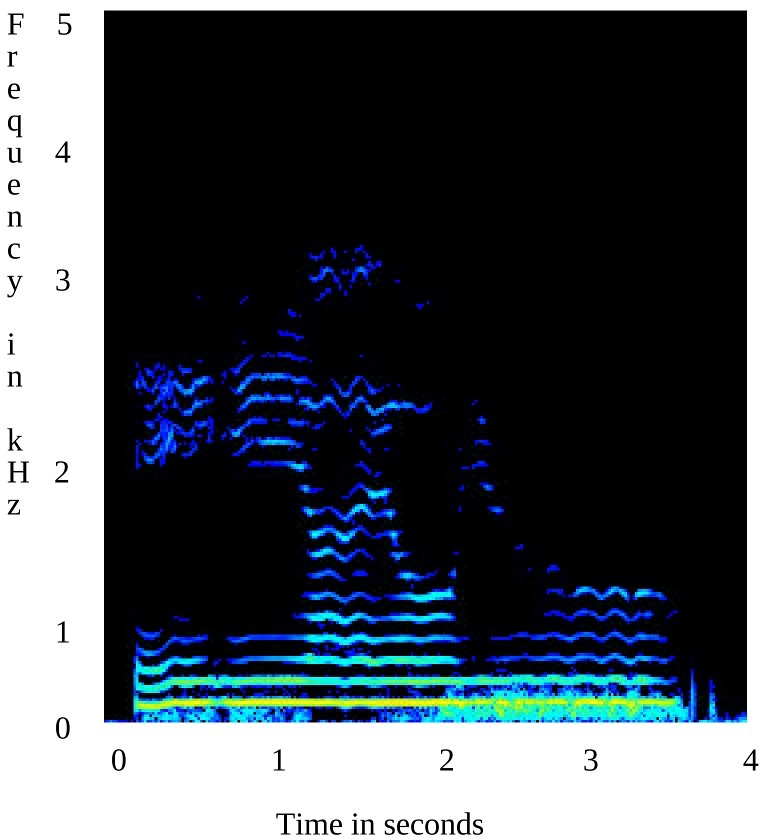
The beginning of Mark's seventh lesson was delayed slightly because the computer with the spectral analysis software had been attacked by a computer virus. We vocalized in a separate room while a technician cleaned the hard drive. Mark was singing well, but his voice seemed a little tired, perhaps from the practicing he had been doing for his musical production. He remembered the process involved in using the equipment, so I did not need to re-explain the procedure.

Figure 4.11. Week 7 spectrogram of Mark saying "My name is . . . and today’s date is"



When we compared the recording of his speaking voice (Figure 4.11) to that of five weeks previous, he noted that the pitch of his voice had raised slightly, which had been our intention from the beginning lessons. I was able to demonstrate the relatively high number of upper partials in his speaking voice through the graphic. When we compared his singing in the middle range (Figure 4.12), he sensed no difference immediately, but I felt that his present tone was less forced and more open.

Figure 4.12. Week 7 spectrogram of Mark singing [e i a o u] in the middle range.



On the low tones (Figure 4.13), his voice was less stressed. The most notable difference was in his high range (4.14), which sounded quite pinched on the earlier recording and had improved greatly. He would not allow me to play the recording of his old singing more than once because of what he felt was a poor tone.

Figure 4.13. Week 7 spectrogram of Mark singing [e i a o u] in the low range.

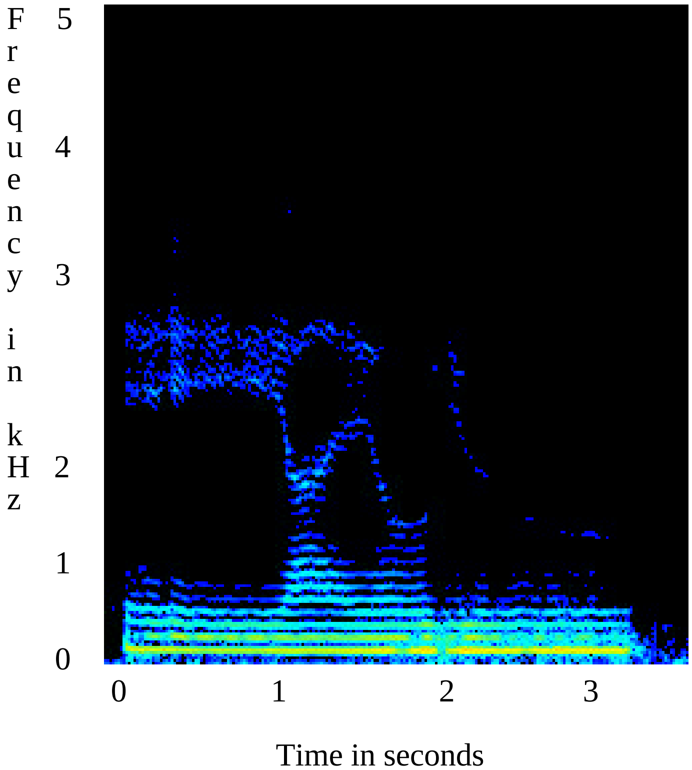
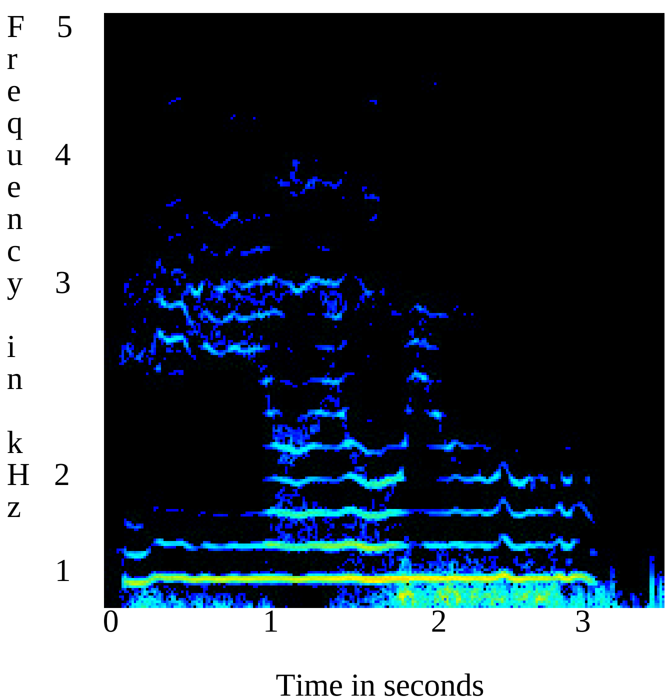


Figure 4.14. Week 7 spectrogram of Mark singing [e i a o u] in the high range.



The work with the snapshot spectral analysis was less inspiring (Figures 4.15-4.20).

Figure 4.15. Week 7 spectrographic snapshot of the [e] vowel for Mark.

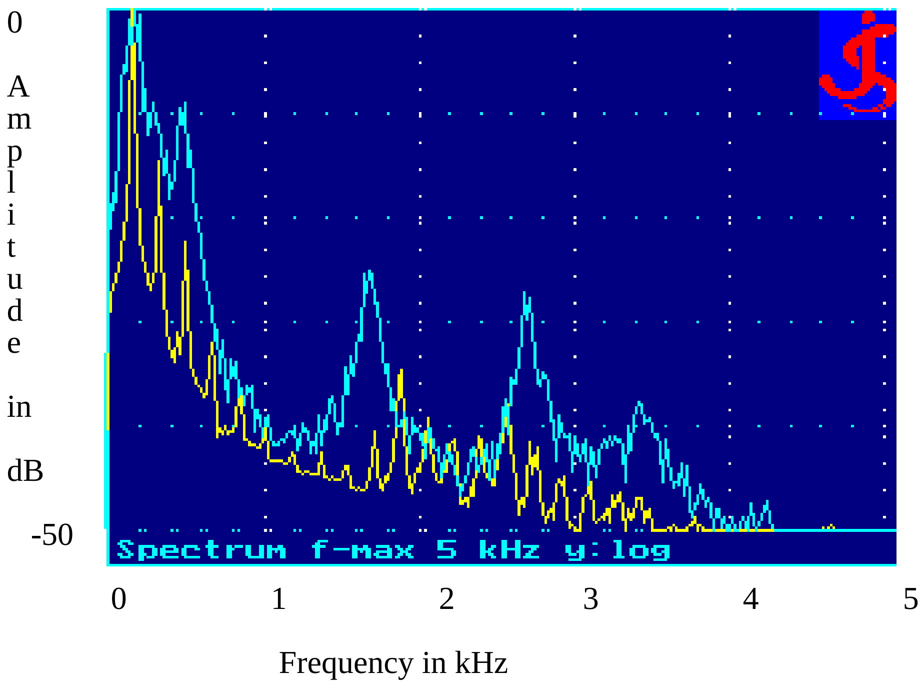


Figure 4.16. Week 7 spectrographic snapshot of the [i] vowel for Mark.

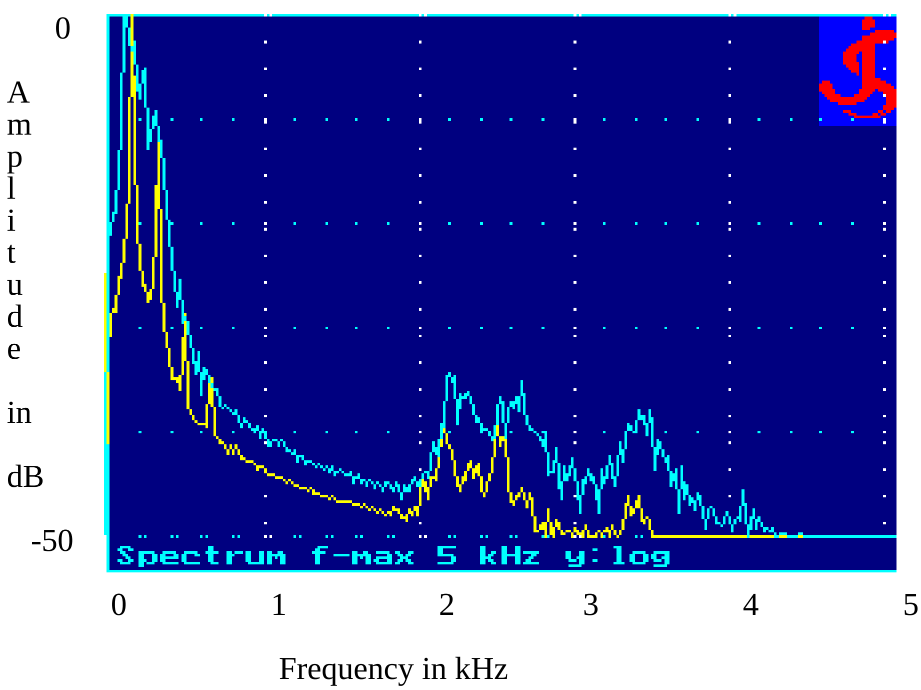


Figure 4.17. Week 7 spectrographic snapshot of the [a] vowel for Mark.

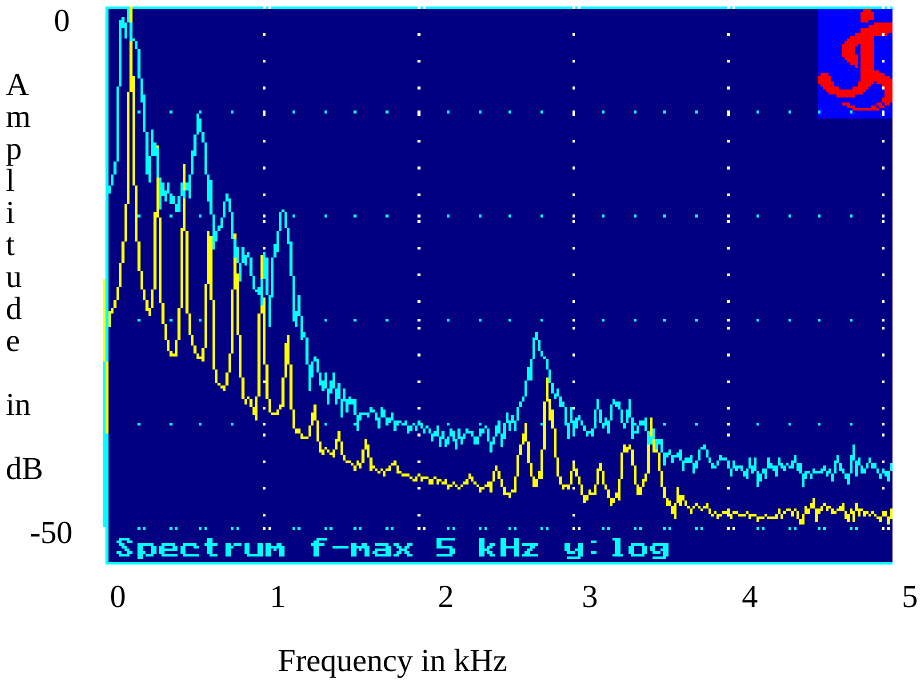


Figure 4.18. Week 7 spectrographic snapshot of the [o] vowel for Mark.

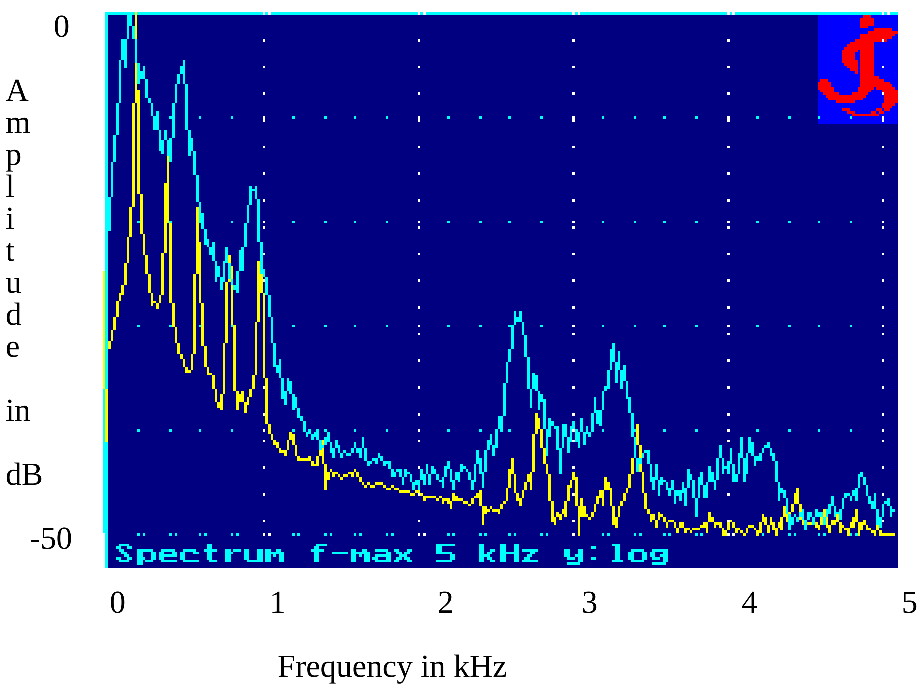
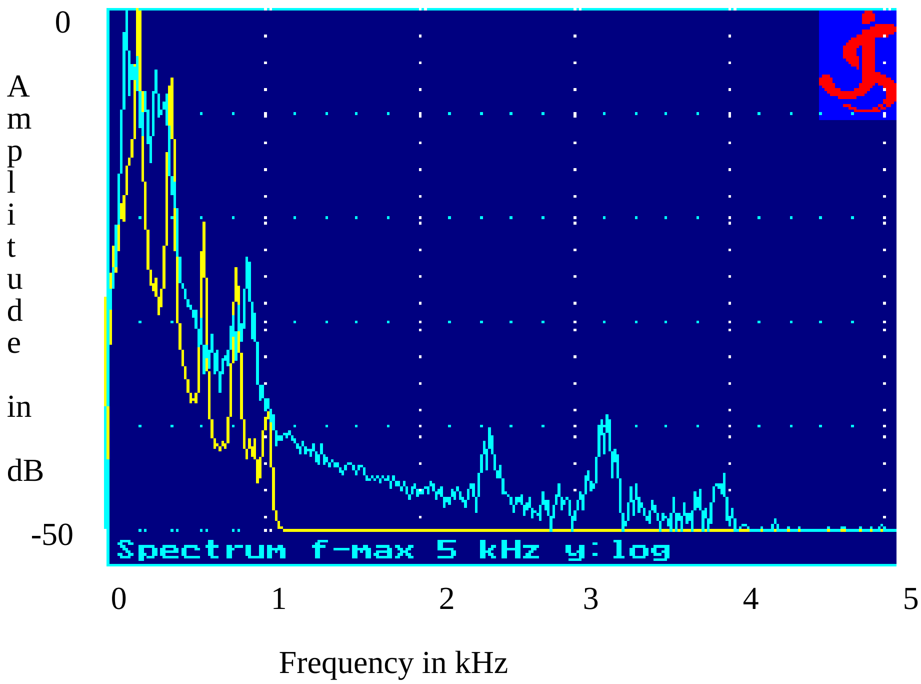
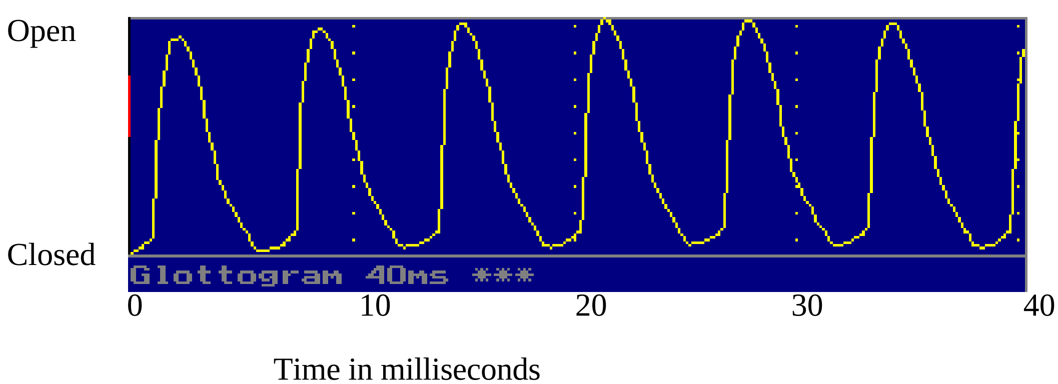


Figure 4.19. Week 7 spectrographic snapshot of the [u] vowel for Mark.



He had already possessed harmonics in the upper range at the first reading (Figures 4.5-4.9), so we did not see much improvement. The one exception was the [o] vowel (Figure 4.18), which showed more resonance after we had manipulated his tone slightly. The Week 7 EGG reading (Figure 4.20) showed Mark was making a more efficient tone than his earlier reading (see Figure 4.10).

Figure 4.20. Week 7 EGG reading for Mark.



During the seventh week, Mark continued his heavy practice schedule with his choir and musicals. In his personal singing, he reported spending about 30% of the time on vocalises, "We've been doing quite a bit of warm up in chorus lately, so I'd say about 70% to 30%, singing to exercises." He was unable to use the software because of the intervening Easter weekend. He thought the use of the spectral analysis software was understandable and useful:

> It was good to compare my voice now to the measurements from a month ago, especially since it showed improvement. . . . I understood most of what was going on the first time, but having another sample to compare the first to made it a little easier to understand. . . . I think the time was well spent.

During the eighth lesson, Mark showed great progress from the beginning of the semester. He continued to make progress in the McClosky Techniques, and was able to move his jaw freely when singing. When I checked his swallowing muscles during phonation, I felt very little tension. His posture was in correct alignment and his ribs moved only slightly as I monitored the expansion of his rib cage during exhalation. He was able to sustain an [s] sound for 44 seconds, a great improvement from his initial 20-second result. I was able to have him vocalize down to a clear F2. He vocalized to an F4 without his breaking into falsetto. I believe he will continue to improve his upper range with experience.

He was able to recite the text verbatim in a dramatic fashion. On the first run-through of his piece, he was singing well, but he missed a few entrances and notes. I suggested that during the intervening week he practice should more with the accompaniment so that he could familiarize himself with the software. We also worked on slight adjustments such as the placement of his hands. I felt that the piece would be ready for the impending performance.

Most of Mark's practicing in the eighth week was for his choirs and musicals, 25% on exercises and 75% singing songs. He had no time to use the practice room. Unfortunately, he had serious reservations about his participation in the final concert:

> I don't think I am [ready for the concert]. This is something I meant to address earlier with you, but because of the musical haven't had time. I don't feel comfortable about singing that solo on Monday. I don't feel my voice or range is strong enough yet for a solo as such, and would rather not participate if at all possible. I've seen great progress in my voice, but I don't feel like I'm at the point where I can perform a solo like that yet. I did my part in aiding your research for your dissertation these last 8 weeks, but if it isn't imperative that I be there Monday, would appreciatively accept your permission to not attend (sic). . . It's a personal thing. I don't think anything you did or did not do affects why I don't want to sing Monday. I appreciate all the help, and I feel I'm well on my way to having the voice I've hoped for, but I don't think I'm there yet.

I reassured him in an e-mail message that I felt he was ready. I suggested that perhaps the stress of his performance in the upcoming musical production was affecting his confidence. We decided to transpose his piece down a step so that he would not need to worry about the range of the piece.

Concert. At the concert, Mark's performance belied his insecurities with his preparation. In the rehearsal, he did miss one note and one rhythm, but after another run-through, he corrected his mistake, and none of these mistakes materialized in the concert. At the beginning of the piece, the balance with the accompaniment was off. Mark made the choice to sing the beginning phrases softly and musically, and the computerized accompaniment could not adjust to his volume choices. Once he reached the more aggressive portions of the song, the balance was acceptable. The computer's entrance to the last verse ("and the world . . .") also seemed awkward. Mark's part of the performance went well, as he sang with confidence and emotion.

Final journal for Mark. In his final journal, Mark had the most positive comments of all the students concerning the spectral analysis process:

> I believe [the technology] helped in the respects that we took 'pictures' of my voice early on in the lessons and then again later. I could visually see the progress as opposed to just hearing it. . . . I found the spectral analyses worth the while because I'm more of a visual learner. I could actually see what my voice was doing, and how I could change it.

He also had positive comments about the SmartMusic system, "I enjoyed using the SmartMusic system. I'm majoring in computer science, so technological advances like this are appealing to me. I think it has great potential for accompaniment in the future." He also found his performance with the computer accompaniment to be acceptable, "For the song I sang, the computer accompaniment was fine. There really weren't many places in the score that I could have gotten off and therefore have needed a human accompanist to cover me."

He found the Web pages useful for reference material:

> The Web pages are nice in that if I forgot how to do something, or couldn't remember what pieces I could have chosen from for the concert, I could go to the site and look it up. It saves having to call you, making a trip to the music building, or fumbling through tons of papers to find one item.

Summary. Mark was a young tenor with a good deal of musical and technical experience. He received lessons that were heavily saturated with technology. He appreciated the use of Web pages both within lessons and as an outside resource. Of all of the participants, he had the most positive comments on the use of spectral analysis. He also had positive comments on the SmartMusic system, although his busy schedule did not allow for much outside practice. Although he felt apprehensive about singing at the concert, he performed very well and was well received by the audience. With his strong technical background, he was a model of the type of student who reacts well to the incorporation of technology into the lesson.

Brenda

Demographic information. Brenda was an 18-year-old freshman music education major with an instrumental emphasis. She reported a good deal of singing experience:

> I have enjoyed singing (and music) for as long as I can remember. I sang throughout elementary school, junior high, and high school. In high school, I was in the concert choir, show/jazz choir, and musicals. I have sung various solos at my church, and have also done many ensembles for contest. I went to IMEA District Choir my junior year. I really enjoy singing, but I regret that I've never had formal vocal training. I think it would be very interesting and also important to do as I am studying music education.

She categorized herself as an alto, because that is the part she had sung in choirs, but reported a desire to sing soprano parts. She had also played French horn for 10 years, participating in "many ensembles, including school band, youth symphony, church orchestra, district band, and all-state orchestra." She also had taken nine years of piano lessons growing up, so she had already accomplished much musically.

Her technical experience was adequate for the use of technology in this study, "I've used computers for personal use for several years, and I use e-mail frequently, as well as the WWW. I've also used word processing for school purposes. I have my own computer in my dorm room, and I use it all the time." She said she checked her e-mail regularly, and stated that she would definitely make participation in the experiment "a priority."

Lessons. During the first week of practice, she kept good logs, reporting practicing "Wednesday for about 10 minutes in the evening, Thursday morning for 10 minutes, Saturday afternoon for 5 minutes, Sunday evening for 15-20 minutes." She accessed the pages only once for about 10 minutes, but stated they were a "good supplement and reminder of exactly how I should be doing the exercises . . . mostly I practiced from memory, but the pages were a good reference." Within the lesson setting, she found the pages

> effective for me because it gave the words used by the teacher a visual [aid], which is good for me. And the diagrams (esp. of the tongue) were particularly helpful. The lesson was personal enough, but used the technology well I think. . . . No suggestions [for changes] really come to mind. I thought the use of the pages was just about right, not too much, but enough to help. . . . They're quite good now, but I don't always like having to click next and then having to go back to see the previous ones. If all the sections were on the same page, I would like it better—just a personal thing though, they're good pages.

General comments included, "It wasn't what I was expecting, but it was helpful to learn about tension points and getting everything relaxed. It has been difficult trying to speak in a higher-pitched voice, but I'm working on it!"

During the second lesson, Brenda stated she had used the Web pages to review and she had appreciated the use of graphics. The Web pages had been helpful in the lessons as well. She still had significant tension in the swallowing muscles.

Her posture was acceptable, except for a slight curvature in the back, but her body type made monitoring her ribs a challenge. During the breathing exercises, I found that she collapsed her ribs immediately on initiating a note. Her inhalations were excellent because of her previous experience playing the French horn, but she used her ribs on the exhalation more than I prefer.

Initial vocalizations went well. She had over a three-octave range, down to B2, but I did not take her to the highest point of her voice this early in lessons because tension existed when she sang. I coaxed her to sing less stridently.

During the second week, Brenda practiced every day for between five and 15 minutes, about 70% on exercises, and 30% vocalizing. She found the diagrams in the Web pages effective. She had several comments about the new breathing techniques:

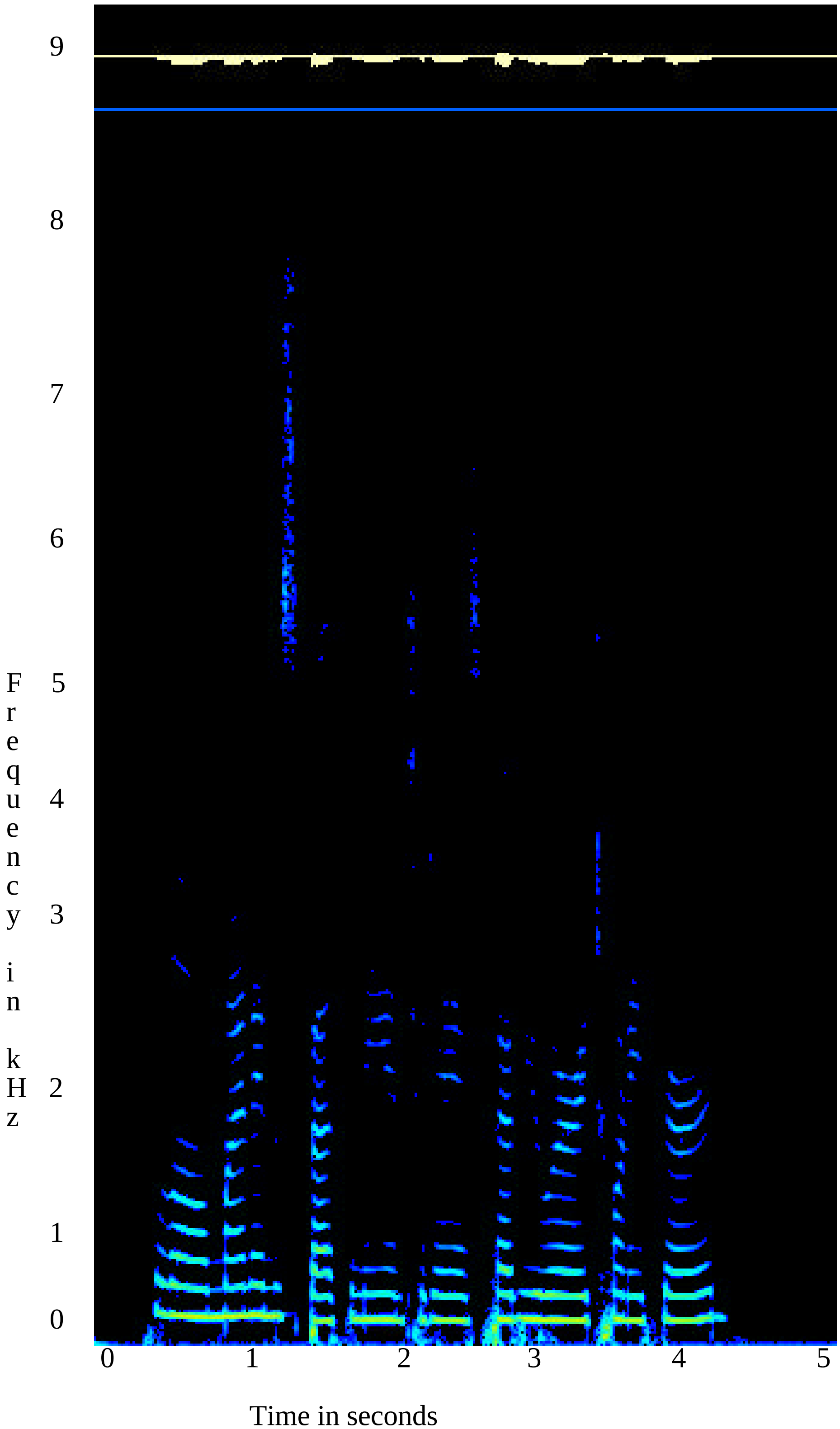
> It was really interesting in learning about breathing from the ribs—I wasn't aware that I was doing that. I always thought I was breathing from the diaphragm, but perhaps not deep enough, when now I know I'm using my rib muscles more than my diaphragm. I still need to work on it more though. It is difficult to keep from collapsing my ribs.

In her journals, she stated she preferred using the on-line survey for data collection, but in her interview the following week she said she had no preference between the Web form and the e-mail.

During the third lesson, Brenda stated she had practiced the breathing exercises during the week, but she was able to sustain an [s] sound for only 20 seconds, which showed no improvement from the week before. She exhibited a nice, long range of 3 octaves from C3 to C6. The tone was open in her middle range until about D5, when she began to constrict her voice.

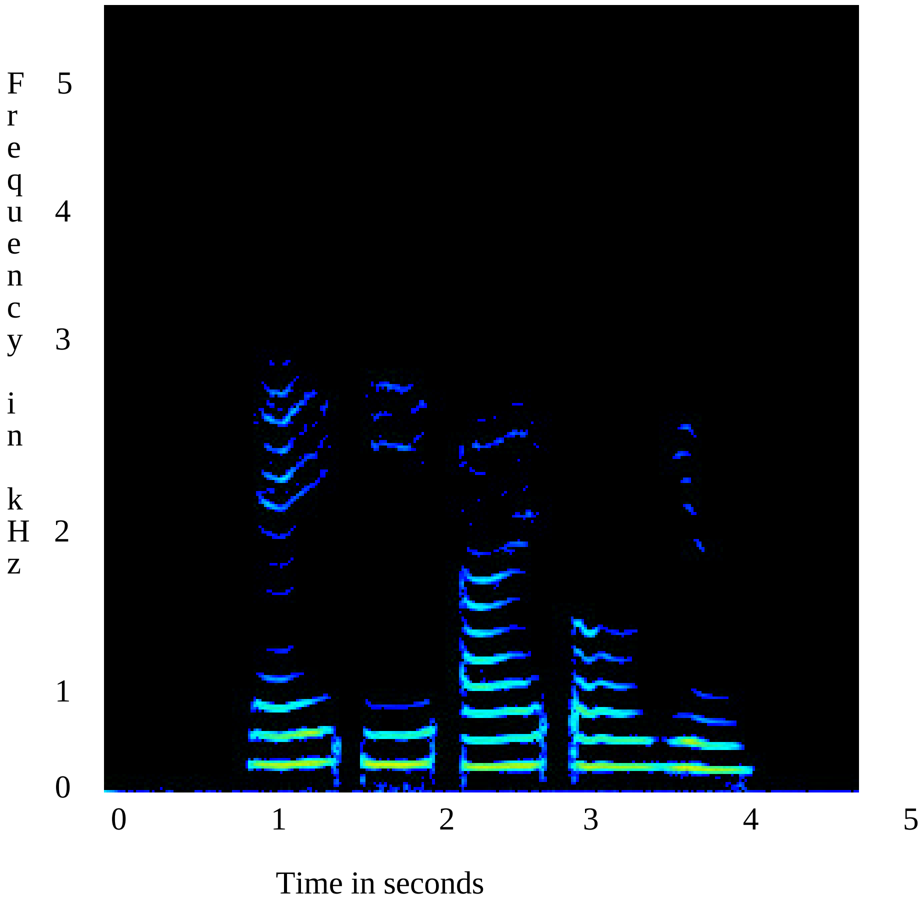
When I began to explain the spectrogram to her, it was clear she had a good understanding of the physics of sound already, so she was not benefiting from my explanations. Initial analysis of her speaking voice (Figure 4.21) was unremarkable.

Figure 4.21. Week 3 spectrogram of Brenda saying "My name is . . . and today's date is . . ."



Time-based spectrographic analysis showed graphically that when she spoke the vowels, the unwelcome glottal attacks were clearly visible (see Figure 4.22).

Figure 4.22. Week 3 spectrogram of Brenda speaking the vowels [e i a o u].



The thinness of her voice was apparent on the high notes (see Figure 4.25) when compared to her middle (Figure 4.23) and low (Figure 4.24) ranges. (Some differences here are natural, but the readout showed that hers were clearly thinner.)

<u>Figure 4.23</u>. Week 3 spectrogram of Brenda singing [e i a o u] in the middle range.

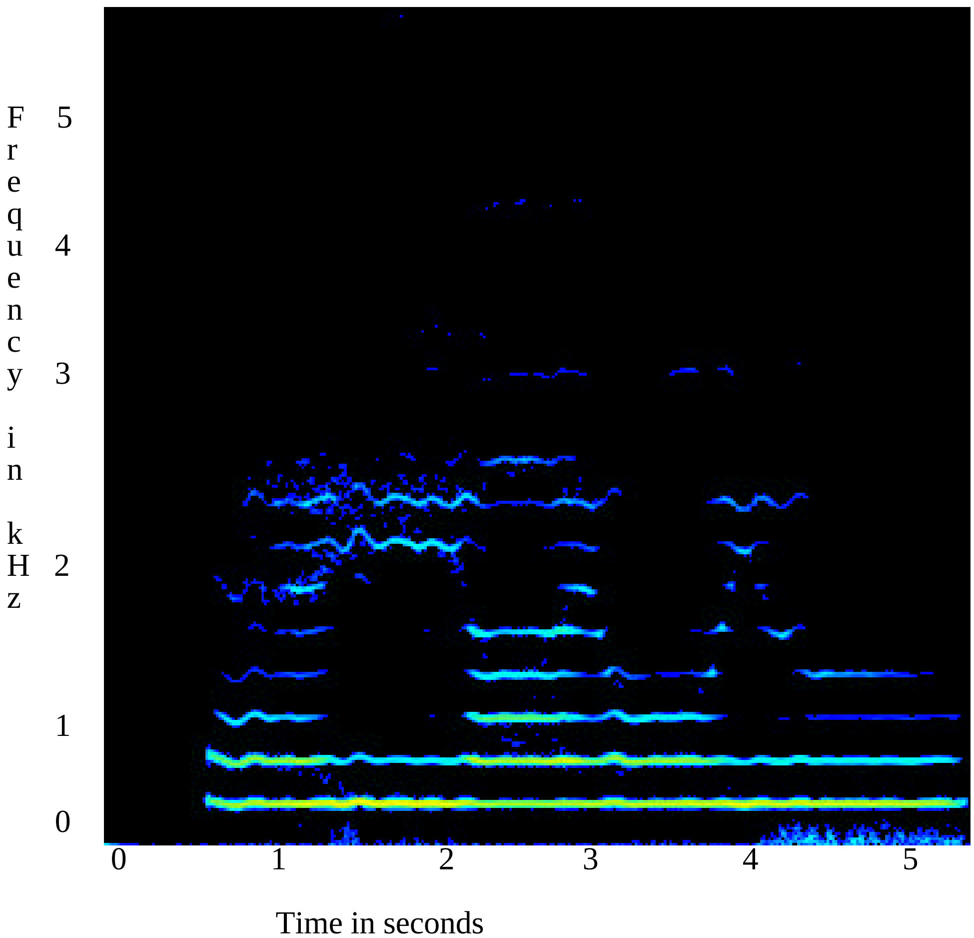


Figure 4.24. Week 3 spectrogram of Brenda singing [e i a o u] in the low range.

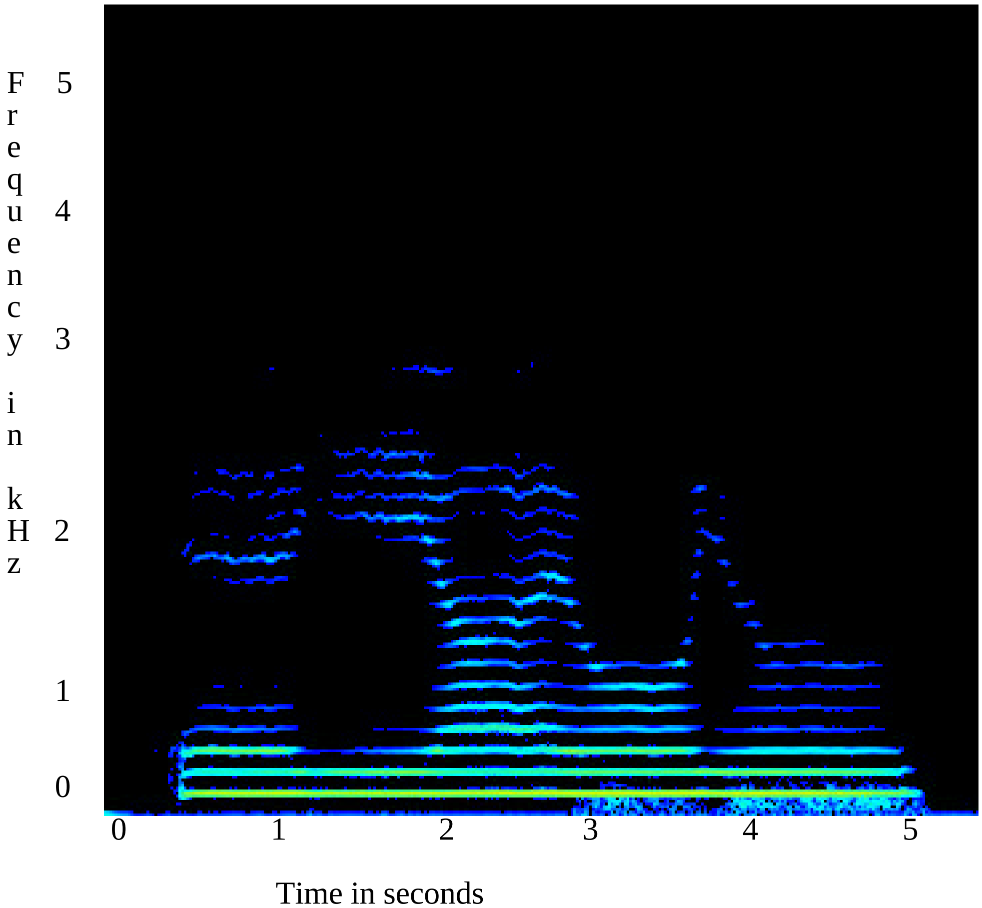
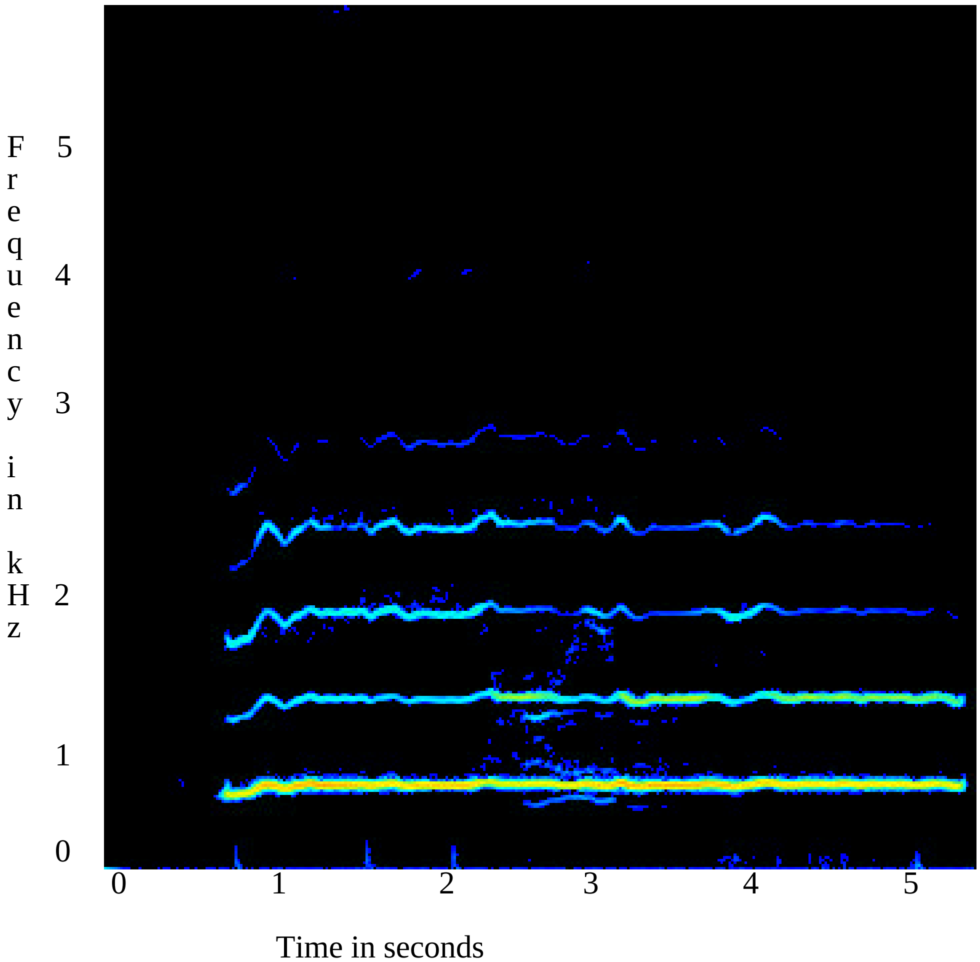
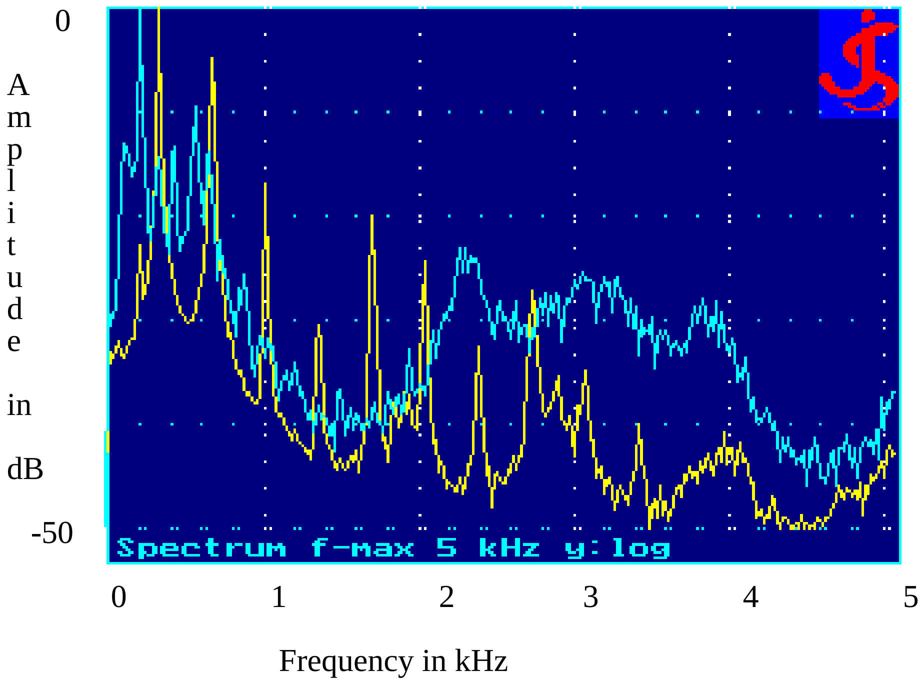


Figure 4.25. Week 3 spectrogram of Brenda singing [e i a o u] in the high range.



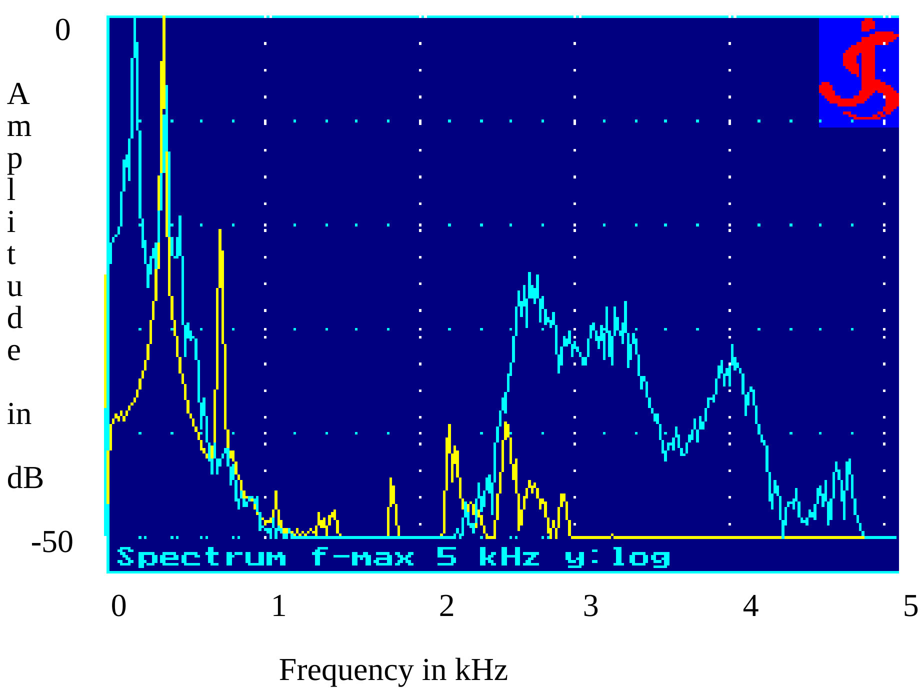
The spectrograph was more difficult for her. She had difficulty producing the fry tone without hurting herself because she was trying too hard. The initial reading on the [e] vowel (Figure 4.26) showed that she was producing upper partials. The graph of her singing tone (the lighter line) contained many spikes, which did not always align with the reading of her potentially most efficient vowel (the darker line).

Figure 4.26. Week 3 spectrographic snapshot of the [e] vowel for Brenda.



The [i] vowel (Figure 4.27) showed an almost complete lack of upper partials, indicating that she was pinching her tone on this particular vowel.

Figure 4.27. Week 3 spectrographic snapshot of the [i] vowel for Brenda.



Readings from Brenda's [a] and [o] vowel (Figure 4.28 and 4.29 respectively) were more acceptable, with resonance peaks approximating their theoretical values.

Figure 4.28. Week 3 spectrographic snapshot of the [a] vowel for Brenda.

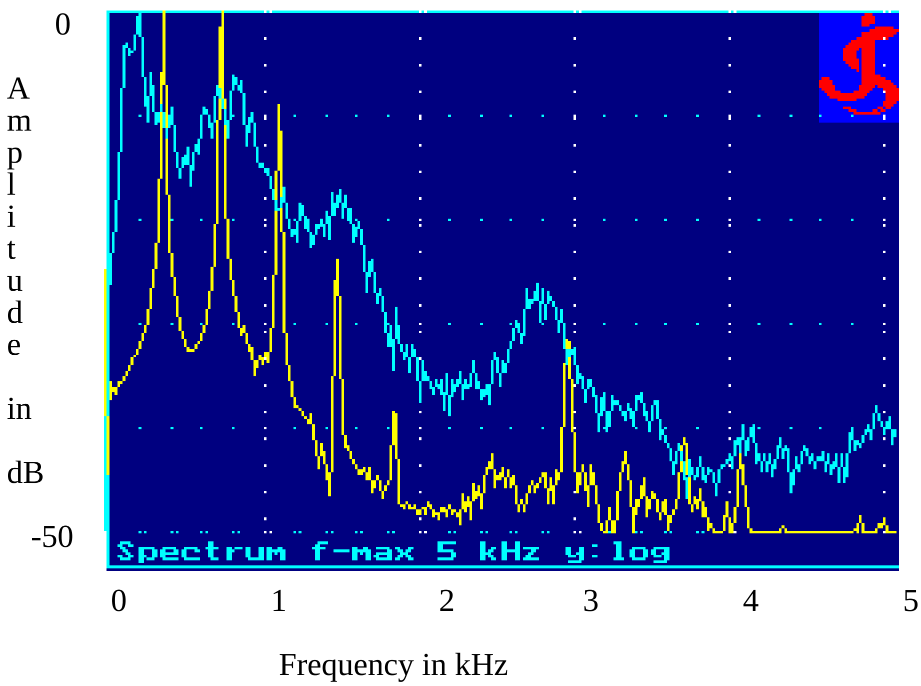


Figure 4.29. Week 3 spectrographic snapshot of the [o] vowel for Brenda.

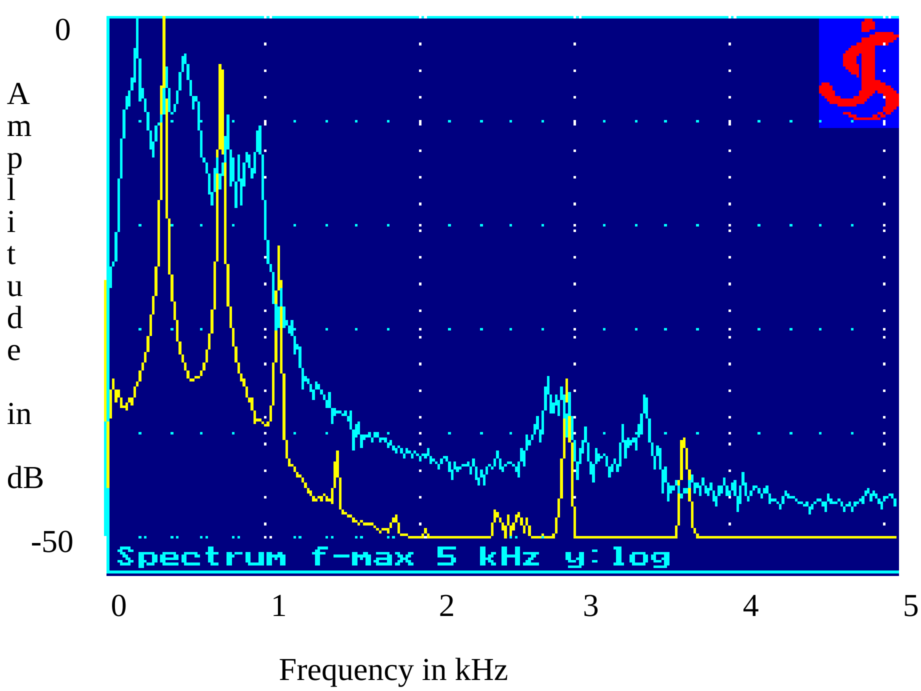
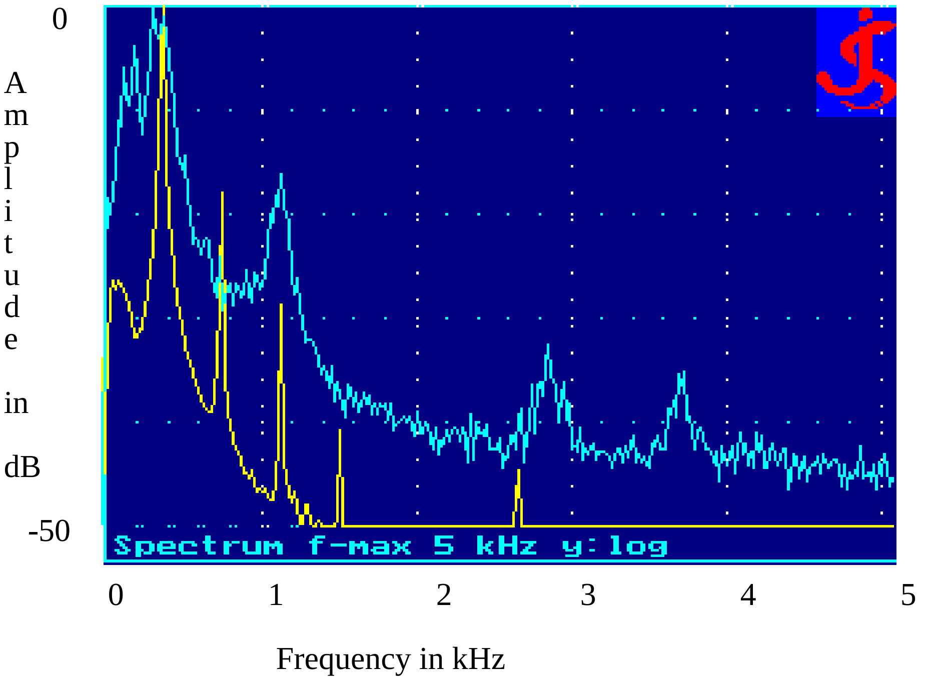


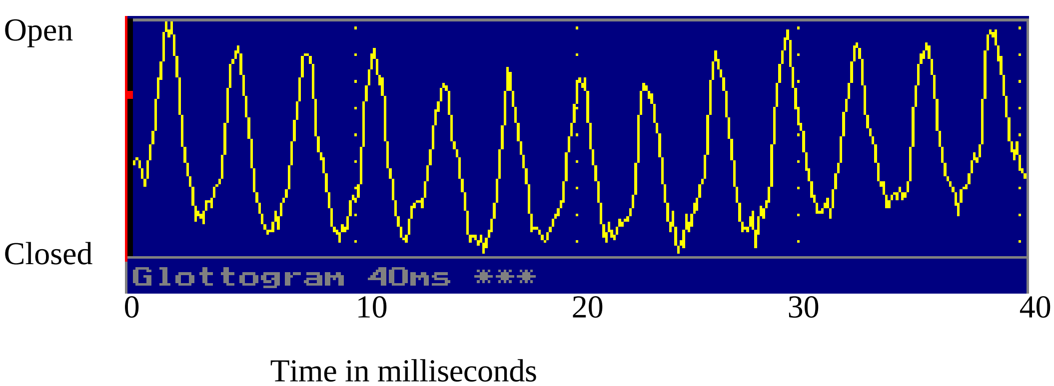
Figure 4.30. Week 3 spectrographic snapshot of the [u] vowel for Brenda.



We were able to change the readings from the spectral snapshots by manipulating her jaw and tongue to produce a more efficient tone.

The EGG reading for Brenda (Figure 4.31) was difficult to obtain. I believe physiological factors influenced this reading, and so I discount the appearance of readout that shows incomplete closure.

Figure 4.31. Week 3 EGG Reading for Brenda.



In the journal for the third week, Brenda reported she practiced for about one and one-half hours, 40% on exercises and 60% singing songs. She found the spectral analysis intellectually stimulating, "I found it very interesting to be able to see what my voice was doing. You did a good job of explaining what the graphs represented, so I think it was very helpful." She also appreciated having the screen shots on line.

During the fourth week's lesson, Brenda again reported that she had found the previous week's spectral analysis "interesting." When prompted, she seemed not sure if using the software had helped her with her singing, or whether it simply had been intellectually stimulating. She had made good improvement in her exercises and we continued to work on opening her tone and making it less strident.

After the initial demonstration of the SmartMusic software, she was able to boot the computer, launch the software, and find the various features of the software without prompting. She had trouble in small-scale adjustments of pitch in the tuner, missing many notes of the scale by 10 cents or more. Since she was a music major, I suggested she refine her pitch-matching ability. She was able to access the songs of her choice without any problem. I suggested she choose from the Italian repertoire because I wanted her to sing in her higher range and make her tone less strident, and the Italian songs are appropriate for this task.

In the fourth week’s responses Brenda reported practicing for about two and one-half hours, including about one and one-half hours with the SmartMusic system. She spent about 30% on exercises 70% on singing songs. She reported no problems using the software:

> It was quite straight-forward, and for anything that I would've forgotten, there were info sheets next to the computer telling step by step what to do, which were good to have just in case, but I didn't have any problems with it. . . . I like the Smart Music program; it's very easy to use and fun.

She preferred using the computer for warm-ups, "It is easier for me to use the computer since then I don't have to think about what I'm playing on the piano at the same time as I'm thinking about warming up, so I'm sure it's easier for you. [It] doesn't bother me at all to do warm-ups from the computer." Concerning the intonation exercised, she said "It was a good exercise for me. . . . I had some definite room to improve, so it was a good thing for me to work on. . . . As for the program itself I thought it was well-designed and useful." She also had generally positive comments on the accompaniment:

> It was a LOT of fun to sing through songs. I think it is most useful when you already know the song. When I sang through some Broadway songs that I already knew, it was very easy to follow and very fun. When I sang through the Italian songs, it was a little harder since I wasn't as familiar with them. Occasionally I would get lost and need to look at the measure numbers on the computer to find where it was. So, usually it took me 2 or 3 times to be able to get through one of the Italian songs decently. But overall I still really liked the program.

Brenda was singing well in the fifth lesson. When we worked on the vowels, we had to work with her tendency to form them too far back and dark in tone color. She made some improvement with the tuner, and was able to perform small changes to match pitch better than the previous week. We chose "Alma del core" (Caldara) for a performance piece. Since she was a music major and had good sight-reading skills, she was able to learn the notes quickly, and the rhythm exercises were second nature to her. We spent extra time on learning the Italian text. She sang well, except for [o] vowels that were too dark.

During the fifth week's practicing, Brenda's practicing had increased to about seven hours, with about 70% on singing her new songs. She did not access the computer accompaniments, but did have these positive comments from previous experiences:

> I really, really like it. It's quite convenient. I've had to work with many human accompanists and this is much less hassle in many ways. You practice on your own schedule, it knows its part perfectly, doesn't mind if you want to start over, will do it many times without getting bored, and best of all you don't have to pay it when you're done practicing! Seriously, though, I think it's a great tool.

She also had positive comments about the Web pages, "I bookmarked several for later use too. . . . They're good resources."

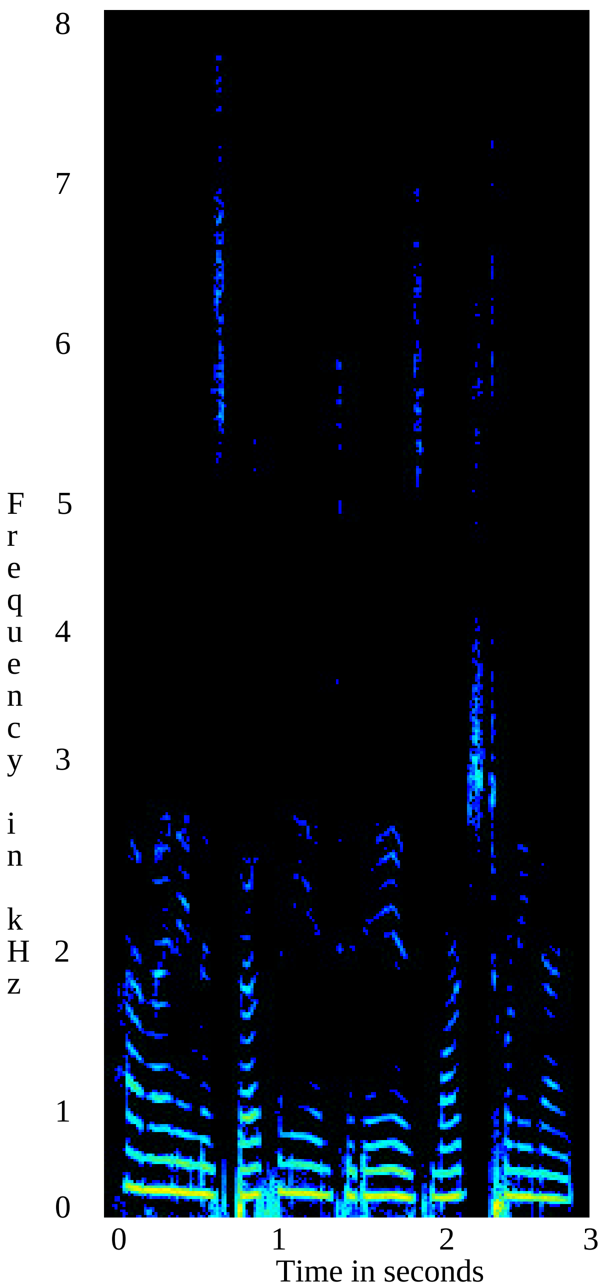
Brenda started the sixth lesson speaking in a very pleasant voice, without some of the stridency I had noticed in her previous lessons. The articulation exercises went well, and since she was speaking so well, I did not find many consonants that needed adjustment. She was pronouncing the Italian text well, with some confusion about open and closed "e" and "o" vowels. When I asked her to increase the meaning in her text, the singing improved greatly. One challenge with her piece was finding meaning in its many repetitions.

During the sixth week, Brenda reported practicing for a total of two hours, once in the practice room for about an hour, with about 75% on singing songs. She had become accustomed to the SmartMusic software, "I feel more comfortable around the equipment now than I did the first time, and it doesn't take me as long to get set up and therefore I can practice longer." She appreciated having the articulation exercises on line so she could work in private, "I am more enthusiastic in practicing them when no one else is in the room, otherwise I'm a little embarrassed, but they are good!"

Brenda's seventh lesson was actually only five days after her sixth because of scheduling conflicts. She continued to show great improvements from her earlier singing and speaking techniques. The exercises I had assigned from previous lessons all showed improvement.

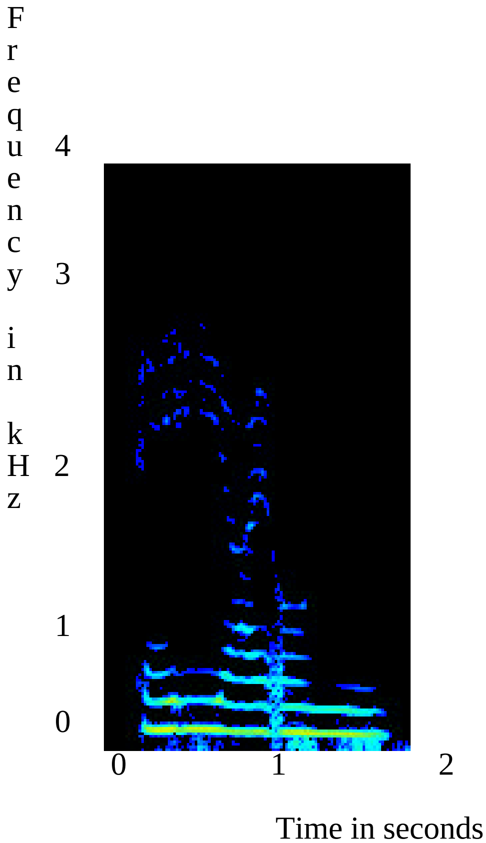
Using the recordings from the time-based spectrogram, we were able to hear differences from her previous tone. Her speaking pitch was far less labored that in the previous recording and the tone was more pleasant (Figure 4.32).

Figure 4.32. Week 7 spectrogram of Brenda saying "My name is . . . and today's date is . . ."



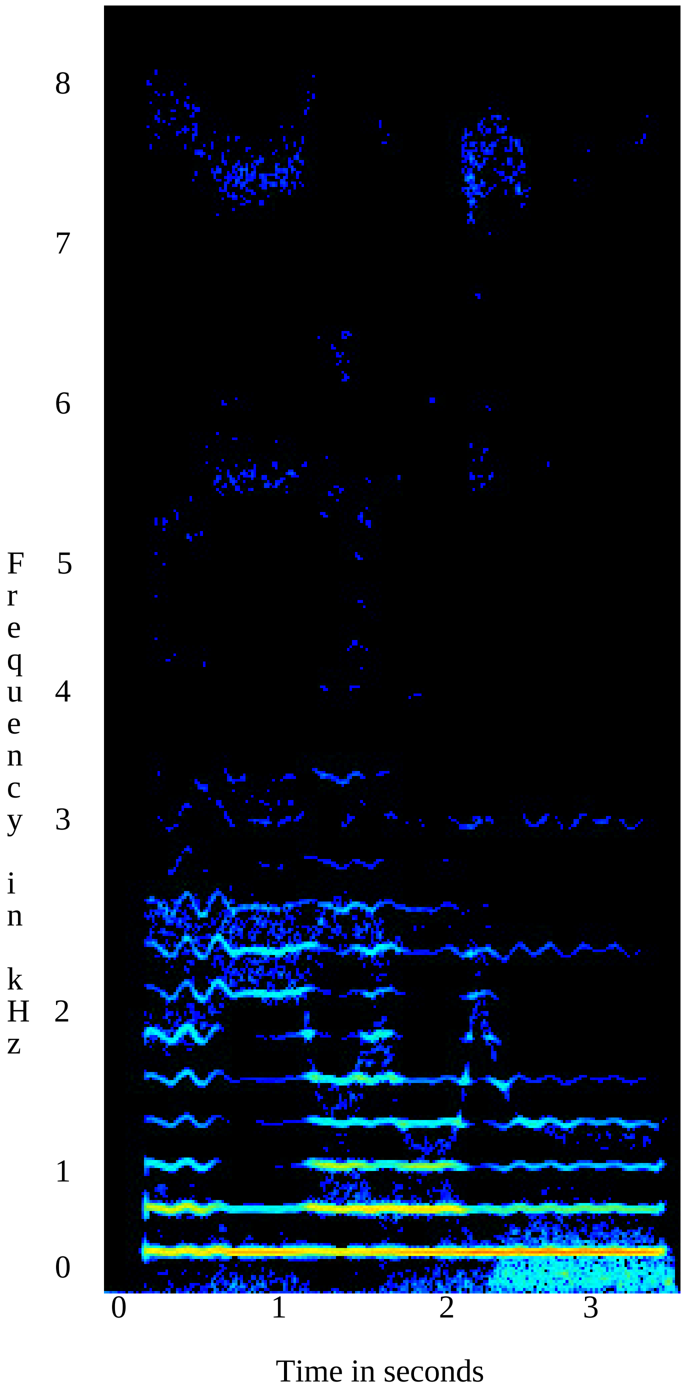
The differences were less easy to notice on her speaking of the vowels [e i a o u] (Figure 4.33).

Figure 4.33. Week 7 spectrogram of Brenda speaking the vowels [e i a o u].



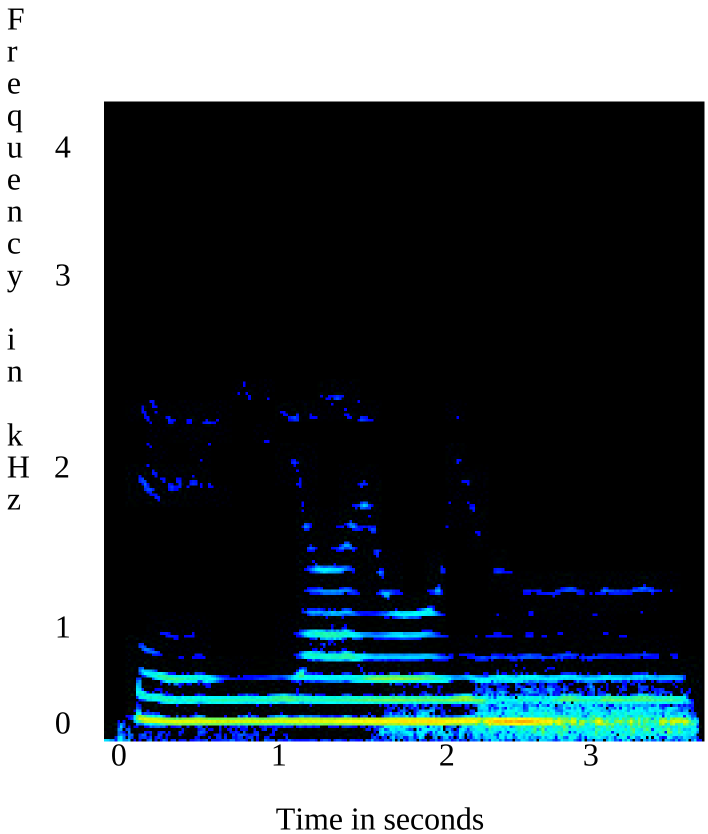
When she sang in the middle range (Figure 4.34), the amount of high resonance was apparent, and I was able to show the difference on the graphic.

Figure 4.34. Week 7 spectrogram of Brenda singing [e i a o u] in the middle range.



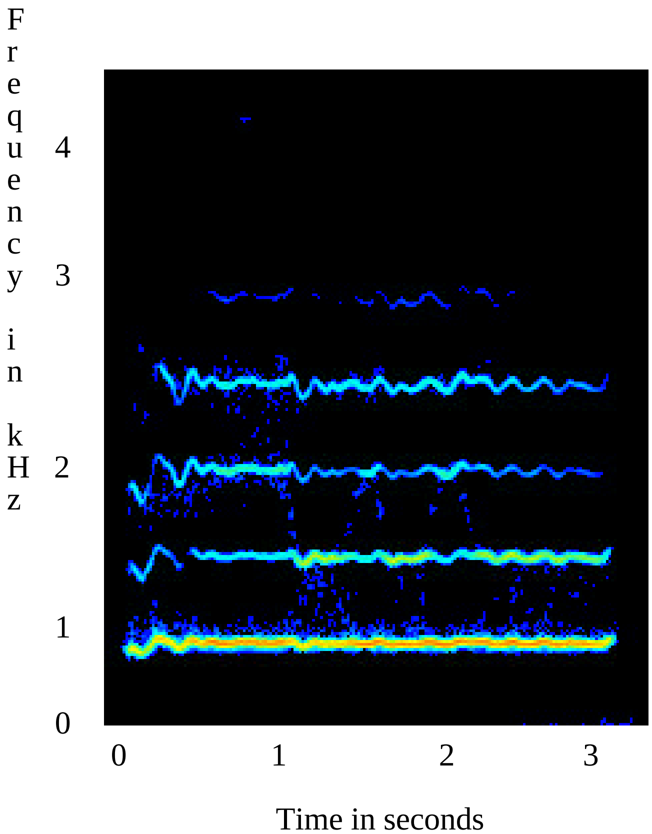
The low tone also showed some improvement and was less strident (Figure 4.35).

Figure 4.35. Week 7 spectrogram of Brenda singing [e i a o u] in the low range.



The high tone showed the least improvement and still was a little covered for my tastes (Figure 4.36).

Figure 4.36. Week 7 spectrogram of Brenda singing [e i a o u] in the high range.



Our exploration with the spectral snapshots (Figure 4.37-4.42) was frustrating at first because I was inadvertently comparing her readings with the older readings from another student. Once we noticed the mistake, a more meaningful conclusion could be reached.

Figure 4.37. Week 7 spectrographic snapshot of the [e] vowel for Brenda.

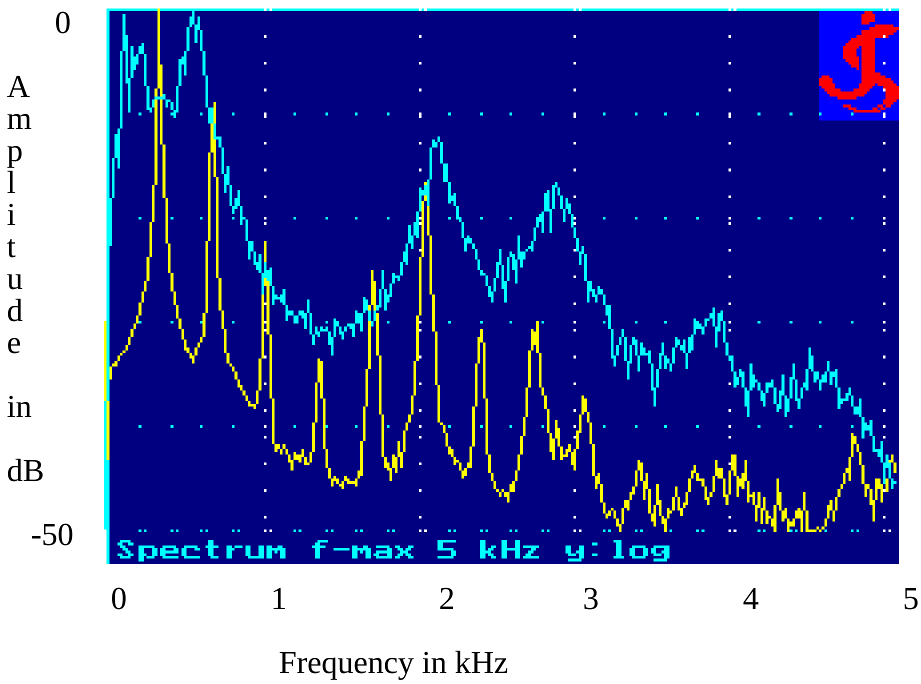


Figure 4.38. Week 7 spectrographic snapshot of the [i] vowel for Brenda.

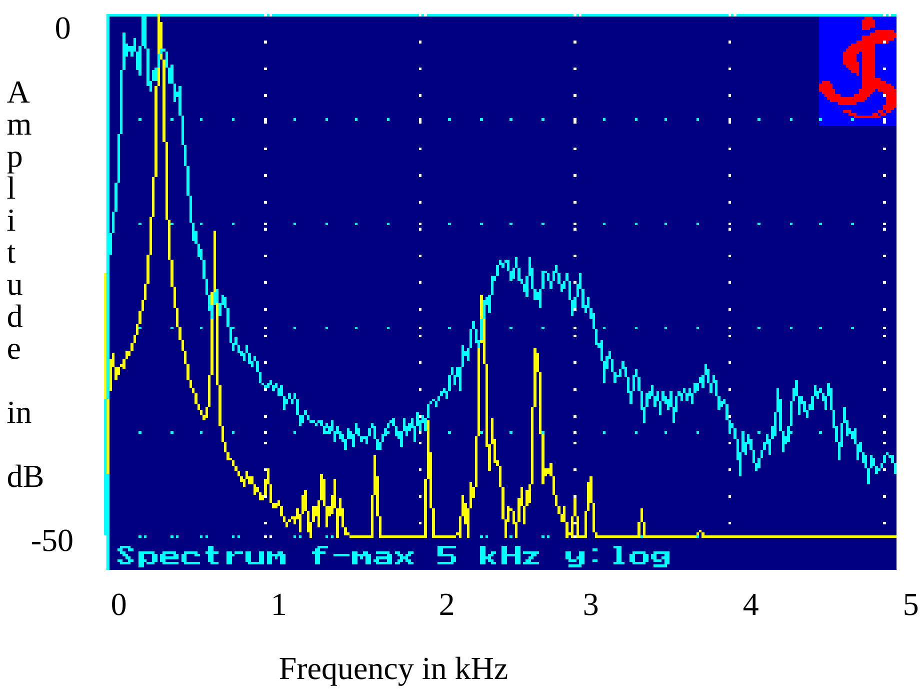
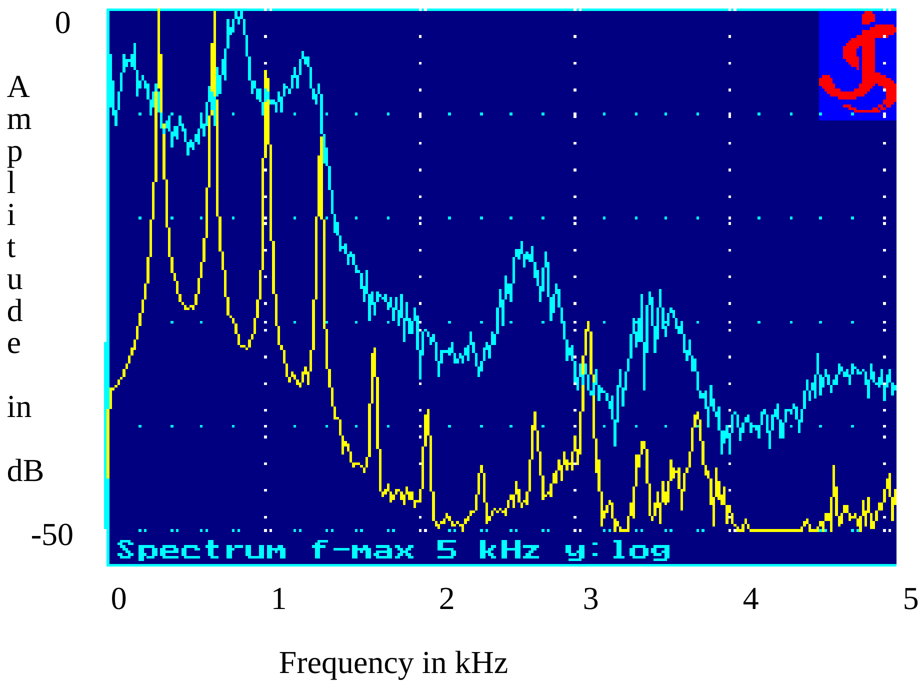


Figure 4.39. Week 7 spectrographic snapshot of the [a] vowel for Brenda.



For most vowels, differences were negligible, but the [o] vowel showed improvement (Figure 4.40).

Figure 4.40. Week 7 spectrographic snapshot of the [o] vowel for Brenda.

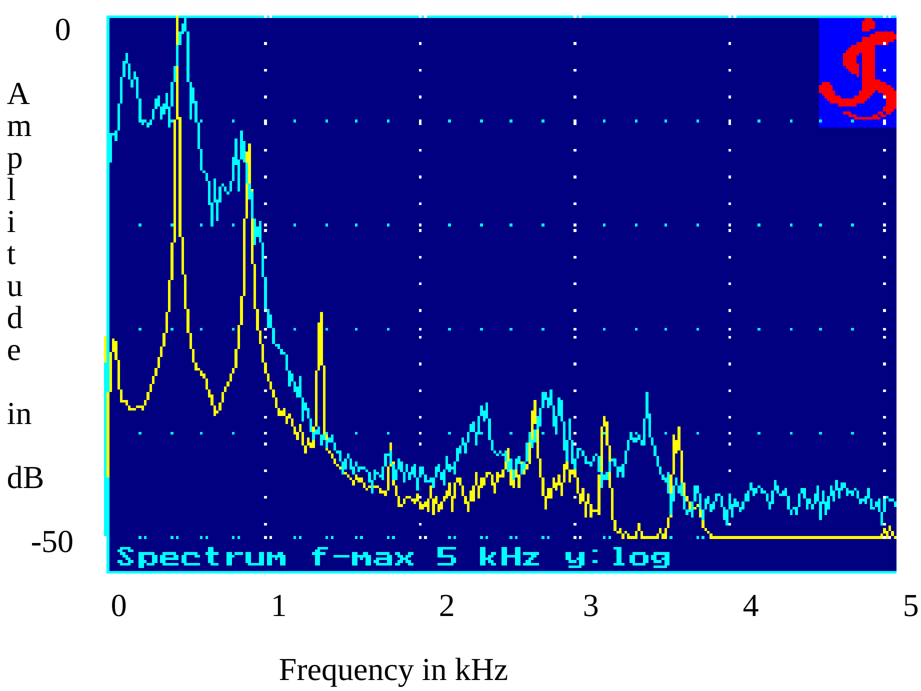
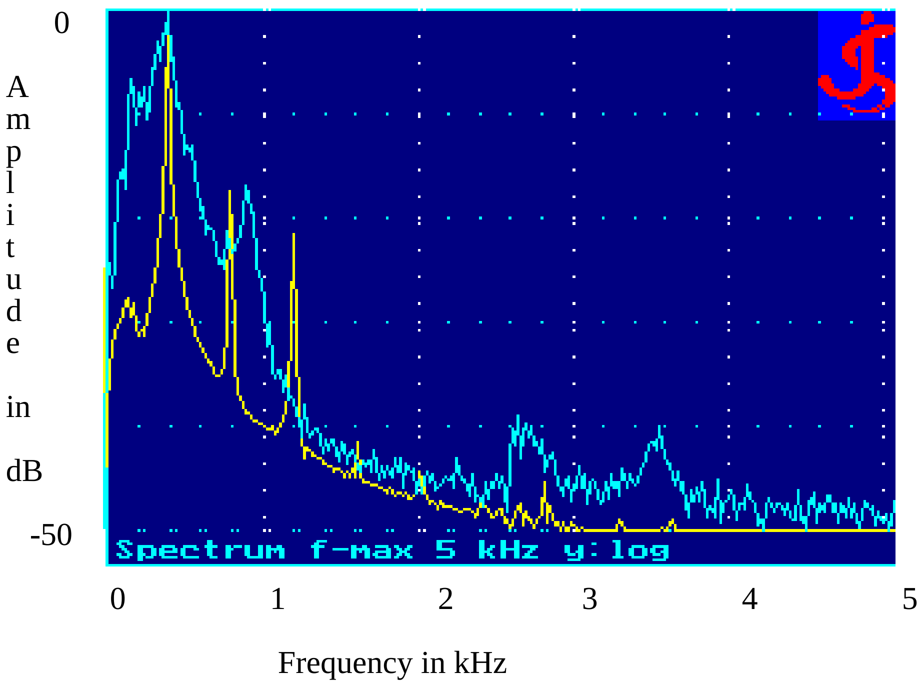
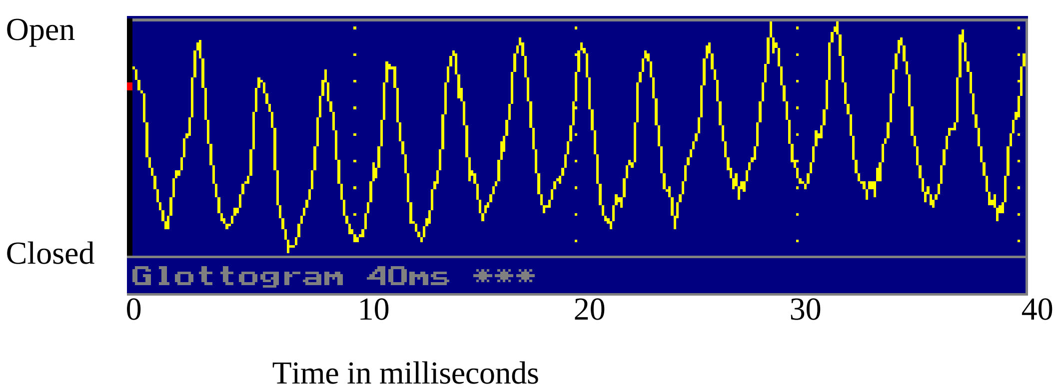


Figure 4.41. Week 7 spectrographic snapshot of the [u] vowel for Brenda.



After several attempts, we were unable to get an acceptable reading from the EGG (Figure 4.42).

Figure 4.42. Week 7 EGG Reading for Brenda.



During the seventh week, Brenda practiced for a total of about an hour and a half, with 30% on exercises and 70% on songs. She did not use the practice area. She found the experience with the spectral analysis software unhelpful, "I could sometimes hear an improvement, but not see it. Also, we were having problems comparing my graph with [another student’s], but even after we figured that out, I still couldn't see that much difference. . . . I think I understood it about the same this time as the first time." She felt the time we spent in the analysis could have been more useful with traditional lessons, "Well, I think it was kind of fun for a while, but I don't know that it really improved my singing or helped me to do anything differently with my singing. So, perhaps not spending as much time playing with the computer would've been more productive."

During the eighth lesson, Brenda showed that she had made good improvement throughout the semester. She was able to move her jaw freely when relaxed and while phonating. Her swallowing muscles were difficult for me to judge because of the shape of her chin, but I sensed no tension either while singing or while resting. Because of her body type, I had a difficult time feeling whether she was collapsing her ribs, but from what I could sense, she seemed to have an expanded rib cage during exhalation. She was able to sustain an [s] sound for 29 seconds, an improvement of nine seconds over her initial reading of 20 seconds. I was able to have her vocalize down to a low C#3 and a high F6.

On the first run-through of the piece, she was concentrating heavily on memorization and lacked musicality. I had to remind her that the song continued during the interludes and ending; since the computer was not a live accompanist, she tended to ignore the final endings after she had stopped singing. Some of the problems we had encountered from the previous week, such as pinched [o] vowels and slight diction challenges, were improved, but still apparent. I stressed adding dynamic swells and dramatic elements to improve the piece, and I suggested experimenting with more ornamentation on the repeat of the main theme.

After the eighth week lesson, Brenda reported practicing for three hours, spread out over the week, with 15% on exercises and 85% on songs. She used the practice room once without incident, "[I] basically just ran through my song many times with the computer accompaniment. . . . I felt quite comfortable with the whole thing." She felt ready for the concert and had no suggestions for what I could have done better. She had positive comments about the lessons in general, "Thanks for giving me the opportunity to have these lessons. I've learned more about singing and have enjoyed it overall."

Concert. During the concert, Brenda performed with the computerized accompaniment. Waiting for the beginning of the piece was awkward for technical reasons, as she was required to look behind her several times to check to see if I had accessed her piece on the accompaniment disk. Once the piece had begun, she performed beautifully, with a smooth legato line, good communication skills, and intricate ornamentation.

Final journal for Brenda. In her final journal, Brenda had positive comments about most of the technology that we used in the lesson:

> I believe that [the technology] helped my voice lessons. The Web pages gave me a way to conveniently access (sic) the information from the lesson when I was at home. I really liked the computer accompaniment, [it was] quite convenient. The voice measurements didn't do that much for me, though. They were somewhat interesting, but not much beyond that.

She found the SmartMusic system convenient, stating, "I like the system a lot for practice and in lesson time. . . . It saves lots of time and effort. I'm not sure it's the best option for performance however." She did appreciate having the SmartMusic system for this concert, though:

> For this particular concert, I am glad I had the computer since it is what I was used to practicing with. However, the computer doesn't really make music as well as a human pianist would—if you know what I mean (no dynamics, phrasing, individual interpretation, etc.). But for the purposes of this recital, the computer worked well for me.

She liked having the Web pages for review outside of the lesson, but had doubts about their use in the lesson itself:

> I don't know that the Web pages IN the lesson helped much . . . probably the diagrams were the most beneficial. BUT, I think the Web pages are best used for the student to review OUTSIDE of the lesson. For me, I found it refreshed my memory and helped me to practice more efficiently and retain more information from the lesson.

She also had mixed feelings about the spectral analysis, "I think it was maybe worth one lesson, but two lessons seemed like too much. I don't know that I learned much from it or that I was able to see any improvement. It was definitely interesting, but like I said earlier, not much more than that."

She finished her journal with some brief positive comments, "Thank you for letting me be a part of your research. I have learned more about singing and have enjoyed it. . . . It was fabulous!"

Summary. Brenda was a soprano with a great deal of musical experience and little technical experience who received voice lessons heavily saturated with technology. She appreciated the use of the Web pages within lessons and more as an outside resource. She found the spectral analysis process intellectually stimulating, but did not feel the software helped her singing. She had very positive comments on the SmartMusic system and performed well with the software at the final concert. She achieved the highest level of technical ability of all the participants.

Jack

Demographic information. Jack was an 18-year-old freshman percussion-performance major whose only voice training had been brief lessons for aural-skills training. Initially he called himself a baritone. He was performing percussion, which he had studied for several years, in several university ensembles, and he had participated in all-state bands. His main goals were to increase his proficiency in aural recognition. He reported his computer experience as minimal, but he stated that he was familiar with the Web and would have no difficulties accessing the pages from home because he owned a personal computer.

Lessons. During the first lesson, I found him laid-back, low-key, and difficult to read. He seemed at ease during the lesson. I did not use the computer as support for the lesson with him. He was naturally relaxed in the McClosky areas and could relax his swallowing muscles without much difficulty. He could even move his jaw slightly, but his laryngeal areas showed some tension.

He had great difficulty in voicing the light, breathy sigh at first. Some improvement was made, but I believe his poor speech patterns influenced his ability to voice the higher tones. I did a good deal of work in establishing optimum speaking pitch, but he reverted to old habits when speaking. His level of excitement was not high, and I anticipated needing to find a way to keep him motivated. He also needed a lot of work on breathing, as his breath was too high in the chest and very audible.

During the first week, he reported practicing for one hour total. He did not use the Web pages as an aid at all, because he felt "Web pages can't be as effective as lessons regardless of alterations." He was very frustrated at the initial slow pace of the lessons, "Personally, I need to sing, I am making a conceded (sic) effort not to fail [an aural-skills course] . . . strange methods . . . I NEED TO SING."

At the second lesson, he reported that he had accessed the Web pages, but could remember the McClosky steps without their support. He said he would have preferred to have the pages in the lesson so that he could have had some visual cues.

I was happy with his progress the second week. He was able to move his jaw very freely. He was a smoker, and I told him that the habit was affecting his singing and speaking, but he showed no signs that my advice would be heeded. He still had a very apparent "fry" in his tone, and he had not adjusted his speaking from the first week.

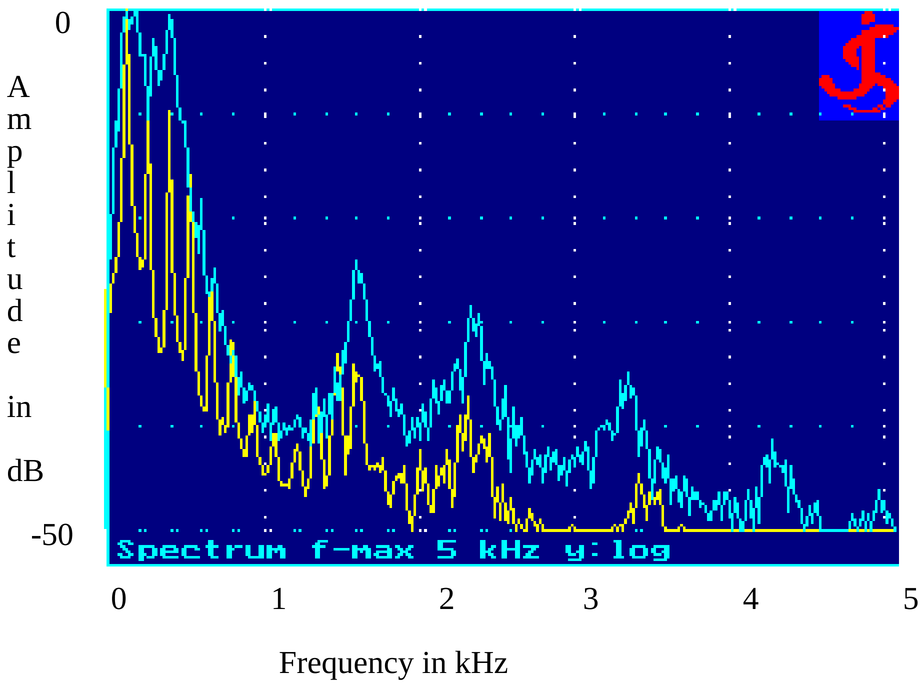
His posture was adequate for singing, although he had a tendency to lower his head slightly. His breathing had a strong clavicular element, so we worked for a long time on a low, relaxed breath. His lung capacity was large and he had excellent control, as he was able to sustain a prolonged [s] sound for 33 seconds, which is quite high for a beginner.

When I had him vocalize, he showed great difficulty negotiating the passaggio. Once he was above the passaggio, he had a light, high voice that could be pleasant. He had pitch-matching difficulty, which I believed came from physical difficulties rather than internalization of the pitch. I started him early on the intonation exercise in SmartMusic because he stated he had a need in this area.

Responses from Jack after the second lesson reflected his growing discontent with the slow pace of the lessons, and his responses became terse. He reported singing for about three hours total, with about 75% being singing and 25% exercises. He was pleased that he had sung more in the second lesson than the first, rather than simply performing exercises. He preferred using e-mail to Web forms for journals.

Because Jack had missed the scheduled time for his third lesson, the activities I had planned for that lesson actually took place a week late, after I had gone through the activities for the fourth lesson. I was therefore unable to make many judgments about the relative effectiveness of the previous week's practicing. The spectral snapshots were not as effective for Jack as the time-based spectrogram was. His voice naturally possessed high overtones that I was attempting to encourage by the use of the software, so none of the manipulations I had him perform changed the readings. Since this was already his fourth lesson in effect, he had already initiated some of the changes to his singing voice (his jaw was loose, etc.), so my suggestions were not as effective as they had been with some of the other students. The reading from the [e] vowel (Figure 4.43) showed excellent potential for resonance (the darker line) and acceptable matching in the resonance peaks when sung (the lighter line).

Figure 4.43. Week 3 spectrographic snapshot of the [e] vowel for Jack.



The [i] vowel (Figure 4.44) did not match as precisely as the previous vowel.

Figure 4.44. Week 3 spectrographic snapshot of the [i] vowel for Jack.

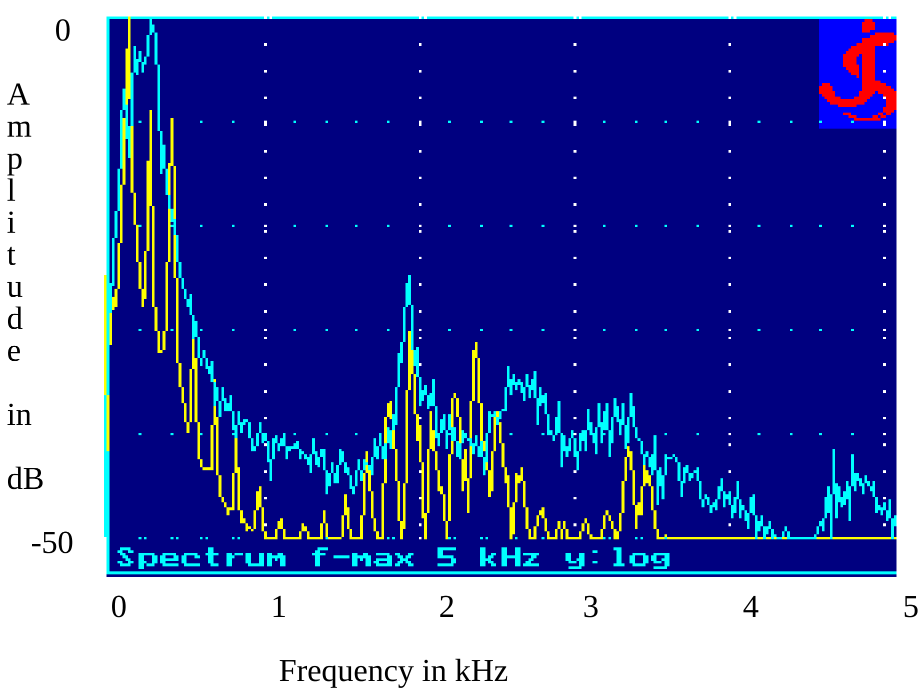
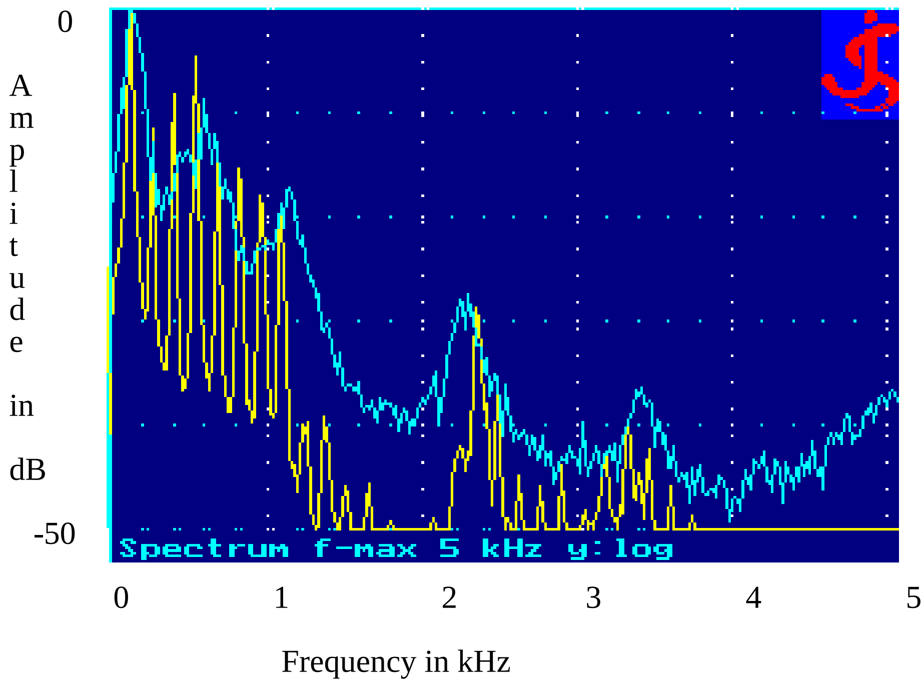
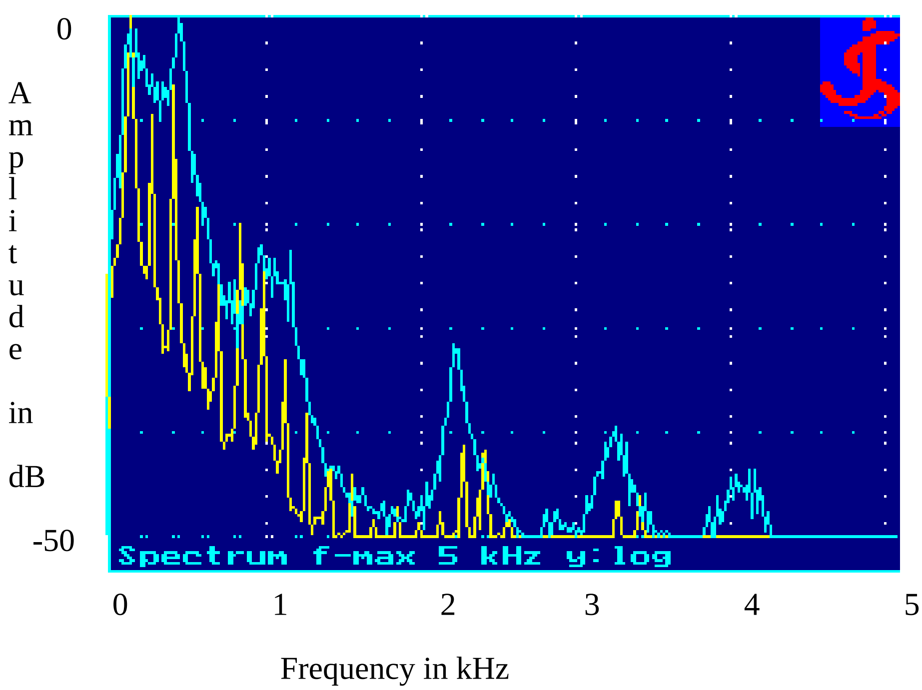


Figure 4.45. Week 3 spectrographic snapshot of the [a] vowel for Jack.



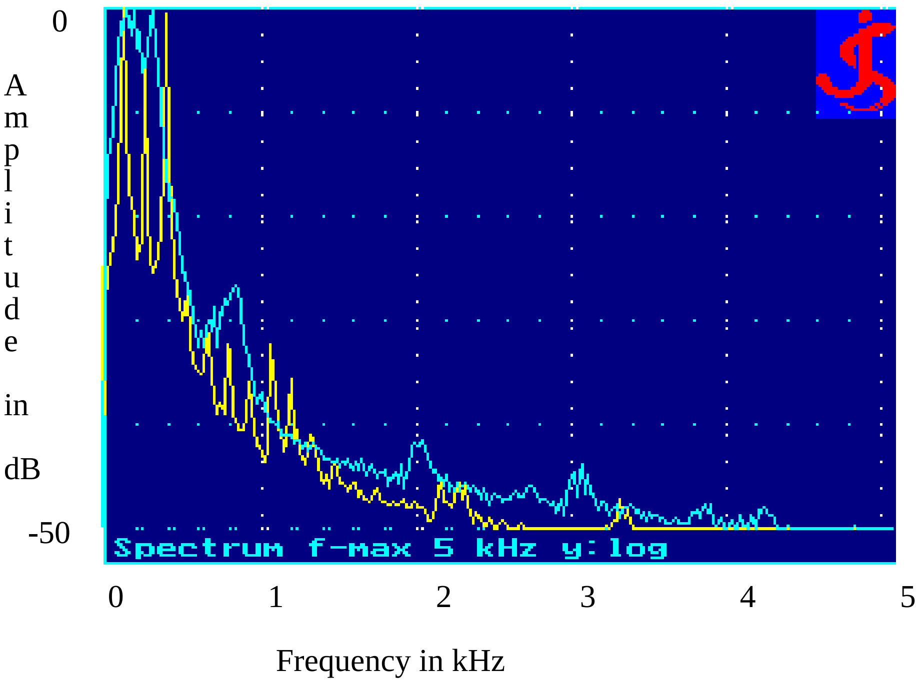
Jack's [a] vowel (Figure 4.45) showed good potential and did not warrant further manipulation.

Figure 4.46. Week 3 spectrographic snapshot of the [o] vowel for Jack.



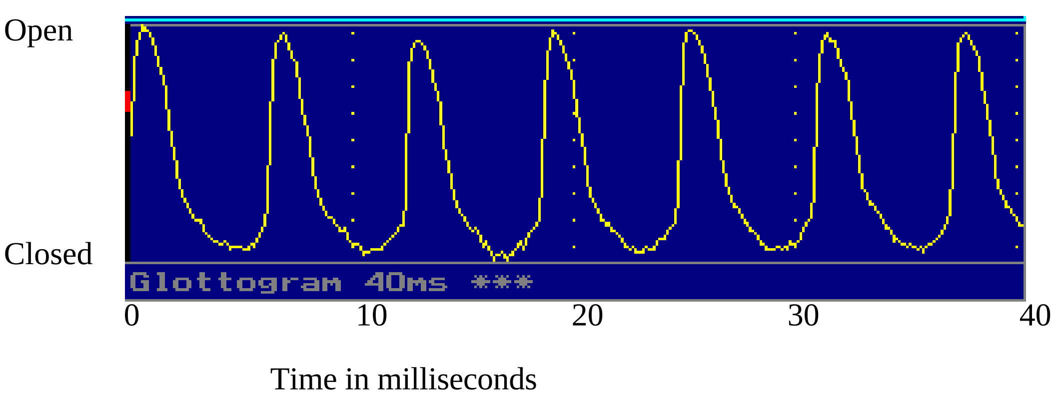
The [o] vowel (Figure 4.46) contained some resonance in the upper partials. However, I was unable to improve the readings by further manipulation. The [u] vowel (Figure 4.47) was the least suited to this exercise.

Figure 4.47. Week 3 spectrographic snapshot of the [u] vowel for Jack.



EGG readings (Figure 4.48) were sufficient for technical explanation, but were not adequate to make pedagogical choices or take CQ readings.

Figure 4.48. Week 3 EGG Reading for Jack.



Use of the time-based spectrogram was more beneficial to Jack. He seemed to understand my explanations of the nature of the acoustics of the voice mechanism and was able to relate to the visual reinforcement from the spectral analysis. When I took the reading from his spoken voice (Figure 4.49 and Figure 4.50), I noticed that his natural voice contained many high overtones, which are effective in the trained singing voice.

Figure 4.49. Week 3 spectrogram of Jack Saying "My name is . . . and today's date is . . ."

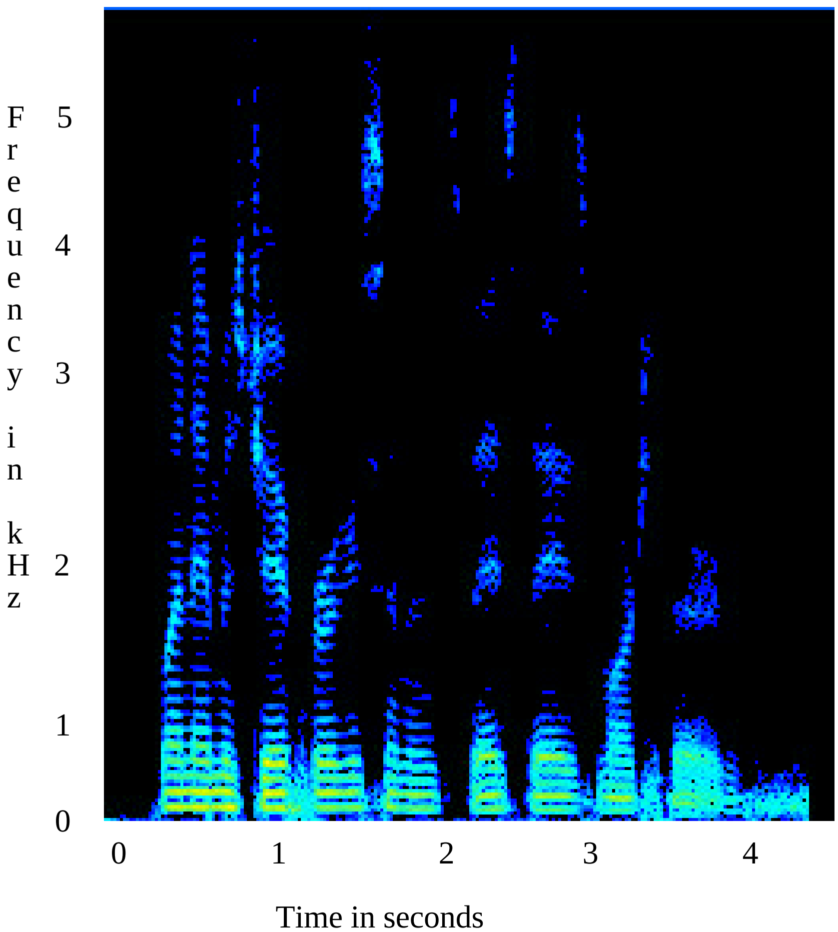
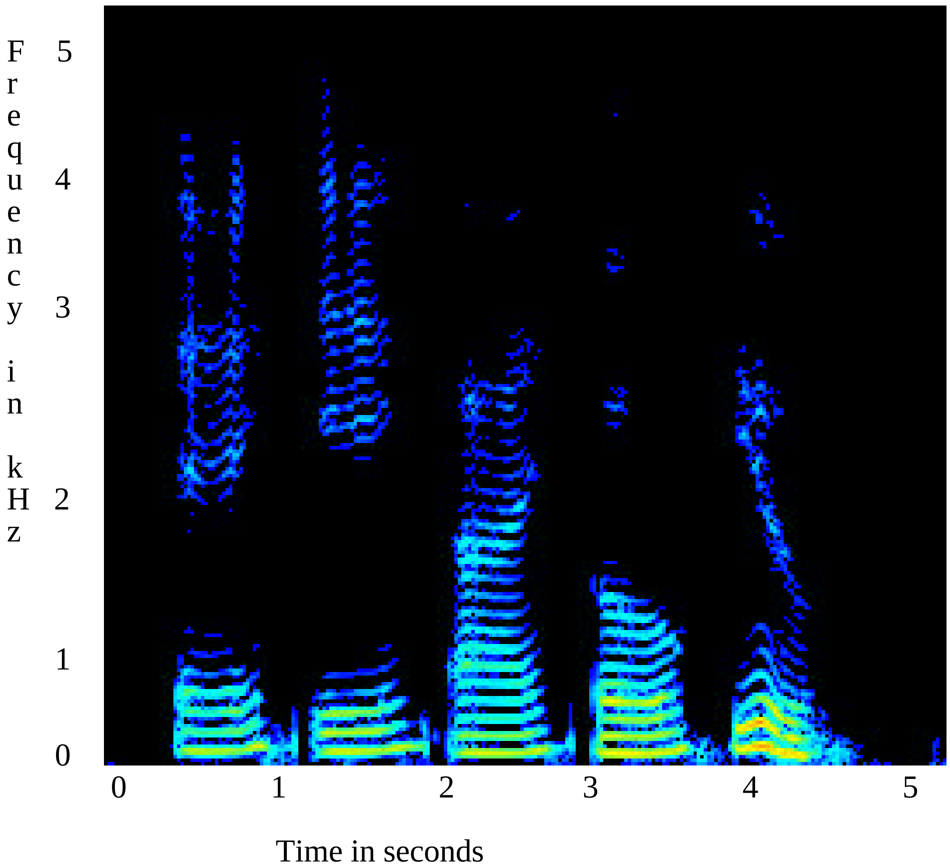
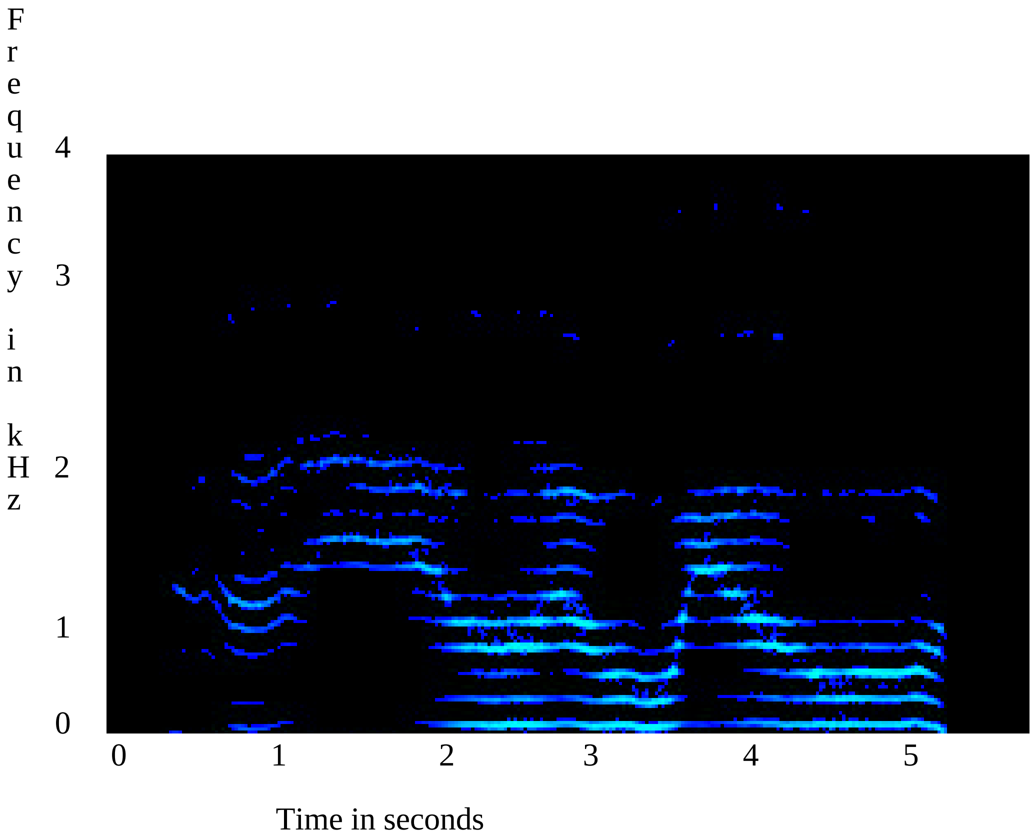


Figure 4.50. Week 3 spectrogram of Jack speaking the vowels [e i a o u].



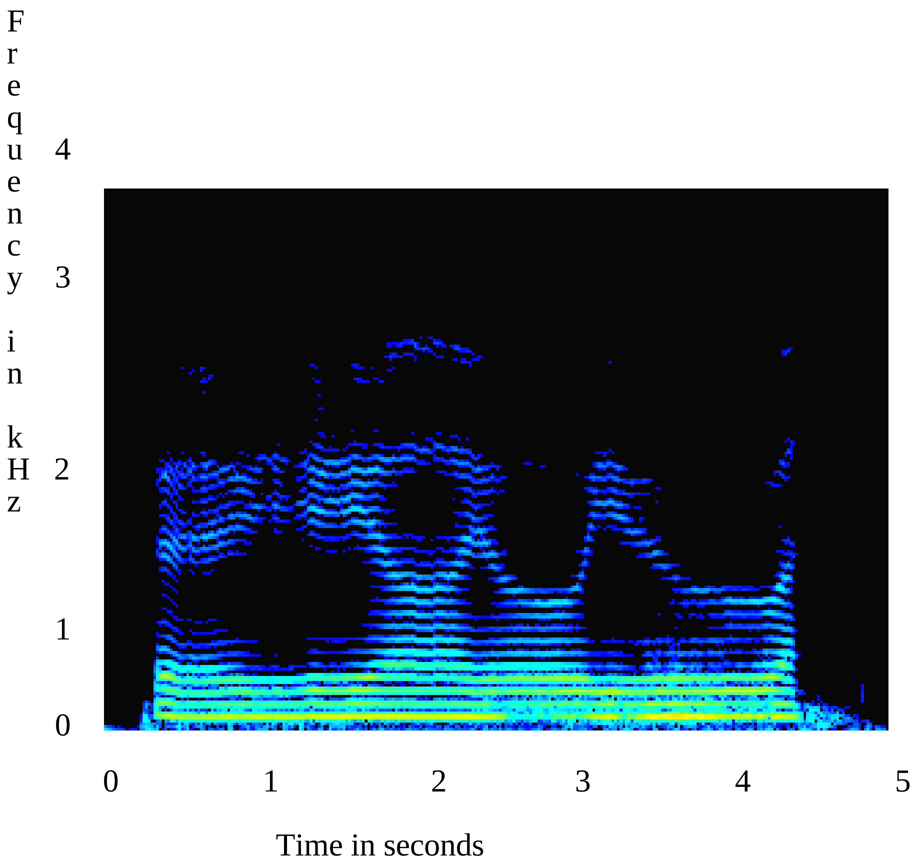
When Jack sang in the middle of his range on F3, (Figure 4.51) this natural resonance carried through into his singing voice.

Figure 4.51. Week 3 spectrogram of Jack singing [e i a o u] in the middle range.



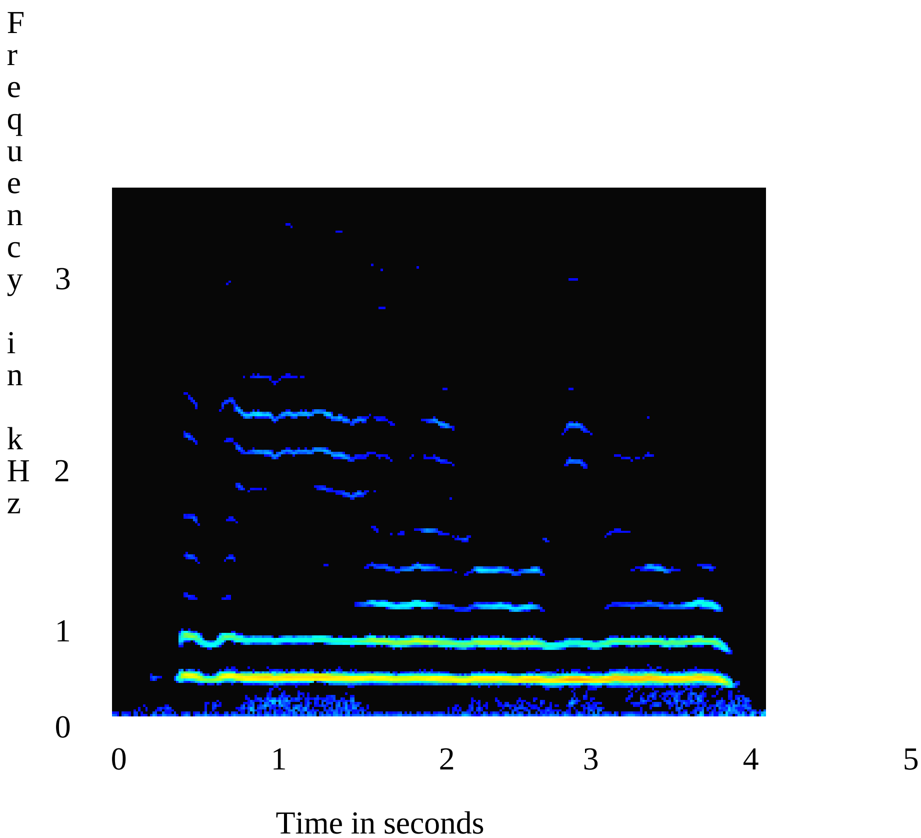
However, when he sang in the lower range on F2, (Figure 4.52) the tone was more forced and the readings reflect the reduction in efficiency somewhat. (The difference in tone is much more apparent to the listener than is reflected in the spectrographic reading.)

Figure 4.52. Week 3 spectrogram of Jack singing [e i a o u] in the low range.



When Jack sang in the high range on D4 (Figure 4.53), his voice was noticeably thin.

Figure 4.53. Week 3 spectrogram of Jack singing [e i a o u] in the high range.



Because Jack had taken his planned third lesson after his planned fourth lesson, the responses from the third and fourth lessons arrived at the same time. Reflections from the third lesson stated that he had practiced every day for about one hour, about half on exercises and half on singing for his aural-skills class. He said he had experienced problems when he tried to view his screen shots on line because some kind of technical problem occurred, so he was unable to comment on its effectiveness.

During the fourth lesson (which was in reality his third lesson chronologically), I noticed that Jack had an excellent lung capacity. However, his breath still tended to be high in his chest with noticeable strain on the inhalation. Although he had good lung capacity, he did not transfer it into his singing voice. His vocalizations were strained and he had a difficult time matching pitch. Because he tended to begin singing before adequately audiating the pitch, I attempted to have him slow down and concentrate more on what he was singing. By the end of the lesson he had become more confident in the range between Eb3 and Ab3, which had been problematic.

He reported that the tuner exercise had been very frustrating during the interim week and he preferred to use the piano keyboard for reinforcement. Since I was unsure of his ability to match pitches from the piano, we worked out a compromise. I had him play the notes on the piano while singing into the microphone so he could have the familiar piano feel along with the reinforcement from the SmartMusic system. He enjoyed most of all singing along with the SmartMusic accompaniments, and stated that this lesson was closer to what he had initially expected from lessons. He was already familiar with the SmartMusic system, so I did not have to show him its intricacies; I simply made sure he knew how to change key and tempo.

I was a little surprised to receive responses from the fourth week’s lesson. He had not been present for his fifth week's lesson, giving no excuse, and as I had no luck getting in touch with him, I had assumed he had decided not to continue. He reported practicing every day for about one hour, with about half on singing and half on exercises, and accessing the SmartMusic system once for about an hour. He had no problems using the software or hardware. He preferred using the keyboard for warm-ups and was nonplused by the intonation exercises. He also had a positive response to the accompaniments. He continued to be unresponsive to my e-mails and attempts to telephone.

He did not attend the fifth lesson and I received an e-mail message two days later stating simply "Sorry Rich, I am through." I made no further attempts to influence his decision as is necessitated by the university's Institutional Review Board policy of allowing any research subject to remove himself from a study at any time with no penalty.

Special summary for Jack. Because Jack did not complete the lesson process, his data have been removed from the final analyses. I feel that Jack had not been as interested in learning to sing as the other participants had been. Rather, he was looking for a short-term solution to difficulties in his aural-skills classes. Because his goals and mine did not overlap, he became frustrated with what he considered the slow pace of lessons and chose not to continue. I do not believe his choice not to continue was influenced by the use of technology in the lesson. Jack was the only participant who chose not to complete the study.

Jane

Demographic information. Jane was an 18-year-old freshman majoring in microbiology. She had experienced a good deal of singing activities before the lessons:

> I have been singing for almost my whole life in church. In school I have been part of numerous chamber choirs and show choirs. I almost majored in music but decided to keep it a hobby instead of a profession. I have never had formal voice lessons and have always wanted the extra instruction. I really love singing and think that this will give me the opportunity to continue learning how to use my voice. . . . I have a range that allows me to sing soprano parts. However, I like harmonizing through second soprano, alto, and even tenor parts. I think of myself as a second soprano just because they are so awesome.

She had also played the trumpet for five years, the piano for one, and had choreographed show-choir routines. Since Jane had sung in church choirs all of her life, her main goal was to sing better to improve her choir singing. She had some experience with computer use including Microsoft Word, Excel, and the Internet. She had easy access to a computer and was willing to take the time necessary.

Lessons. During the first lesson, I did not use the computer for support. Because she had considered music therapy as a career, she was very open to the McClosky Techniques. Without the visual support from the Web pages, she was unable to repeat the steps in order.

She was constantly smiling and laughing, and there was some tension when she spoke. Once I had made her aware that she had been "frying" her spoken tones, her voice improved. She reported that the optimum speaking pitch I had determined seemed high to her.

During the first week, she practiced for an average of 15 minutes a day. She accessed the Web pages twice for about an hour each time, but did not find them particularly effective because she had remembered the steps from the lesson. She still saw some use for them, "I think they're good for supplementary instruction. If I were to forget, they could be a great help."

Her comments about the first lesson were mixed, "I like [the McClosky Technique] because it's relaxing. . . . I am still skeptical of the 'hi-pitched' speaking tone you have me trying. I think it's annoying."

During the second lesson, Jane reported having had troubles with her jaw, but I noted she had made progress with the McClosky Techniques. She said the Web pages had been an excellent reminder, but she saw no need to use them in the lesson itself.

She had serious postural challenges, as her lower back was curved, and when I tried to straighten it, she became very uncomfortable. Her chin also jutted forward. Ribs were acceptable, as she was able to control the rib collapse when made aware of proper breathing. Initially she was able to sustain an [s] sound for 13 seconds, but then she asked for another attempt and was able to last 22 seconds. I was unable to do as much vocalization as I would have liked due to time constraints. She had difficulty initiating the pitch without extraneous movement in her head and jaw. She had improved on her legato singing from the previous week.

During the second week, Jane reported not being able to practice for as long as she might have liked because of illness and time pressures. She had worked on her posture, though:

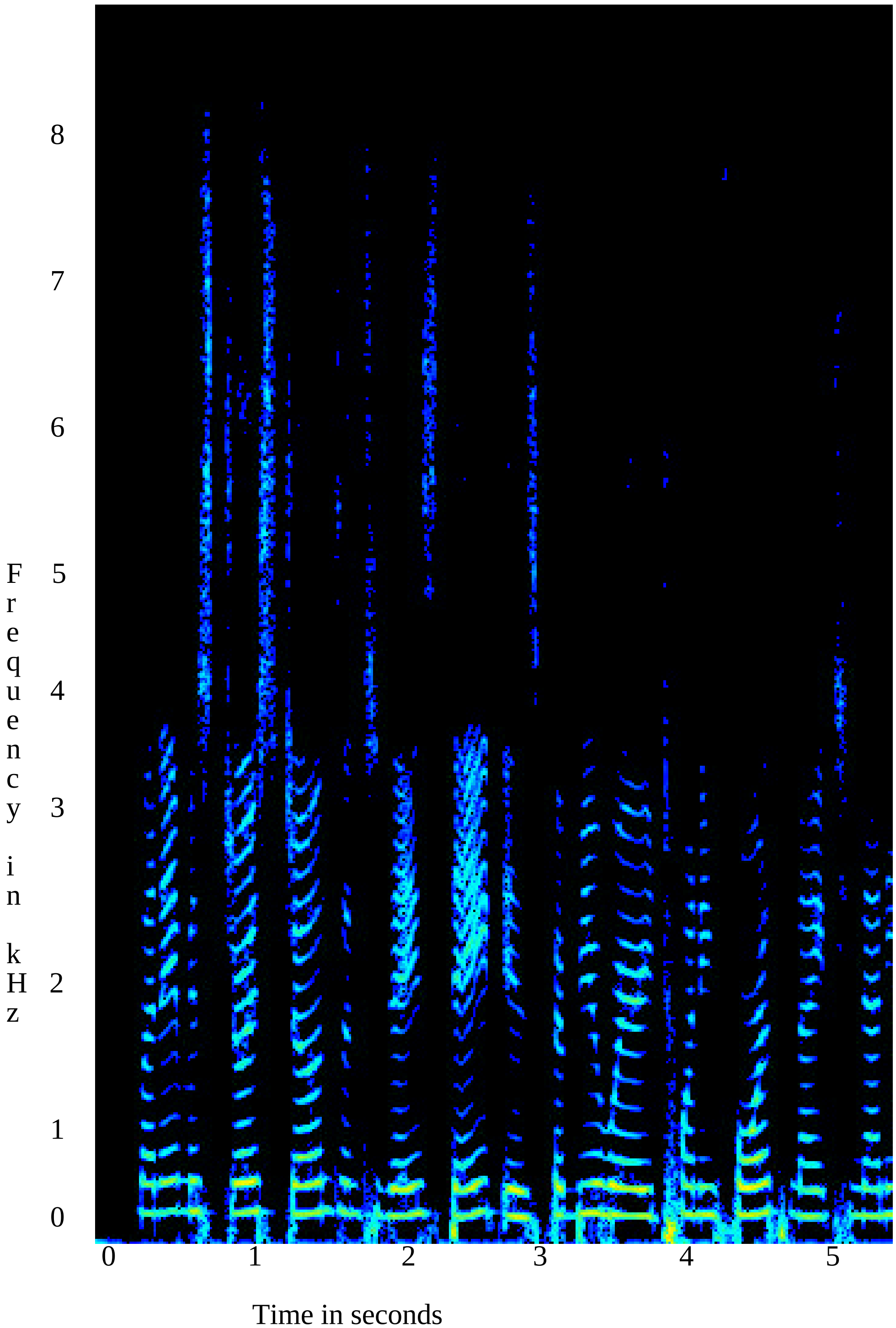
> I have been thinking a lot about my posture. I don't think it is going to help me with confidence, though. In fact, it is becoming insecurity very quickly. . . . Most of [my practicing] was spent thinking about my posture. I tried to do the relaxing part too but the two don't mix . . . I need to start working on application of the techniques to my voice. Otherwise, it's just a pain in the neck . . . really, hehehehhe. . . . I really disliked [the second lesson] in comparison to the first. However, the intentions were good; you need to realize that not everyone is built the same.

She stated a preference for having Web pages in her lesson and did not prefer either on-line forms or e-mail.

Jane said at the third lesson that she had had many exams the preceding week and was unable to sing as much as she would have liked. She did not access the Web and she was still frustrated with the posture and breathing exercises.

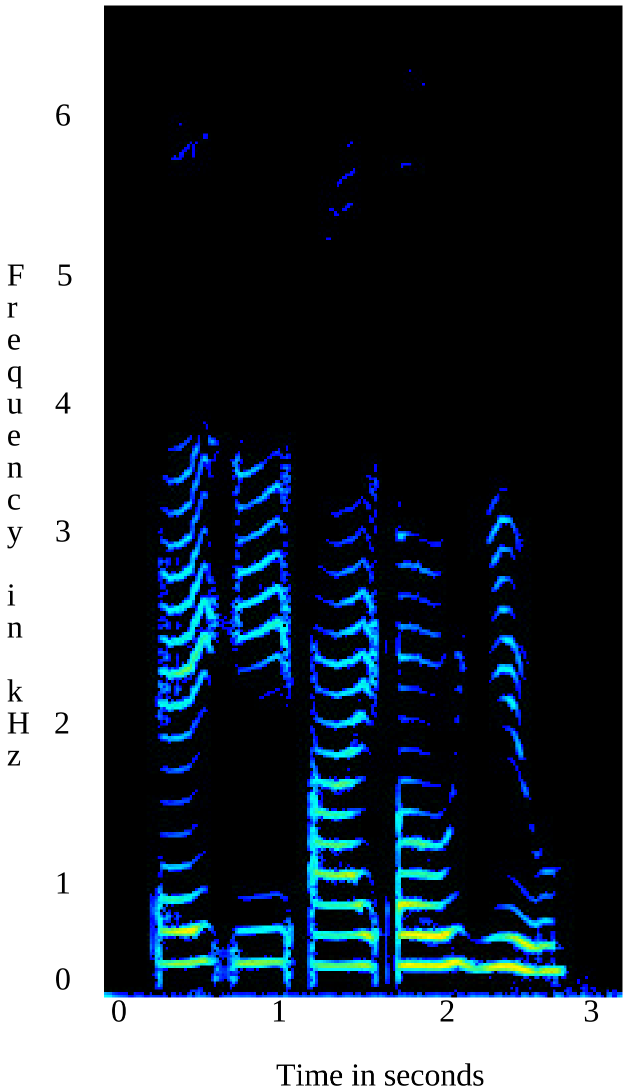
She was very eager to undertake the spectral analysis. She seemed to enjoy having the readout from her voice appear. Since she had never heard herself recorded while singing, she reacted strongly to hearing her voice played back through the computer. During the initial reading from her speaking voice, I noticed that she had a very large amount of spectral weight in her upper partials (see Figure 4.54).

Figure 4.54. Week 3 spectrogram of Jane Saying "My name is . . . and today's date is . . ."



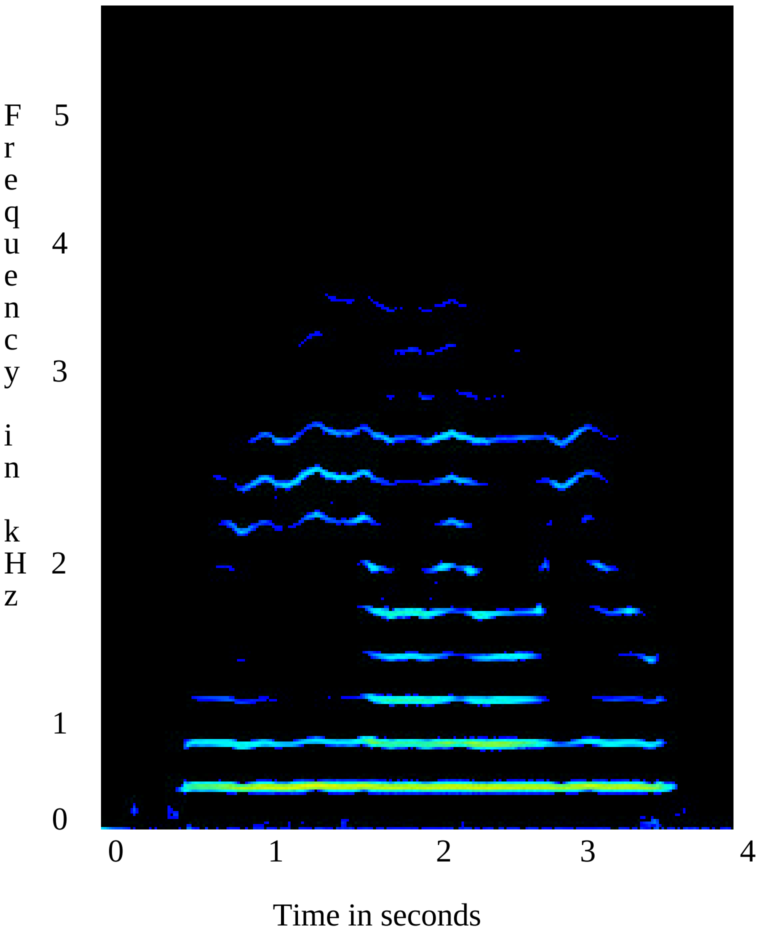
When I had her speak the vowels [e i a o u], the glottal attacks and harsh releases we had been working to avoid became apparent (see Figure 4.55).

Figure 4.55. Week 3 spectrogram of Jane speaking the vowels [e i a o u].



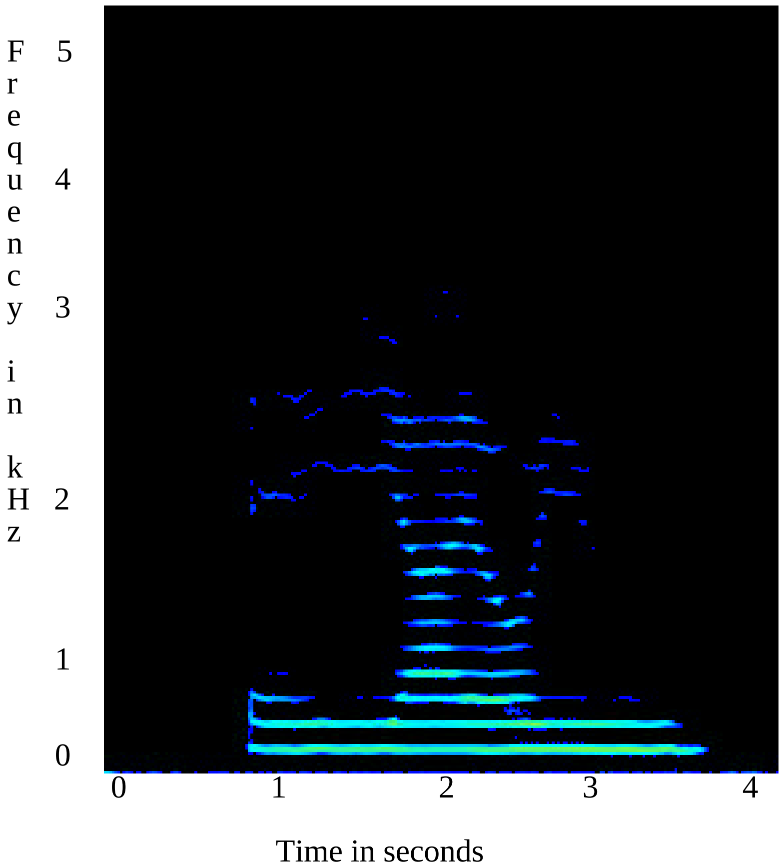
I was a little disappointed that the high resonance from her speaking voice did not directly transfer into her singing on F4 (Figure 4.56), and I wanted to incorporate more of her natural resonance into her singing.

Figure 4.56. Week 3 spectrogram of Jane singing [e i a o u] in the middle range.



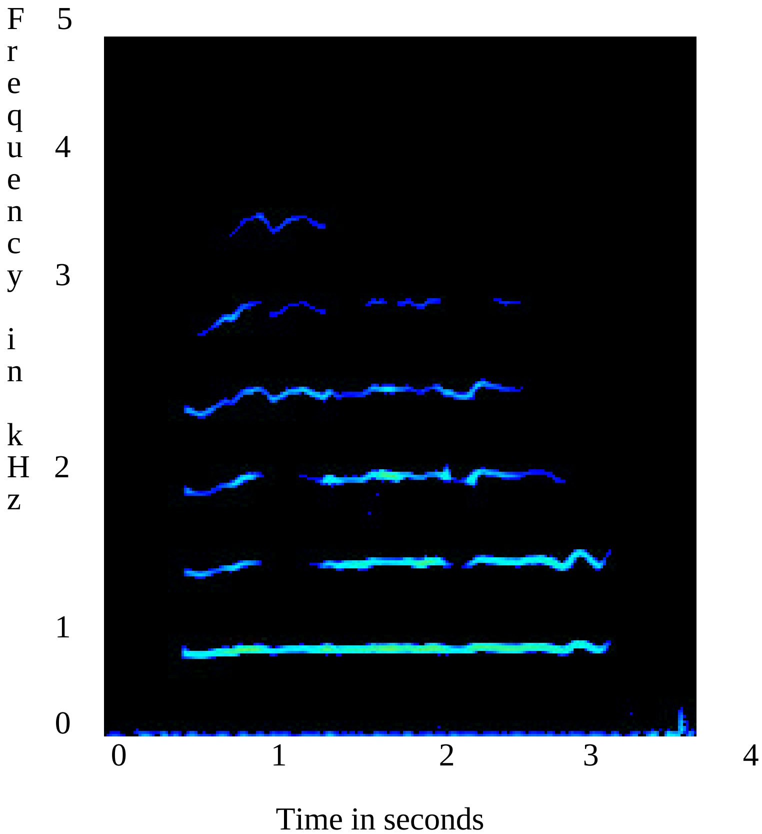
Because Jane was not comfortable singing the low F3, I had her take the reading for the low range on Bb3. This reading (Figure 4.57) again showed relatively less high spectral weight when compared to her speaking voice.

Figure 4.57. Week 3 spectrogram of Jane singing [e i a o u] in the low range.



When she sang the high note F5, she was disappointed with the result (Figure 4.58), finding the sound thin and unappealing. When I played back the recording, she reacted visibly and asked me not to play it again. I assured her that this part of her range would become fuller over time, and that she should not worry, but be pleased with the amount of progress she had made so far.

Figure 4.58. Week 3 spectrogram of Jane singing [e i a o u] in the high range.



When we began working with spectral snapshots for Jane, I was again struck by the amount of natural resonance she could produce, particularly on the frontal vowels [e] (Figure 4.59) and [i] (Figure 4.60).

Figure 4.59. Week 3 spectrographic snapshot of the [e] vowel for Jane.

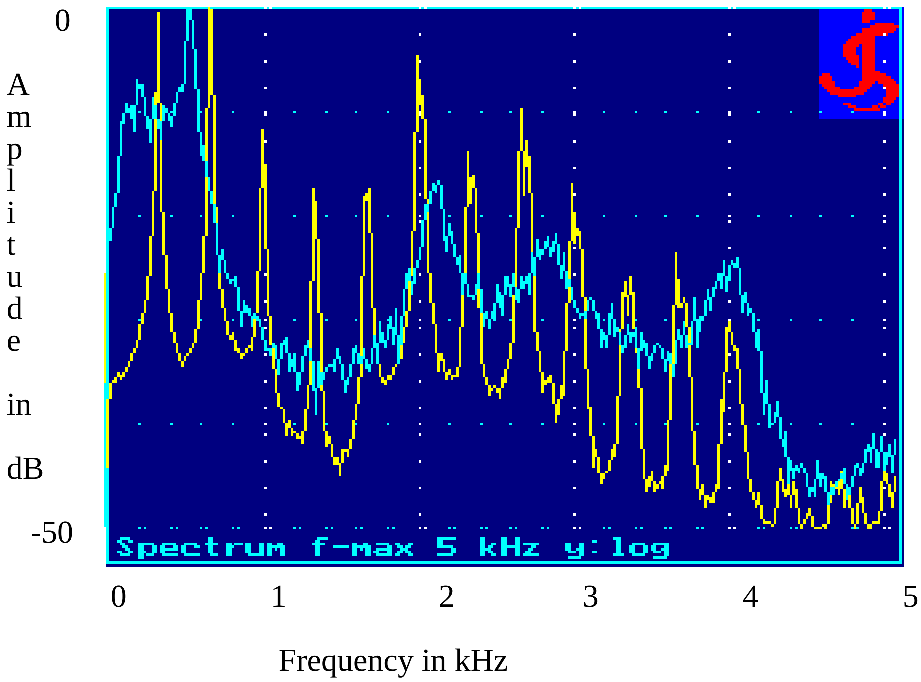


Figure 4.60. Week 3 spectrographic snapshot of the [i] vowel for Jane.

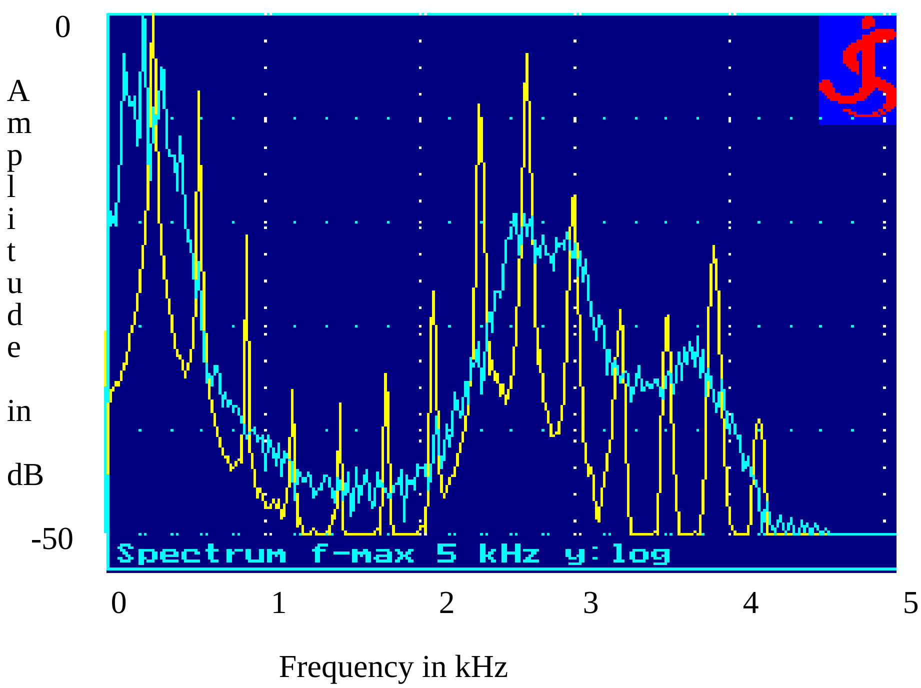
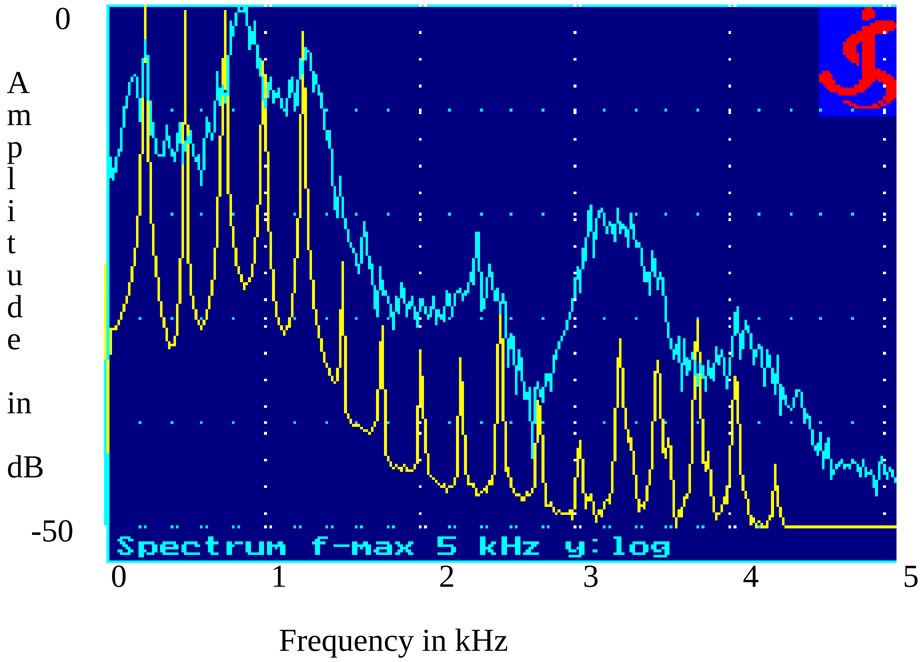
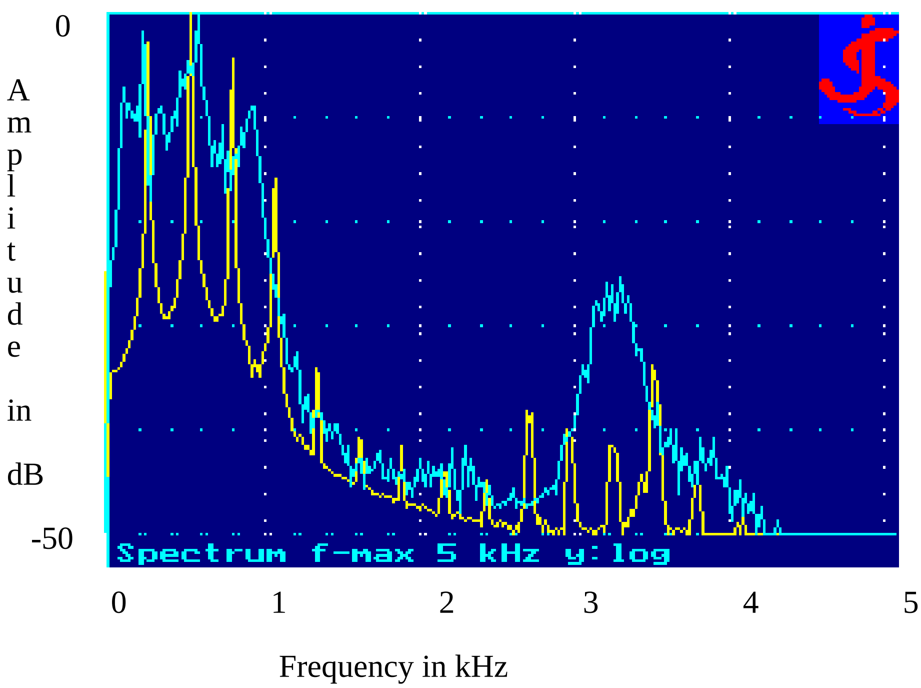


Figure 4.61. Week 3 spectrographic snapshot of the [a] vowel for Jane.



The reading for the [a] vowel (Figure 4.61) was less impressive, but still acceptable.

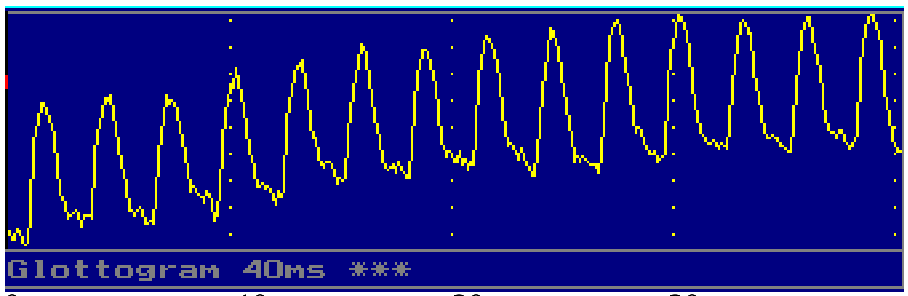
Figure 4.62. Week 3 spectrographic snapshot of the [o] vowel for Jane.



Although the back vowels [o] (Figure 4.62) and [u] (image corrupted) were acceptable, the readings did not compare with the excellent readings I had found on the front vowels. The EGG reading (Figure 4.63) was very disappointing, as I was unable to register a clear signal.

Figure 4.63. Week 3 EGG reading for Jane.

Open



Closed

0 10 20 30 40

Time in milliseconds

In the third-week's journal, Jane reported she had spent much of her vocalizing singing along with her compact disk collection. She had not abandoned her exercises completely, though, and spent about 30% of her practice time buzzing her lips.

She had very positive comments on the use of spectral analysis software, "I thought it was awesome. I could actually see my weaknesses. I had never heard myself sing before, either. . . . I noticed the good points and bad points of my voice. . . . I really think they're good for me. I like quantifying things. It helps me understand concepts. It is the same with my voice."

During the fourth lesson, Jane again indicated that she had enjoyed the previous week's session with the spectral analysis software. She seemed genuinely excited about the possibilities of improving her voice with the visual reinforcement. She stated the she had learned about her voice and was not simply responding to the novelty of the situation. During the lesson, I noted improvements in the back vowels, which had been shown less efficient by the readings from the week before.

I demonstrated the warm-up feature of the SmartMusic system only briefly. She indicated that she preferred to use the keyboard commands rather than using the mouse or foot pedal to control the playing of the notes. She was able to match pitches to the tuner well when she received aural reinforcement, but when I removed the reference tone from being played, her pitches would stray relative to each other. This indicated to me that she had learned to match pitches in choral settings, but she had not internalized the relationships of the pitches.

She was able to boot the computer, access the tuner and warm-up functions, and change songs without prompting from me. One song she worked on, "The Simple Joys of Maidenhood" (Loewe and Lerner), contained a number of entrances in the beginning recitative section that she found difficult to match. Once the song entered the more aria-like section, which contained music she knew better, she performed well.

During the fourth-week interim period, Jane only had one chance to practice, which she spent in the SmartMusic room for about two hours. She did say she was incorporating the McClosky Techniques into her daily life and she reported no problems using the software. She had positive comments about the warm-up feature ("I found them to be very fun and efficient.") and the tuner, "I loved it. I said in practice how I thought it would help me grab pitches. I really like seeing where my weaknesses are so I can make a mental note and try to alter my vocalization of the pitch." Concerning the accompaniments she stated:

> I felt pretty comfortable. I need a little more practice with the accompaniments for the songs. I see it as giving me more freedom than a human piano player, but at the moment, I'm still trying to get the hang of it. I don’t know any of the songs, either. That means that I'm sight reading everything. It would help if the program had an option of a background line, so that I could follow what I'm supposed to be singing if I don't already know the music. This would aid in teaching younger students who have the same level of sight reading ability. [Note that this option does exists, but I had neglected to point it out to the students, as the setting is not apparent from cursory examination.]

During the fifth lesson, Jane explained that during her practicing of songs, she was more comfortable using the piano keyboard to find notes than using the pitch button in

SmartMusic. However, she still enjoyed using the warm-up feature because she did not know all the chords on the piano.

Her voice was thin that week when compared with the previous week. She said she had eaten ice cream before the lesson, and she felt it necessary to clear her throat occasionally. I felt that even by the end of the lesson, she never warmed up sufficiently. She chose "Can't Help Lovin' dat Man" (Kern and Hammerstein) as a performance piece. She had some difficulty with the syncopated rhythms at the beginning, and she found isolating the vowels to be a challenge. Her vowels were not as clear in her singing compared with her warm-ups.

Jane did not practice much during the fifth week because of the intervening Spring Break. She only practiced once for about 45 minutes in the practice room, and did not do any exercises. She showed her sense of humor with her comments on the new counting and vowel exercises, "I am really glad I had a chance to go through the counting exercises without you in the background. Learning is an individual responsibility. The vowel exercises made sense to me, but my boyfriend thought I bit my tongue." She had mixed feelings about the Web pages, "They are helpful, but they are not as informative to me as the personal examples provided in lesson."

During the sixth lesson Jane had not warmed up before the lesson, so her voice was thin throughout. Her articulation exercises went well, but she lacked clarity on the nasal consonants and the [l] sound. She also had a tendency to strain the glottal attacks on words that began with vowels. Adapting the speech to her song belied the problems she had had with the diction exercises than the exercises. She seemed slightly uncomfortable about adding meaning to the text.

During the sixth week, Jane gave me a good indication of how her practice sessions were progressing:

> I practiced every day at least once on my own in my dorm room. I mostly went over the song lyrics and phrasing. It only took a few minutes to sing through it.

> Once I grasped the song on my own, I practiced only once in the room with the computer. . . . Almost all of my time was spent on the song [as compared to vocalises]. I felt that I had to have it memorized before the next lesson.

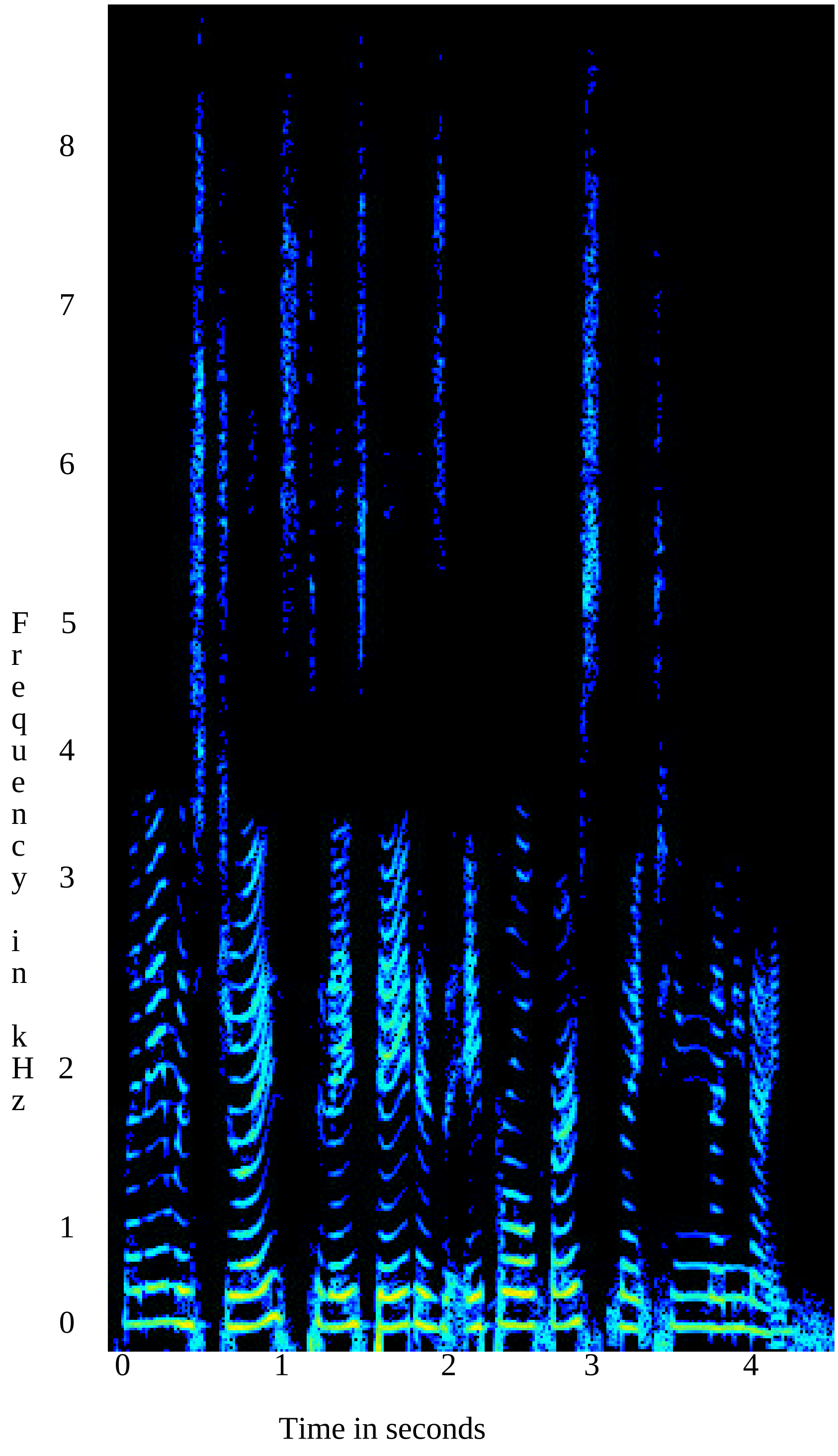
She had mixed feelings about the SmartMusic timbres, "I'm still a little shaky with it. I know how to use it, but, I still don't like the fake sound." She also did not feel the articulation exercises were helpful:

> I don't feel that they were helpful at all. I felt more conscious about what sounds I was making—they're just words. If the music isn't there, who cares what the words are? I can't sing when I'm tense like that. I have never had a problem with articulation in vocal music or public speaking. I think it would be best if I just sang and focused on relaxing and those exercises. (It works. I've tested it. I really sing better by myself in the evening, when I'm not worried about so many physical aspects of what I'm doing.)

At the seventh lesson, Jane was in good spirits. The warm-ups went well and I attempted to make her come out of her shell vocally and produce louder pitches to bring out the beauty in her voice.

When we listened to her recordings from the time-based spectography, I noticed a difference in all recordings, with her voice being much less strident and more professional sounding. Jane could not hear many of the changes that I attempted to point out to her, but she did notice a difference in her diction (Figure 4.64 and 4.65).

Figure 4.64. Week 7 spectrogram of Jane Saying "My name is . . . and today's date is"



When I had her speak the vowels [e i a o u] (see Figure 4.65), the glottal attacks and harsh releases we had been working to avoid showed improvement from the previous readings (see Figure 4.55).

Figure 4.65. Week 7 spectrogram of Jane speaking the vowels [e i a o u].

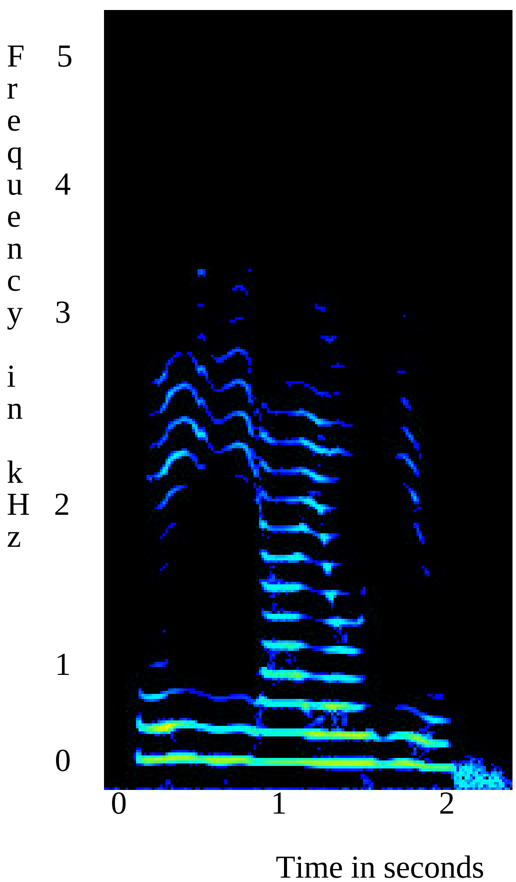
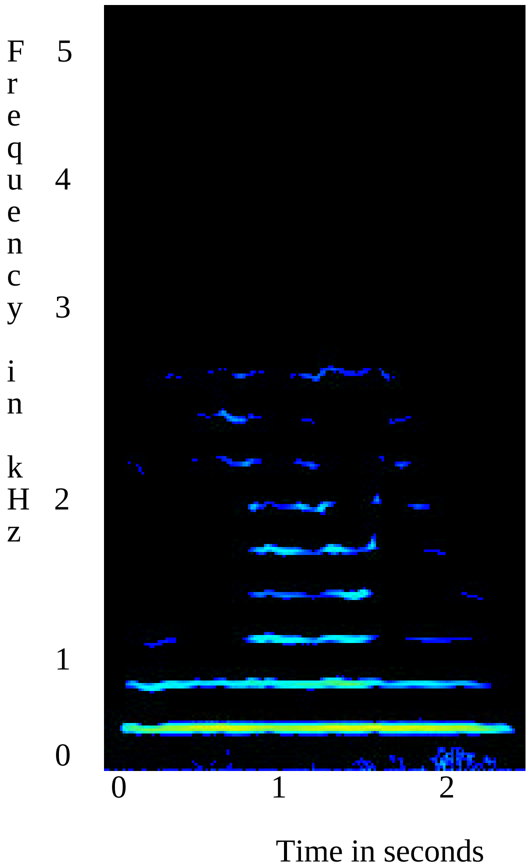
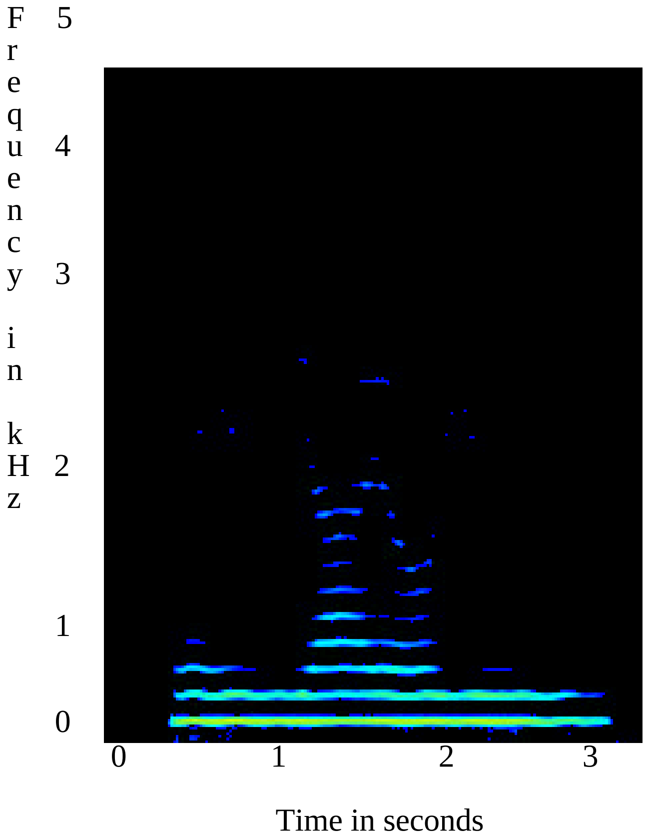


Figure 4.66. Week 7 spectrogram of Jane singing [e i a o u] in the middle range.



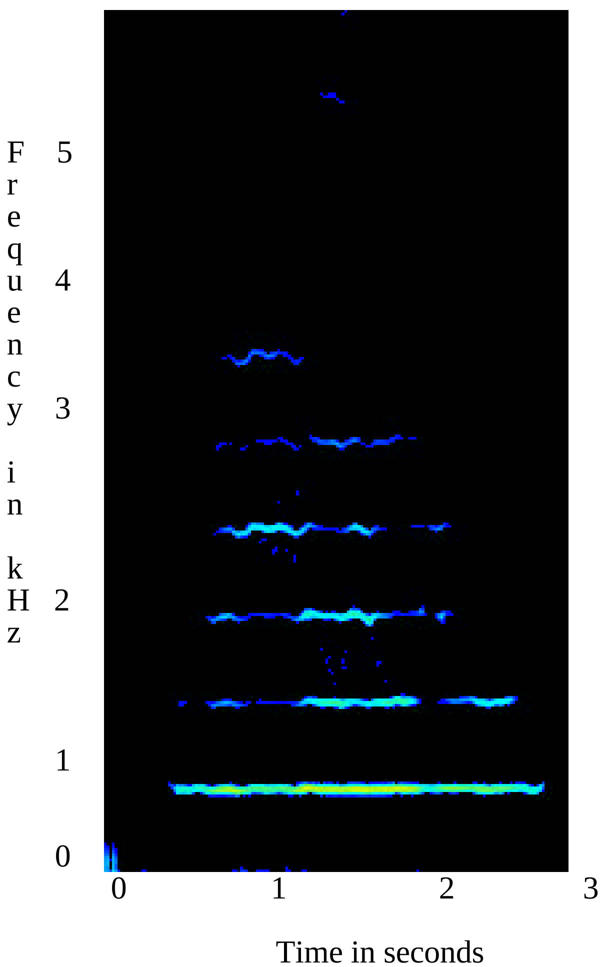
The difference in her singing in the low ranges was particularly marked (Figure 4.67).

Figure 4.67. Week 7 spectrogram of Jane singing [e i a o u] in the low range.



The high notes (Figure 4.68) were still a bit thin, but showed some improvement from the previous measurements. The graphical representations of the readout did not reflect the improvements in her voice.

Figure 4.68. Week 7 spectrogram of Jane singing [e i a o u] in the high range.



The use of the snapshot gave interesting result. The forward vowels [e] (Figure 4.69) and [i] (Figure 4.70) did not show as much energy in the upper formants as in previous weeks, and Jane was disappointed in her results.

Figure 4.69. Week 7 spectrographic snapshot of the [e] vowel for Jane.

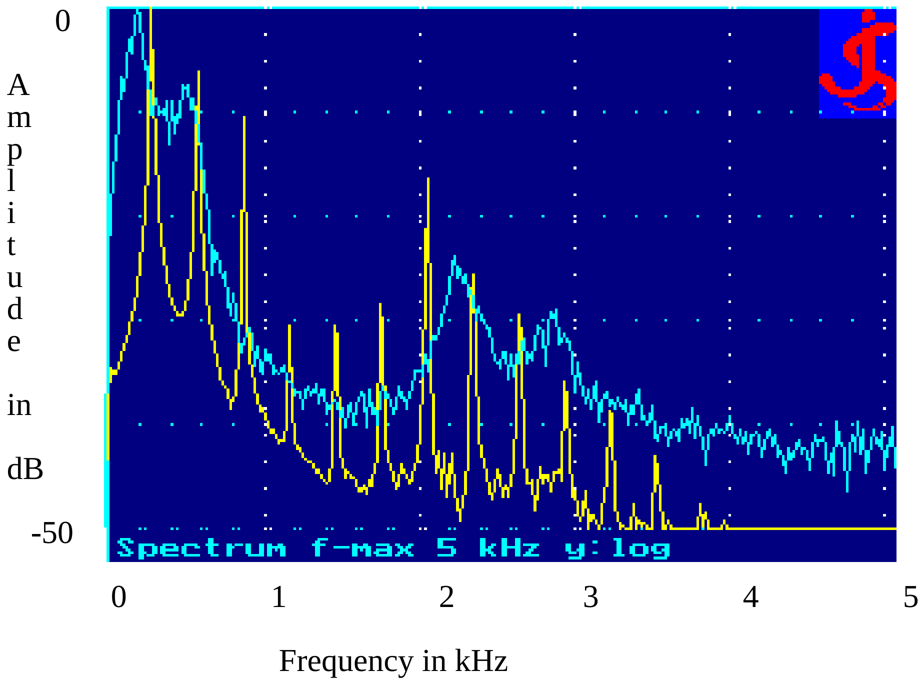


Figure 4.70. Week 7 spectrographic snapshot of the [i] vowel for Jane.

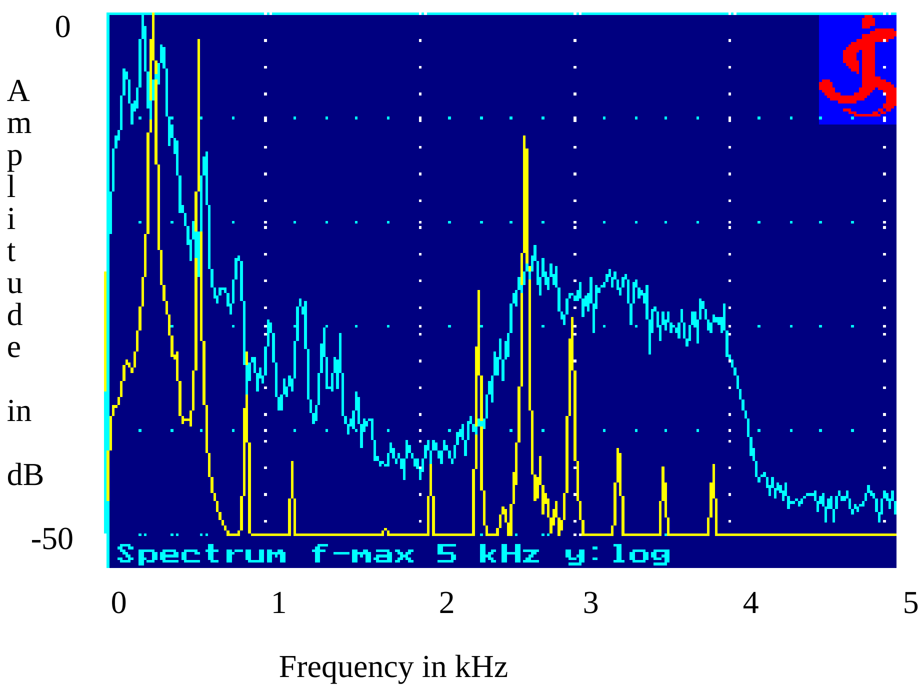


Figure 4.71. Week 7 spectrographic snapshot of the [a] vowel for Jane.

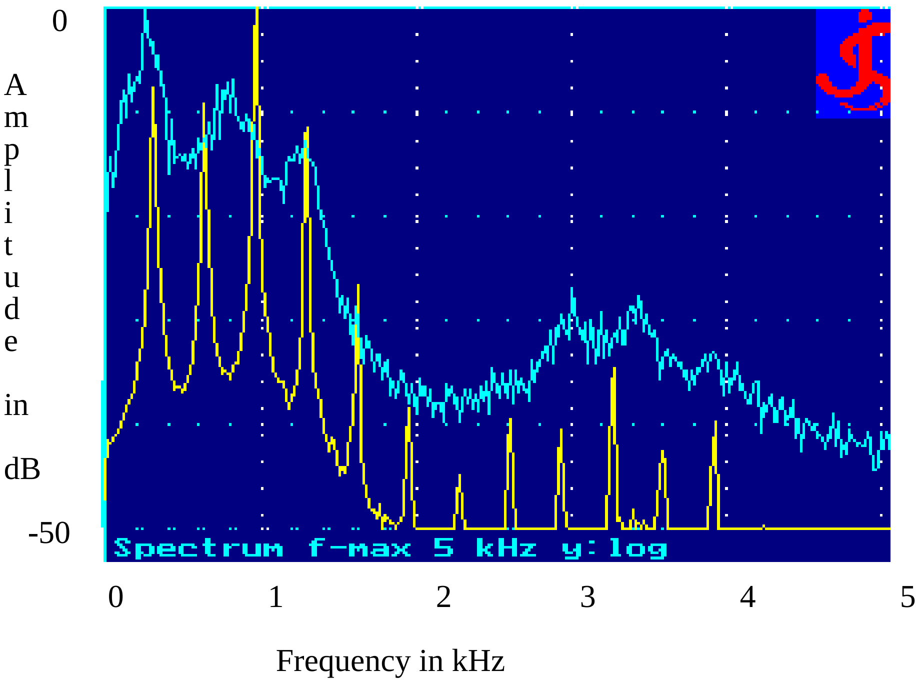
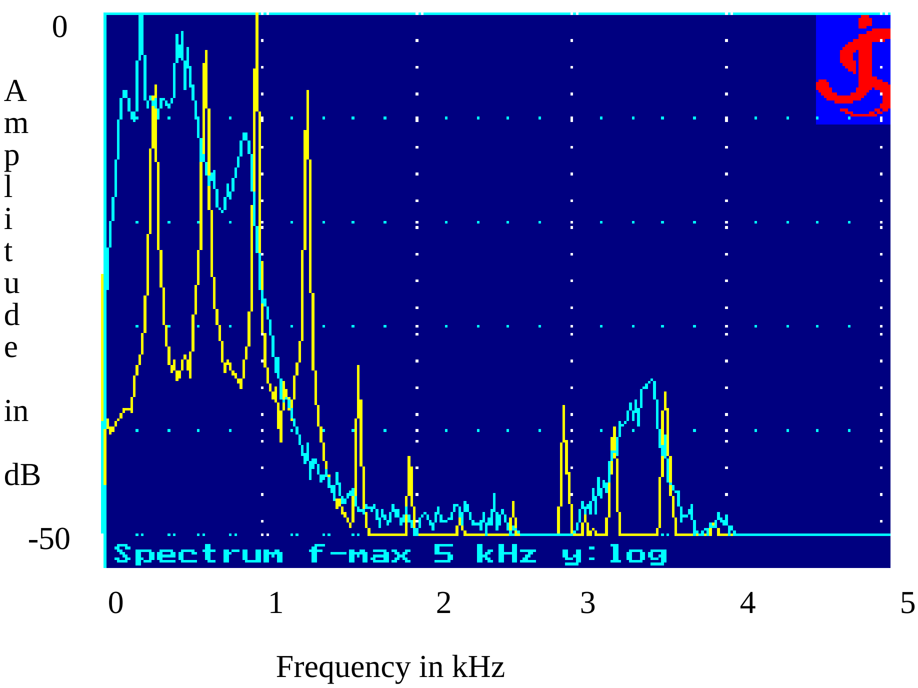


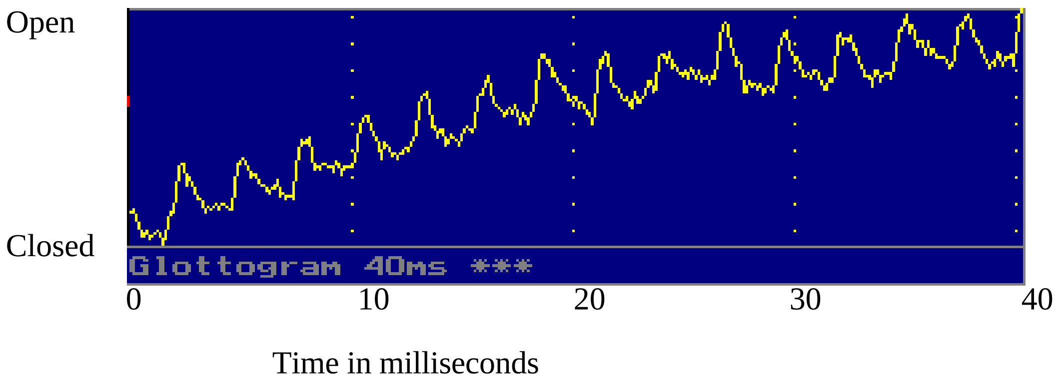
Figure 4.72. Week 7 spectrographic snapshot of the [o] vowel for Jane.



However, the back vowels, particularly [u] (image corrupted), showed a great improvement. I took the result to mean that her vowels were settling in to a consistent position as opposed to her earlier singing.

I was again unable to take a meaningful reading from the EGG (Figure 4.73).

Figure 4.73. Week 7 EGG Reading for Jane.



She had her piece memorized well, and sang much better when I told her to "put more life into the song" and sing out.

During the seventh week, Jane practiced every day for at least 45 minuets, but due to the Easter weekend, she did not have a chance to work with the computer. She worked on songs only, stating that, "The exercises were incorporated into the song." She reported understanding and enjoying the use of the spectral analysis, "I understood it well the first time, so I could really compare the images I was seeing with the past ones. It was neat." She was ambivalent about whether the process actually helped her singing, though, "It was cool. I can’t say that the time was helpful toward the concert goal, but it was part of your research. It really didn’t have any use in the instruction with the exception of allowing me to hear and see my weaknesses."

At the eighth lesson, I found that Jane had made great improvements in her basic techniques. She was able to move her jaw freely while relaxed and while phonating, and her swallowing muscles were pliable and did not engage when she began to phonate. The breathing had also improved, with no collapse of the rib cage. She was able to sustain an [s] sound for 38 seconds, a great improvement for the initial reading of 13 seconds. I was able to vocalize her down to a low Eb3 and to an extraordinary Ab6 (above high C). She had a few memorization problems when I had her recite the text, and she did not give as dramatic a reading as the previous week.

On the initial run-through of her piece, she seemed to be unprepared for the entrance. She missed her initial entrance, and stated that she had expected the accompaniment to stop to wait for her. (At the entrance to the final verse, the accompaniment will no longer continue unless the foot pedal is tapped.) I had expected that the software would sense her entrance, so I did not press the pedal. This led to an awkward moment when she attempted to sing her note repeatedly into the microphone to no avail. I finally realized that I was at fault, and that I needed to be aware of this feature of the software at the concert. She was unhappy with her initial performance, so I suggested singing at a higher dynamic level to increase the beauty of her voice, and suggested adding much more drama and musicality.

During the eighth week, Jane had practiced for two hours, including twice in the practice room, and planned to practice more before the concert. She had abandoned vocalises, "[My practicing] was all song. But now the exercises are mostly implied." When asked if she felt prepared for the concert she stated, "Almost, but not yet." When asked for comments she stated, "Ah, you did fine, it's all going to come down to whether I'm nervous or not. The fact that I won't get there until it is time for me to sing scares me. I won't have ANY TIME to warm up!"

<u>Concert.</u> At the concert, Jane performed well with the computer accompaniment. At the start of her song, an uncomfortable pause occurred when I accidentally inserted the wrong accompaniment disk into the computer. I experienced a panic moment when Jane's song did not appear in the menu of song choices, but I eventually realized my mistake and found the correct disk. I made a quick joke about my nervousness, and Jane said that the pause had actually helped her assuage her nervousness. Once she began singing, she immediately got into character and communicated very well. She smiled and seemed to enjoy the performance. I noticed a slight tendency for her to follow the accompaniment rather than taking command of the situation. The final entrance, which necessitated my triggering the software at the proper time, went well.

Final journal for Jane. Jane felt that the use of technology was a good motivating factor, "I found that the tech stuff really helped me practice since I didn’t have to arrange a time with another person. As far as lessons, it was only slightly helpful. I see technology as a tool for teaching and not a teacher." She did, however, appreciate the use of the SmartMusic system in her lessons:

> If I would have had to arrange a time every week with another person [human accompanist], I think that the lesson experience would have been more stressful. I feel that the tool helped me due to my lack of piano knowledge. (I've only had one year of piano.) I could practice on my own and learn on my own. After all, the teacher is only there to present material; it's the student's job to do the learning part.

She preferred the use of the computer in a concert situation:

> I like the computer because it plays the same way every time. However, the computer should only be used with students who have experience playing and listening to other musicians. If young musicians (not referring to age) learn to only sing (sic) with a recorded piece, they will lose the potential to develop listening skills. Those skills are most important in choral singing.

She felt the Web pages should be used for "reminders and follow-up practicing." She had mixed comments about the use of spectral analysis, "I found [spectral analysis] helpful the first time because I could see where my weaknesses are. However, the second time I felt that it was used for the research and wasn’t as helpful of a learning tool."

Summary. Jane was a young soprano with a good deal of musical experience and some technical experience. She received spectral analysis, did not have Web pages in lessons, and performed with the software accompanist. She appreciated the use of the Web pages as an outside resource, but saw no need to add them to the lesson format. She found the spectral analysis process "fun," but was not sure if the software helped her singing.

She had positive comments on the SmartMusic system and performed well with the software at the final concert.

Kevin

Demographic information. Kevin was a 21-year-old junior majoring in Chemical Engineering. His previous singing experience had been minimal, "only under extreme social pressure in large groups." He was apprehensive because friends had given him negative reinforcement about his singing. He initially classified himself as a tenor. Other musical activities included five years of band experience from grade school to high school.

He had a good deal of technical experience before the lesson, including moderate amounts of computer programming for the university. He had easy access to a computer and reported being able to make the time commitment.

He was very eager to learn to sing better, "I have often thought about actually paying for voice lessons. My girlfriend constantly pesters me about my inability to sing. Hence, I am bursting with enthusiasm to participate in this experiment."

Lessons. During the first lesson, I used the computer as support. He was able to repeat the McClosky steps in order, but he forgot the last step. His swallowing muscles were remarkably relaxed when not phonating, but the jaw, face, and neck needed further attention. He smiled when nervous, and this habit caused tension in his face. Initial tests of his breathing indicated that he did not have a good grasp of what a diaphragmatic breath entailed, and would need extra help in breathing exercises.

He had great difficulty initiating a sound without tension in the swallowing muscles. I did not do much work beyond finding an initial healthy light sigh because he was having so much trouble, and he reported finding the process extremely difficult. His speaking voice was not terribly low, but was unsupported. He tended to fry his tones, and I was unable to coax him to speak in his proper range.

During the first week, he was not able to practice as often as he would have liked, "perhaps five times, mostly within the few days following and preceding my lesson." He did not access the pages often (only twice), but found them "quite useful as a reference. . . . If ever I was unclear about a technique, the Web page was available. The universal accessibility of the Web page makes it a great reference material." Use of the pages during the lesson was not as well accepted, "The Web pages were minimally useful during the lesson itself. They were probably most useful as a script for the lesson." He had good suggestions for using the pages within the lesson:

> Seating the student closer to the monitor would be the first step. I think if one were lacking good vision, the Web would have lost all utility from the where I sat. Also, some interaction of the student with the computer would actively demonstrate that it is a viable resource for learning these techniques. This would emphasize that both the teacher and the Web lesson are legitimate sources during the lesson. I wasn't quite sure if I should pay exclusive attention to one or the other. . . . [Other suggestion included] incorporation of frames with side menus. It is always nice to be conscious of one's position in the hierarchy of lessons while on the Web (unlike a book, its not always easy to flip through a large number of pages quickly). Actually, upon further thought, I would say that this is a VERY important thing. I design the interactive Web classes for the chemistry department, and this is the kind of problem we encounter frequently. The easier navigation is, the more likely people are to use the page.

He also had some cogent comments about the lesson in general:

> I was very embarrassed to make noises aloud, even in front of only a single person. I was comfortable up until the noise making part. In general, I thought everything was great. I think my greatest obstacle will be overcoming my fear of singing. (Actually, this is another reason why the Web lessons are good; its much easier to

sing to the computer than a human!) I look forward to the next lesson with great anticipation.

During the second lesson, Kevin reported that he had experienced no trouble remembering the McClosky steps in his practicing, so the Web pages had been useful only as review. In the lesson, he had found dividing his attention to be distracting because he had been so far away from the computer. He had made good progress on the jaw movement from last week, but still was tight when initiating the sounds.

He had a curvature in his back and experienced great difficulty making any kind of adjustment. After coaching, he was able to maintain excellent rib expansion on the exhalation, although he said he had not been aware of those muscles before that day. He sustained an [s] sound for 26 seconds.

His vocalizations were still labored. I had him work the falsetto, but he had difficulty with his passaggio. When he was tense, his voice had a noticeable nasal quality. His "fry" sounds in the speaking voice had not improved as much as I would have liked because his voice was under-supported.

Kevin reported that during the second week he had been busy, so he worked on posture and breathing (75%) more than vocalizing (25%). He did not access the Web pages at all because he felt he did not need the information. He thought the on-line survey was easier to use than e-mail, "E-mail is a little more versatile, but the Web interface is sometimes more convenient."

During the third lesson, Kevin reported that he had been working on the breathing exercises in his everyday life, but had not done as much of the vocalizing due to time constraints. He had not felt the need to review the Web pages because he felt he understood the concepts already.

He was still having difficulty finding his passaggio. I could vocalize him up to about G3 and he would start to lose the pitch and be unable to match pitches. We worked on "siren" exercises to make him aware of the break between his head- and chest voices.

By the end of the lesson he could discriminate and reproduce pitches all the way up to C4, so he had made some improvement.

When allowed to operate the computer on his own, he had no difficulty accessing the tuner and warm-up features of SmartMusic. He found the tuner to be fun and a challenge since he was having trouble with pitch discrimination. I asked him to attempt to make the note reinforcement box on the software register the notes of the C scale, so that if he saw a sharp or a flat, he would know he was off pitch. After a few minutes he had improved in his ability to reproduce pitches, but still had not become proficient. Saying the names of the notes as he sang helped him to learn the pitches. Because he was able to match pitch a good deal of the time, I believed his initial pitch-matching challenges were due to mechanical flaws rather than internal pitch discrimination.

In the third week journal, Kevin reported spending perhaps 30 minutes of singing a day with "a lot of other practice on breathing and posture and comparatively little on singing songs. I would do the breathing exercises in class and sing scales in the shower." He used the practice room twice for an hour and 45 minutes and experienced no problems with the software, finding it very user-friendly. He preferred the computer as accompaniment, "I like the computer better. I'm not sure why. I feel more secure with it rather than the keyboard. Maybe I've been around more computers than keyboards." He also found the tuning function helpful and enjoyable. He had positive comments about the progress of the lessons, "I really feel like I am making progress now. In particular I have a great deal more confidence. Being able to use the computer software help with that a lot."

At the fourth lesson, he stated that he had asked one of his friends, a music major, to help him out with theory elements such as where sharps and flats lie in the scale. He said he had actually spent "too much time" in the practice room, neglecting his other homework. His singing reflected the extra time he spent practicing. He had made great improvements in his ability to match pitches, and he was much more comfortable in his middle range up to Bb3.

He was able to understand and manipulate the accompaniment feature of the SmartMusic system without any problem. Choosing songs was difficult because of his limited range. We had to transpose "Swing Low, Sweet Chariot" (arr. Burleigh) down a minor third so that he could sing all of the notes. Transposing went well in practice, but since I was planning to have him switch to piano accompaniment, we needed to find a piece he would be able to sing in the published key. The sight singing was hampered by the fact that since he had trouble matching pitch, often he could not trigger the mechanism on the accompaniment to continue the song.

During the fourth week, Kevin again was not able to practice as much as he would have liked, and he was unable to use the SmartMusic system. He spent most of his singing on vocalises, mostly in the shower, "My shower is my practice room. I have become more confident in my singing, so I don't feel I need to isolate myself to sing." He had positive comments on the warm-ups, carried over from his previous week's practice, "I really like the computer. In fact, I like it a great deal more than the keyboard. I think I just feel more comfortable with it." He also had positive comments on the intonation exercises, "These were very helpful. It is great to have the computer express to me the quality of my note." However, he did not have a positive reaction to the accompaniment feature, "The accompaniments are somewhat confusing and unnatural. I suppose that I will become accustomed to them eventually. It seems that the computer's ability to slow down is inferior to that of a human accompaniment, or so I imagine." He had positive comments about the lessons in general, "I always look forward to my lesson each week. It is really great fun."

During the fifth lesson, Kevin reported that he had not accessed the SmartMusic system during the intervening week. He had made good progress in negotiating his passaggio. He found the concepts involved in isolating the rhythms challenging, but he was able to isolate the vowel sounds without too much difficulty. Many of the songs available were not appropriate because of his challenges with his usable range, so we chose

"Sometimes I Feel Like a Motherless Child" (arr. Burleigh), which lay in a comfortable range.

During the fifth week, Kevin continued to practice in small increments, averaging about ten minutes each, concentrating mostly on exercises. He accessed the SmartMusic software, but still found the process frustrating:

> I was very frustrated with the accompaniment. I couldn't figure out where to come in and the computer wasn't very helpful. I definitely felt this week like I needed some human help rather than computer. . . . When I am in my lesson I don't have any problems knowing where the accompaniment is or what is next, etc. But, when I'm alone the computer (can you believe it) is unresponsive to my questions. I hate them when I am alone.

He also had difficulty with the new counting exercises, "The counting is nearly impossible for me. It has been so long since I've looked at music; it’s very unfamiliar. The vowels are not that hard." He had positive comments about the use of the Web pages, "The Web page is becoming increasingly helpful. I find that I quickly forget anything productive that I learned during the lesson, so I am more than delighted to find it on the Web. It's nice just to have an on-line mini-lesson whenever I need one."

He was also very interested in whether he was practicing enough for my research purposes:

> I'm not quite sure what I am supposed to be doing to be "on track" with the research. Should I be going in to use the smart music (sic) a certain amount of time? Should I access the Web page a certain number of times? I find that my use of these resources is not limited by their utility, but rather my schedule. I wish I'd get in to use the computer more (although I do wish it were a bit more user-friendly with the accompaniments). By only using it once a week, am I disrupting the research?

In an e-mail response, I assured him that he was not hurting my research, but as a teacher, I wanted him to access the computer more.

During the sixth week's lesson Kevin reiterated that he had practiced with the accompaniment, but found the experience frustrating because he felt the need to ask questions and get reinforcement. His diction was acceptable, and needed only slight adjustments. He was still having a few note problems on his piece, but his pitch matching had improved from the previous week. His biggest challenge was incorporating emotions into his singing. He related to me that he was naturally a very reserved person, so opening up was a challenge. I assured him that the process of getting in touch with his affective nature would be beneficial.

During the sixth week, Kevin reported that he was having a difficult time scheduling times to sing:

> This week was my all-time low as far as practicing goes. I can't seem to find an appropriate time for singing in my life (other than the shower). I always hum my tune but very rarely do sing. I do, however, enjoy practicing the word phrases. . . . Almost all of my time is [spent] on exercises, or singing songs other than my song [assigned in lessons]. Exercises just seem more random and easy to fit into my day.

He only practiced once with the software, and found the accompaniments "unenjoyable." He commented on the intonation exercises also, "I enjoyed the intonation exercises very much the first time I used it. Now I am less excited by it. I find myself frustrated whenever I am in there because the computer can't answer the questions I have for it." He did have positive comments about the Web pages, "The Web pages are formatted quite well. I found them very informative. . . . They were great fun. It's something that becomes a conversational piece later in the week with friends. I also found them a great help in my song. I know what sounds I should be making."

During the seventh lesson, I told Kevin I had been happy with his steady progress, but I felt that he should be practicing more often and for longer periods in order to strengthen his voice. He had made more improvement on establishing the pitches between

G3 and C4. Use of the tuner was highly effective in this lesson. After an initial run-through of his piece, I returned to the tuner and had him sing the entire song into the microphone so we could tune pitches individually. When we returned to the song, his pitch-matching ability had improved greatly. I was then able to work on the thrust of this lesson, which was adding meaning and musicality into the music. He was more comfortable in reading the text of the song expressively. He responded well when I had him place dynamic changes and swells within the piece itself.

During the seventh week, Kevin had changed his practice habits:

> More this week than any other week, I took a few ten-minute blocks out of each day to goof around with my voice. I think it helped. . . . I hardly did any exercises this week. I feel that as I get more comfortable with my singing I am less inclined to do exercises and more inclined to actually sing (sic).

He did not practice with the computer because the one time he went to the music building, the room was occupied. He had some very kind comments about the experience, "I am so very happy I participated. I have always been a confident person, except with regards to singing (actually dancing, too). Now that I have conquered singing, I actually feel more able to tackle life's other problems. It has been a very good experience for me."

During the eighth lesson, I was impressed by the amount of progress Kevin had made over the previous eight weeks. He could move his jaw freely while at rest and while vocalizing, and his swallowing muscle relaxation while phonating had also increased dramatically. He did not collapse his ribs on exhalation, and he was able to sustain an [s] sound for 44 seconds, an improvement from 26 seconds. He was also willing to read his text dramatically.

During the initial run-through with the human accompanist, he was extremely tentative and seemed nervous. He fidgeted with his hands and rocked back and forth on his feet. He also had great difficulty matching pitch. He missed his initial entrance totally, and missed the entrance to the second verse. When I asked him to comment on the experience, he stated that he was nervous because of the unfamiliar situation and that he did not want to make any noise. I encouraged him to put more energy into his performance and ignore the new situation. We also worked out places where the pianist would cue him by anticipating his notes, so that he would have the pitch in mind. On the second run-through, some of Kevin's confidence had returned, and the music improved. By the third run-through, he sang the piece better than he had ever sung it before, hitting all his entrances and singing all the correct notes. He reported that he enjoyed having the human accompanist rather than the software because of the human element. ("He is there for me.") He appreciated the accompanist's ability to adjust to the situation. He also stated that because the piano is louder than the computer accompaniment, it forced him to sing out, and his tone improved. I took this to mean that I could increase the volume during my practice sessions with the computer.

During the eighth week, Kevin increased his practice time to "even more this week than last. I am becoming more confident such that I even sing on the way to class or really anywhere. I practiced at least once a day for a little bit and more some days." He spent all of his time practicing songs and none on exercises. He did not feel the need to use the practice room, "I'd rather be somewhere else to practice." He felt ready for the concert, but nervous and suggested "more practice in a concert-like environment." He had a strong preference for human accompaniment, "The person was much better. I liked that he was able to keep up with me and adjust to my many faults. . . . It’s more fun and I feel like it is a mutual effort. The music seems more alive and dynamic I guess." However, he felt uncomfortable practicing with a new person, "A person is more likely to be amused by your lack of [vocal] abilities than is a computer; however, unless one is planning to sing only in front of one's self it is a fear that must be overcome."

Concert. At the concert, Kevin performed the piece with the human accompanist admirably. At the rehearsal situation he seemed a bit tentative and missed some of the initial pitches. The accompanist stated that he would make sure in the concert that Kevin matched the pitches. In order to facilitate pitch matching, the accompanist changed the introduction of the piece to highlight the pitches Kevin was to sing. However, since the introduction was now different than practiced, at the concert Kevin entered two bars too late. The accompanist noticed, so no one in the audience knew the introduction was too long. When Kevin did enter, he was on pitch and he remained on pitch extremely well throughout the performance. His posture was slightly defensive, with his hands in front of his body. The song showed great improvement in musicality and emotion. Kevin improved more than any of the other students did that semester, and I was proud of his excellent effort.

<u>Final journal for Kevin.</u> Kevin found the use of technology to be an important part of his lessons, "[The lessons] would have been a completely different experience without the technology. I genuinely enjoyed it. Any kind of learning is maximized as more resources are made available to the student; this is a good extra resource." He appreciated having the SmartMusic system as a resource, but found using the software challenging:

> I liked singing with the computer, not as much as a person though. The nice thing is that you are free to practice alone rather than only with a person. Hence, more practice time. However, I did find it difficult to use the SmartMusic software alone, not because of any technological problems, but due to my lack of music background.

After performing with the human accompanist during the concert, he had a strong preference for the personal experience, "I would rather have the human [accompanist] because they have the ability to adapt intelligently to my follies. The computer is fine, but more of the responsibility lies on my shoulders."

He also had kind comments about the use of the Web pages, "The Web pages were excellent. It is a wonderful resource that should be used for these kinds of lessons. Often times one forgets what was learned in the lesson and it is a great way to recall." He did not participate in spectral analysis, but thought the Web pages looked interesting.

Summary. Kevin was a baritone with a no musical experience and a great deal of technical experience. He received Web pages in lessons, did not have spectral analysis, and performed with the human accompanist. He found the Web pages useful both in lessons and for outside reminders. He had difficulty learning songs on the SmartMusic system, and he stated a preference for the human accompanist because of the adaptability of the musician. Kevin improved more than any other student and had a very positive experience within the lessons.

Tina

Demographic information. Tina was a 21-year-old junior majoring in music education with an instrumental specialization. She initially categorized herself as an alto. Tina sang in the Women's Glee Club and her goals were to improve her singing for that organization. She had also sung in other choruses at this institution and previous colleges. Other musical experiences included eight years of piano, including choir accompaniment, 13 years of saxophone lessons, and participation in musical ensembles, so her grasp of musical notation and concepts well exceeded the expectations for this study.

She reported that she could use computers, and had even worked with computer data entry in jobs she had held at department stores and in a chemical laboratory. She was familiar with e-mail, various music programs for scoring and aural-skills practice, the WWW, and word processing. She assured me that she would be able to access and understand the pages on the Web if I supplied her the correct address. She had e-mail in her room and checked her mail regularly for her job, so I did not believe contact by e-mail to be a hardship for her. She reported that she was willing to put in the extra work for journals. Her initial attitude toward the lessons was summed up with this quote:

> I do not consider myself an advanced singer by any means, but because of my musical background, can read music, and sing in tune—I think :). In regards to your

> project, I think it is very interesting, and I am told I am good at explaining my feelings to others. Voice lessons are something I've always wanted, and including technology sounds like a great idea! I have worked with my own saxophone students and the Vivace SmartMusic accompaniment program, and they were very enthusiastic!

Lessons. During the first week's lesson, I used the Web pages for reinforcement within the lesson. As I explained the McClosky Technique, her eyes began on the Web pages, but after a time she made more eye contact with me and only looked at the Web pages if I pointed something out to her. She was open to the technique, but had some trouble moving her jaw. Because she was a saxophone player, she already had a good grasp of proper breathing. She was surprised when I told her that her optimum speaking pitch was at a higher pitch level than she was used to speaking, although the difference was not as large as the difference for some of my students.

During the first week, she practiced for about 15 minutes a day. She accessed the Web pages twice, for about 15 minutes each time and found them "very helpful, as they provided a visual aid and followed in an easy to use sequential fashion with [an] option to review quickly." The Web pages were helpful in the lesson because "they helped me see by using another example what you were telling me to do." She suggested I have students scroll through the Web pages themselves in the lesson to make students explore right away. I found this an excellent suggestion, and I believed her training as an educator gave her good insight into the teaching process. The only suggestions she made for changes was that I should consider adding trouble-shooting suggestions.

In her e-mail journals, she let me know that my using touch in the lesson had made her feel uncomfortable, although she had not said anything at the time, and I had not sensed her discomfort:

> [I suggest that you] not touch [the] student. Trust that they will learn and grasp concepts on their own—if not immediately—with practice. . . . I thought it was very interesting and appreciated how it was personalized to benefit me, i.e., teaching and talking in future. Although I said it was OK to touch me, I think this made me nervous and later did not really like that aspect of it, although I understand why it is helpful. If trouble-shooting examples were provided on the Web pages, then maybe it would not be necessary for the teacher to check the students by touching them in [the] lesson, as long as good results were achieved from students trying and progressing on their own.

I assured her in a return e-mail that since touching made her uncomfortable, I would not use this technique on her in the future.

Before the second lesson, Tina had been sick and was not able to practice as much as she would have liked. She reported that she had reviewed the techniques as she lay awake sick in bed, but had not been able to access the Web until later in the week. She said that while she was ill and could not get to the computer, having had the pages in lesson helped her visualize the technique. The pages helped reinforce the teaching later, once she could access the Web. Because the students all had access to the Web in their everyday lives, her inability to use the Web during her illness was one of the few difficulties any of the participants experienced with access to the technology.

Her main postural challenge was her tendency to lock her knees, and I noticed a slight curvature in her back. In the past, she had taken lessons where expanding the ribs was stressed, so she had a good grasp of the breathing technique I prefer. Since she was an instrumentalist, her breathing was already developed. When I tested her lung efficiency, she was able to sustain an [s] sound for 30 seconds.

Despite her good breath support, her voice was smaller and thinner than I believed was possible. We worked on connecting her sound to her breath and having a less intense airflow than she might have used for saxophone playing. Stressing a wide, warm airflow warmed the tone of her voice considerably.

During the second week, Tina reported practicing about 15 minutes per day, with about 80% on exercises. She had positive comments about the use of Web pages in her lesson, "[The Web pages were] helpful—similar to last time—[and] good as another visual aid. . . . I think they are efficient. I really like that they're not too complicated because that is the exact thing that scares people away from using computer technology." Suggestions for changes included:

> Keep them simple and organized with easy option to review—not too much writing (like they are). Add problem-solving option—i.e., like for the things you might touch a student to check. Instead, add option so they can check themselves and know what to feel during practice or what to watch for to ensure they are confident they are doing things right and can do it on their own.

She had become bored with the slow pace of lessons and the difficulty in changing her postural habits:

> [The postural exercises were] tedious. I understood everything, and while it was very sequential and all very important and you told me how to check for and practice posture, etc., I felt that it was awkward standing with hands over head, against wall, knees so bent for such long periods. I wish it could have seemed more practical to me, or we could have compromised so I did not feel so uncomfortable, but you said it would be a strain, and it all made sense. I think something to realize is if something is uncomfortable for someone they are more likely to compromise on their own—i.e., like you kept having to tell me to bend my knees. I think another important aspect of posture is to be comfortable and relaxed, yet with good posture. Other areas can be affected by strain, and we are all different.

She did not appreciate the on-line survey and she preferred the e-mail version of the questionnaire because she was in the habit of checking her e-mail every day. She did feel that the Web forms were "nicely laid out." She wanted to be able to comment in places where no comment box existed:

> I felt that [the use of Web forms] was redundant. I thought I answered the same questions via e-mail. [The Web forms were] more helpful to you than to me. [The Web forms were] well organized and easy to do quickly, though! . . . I really liked the organization of the on-line survey, but not all areas had space for comments, and e-mail is something I check more regularly. I had to log on to WWW esp. to do that, so I think [I prefer to answer questions] this way, [by] e-mail.

During the third week's lesson, Tina and I discussed her aversion to being touched. She said that her discomfort was not a major issue, but she had felt uncomfortable about saying anything during the lesson. The breathing exercises had not been a challenge to her because she had done significant previous work on breathing. She still had some postural challenges, particularly in keeping the knees bent. Some jaw tension still existed, with little improvement from the previous week. She was able to sustain an [s] sound for 36 seconds, an improvement of six seconds. She stated she had been practicing this breathing exercise.

I vocalized her up to a Bb5 before she began to show strain in her voice. I believed she could sing much higher, however I did not want to damage her voice. I told her I would consider her a soprano, although she had been singing alto in choirs. Since she lacked frontal resonance in her singing, I had her sing [mjou] (like a cat) to open her frontal resonance. The exercise, along with the messa di voce exercise, was helpful in helping her find her frontal resonance.

I then demonstrated the tuner and warm-up functions of the SmartMusic system to her. After my demonstration, she was able to boot the computer, launch SmartMusic, and find both the tuner and warm-up features without further prompting.

In her journal from the third week, Tina indicated she was practicing at least 15 minutes per day, mostly on exercises, and she had applied what she learned to her choir rehearsals. She did not choose to avail herself of the practice room because she had her own tuner at home, "I used my own tuner because I did not have time to use [the practice] room, and it was much more convenient for me to use my own. . . . It's helpful, but takes time." Apparently, she did not see the need to access the accompaniment feature on her own, but had positive comments nonetheless, "For me it is nice, because I don't have to plunk out notes, but this week it was more practical for me to practice with my own equipment." She felt she could have accessed the software if needed, "I understood how to use the software that you showed me, and could if I wanted to, but it was just easier on my own."

During the fourth week's lesson, Tina had made some progress in her vocalization. I was able to vocalize her up to D6. Her voice was still a little pinched, so I had her manipulate her jaw and perform other exercises to open her vocal passage. I noted little improvement in this area during the lesson.

She seemed uncomfortable in her first attempts to sing into the microphone. Since she had a small voice, the computer did not always recognize her entrances, although she sang on pitch. Having used the system before, she was able to access the accompaniments on her own without much difficulty, but she had to be prompted to change the pitch to the published key. She was uncomfortable singing on her own, and I had to sing with her to make her more comfortable.

Because Tina had a prolonged illness and the Spring Break intervened, her fifth lesson took place during the week when other students were having their seventh lessons. She gave no response from the previous week's lesson because of her situation. She seemed to have recovered from the major problems with her illness, but still had a slight cough. On our vocalizations on the various vowels, I was able to bring out many of the high overtones in her voice and diminish the woofiness that she had shown in previous weeks. I made her aware that her back vowels lacked clarity.

She already had a good grasp of her song, so we only needed to work out idiosyncrasies of the Italian text, such as closed- and open vowel forms. Since she was a music education major, the counting exercises were second nature to her. She was able to sing through the piece on vowels with only a few challenges.

Because Tina had been ill, her practice time had been diminished. In addition, because we were forced to have two lessons per week in order to make up for lost time, the total amount of practice time she had available to work in the SmartMusic studio was limited. During the period after the fifth lesson, she practiced for about 90 minutes without using the SmartMusic system. She had positive comments on the use of the warm-up feature of the system, "I like being able to do it, because it is free and gives me the opportunity to practice with the accompaniment for as long as I wish." She found the intonation exercises useful, but frustrating:

> It's good practice, and certainly valuable. I like to match pitch better than just match up a needle. It is kind of frustrating trying to match pitch perfectly with a little needle on a computer screen—or to a tuner for that matter. I think that an exercise such as this needs to have direct transference to singing, vs. just being an exercise. Time permitting, I would check the notes of my solo to see if I naturally sing them sharp, on, or flat, and use it that way.

The peculiar nature of the ending to her piece in the SmartMusic accompaniment lessened the effectiveness of the experience. The ending for the piece "Caro mio ben" on the SmartMusic software was challenging because it has been programmed so that the performer must tap the foot pedal in order for the piece to continue. Unfortunately, if the performer taps the foot pedal at the wrong time, the software returns to the beginning of the piece. She stated, "It's fine, although my solo is a little frustrating with the necessary pedal pushes. Perhaps it can be programmed to follow more (?), but I feel the pressing the pedal (the singer pressing the pedal) or worrying about it takes away from the musical experience."

Tina was well prepared for her sixth lesson. She made quick work of the diction exercises and showed no major difficulties in pronunciation. She had a good grasp of the Italian pronunciation and was able to produce the minor corrections I suggested without much difficulty. I was happy when she was able to sing through the piece on vowels with no difficulty.

Frustration with the SmartMusic system and the piece "Caro mio ben" continued. At first, I had forgotten to transpose into the correct key. She showed hesitancy in bringing dramatic elements into both her reading of the text and the singing of the piece.

After the sixth lesson, Tina reported practicing for about two and one-half hours, with about 20% vocalises, and not accessing the SmartMusic software. Since she had used the system before, her perception of it did not change over the semester. She also did not access the Web pages outside of class. She found the articulation exercises helpful, but too time-consuming.

During the seventh lesson, Tina was singing well, but she had great reservations about her ability to add dramatic elements to her music and to express herself musically. During the warm-ups, I tried to stress basic relaxation and breathing techniques, which were still lacking. We then moved to the tuning exercise. She had improved in her ability to match pitch, but she still could not conceive of what muscles to use to make minute adjustments in pitch. I told her that the muscles used for small-scale pitch control were intrinsic laryngeal muscles which cannot be controlled directly, so she should audiate the pitch changes and "allow them to happen," rather than trying to control the situation. She did not seem satisfied with my explanation.

When we began working with her piece, her inhibitions about singing musically became evident. She stated that she had thought about adding drama to her piece, but that the experience would be "fake" and would not succeed. She said that since she did not want to sing musically, a musical performance would never manifest in her singing. I assured her that this self-expression would become easier as she practiced, and that she was being hard on herself for no reason. I hoped that the next lesson with the accompanist would be beneficial because he plays with a great deal of emotion, and I was hopeful the emotion would transfer to Tina.

During the period after the seventh week, Tina sang for a few minutes on days when she did not have choir, concentrating on McClosky Techniques. She sang up to 90 minutes on days when she had choir, with about 40% on exercises and 60% on songs. She had not used the practice rooms yet that week. She also included an explanation of some of her reasons that she had not been motivated the week before.

> Sorry I didn't practice in the room yet, but I'm pretty familiar with the accompaniment anyway, and figured I'd rather practice the musicality rather than wasting time getting the [practice room] key, and working with the computer. I also apologize for not being a very willing participant last week. Most of it was just stress, because I had to drop a class because it was too much to get caught up with after being sick, and I would have dropped voice lessons if it wouldn't have made such an impact on your research. I know I'm not getting as much out of it as I could, because I'm not giving a lot of effort to it. I do think you give good feedback. [I am] still embarrassed to do some exercises—i.e., motor boat lips—but [I] understand they help with air, etc. I will try to practice more before tomorrow, and pray that the recital will be a good experience.

During the eighth lesson, Tina had overcome some of her inhibitions about performing in a musical style. The observations of her physical state were hindered by the fact that in the past she had expressed a slight aversion to being touched. I was unable to monitor her the way I could with other students; instead, I simply had her describe her physical sensations. She could move her jaw well when relaxed, but still struggled in moving the jaw while phonating. She said that her swallowing muscles were more relaxed when singing than they had been in the past. Her posture still showed a few discrepancies from what I had originally taught her. She had neither straightened her lower spine nor become comfortable bending her knees while breathing. She reported that her ribs still collapsed slightly while exhaling. She was able to sustain an [s] sound for 40 seconds, an improvement of 10 seconds from her original measurement. When I vocalized her, she was able to sing a low F3 and a high Eb6. Her Italian diction was passable, and she had greatly improved at adding drama and musicality to the text while reading.

When we began working with the piano, I noted that the tempo was slower than we had usually practiced, and that she wanted to sing faster. However, she did not take control of the piece in order to accelerate the tempo. She asked to use the music during the first run-through, but I believe that she had the piece memorized well enough to perform. She was very comfortable with the human accompaniment, and she stated that she preferred the human accompanist because of the better sound quality and the more "natural" feel of the experience. She had found the computer "cumbersome" at times, however she did state that the computer had been an excellent overall practice tool. She related how previous solo and ensemble concerts had been tense because of the limited time she had available to acclimate to the accompaniment. She also related how that since the computer was the "same every time," after a while the experience became stagnant, while the piano was able to adjust to her and vary the volume with her.

During the eighth week Tina reported practicing "regularly, whenever [she had] a chance," with 10% exercises and 90% singing. She had not used the practice room at the time of her journal. She felt ready for the concert, but suggested I could have made her a practice tape of her run-through with the human accompaniment.

She reported having felt slightly uncomfortable with the new accompanist, particularly when I distracted her by taking notes during her song. She preferred the piano accompaniment, and in her journal referred me to comments she had made during the lesson.

Concert. At the concert, Tina performed well with the human accompanist. Because she was late for the scheduled practice session with the human accompanist, the pre-concert warm-up had to be completed with the software. The performance at the concert was in fact the first time she had sung through the piece with that particular accompanist. The introduction he played was noticeably different from the computer accompaniment, but the differences did not seem to affect her performance. Although she was first on the program, she seemed confident and performed well. Her Italian diction was excellent and she had made great strides in the task of adding emotion and drama to the piece.

Final journal for Tina. Tina had positive comments about the use of technology in the lesson, "I got more comfortable with using the computer simply by using it more." She also felt the SmartMusic system added to the lessons:

> I do not feel that these tools can replace a teacher, but that they are certainly helpful both in a private lesson and during practice sessions. While certain fundamental techniques are important to practice, it is nice to work along with a computer to check yourself even when a teacher is not present. . . . I liked the tuning features, and it helped me most to know that I could practice with an accompaniment anytime I wanted.

However, she appreciated the human accompanist in the concert situation, "I appreciated having a human accompanist, mainly because my piece was tricky to run with the computer, and thus distracting from an overall musical aspect."

She felt the use of the Web pages were beneficial both in and outside of lessons:

> I think the Web pages were a great supplement to the lessons. They served well as a visual aid. I also like the idea of referring to them in the future for reference. I have already referred people from outside of the school—some teachers starting to teach voice—to check out these Web pages because they are simple, easily understandable,

> and have good visual aids. I think the introduction I got to them in lessons was very appropriate.

Summary. Tina was a soprano with a great deal of musical experience and some technical experience. She received Web pages in lessons, did not have spectral analysis, and performed with the human accompanist. She appreciated Web pages both within lessons and as an outside resource. She found idiosyncrasies for her particular piece on the SmartMusic system frustrating and had a strong preference for the human accompaniment. Although she had been apprehensive about her performance, she performed the song acceptably at the final concert.

Tony

Demographic information. Tony was a 19-year-old sophomore majoring in materials science and engineering. He had not experienced formal training in singing since the fifth-grade chorus, but he had recently formed an alternative rock band and was interested in improving his voice to sing backup vocals with his group. He reported that both of his parents sing very well and he was "hoping to tap into some of those genes." He was not sure where to characterize his voice, "I'd say I'm somewhere between tenor and bass. I have a deeper voice, but I don't really know where to put myself as far as when I'm singing." He had played guitar for about eight years informally, and had increased the amount of playing time recently.

He had a good deal of technical experience before the lessons started:

> I wouldn't say I'm a computer junky (I mean, I don't play video games all the time, I really only use it as a tool for Web browsing or e-mail) or anything like that, but I have a pretty good knowledge of what's going on. I've taken three programming classes (mostly introductory) and know a little bit about recording.

Since he had an Ethernet connection in his room, checking e-mail was not a hardship. He was committed to the experiment, as long as it did not interfere with his grades or his guitar practice.

Lessons. During Tony's first lesson, I did not use the computer for support. He was a laid-back person, so his face was naturally relaxed, but there was tension in the swallowing muscles and some difficulty in moving the jaw. I anticipated his breathing would need significant attention in the next week's lesson. His speaking voice was extremely low; he said he had recently given up smoking and the effects were still apparent. I worked on raising the speaking pitch, but he had difficulty maintaining the high pitch and said the new pitch felt awkward. I told him we would work on musical theater songs since those were the closest to the style of music he wanted to sing.

During the week after the first lesson, Tony reported attempting the techniques "once a day or so." He accessed the Web pages twice and found that:

> They served as a reminder of what order I was supposed to do the exercises in. . . . I think that they're already very descriptive and serve their purpose. I don't think they could really use any improvement. They have a picture of what you're supposed to do along with a written description.

He had few suggestions for changes in the lessons, but did state, "At first I was a little taken back by these exercises. But, now I see how they can help to relax your face and throat muscles."

During the second lesson, Tony reported having viewed the pages during the previous week and having appreciated the use of graphics, but he saw no need for using the pages in the lesson itself. Tony had had a stressful week before the lesson with many tests. He said he had worked with the technique to some extent, but I noticed only minimal improvement in relaxation from the first week. Much tension still existed in the swallowing muscles.

He had some postural challenges we needed to overcome, particularly in the lower back. He stood with a curved spine, and when I straightened his back, he found the new posture uncomfortable. His breathing had more intercostal movement than was acceptable, but no clavicular movement existed and he was able to breathe properly when coached. When I tested his lung efficiency, he was able to sustain an [s] sound for 20 seconds.

I was encouraged by the vocalizations he made. He was able to move from chest voice into head voice without a noticeable break. I reiterated that he should be speaking at a higher pitch. I decided to attempt repertoire with him in the tenor range.

During the second week, Tony practiced singing for at least four or five hours, with 90% on singing. He tried to practice the exercises once a day. He thought that the bullet-point format of the second set of pages lacked the descriptive information of the first set, "Well, these pages are okay, but they don't seem quite as descriptive as the first set of pages with the McClosky Techniques."

He found the postural changes challenging:

> Posture seems to be a little more difficult since this is how I've been standing for as long as I can remember. . . . I thought that the lesson was pretty good, but I found it hard to focus on all those things at once. I felt kind of uncomfortable with my knees so bent, so it was hard to think about keeping my back against the wall and singing and doing various McClosky Techniques without letting my lungs collapse. However, I did seem to improve a lot during that lesson and I've noticed a difference in how I sing already, so maybe it is working! . . . I think that the breathing is crucial because a person is really supposed to breathe like that anyway, whether they sing or not. The posture thing is a little tough, but it did seem like there was less stress on my back. I often have a sore lower back, mostly from football and weightlifting and things like that, but it seemed less sore on my walk back home after I tried to straighten my spine out a little.

He noticed that the Web page form would give better information for statistical information, but felt he could add more by e-mail, "Well, the on-line survey was quick and easy, but I seriously doubt that it gives you the feedback that you're looking for. I could be wrong, but it seems like I can elaborate more with these questions and describe exactly what I thought about particular parts of the lessons."

At the third lesson, the majority of his singing during the previous week had not been with the exercises I had shown him, but with his band. He did not exhibit much improvement on the McClosky Techniques or breathing exercises. He was able to sustain the [s] sound for 21 seconds, an improvement of only one second from the first week. His breathing still depended on the intercostal muscles.

I found him to have a pleasant, light upper range. I was able to vocalize him up to a Bb4 without too much tension. He was worried that the high notes were not strong enough, but I told him to let them be light for now and they would grow. When he sang I noticed many extraneous movements, such as gasping for breath and moving the head, which were interfering in his voice production.

He was very interested in using the tuning feature of the SmartMusic system. Since he had experienced pitch-matching difficulty on some of the warm-up exercises, I suggested he take extra time in this exercise. He said he had a tuner at home, and would use it regularly. He had no difficulty in launching the SmartMusic system on his own after I had demonstrated the software.

In the third week’s journal, Tony reported that he had practiced for about five hours, with about 20% being voice exercises. He entered the practice room once, for about 45 minutes, and had no difficulties using the software. He had no preference between the warm-up feature and the piano for warm-ups, "It's essentially the same thing. The computer is probably a little bit easier for me." He also had positive comments about the tuner, "I think it's good for me. [It] helps me find the notes a little better."

At the fourth lesson, he had made good improvement in general tone quality from the previous week. His main difficulties were tone quality during loud singing and scooping up to the pitch.

He was able to understand the workings of the accompaniment feature of SmartMusic. Although I had demonstrated the procedure to him earlier, He had several questions, including how to change songs, once he began to use the software without my guidance.

We had a difficult time finding pieces that I felt were appropriate to his light, tenor voice. I suggested we work with Italian repertoire. However, since he did not know any of the songs and he had limited note reading ability, the Italian repertoire was beyond his abilities.

During the fourth week, Tony practiced for an average of an hour a day, except when his band practiced, when he did more singing. He spent much less time on exercises as the semester went along. He used the SmartMusic software once, without any difficulties, and he preferred to use the computer for warm-ups as compared to the using the piano. He also had positive reactions to the tuner feature, "I like to use the computer because it has the tuner and when it plays a note it's easier for me to match it. . . . I liked it a lot because it helped me to find the right pitches." His comments about the accompaniment feature again centered on pitch, "Just like before, [the accompaniment feature] makes it easier for me to find the pitch in the songs."

During the fifth lesson, Tony reported that he did not access the practice room during the intervening week. He was singing well and showing an excellent legato line in the high range. His chest voice was still choppy. The chest voice was possibly influenced by his speaking habits, which I had been unable to influence. We chose the song "If I Loved You" (Rogers and Hammerstein), which was new to him. I felt this piece would accent his high range without being overly taxing. He had a difficult time negotiating the rhythm exercises in the initial recitative-like section, but in the main theme, he performed better. We were running short on time and did not have as much time to work on the vowels as I would have liked.

During the fifth week, Tony's practicing was limited mostly to singing with the radio, and he had abandoned vocalises. He did access the practice room once ("only for a few minutes"), and he did not use the Web pages that supported the lesson. He was able to sing the vowel exercise with me, but he noted that the process was a mental challenge. The technology was not an issue.

During the sixth week, Tony stated that he had not had a chance to sing extensively over Spring Break because he had suffered a death in the family and had other concerns. During the articulation exercises, I noticed that some of his consonants were affected by his Chicago accent, particularly final [t]s and [d]s. When we transferred the articulation exercises into his piece, I noticed a good deal of improvement in his ability to sing in a legato manner. However, the recitative-like section at the beginning of his piece was still choppy.

In the sixth week, Tony reported that he continued to sing for more than an hour each day and longer on days when his band practiced. He did not keep logs of his singing, though, "It's hard to say all the time because I sing a lot even when I'm not necessarily intending to." He had abandoned any vocalises or exercises in his practicing and did not visit the practice room. His comments on the SmartMusic system were positive, "To be honest, I never had any reservations about using the room. It's private and the equipment is easy to use."

He appreciated having the articulation exercises on line, but would have preferred personal reinforcement, "I feel that they are very helpful in articulation. However, it's not as helpful if you don't know what mistakes you are making because there is no one to correct you. I felt that it was more useful in the lesson than outside of it."

During the seventh lesson, I warned Tony that he was reinforcing bad habits by not spending enough time on vocalization exercises. His high notes were becoming stronger, but his low pitches and speaking voice still lacked fluidity. In our work with the tuning exercise, I did not note much improvement from our previous work, leading me to believe that he was not using this feature. I tried to make the process more applicable to his singing by having him sing portions of his piece into the tuner to help with intonation on his personal songs.

His piece was memorized and the notes were all in place, so we began work on adding musicality. He had difficulty making dynamic contrast because his dynamic range was not wide on his higher notes. His lower notes, such as the recitative section, were still pedantic, so we worked to add more meaning to the text in order to influence the cadence of the piece.

During the seventh week, Tony practiced for two hours per day with about 90% singing. The amount of response he gave was limited because of the death in the family, and he did not have time to journalize.

During the eighth lesson, I judged that Tony had made reasonable progress during the semester. He was able to wiggle his jaw freely when resting, but still had difficulty when vocalizing. The swallowing muscles were also not as pliable as I would have liked, but they had shown improvement from my previous observations. His ribs still collapsed during his exhalations, and he could sustain an [s] sound for 26 seconds, an improvement from 20 seconds. His usable range had improved greatly to from an F#2 to an Ab4. He had memorized his piece well and was working to add drama to his reading of the text.

During the first run-through of the piece with a human accompanist, Tony missed some entrances that normally would have been performed correctly. When I asked him why he missed the initial entrance, he stated that he had been taken unawares. I noticed that he seemed less confident performing with the piano. This lack of confidence was manifested in nervous hand movement, rocking back and forth, and throat clearing.

When I asked about differences from the practice room experience, several differences came to the discussion. Tony noted that slight tempo fluctuations existed when compared to the static computer accompaniment. The pianist wondered whether he should play the notes in the accompaniment that doubled the melody line, since Tony already knew the notes. The piano was also considerably louder than the computer accompaniment, so Tony had a tendency to try to push his voice to be heard above the piano.

After the eighth lesson, Tony practiced for more than two hours per day, but did not access the practice room. He commented on his use of exercises:

> I spent a lot of time singing songs, but I noticed that I was, subconsciously, using techniques that you taught me throughout the course of the eight weeks. It was simple things like the crescendos, annunciation (sic), and light attacks and things like that. Percentage-wise I'd say about 90[%] on singing and 10[%] on exercises.

He felt ready for the upcoming concert ("Yes, I think I'm ready. I just have to try to keep cool and sing like I did during the lessons."), but he also stated, "I would have liked to have just one more lesson where I just sang the song, but that's about it. I know that you were busy, and I've been busy, too. So, I'm not sure how practical that would have been anyway." His comments on the change to human accompaniment included, "It was just different in the respect that I could always rely on the computer to play exactly the same, so I kind of depended on it for my timing. The accompanist was waiting for me. That was a little different."

When asked if he had been nervous with another person present, he said, "Slightly, I don't know why. I think it could be that I am always nervous when I'm dealing with someone who is a much better musician than I. I've performed in front of people before, but usually people I know, and the songs are often easier for me to sing."

He preferred the software accompanist to the human, "I think that in hindsight I'd like to have the [human] accompanist more just for the realism. But, like I said, sometimes it was nice to have the computer that never changes time and always reminds me of what note to sing."

Concert. At the final concert, Tony performed well with the human accompanist. He seemed confident and sang the piece with emotion. Occasionally he experienced minor difficulties passing into his head voice, but once over the passaggio, his voice was clear and beautiful. He seemed to have adjusted well to the human accompanist.

Final journal for Tony. In his final journal, Tony had positive comments on the use of technology in his lesson, particularly the accompaniments, "I think that the technology helped my voice lessons this semester mainly because of the accompaniment. I think that it is a tremendous help to hear the pitch when you're trying to sing a note, especially when you don't have much experience with music. . . . I really like the accompaniment." The other features of the SmartMusic system received different responses:

> I honestly don't really remember much about the warm-ups because you usually punched 'em out on the keyboard. But, I think that the tuner was very helpful, I just didn't like how hard it was to actually get (sic) the thing to center on a note. It was very sensitive, I thought. But, all these things were good for practice, and the accompaniment was good for performance, too.

Although he performed with the human accompanist during the concert, he had only a slight preference for the live accompaniment:

> To be honest, [the choice of human versus computer accompaniment] really didn't make that much difference to me. If I had to choose, I'd choose the human just because I think it sounds a lot more realistic. The computer works fine, but it plays synthesized-sounding notes that are sufficient, but leave something to be desired.

He found the Web pages useful as a reference, but saw no need for them to be added to the lessons themselves:

> Well, I liked the Web pages. I thought they served as a useful reminder. Most everything on the Web pages we went through during the lesson, so I never really

> learned anything new from them. But, like I said, they are a good reference. As far as being used in the lesson, I don't think it's necessary. I think I'd rather see a person demonstrate the techniques than to see a picture of them.

He did not receive spectral analysis, but was interested by the Web page results of the other students, "I didn't do [the spectral analysis], but I think it would have been kinda cool. I'm not really sure that we had time, though. So, it's probably okay that we omitted it."

Summary. Tony was a tenor with a little musical experience and little technical experience. His lessons were the least technologically saturated of any of the participants. He found the Web pages useful as an outside resource, but saw no need for adding them to the lessons themselves. He reacted well to the SmartMusic system, but did not access the practice area often in his own rehearsals. He was the only participant (with access to the human accompanist) who did not have a strong preference for the experience. Tony's improvement was hindered by the fact that he spent relatively little of his personal practice time on vocalises and exercises.

Linda

Demographic information. Linda was a 20-year-old junior who majored in biology She had had no formal singing training other than elementary chorus, but said, "sometimes I like to make up my own songs and just sing for fun!" She was not in any musical group, and did not have any clear goals for what she wanted to do with her singing once lessons were over. She initially categorized herself as an alto. Since she had played the violin for seven years and the piano for three years, basic musical concepts had been established.

She had a good deal of experience with technology:

> When I first came to the university I was a [computer science] major, but I didn't enjoy programming so I switched majors. However I can program a little bit and I

> understand how to use word processors and spreadsheets. I also have taken two computer applications courses in high school where I learned how to use several different formats of spreadsheets and Corel and basically played around with the computer.

She checked her e-mail regularly and used the Internet frequently, so I did not anticipate any need for special technical training for her. She reported being very committed to the project, "This would be such a great experience and I would be dedicated to it. . . . I would be delighted to help and learn some things about singing!"

Lessons. During the first lesson, I did not use the computer as support. Without the added visual support, she had a difficult time remembering the McClosky steps in order, despite the fact that she was very intelligent.

Linda was a non-musician, so some of the concepts as well as her body control were not as well established as some of the musicians I had taught previously. However, as she was more of a true beginner than some of the students were, she was very open to my teachings. She had great difficulty moving the jaw. Some of her troubles came from postural challenges we needed to work on the following week. She had significant head tension, and when I tried to move her head, there was considerable resistance. When I had her take a test breath, she breathed clavicularly and had difficulty understanding what I meant by a diaphragmatic breath. I anticipated that the posture and breathing unit the following week would be a challenge for her.

During the first interim week, she practiced on average about two to three times a day for about three minutes each time. She did not feel the need to access the Web pages because she remembered the exercises. When she reviewed the pages, she stated, "They are very effective already . . . everything is laid out in an organized fashion according to each week. The photographs and drawings are helpful too."

Her general impressions of the first lesson were positive, "So far it seems effective, and I feel comfortable at the lesson. I was explained what I am to expect and why I do the techniques. I like the lesson!"

During the second week's lesson, Linda indicated that she had gone back to the Web pages and found them informative, although she had had no difficulty remembering the McClosky steps. She particularly appreciated the graphics and she had no suggestions for improving the pages.

Her McClosky work was excellent. She had a loose jaw, but there was still swallowing-muscles tension when phonating. Her breathing had improved from the first week, as she had become aware that she should not use her shoulders to breathe. The breathing exercises went well. She had a curved back, so I paid special attention to straightening her spine. The graphics from the Web pages would have been of use to me as a teacher at this point. Her rib cage was very small, so it was difficult for me to judge whether she was collapsing her ribs. She tended to look down slightly. She sustained the [s] sound for 10 seconds. Beginning vocalization showed a breathy, untrained voice. She had great difficulty in going over her passaggio, so I anticipated some extra work in the head voice.

During the second week, Linda reported not being able to practice much because of a number of tests. She spent about 75% of the time on exercises and 25% on vocalizing.

She found the Web pages lacking in comparison to the face-to-face lessons:

> I think [the Web pages] are still effective, however, I liked the way that you explained in class why we did techniques and how it helps. The Web pages don't do that. For example, with the ribs, you told me in class to keep my hands over my head to keep them open. I never would have gotten that just from the Web. However, as a supplement to the class, the Web pages are great for a quick referral to what the actual main points of the lesson were.

She had positive comments on the second lesson, "I thought the second lesson was just as effective as the first. You explained the concepts of breathing and posture very well and I understood why I should do it. . . . I liked the second lesson equally to the first one. I feel that I am learning how to make my voice stronger."

She had no preference between on-line forms and e-mail, but was confused by some of the questions in the survey, "I don't really know enough about how voice production is taught in general and so I can't really say whether technology will improve it or not. I also was not exactly sure what you meant by technology, the Web pages or actual programs or devices or things like that."

In the third lesson, Linda reported that she had not been able to practice as much this week as she would have liked because of tests and other scheduling challenges. She did show some progress, though, as her McClosky Techniques had improved greatly. She also reported that she had practiced the breathing exercises, and she was able to sustain an [s] sound for 15 seconds, a 5-second improvement. She had done good work on breathing this week and seemed to be taking to the concepts. She was still limited by her small lung capacity due to the size of her frame. She asked if the new exercises I showed her this week were on the Web. I explained to her that since I do different exercises with different students, the Web pages could not reflect all possible vocalises and breathing exercises that I had learned over the years.

I was surprised when she vocalized to a C5. Once she had established her head voice, I suspected that she was not an alto, as she had originally indicated and as her speaking voice might suggest. I suggested she work extensively on her high range. The most beneficial exercise for her was to sing while buzzing the lips together, thus engaging her airflow in order to move the lips.

Because she had not been used to singing in the higher range, she had difficulty matching pitch. I suggested she should use the tuner feature in the SmartMusic software extensively, and she seemed to enjoy the tuning exercise. After my demonstration, she was able to boot the computer on her own and access to the two exercises I had shown her earlier.

In the third week's journal, Linda kept notes that were much more detailed, "I practiced Tuesday for about 15 min., Wednesday for an hour (I came in to the room and used the equipment), Thursday for an hour Friday maybe 10 min. on the McClosky Technique and a bit for my back, Saturday about 20 min. total, and I have yet to practice today and tomorrow." She spent about half her time on exercises and half on singing.

During her one 1-hour session with the technology, she had no problems using the software. She had no preference between warm-ups on the computer compared to piano. She had positive comments about the tuner, "I like these a lot because I like being able to see the little green arrow when I match the right tone. It helps me remember the right sound of it." She stated she was enjoying the lessons.

During the fourth lesson, Linda indicated that she had come into the practice room and accessed the SmartMusic warm-up and tuning features. She enjoyed using the tuner and showed great improvement in her pitch-matching abilities.

When vocalizing, I found that if I had her sing with her tongue out of her mouth, she had a much more resonant tone, even after she retracted her tongue. I suggested she should continue with this exercise and exercises that encourage good support.

Our initial explorations with the SmartMusic software were hampered by the fact that she did not know any of the spirituals I had chosen as example pieces, so my intention of beginning with a song she knew was thwarted. We had a little more success with the musical theatre songs, but she knew only a very few. She was able to understand my instructions on using the system and had no trouble accessing the accompaniments when prompted. She did ask how to change disks between songs that were in the same book, but I believe that if she were on her own she would have been able to access the music through trial and error.

During the fourth week, Linda reported practicing about one hour per day, with about 65% on songs and 35% on exercises, including two sessions with the SmartMusic software. She had difficulties using the SmartMusic system the second visit because, as I discovered later, someone had used the serial port on the computer for printing and not reconnected the SmartMusic system:

> I did everything as instructed, however the last day (Sunday) I went in, the computer would not make any music for me. I could still practice the intonation, but it would not play the reference notes for me. The computer also didn't play the songs for me from the disk. . . . I noticed the microphone was set to ON, so maybe the battery had died?

She did not prefer either using the keyboard or the piano for warm-ups, "I honestly had no preference, I liked both ways. They were similar to me." She again had positive comments about the intonation feature, "I like it. It helps me with my scale and helps me memorize what the different notes should sound like. I like having to match up the green arrow in the triangle." Since she did not know many of the songs available, she had a difficult time using the accompaniment feature:

> I didn't really know any of the songs, and so without the words I can't get a good feel for what the song should sound like. Also, it goes pretty fast, and I am usually confused about where the computer is and where I need to come in. I think I would like it more if I got to hear the actual song sung several times, and then I would know what pauses to make and what key to sing. This to me would be better than trying to figure out how long I should hold something, what note it is, and what word it is all at the same time that the computer is quickly playing the music accompaniment.

During the fifth week's lesson, Linda reported that she had come in to use the software twice, but the second time she had the problems mentioned in the e-mail. I explained to her that she had done nothing wrong and that some of the hardware was not in the proper place. She was, however, able to use the tuner without audio reinforcement. We spent a good deal of time negotiating vowel changes in her warm-ups. She had picked "I Could Have Dance All Night" (Lerner and Loewe) for her piece. I felt this was a good selection because it used her high range, but she had some difficulty with the G5 at the end.

She had trouble grasping the concept of counting the rhythms, and would get confused when counting the numbers. She had a good idea of singing legato with the vowels only. In the final run-though, I felt the vowels lacked the clarity we had found in the warm-ups. We had to abandon the accompaniment in SmartMusic to isolate individual challenging passages.

During the fifth intervening week, Linda practiced for about half an hour every day, reporting spending about 75% on singing and 25% on exercises. Practice included one session with the SmartMusic system for about 30 minutes.

She was slowly becoming accustomed to the exercises, which had been new to her, "The vowels did not give me trouble, but the counting is just a bit difficult— I think I may have forgotten the count a bit, (which numbers when) but I have it in my head for how long to hold the beats for." She did not access the Web pages that were intended as support.

Her comments on the accompaniment feature continued in a similar vein from the week before:

> The accompaniments are nice now because I can hear the background music, although at first, it was a bit confusing because I had never heard the song and wasn't sure when to hold notes, when to stop, when to start, because I was too busy trying to figure out what the notes were and what the words were. Also, as I mentioned before, I like to have an idea of what the song as a whole is like before I attempt it so I can get a feel for it.

During the sixth lesson, Linda reported that she had done some singing over the break for her parents and her voice was responding well. Her voice was clearly a light soprano by this lesson, as compared with the darker sound with which she had begun.

She understood the consonant exercises, and we decided she needed practice on the sustained consonant sounds like [z] and [v]. The vowel sounds were well established from the previous week, so adding the text worked well. At first reading through her text of the song, her presentation was mechanical. When I emphasized to her the importance of incorporating drama and meaning behind the words, she improved in her dramatic content, and her acting seemed natural.

During the sixth week, Linda practiced singing for about 90 minutes and spent another hour working through the diction exercises, with about 75% of the time singing. She had not accessed the practice room at the time of her report, but she did have these comments, "The room feels like my practice area now. I feel comfortable in the room with you as my teacher and on my own because I know how to use the equipment and I know where to get my music and disks from." Concerning the diction exercises she stated, "I accessed them once, they were helpful, similar, I believe, to the ones I learned in class. . . . They are good, and I see myself using it in my song 'I Could Have Danced All Night.' " She also reported being excited in anticipation of the concert.

During the seventh lesson, Linda was singing with much more feeling than she had been in the previous week. When I practiced vocalizations with her, we had to rediscover her high range, which had begun to slip. With practice, she easily sang above C6. She had memorized her piece and showed more of a dramatic flair on the read-through. Once we began working on individual phrases, the SmartMusic software was again not adequate to the task, so I was again forced to switch to the piano. Because she had a limited dynamic range, it was difficult to establish musicality within the piece. I attempted to get her to perform swells and dynamic contrasts, and she seemed to be enjoying the process.

During the seventh week, Linda completed her e-mail journal early, so she could not give an accurate account of the amount of time she would spend practicing. She did, however, state that she was still spending about one-third of her time on vocalises. She felt we should be spending more time working on music, as opposed to vocalises:

> I think maybe more time on the songs would be better. . . . Although I realize that warming up the throat is good, I could do that before the lesson and then spend a lot of time on the song, and even make notes on the song, and go into detail of what to perfect. Sometimes when something I sing is wrong, I try to make a mental note of it, but I forget what was the problem, or what I did wrong because we went over it once and moved on to another aspect of the song. But I really still enjoy the way the lesson is, I feel very comfortable singing and I feel that I am learning how to use my voice to the fullest.

During the eighth lesson, Linda was excited about the upcoming concert, and she showed great improvements on the measurements of her fundamental progress. Her jaw was loose while resting and phonating, and her swallowing muscles were relaxed. She had learned to exhale without collapsing her rib cage, a process that was impossible just a few weeks ago. She was able to sustain an [s] sound for an impressive improvement to 30 seconds, triple her original reading of 10 seconds. She was also able to read though the text of her piece dramatically.

On the initial run-through with the human accompanist, she made some errors that I had not observed in our lessons before. When I asked her about some note problems she had experienced, she was unaware that the notes had been missed. By the second run-through, most of these mistakes had been corrected and she seemed comfortable with the accompanist. The main suggestions I made were to include much more drama and musicality into her piece.

When I asked her about the differences between the computer and the human accompanist, she noted that some of the tempos were a bit different. She also noted that even when singing with a human, she was aware of the places when the computer would have stopped and she would have needed to trigger the accompaniment had she been using the software. The piano was also louder than the computer accompaniment, so she had a tendency to over-sing some notes. She preferred the human accompanist, citing his musicality, the "more lively" feel of the music, and the feeling that she was in an ensemble situation.

After the eighth lesson, Linda had practiced for about two hours, about 75% on singing and 25% on the exercises, "all the way from the McClosky Technique to the consonants," using the practice room for one hour. She felt ready for the concert, but was "a little nervous now that the accompanist I practiced with won't be there. Hopefully the other accompanist and I will be able to get right, right away." (Note: A switch in accompanists took place shortly before the concert.) She felt that "maybe a bit more with the accompanist [would] make me feel more comfortable." The differences in using the human accompanist were that "the person had his own idea of how the piece should be played, and he went faster than the computer, and I was not used to that. He played louder and just different than I was used to, but I liked it." She said at first she was uncomfortable, but then she enjoyed the experience, "I think I like practicing with the piano player because it makes it more real, instead of just like a karaoke. I feel that I am really singing for an audience, and it is a group effort (me and the piano player) and that makes it more challenging, but fun as well."

<u>Concert.</u> At the concert, Linda performed well with the human accompanist. At first, she seemed unsure of how to relate to the piano player, as she occasionally looked over to him in a distracting manner. She seemed to be enjoying the performance and sang with a great deal of energy and emotion. The piece went well, including the G5 on the last note of the piece.

Final journal for Linda. Since Linda had less technology incorporated into her lessons than some of the other students did, most of her final comments had to do with the SmartMusic system:

> [The technology] helped me when I used the warm-ups. In practice, I could hear what notes I should be hitting and the green light on the intonation was helpful. The music for my piece was helpful too, but it hindered me a bit because, first of all, since it didn't have words I really didn't know where I was to go with it the first couple times. In addition, when I played with the human accompaniment, it was different, and I liked the way it sounded with the human accompaniment, so it took me awhile to get used to singing with the human accompanist. Whereas if I would have started with the human accompaniment I wouldn't have to do a transition. . . . I liked the smart music (sic) for the practice. It helped me learn the notes I needed without having to rely on someone playing them for me on the keyboard. It also indicated to me whether I was on or off the right note (the tuner did). For the concert it helped me be prepared, but the accompaniment on the piano to me sounded better quality than the computer accompaniment. It seemed more real and lively.

She strongly preferred the use of the human accompanist for the concert:

> I am glad I had the human accompaniment because it makes it more fun and sounds better in my opinion and is livelier. It also feels good knowing that I accomplished a piece with another person successfully and together we made it seem nice. It seems also like more work was put into the person singing with the human accompaniment, hence a better quality of performance in a sense with the human accompaniment.

She appreciated having the Web pages outside of lesson, and thought they might have been helpful in the lessons themselves:

> I liked the Web pages. They were informative to me during practice. I never had them used during the practice with you, but I would assume that it would be the same

> effect. The Web pages also reminded me of things you had mentioned in class that I might have forgotten while practicing by myself.

She also did not receive the spectral analysis, but thought the Web pages looked interesting:

> [Information about readout from my voice] would be interesting to know, and might have helped me to see what range of notes I can play or things like that. But I think that it in no way hindered my performance that I didn't get to do the spectral analysis.

She also had positive comments to end her journal, "The lessons were very informative and I learned a lot in a short amount of time. I felt comfortable singing in front of you and I think you are a great teacher!"

Summary. Linda was a soprano with a little musical experience and a good deal of technical experience. Her lessons were the least technologically saturated of any of the participants. She found the Web pages useful as an outside resource, and felt they should be added to the lessons themselves. She reacted well to the SmartMusic system, but she had a strong preference for the human accompanist, with whom she performed admirably with a great deal of energy. Of all the participants, Linda had the most positive comments about the lessons in general.

Summary of Case Studies

Having presented a detailed report on both the responses of each of the participants and my observations of each student, I now present summaries of general trends in the findings. These data are presented in a chronological fashion, beginning with information from the initial questionnaire and then alternating between my observations and student responses.

Demographics

The participants were all undergraduate students at the University of Illinois. The average age at the beginning of the lesson was 19 (SD 1.4). Grade level of the students included four freshmen, one sophomore, and three juniors. Four women and three men completed the study, and one male participant dropped out of the study during the fifth week. Five of the participants majored in the sciences, while three were instrumental music majors of some kind. Three of the participants had minimum singing experience, three had experience with voice technique when singing in choirs and other organizations, and two had taken private voice lessons or done extensive choral singing. Three of the participants had little experience with music outside of singing, two played instruments as a hobby, and three had extensive training as music majors. None of the participants was a true novice in the use of technology. Four had experience with basic applications and were already familiar with the Internet, while four had extensive training in technology, including programming experience. All of the participants reported having some kind of easy access to e-mail and the Web. All participants expressed the willingness to spend the time necessary to help in the research effort.

Week 1 Observations

In order to use the computer for support in the lesson, some of the students faced me at an angle. When I was positioning the student to see the computer screen and teacher at same time, I was distracted because I am accustomed to facing the student directly. This positioning caused a temporary break in eye contact. Since I am accustomed to judging the attention level of the student by the amount of eye contact made, having the student look at the computer screen was distracting at first. I also had to be aware of when to change the Web pages within the lesson. The position of the mouse was such that I had to turn my head in order to find the "next" button on the Web pages. The experience was similar to giving presentations with PowerPoint, and once I became accustomed to the process, the presence of the computer did not distract from the lesson in an important way.

Since I was presenting the same material to all of the students, I quickly fell into a routine. Because I was working from a pre-existing model, I was forced to teach each student in the same manner. Since these were the initial lessons for the students, this basic material needed to be taught to everyone. Nearer the end of the lesson, individualized, unpredictable problems arose when we were experimenting with the basic rudiments of singing. These problems could not have been anticipated in the design of the Web pages.

After I had become used to using the Web as support, I found myself frustrated by not having the visual aids for reference when I was teaching students without the Web pages. I had grown accustomed to the Web pages and missed using them. The students who viewed the Web pages were more likely to be able to repeat the steps to the McClosky method in order. When teaching students using the Web pages as support, I found the initial exposure to the visual stimuli to be helpful as a teaching aid.

Student Responses Week 1

The use of the Web pages in the lesson did not affect in a meaningful way the amount of time spent practicing. Students exposed to the Web pages reported practicing for an average of 59 minutes (SD 30) while students not accessing the pages practiced for an average of 64 minutes (SD 29). This difference was not significant (t=-.23, df=6, p=.83). Having the Web pages used in lessons may have had a possible positive effect on whether the student would access the pages outside of lessons. The students who used the pages in class accessed the pages on their own an average of 1.75 times (SD .50). Those not seeing the pages in class accessed them an average of 1.25 times (SD .96) (t=-.3, df=6, p=.39).

Reaction to the Web pages was generally positive whether or not the student had used the pages in the lesson, but the use of the pages within the lesson received mixed reviews. Some of the students who had access to the pages in lessons found them useful as a visual aid, while others found them distracting or difficult to read. The students who did not use the pages in the lessons had mixed feelings about whether the pages would have helped if I had chosen to use them. Some would have liked the reinforcement, while others stated that the personal instruction was adequate.

The students appreciated having the Web pages available to them outside of lessons, but few actually needed the pages to remember the steps or gather new information. The use of graphics in the Web pages was lauded by several of the participants, and some students gave excellent suggestions for changes in design. One suggestion given was having the students, rather than the instructor, manipulate the pages in the lesson. (This option had been anticipated and rejected because of time concerns.)

Week 2 Observations

At the second lesson, students seemed willing to talk about their weekly practice activities. All of the students had completed the e-mail questions on time, but I had been forced to send reminder messages to some of the students. The novelty of the voice lessons was still high, so most of the students were still highly motivated.

The students had all made progress on the McClosky Technique, and most students remembered the steps in order. Their jaws were noticeably more free when I tested them, and female students had better results. The students who indicated they thought the technique was helpful made the best responses, while those who did not see the immediate benefit did not show as much improvement. Having the Web pages used in the lesson had no noticeable effect on either memorization of the steps or proficiency in the technique.

With the students using the Web pages in the lessons, I began showing the new pages on breathing by informing the students I had considered some of their suggestions in the design. I mentioned my implementation of the suggestion to make the text larger. The posture lecture worked well with the graphics I had chosen. Each participant had his or her own hurdles within the lecture; most seemed willing to accept what I was saying about the posture changes I wanted to make, but several had difficulties with changing their postural habits. When I taught the students who were not viewing the pages, I would have rather had the Web pages there for visual support. This desire was even stronger than the week before, when I had been teaching the McClosky Technique, because the anatomical graphics were of great aid to my teaching.

On the inhalation exercise, the students who had previous experience with wind instruments already knew how to take a diaphragmatic breath, so I spent less time on this exercise with those students. Those students with less experience still had a tendency to breathe with the chest and ribs, although by this point they were already breathing more healthily because of cues I had given them throughout the first two lessons. I referred back to the Web pages when I noticed difficulties in posture. During this exercise and the next, I used the door to help support posture, and because the door is not near the computer screen, the students were not easily able to see the Web pages.

The exhalation exercise was a challenge to most of the students, as the students could hold the sustained [s] sound for an average of only 22 seconds (SD 8). I told them that I would use this exercise as a measurement to see if they were practicing the breathing exercises. Tension was apparent in the McClosky areas during this exercise, so I had the students review the massages from the first lesson.

The students showed improvement in voicing a healthy sigh to begin phonation. Trends from the introduction of the onset and legato exercises were difficult to classify, as each student had his or her individual challenges. If a student could initiate a healthy onset and release and could sing in a legato manner, I began exercises as indicated by the particular issues faced by the individual.

Student Responses Week 2

Student responses from the second week indicated that the Web pages had not been as useful as the first week's, and the pages were not accessed as often. The students who did not access the pages stated that they had remembered the postural and breathing exercises, and so no need to review came about. Because of responses from the pilot test stating that the first set of pages had been difficult to read, I had designed the Web pages for Week 2 in a bullet-point format, with little supplementary information. This scaled-down format had meliorated the use of the pages in the lesson, but outside of the lesson, the bullet points did not add enough new information to keep the students’ attention. Many positive comments about the Web pages again centered on the use of graphical images.

When queried as to whether the students preferred to use e-mail correspondence or Web forms for their journals, reactions were mixed. Students appreciated the ease of use of the Web forms, and some noted that the information the experimenter could glean from these forms would be useful for data analysis. However, many of the participants commented that e-mail journals offered them the opportunity to expand on their answers in a way that the Web forms did not allow. I had included text boxes on the forms to encourage open-ended responses. However, at certain points in the form, students wished to make comments and were unable to do so because not all of the items had a text box associated with each question. Several students also noted that e-mail is ubiquitous, while filling out a Web form meant launching a Web browser and accessing a page. Although the question regarding this preference is not directly involved in student instruction, the information is useful from a research perspective and useful as a model for collecting information from students.

Although attitude toward the lessons was still generally high, morale was beginning to slip with some students. Some students noted that the deliberate pace of the lessons was frustrating and that they wished they could sing more songs and work less on exercises. The amount of time the students reported practicing also diminished from the first week, with students giving excuses such as illnesses and test schedules. (Since at the time the students were approaching midterm exams, many of the reasons for not practicing were certainly legitimate.) Several of the students also complained that the postural exercises were difficult and frustrating.

Week 3 Observations

Because for those students participating in spectral analysis the third week's lesson took place in a larger studio than the previous weeks' did, many of the students remarked that the surroundings were much more likable. Pre-lesson comments concerning the Web pages were not noticeably different from the first week.

When questioned, most of the students said they had not used the McClosky Techniques before the lesson, so I took them through the techniques briefly. When prompted, the students remembered the breathing and postural tips I had given them the previous week. During the breathing exercises for this week, I timed each student in again sustaining an [s] sound. The amount of time the students could sustain the [s] sound improved to an average of 25 seconds (SD 7) (Table 4.1).

Table 4.1

Improvements in Breathing by Group in Mean Seconds

Group	n	Week 2	SD	Week 3	SD	Change	SD
Computer	4	24	5	28	7	4	5
None	4	19	10	22	7	3	4
Total	8	22	8	25	7	3	4

During the vocalization exercises, I worked to determine the potential of each voice so that I could plan tactics for later lessons. All of the students were warmed up well before the introduction of the measurements or the exploration of the SmartMusic system, depending on the activities for their particular group.

The students who had the opportunity to use the spectral analysis software seemed interested and open to the use of the equipment in measuring their voice. Several remarked on the novelty of hearing their voice played back through the computer. The time-based spectrogram was useful in imparting knowledge-based information. Most students seemed to understand my explanations of the spectral makeup of the voice as shown on the computer screen, but a few students may not have understood the intricacies of my explanations. Use of the software to record and play back the students' voices was extremely beneficial pedagogically, although the recordings played back through the computer speaker were not a perfect reproduction.

The use of the glottal fry to produce a picture of the optimum formants was surprisingly enlightening to the students. I could explain, and the students seemed to understand intuitively that they were expected to make the graph on the top of the image look the same as the graph on the bottom (see Figure 3.8). (The bottom graph showed their theoretically most resonant vowel form.) The differences in the five vowel measurements helped us to discover which were the student’s "good" vowels. Particularly effective was comparing the spectra of a vowel before and after use of the McClosky Technique; after a jaw wiggle, some students showed more spectral weight in the area of the singer’s ring.

The use of the EGG was less inspiring. Most students had difficulty placing and holding the electrodes, so taking an accurate reading was challenging. Even when the reading was taken accurately, I had difficulty in interpreting the results because many of the signals looked more like a sine wave than the shapes suggested in the literature. The male EGGs were more easily interpreted. Because of the lack of contours in the waveform, measurement of the CQ was impossible with my level of expertise.

With those students not receiving spectral analysis, I was able to begin tuning and warm-up features of the SmartMusic system (Coda Music Technology, 1999). The use of SmartMusic’s built-in warm-up feature had benefits and detractions. Because the foot pedal controls the sequence of chords played, I was able to keep my eyes on the student at all times without looking to finger the next chord. Unfortunately, since I do not have perfect pitch, often I would lose track of exactly which pitch was being produced at a given time. At times, I decided to use the mouse on the built-in keyboard so that I could better keep track of pitches; unfortunately, I then lost continuous eye contact with the student. The use of the software as an accompaniment for vocalises did not seem to affect the student’s performance as compared to previous weeks’ efforts on the piano or electronic keyboard. Another drawback of the software was the fact that I could only choose from single pitches or chords, and could not play scale patterns in a controlled tempo.

The use of the tuning feature of the software showed the students their difficulties with pitch production. I found personally that the process of producing a pitch in tune according to the meter provided was difficult. Technical problems with converting a sung pitch to a voltage, which can be analyzed by a computer, had not been overcome perfectly by the designers of the software. The students enjoyed the challenge of the exercise, but seemed disappointed at the results. Many of the difficulties they were experiencing were due to the fact that the measurement device lacked precision.

One of the research factors under discussion was whether the spectral analysis was worth the extra time and effort. In this initial use, I found that when I performed the spectral analysis, I felt rushed in the lesson and did not have as much time or attention to test the students' voices.

Student Responses Week 3

In their responses for the third lesson, the students who had used the voice analysis software the week before had generally positive reactions. Students appreciated the ability of the software to quantize their voice progress, the use of graphical interfaces and visual reinforcement, and the ability to hear their voices recorded. The students also appreciated having the screen shots from their sessions put on the Web page so that they could review the lesson and show the graphics to friends and family. Some of the comments led me to believe that the students may have found the process intellectually stimulating, but saw little improvement in their singing after the session.

The group that did not have a session with the spectral analysis software also had generally positive comments about their lesson and the SmartMusic software. Most students accessed the practice room during the interim week, although some felt practicing with their own personal tuners was sufficient. (Note: This software is discussed again in the review of the fourth week's lesson, after all students had the chance to access the SmartMusic system.)

I found difficulty in determining which of the activities had a more positive effect on the practice habits or attitude of the participants. Other factors such as the students missing lessons, illnesses, and other uncontrollable factors made conclusions difficult. The general attitude had improved from the week before for both groups because we were singing more and working on exercises and technique less. The pace of the lessons was beginning to accelerate.

Week 4 Observations

By the fourth week students were less inclined to check their e-mail and respond to the questions in a timely manner. In fact, one student did not actually complete the week 4 questionnaire until the next lesson time, at which I had the student fill out the questions while I watched. (The tendency to wait until after the next lesson to answer questions regarding a previous lesson could affect the data because the student would undoubtedly be affected by the subsequent lessons.) After this week, I became increasingly vigilant about making sure the students had completed the questions within a reasonable time. I was limited by time constraints. If I gave the students the questions too early, then they did not have the chance to log the amount of time they spent practicing and viewing the supplementary materials. If I waited too long, they came to lessons without first answering the questions.

When questioned about the use of spectral analysis software from the week before, reactions were generally very positive. Students reported that they enjoyed having visual reinforcement from the computer. When asked whether they understood the procedures, they reported different levels of understanding depending upon their technical expertise. Several students reported that the pictures helped show them how their voices could be improved, but they were not sure exactly what to do to improve their results. Most students reported that the initial use of the reinforcement was more than just a novelty, and served some pedagogical purpose. Almost universally, they reported that they wished they had more time with the equipment and looked forward to subsequent uses of the software. As we will see from later results, many of the positive responses came about because of the novelty of the situation.

Students seemed to enjoy the accompaniment feature of the SmartMusic system. At this point, I was more worried about whether the students would be able to use the system on their own during the intervening week than the authenticity of the accompaniment. Most students were able to trigger the entrances while singing through Burleigh’s arrangement of "Swing Low, Sweet Chariot." One student had not heard the spiritual before, so we chose a piece with which he was more familiar. As I guided the students through the steps to boot the computer and access the SmartMusic software, I tried to take note of any technical problems that might occur. Some students were not familiar with the use of a Macintosh computer, and the method to eject one accompaniment disk and insert another had to be stressed. I was satisfied that the students would be able to access the software without my presence.

Student Responses Week 4

During the fourth week, the amount of time the students practiced continued to increase with the addition of the SmartMusic software to all participants. As expected, the amount of time spent on exercises and vocalises decreased as the students were exposed to songs. I was disappointed that about half of the students did not choose to access the practice room very often or at all. The novelty of the situation for those using the room for the first time was high, but those who had already used the software the week before were less likely to make the effort to access the practice rooms. The only technical difficulty reported was when one student was unable to use the hardware because someone had removed the SmartMusic system from the serial port in the computer.

Reactions to the components of the SmartMusic system were individualized. Those participants who did not have piano skills appreciated the ease of the warm-up feature, while some more advanced students preferred to use the piano keyboard, with which they were more accustomed. The tuner feature continued to receive good reviews from the students who felt challenged by the task of centering the needle on the readout, and the graphical visual response to the students' singing held great appeal for many. Other students had become bored with the tuner and did not access the feature often.

The accompaniment feature, which is the primary purpose of the software, was new to all of the students this week. Again, this feature received mixed reviews. Those students who had a good grasp of the music and knew the songs available appreciated the ability of the software to play accompaniments. These students greatly enjoyed working through the songs they knew. Those students without a strong musical background often found the process frustrating. Several students mentioned that the software could be improved by including a track that played the melody only, so the student could learn the song without the necessity of reading the music. The software does have the capability to play the melody lines, but the students were unaware of how to access this feature because of incomplete instructions on my part.

Week 5 Observations

Student use of the SmartMusic system during the week progressed smoothly. I was disappointed that three of the students did not feel the need to access the practice room during the intervening week. Technical problems reported included forgetting to power on the microphone (she discovered the problem in a subsequent attempt), the inability to find the tuner function in the software, and improper changes in the hardware.

Students again appreciated the warm-up feature because it allowed them to concentrate on the warm-ups rather than finding the correct chords on the keyboard. Students also continued to find the tuner challenging, but some frustration at the lack of ability to match pitches was evident. Most students showed an improvement in the ability to match pitch as measured by my observations of their results. As I initiated increasingly complex patterns into the tuning exercise, the students with more musical experience were better able to repeat the patterns in tune. One student noted that since most of the warm-up exercises thus far had been in a major tonality, switching to minor and diminished scales was difficult.

Most students had at least one song chosen to rehearse. I eliminated some of the first choices of some students because they did not readily lend themselves to the lesson's pedagogical context, the use of legato. Luckily, I was able to choose a song that was mutually acceptable for each of the students. I had some difficulty in refraining from interrupting the students during the first run-through of the piece, but I was determined to allow the student at least one pass through the song without comment from me.

Unfortunately, due to limited computer memory, I was unable to keep Netscape and SmartMusic open at the same time. (SmartMusic will not launch with virtual memory enabled.) I had to describe the techniques for learning the song without the use of the Web support. I instructed the students to access the Web pages on their own as needed.

Some of the students had worked with the counting exercise before, and so they had little difficulty in translating their particular songs into rhythmic units. The students had some difficulty when I asked them to count the rhythms without using the pitches of the songs; many would approximate the contour of the melody line with their speech inflection. The translation of the spoken rhythms to sung rhythms was less problematic.

All students were able to understand the need for a legato line when singing the song on a single vowel. I was pleased that the use of legato line within the context of the song seemed easier than using legato in the vocalises I had introduced weeks before had been. When the students added the [l] consonant, the legato line decreased in all students. I had to reiterate my instructions to use a very light "liquid" [l] with most of my students.

Students had difficulty extracting the vowel sounds from their pieces. They could recognize and produce the individual vowel sounds, but keeping from producing a glottal attack between the vowel sounds proved difficult for many. For those students singing in Italian, familiar hurdles such as avoiding diphthongs and the differences among the open and closed vowels arose. Those singing in English had to overcome the mixed neutral vowels inherent in the language and learn to extend the initial portion of the diphthong. Once the vowels were to be sung, many students lost clarity in vowel formation, and some frustration occurred.

Student Responses Week 5

The practice habits of the students during the fifth week were interrupted by the fact that Spring Break had taken place between the fifth and sixth lesson. Although some of the students took advantage of the extra time to work on their voices, most practiced less than had been typical. The break also influenced the number of times the students accessed the computer room. Many of the students did not take the opportunity to use the SmartMusic software at all, and few used the room more than once. Most of the students were becoming more familiar with the SmartMusic system and could use the software efficiently. Those with little musical experience still found determining proper notes or finding their place in a song difficult.

The students who commented on the rhythm and vowel exercises seemed to understand the process; however, I believe that most of the students did not practice these exercises extensively. About half of the students accessed the Web pages and found them helpful as a resource, but not as helpful as a personalized lesson would be.

Week 6 Observations

The sixth week's lesson did not incorporate any new technologies, so I attempted to judge whether the technologies were losing their novelty effect and were continuing to serve as successful teaching tools. Because the previous week had been interrupted by Spring Break, and thus many of the students came in without having practiced as much as they ordinarily might have, the singing in general was disappointing.

When I began working with the diction exercises, I elected to use printouts of the Web pages rather than the computer because the students were reading large amounts of text, and using the screen would have been cumbersome. Each student had his or her own individual difficulties with the various consonant sounds, depending on their individual habits. The most problematic consonants were typical: [l], [r], "th," and [s]. Some students remarked that they had never considered the differences among the consonants in such a systematic manner. The students seemed to enjoy the recitation of the various sentences designed to isolate the consonant sounds.

Because of the amount of time we spent on articulation exercises, I noted a comparatively greater fluidity when the student read though the text. As the student read the text in rhythm, I was able to isolate individual difficulties of which he might not have been aware. When I had the students sing through the songs on vowel sounds only, as had been assigned from the week before, I felt that about half of the students had taken the assignment seriously and had made great improvements. Addition of the text following the previous exercise brought about a more legato line for all of the students.

The final portion of the lesson, reading the text in a dramatic manner and attempting to add this drama to the piece on one final run-through, was difficult for some students. Many felt uncomfortable in expressing their emotion through the text, although I was the only other person present. I reiterated to those students that the affective portion of the singing experience was the most important element, and encouraged them to continue. The students with more performing or acting experience adapted to the dramatic element more easily, and their singing improved technically with the added emotion.

Student Responses Week 6

During the sixth week I noticed a dichotomy developing between one group of students who were practicing a great deal, often with outside activities such as choirs or musicals, and another group, which practiced little. The group that was involved in outside activities generally had diminished the amount of time they were spending performing exercises and vocalises. The students were spending an average of one session per week lasting about 45 minutes with the SmartMusic software. This amount was greater than the previous week, which had been interrupted by Spring Break.

Most students were comfortable with the software, and reported that its use had become transparent in their lessons. Some students still reported challenges such as frustration over note problems or entrances, or the poor timbres of the sound samples. Most students found the articulation exercises presented on the Web useful in remembering the information presented in class. Some students felt that the articulation exercises were unnecessary, or that they were difficult in their own practicing because of the lack of instructor response.

Week 7 Observations

At the seventh lesson, the momentary drop in achievement from the previous week due to the Spring Break had righted itself. I noticed a steady increase in proficiency on the vocalises, and since I was more aware of the needs of individual voices, I was able to tailor my warm-up exercises to the individual student.

I had to adjust my teaching since half of the students would receive the spectral analysis experience. With the group that received no spectral analysis, I had more time in the lesson to work out problems with vocalises. Since I knew that this group would be working with a human accompanist during the following week, I felt the need to introduce more of the concepts such as musicality and dynamic changes. This extra material took up the added time used for spectral analysis with the comparison group.

I also had the opportunity to review the tuning feature of the SmartMusic system with the group. I found that although the students were more comfortable with the feature, the proficiency with the exercise had not increased greatly. I therefore concluded that the students had not been practicing intonation exercises regularly in their own practice sessions. I attempted to show the usefulness of the software by having the student sing portions of his or her piece into the tuning mechanism. I hoped that the students would see the transfer of the exercises from simple scale patterns to actual music and put the technique into use in their personal singing.

Trends in the use of the spectral analysis software differed from the experiences of the pilot study. Use of the time-based spectral analysis was particularly effective. In all cases, I was able to demonstrate improvements in the timbre of the student's voices by playing back the recordings and comparing them to the recordings from the previous session. These differences were not always apparent in the graphical representations of the sound.

The use of the spectral snapshots was not as beneficial. In only a few cases was I able to demonstrate an improvement of the tone using the graphical reading. Most results showed no change, but in no case did the readings show a poorer sound quality, and the ambiguous results from the pilot test were not repeated. (In the pilot test, some students showed less positive readings even after their voices had improved.)

This week contained the first serious technical problems I had encountered, with the exception of a few blown fuses. A computer virus had attacked the computer housing the spectral analysis software, and one lesson was delayed in order to clean the computer. Another technical problem (in reality a human error on my part) occurred when I attempted to compare the readings for one student to the previous readings from another student. Luckily, we caught the error in time and were able to explain the puzzling results we had received.

Student Responses Week 7

After the seventh week's lesson, the practice habits and the amount of response given by students were diminished because Easter weekend affected the amount of time the students could participate. Students were also spending less time singing vocalises and other exercises as they prepared for the upcoming concert.

Those students who had experienced the spectral analysis had mixed reviews. Most stated that the experience had been worthwhile, but were not sure that the experience had helped their singing. Some agreed that if the spectral analysis were to be used, then going through the process more than once in order to judge progress was beneficial. Others felt that the second session with the technology offered them nothing new, and they would have rather spent the time preparing for the final concert.

Week 8 Observations

At the eighth and final lesson, I was impressed by the amount of improvement the students had made. Five of the students could move their jaw totally freely during phonation, and the other two had made great improvement in this area. All of the students had made improvements in tension surrounding their swallowing muscles, with four of the students being totally free in this area. (None of the students came in with this ability.) Five of the students could exhale while keeping an open rib cage and the other two had improved since the initial breathing exercises. Posture had improved across the group, with a few students who did not feel the need to incorporate my suggestions about postural changes. All of the students had improved in these measures, but I noticed no discernible differences among the comparison groups.

The overall change in the students' ability to sustain an [s] was significant (t=5.54, df=6, p<.001), with an average improvement of 16 seconds. However, the differences among groups as determined by an ANOVA test was not significant (F=.44, df=3, p= .74). One notable difference was that the group which received spectral analysis (A & B) improved their breathing by six seconds more than the comparison group, but again, this result was not statistically significant (t=1.00, df=5, p=.36). The quantitative analysis of measurements of the sustained [s] sound can be found in Table 4.2. Students continued to make great strides in their ability to recite their text in a dramatic fashion. Five of the seven had their text memorized perfectly. The group that had not received the spectral analysis was slightly better prepared than the group that had taken the extra time to take spectrographic readings.

Table 4.2

Breath Control Change in Seconds

Group	n	Pre	SD	Post	SD	Change	SD
A	2	20	0	37	11	17	10
B	1	13	0	38	0	25	0
C	2	28	3	42	3	14	6
D	2	15	7	28	3	13	10
A & B	3	18	4	37	8	19	9
C & D	4	22	9	35	8	13	7
A & C	4	24	5	39	7	15	7
B & D	3	14	5	31	6	17	10
Total	7	20	7	36	7	*16	8

Those students who were singing with a human accompanist for the first time noted the differences in the experience. The students were tentative on the first reading, as shown by atypical mistakes, nervous gestures, and diminished volume. These initial tendencies mitigated as the lesson progressed, and by the end of the lesson, students were singing better than they ever had before. The major differences between the computer and human accompanist included the higher volume level of the piano (causing some students to over-sing), tempo differences, and the ability of the human accompanists to play more musically and react to the needs of the performer. All students who had access to the human accompanist preferred using the human accompanist to the computer, citing the feeling of performing with another person and the suggestions the accompanist could provide. The most prominent result of using the human accompanist was an increase in musicality. The students who had spent the previous week with spectral analysis were less prepared and sang less musically than the comparison group.

Student Responses Week 8

After the eighth week, I noticed that students reported practicing slightly more than in previous weeks, possibly due to the upcoming concert. Use of the practice room also increased, but a surprising number of students did not feel the need to practice with the computer before the concert. Most students reported continuing to incorporate vocalises and exercises into their warm-ups, but some were falling into the dangerous trap of believing they could simply incorporate the exercises into the singing of their songs.

In general, the students felt they were prepared for the concert, with a few notable exceptions. Of the three students who had participated in the spectral analysis, two had reservations about their preparedness, with one having serious reservations.

Those students who had practiced with the human accompanist during their final lesson all felt the experience had been positive, and preferred the personal experience of playing with another person. Several students reported being uneasy about the fact that due to unforeseen circumstances, the accompanist who rehearsed with the students would not be the same person who performed at the concert. Although the students preferred the human accompanist, they had positive comments about the use of the software in lessons. Interestingly, the fact that the computer performs the same every time was seen as positive to some students and negative to others.

Concert Observations

(Note: A reproduction of the concert program can be found in Appendix D.) I was extremely pleased about the performance at the final concert of all students, regardless of the level of technology used in the lessons. All students exceeded or at least approximated the performance level of the rehearsals. Most students were able to overcome their personal fears and perform with increased musicality and dramatic effect. I could see improvement in technical matters such as breathing and relaxed singing. These differences did not seem to be contingent upon the amount of technology used in the lesson.

Use of the human accompanist proved to have both positive and negative elements. Unfortunately, the accompanist who had practiced with the students experienced a family emergency, so a new accompanist was provided at the last moment. The students only had time to run through the piece once with the human accompanist just before the concert. The students were slightly tentative at the rehearsal situation, but once the concert began, they seemed to have adjusted to the new pianist. One student missed an entrance because of the differences in the way his introduction was played, but once the student entered, the pianist was able to adjust without incident. The increase in musicality and the ability of the accompanist to adapt to the performer helped the performance.

The use of computerized accompaniment was surprisingly successful, with some challenges. The amount of time needed to change accompaniment disks between songs led to some awkward pauses in the concert. Balance was also an issue, as students sang at different volume levels, and because of the position of the sound system, changing volume levels during the performance was difficult. Another potential problem that did not occur during the concert, but did occur often in the practice sessions, was the tendency for the software to miss a student entrance. Setup time was also an issue. However, with all of these challenges, the software performed acceptably, particularly on pieces with the more interesting timbres within the continuo.

Final Student Responses

The responses from the students' final journals were overwhelmingly positive. All students reported a positive experience with the technologies, with varying degrees of acceptance of the individual technologies. The students found the technology enjoyable and gradually more beneficial as they became accustomed to the experience.

Most students had very positive comments about the SmartMusic system. The accompaniments were reported to be convenient and easier to schedule than a human accompanist. Some students appreciated the fact that the accompaniments were "the same every time;" however others felt that the accompaniments became stagnant and hindered musicality for the very same reason. The students who had negative responses were those who had less musical experience. They found the process of trying to learn notes from reading the music challenging because the software did not provide enough reinforcement (without manipulating settings beyond the students' knowledge) as to the pitches or words the student should be singing.

The other features of the SmartMusic system were not widely used, but those students who chose to practice with the tuning mechanism found the experience helpful. Others found the tuner difficult and frustrating. Those students without piano skills appreciated the warm-up feature of the system, but, again, this feature was not widely used.

In the performance situation, whether the student preferred human or software accompaniment depended on which accompaniment had been used in the concert. Those students who had experienced the process of performing with a human tended to have a strong preference for human accompaniment. Surprisingly, those students who performed with computerized accompaniment did not feel cheated, and stated no preference between the two possibilities. Some commented that they were glad they could perform with the same instrumentation with which they had practiced.

The use of spectral analysis in the lesson received mixed reviews. All students agreed that the process was intellectually stimulating and informative. One student found the analysis to be the most beneficial part of the lesson process, citing the benefit from visual reinforcement from the process and the ability to judge progress in an objective manner. Other students felt the process took too much time and did not produce meaningful improvement in their singing. Those students who did not receive the spectral analysis, but simply reviewed the Web pages, thought the process looked interesting and would have liked to experiment with the analysis, perhaps when they had more time.

The use of Web pages as an informational source was widely accepted by the students. All students agreed that the pages were an excellent source for information dissemination outside of class. The students were split as to whether the pages should be used in class, with some students feeling the pages added an excellent visual aid and others feeling that the pages were distracting from the personal lesson. Attitude toward the page use for an outside resource was not dependent on whether the students had access to the Web pages in their lessons.

Statistical Results

This section contains the statistical results from the questionnaires that were completed throughout the semester (see appendix C). The first sub-section refers to questionnaires pertaining to the use of Web pages and the McClosky Technique (Week 2), while the second sub-section refers to a questionnaire on spectral analysis and the EGG (Week 4). The third sub-section refers to a questionnaire on the SmartMusic system (Week 6), and the final sub-section refers to the questionnaires given at the end of the process.

Results from the McClosky Questionnaires

During the first and second weeks of the lessons, students completed a pre- and postsurvey to measure the short-term influence of the Web pages on the students' attitude toward aspects related to the study. The questionnaires were taken from a previous study (Repp, 1997) and left intact so that comparisons could be made between that group of preservice music teachers and this group of voice students. (The comparisons with the 1997 study proved to be of little value and have been eliminated for the sake of clarity.) I have also included the data from the pilot test, which had taken place during the previous semester. The breakdown of the groups for this section is explained in Table 4.3, as compared to Table 4.4, the total breakdown. This sub-section begins with demographic considerations, continues with attitude results, and concludes with an analysis of open-ended questions included in the surveys. Issues related to the statistical significance of the data are discussed later in Table 4.12.

Table 4.3

Explanation of Group Labels

Group Label	n	Explanation
Web	4	Students who used Web during their lessons (A & C)
None	4	Students who did not use Web during their lessons (B & D)
Total	8	Sum of "Web" and "None"
Pilot	6	Results from the pilot test

Table 4.4

Breakdown of Participant Group

Group	A (n=2)	B (n=2)	C (n=2)	D (n=2)
Treatment				
Voice analysis	yes	yes	no	no
Web page	yes	no	yes	no
Accompaniment	software	software	human	human
Gender				
Male	Mark	Jack	Kevin	Tony
Female	Brenda	Jane	Tina	Linda

Demographic Comparisons

Tables 4.5 and 4.6 show demographic information. (Note that results from a question regarding teaching experience have been removed from data analysis. This question had been more important for the initial study, in which preservice teachers had been studied. The question has little bearing on the present study, but was retained initially to ensure that all groups would receive the same survey.)

Table 4.5 shows the amount of technical experience reported by the various groups. The group receiving the computer in the lesson reported more technical experience than any of the comparison groups did. Differences between the groups may have been influenced by previous technical experience because of the established positive correlation between experience with technology and attitude toward technology (see chapter 2).

Table 4.5

Technical Experience (1=Most Experience, 7=Least Experience)

Group	n	M	SD
Web	4	3.5	1.0
None	4	4.0	0.0
Total	8	3.8	0.7
Pilot	6	4.2	0.4
Combined	14	3.9	0.6

Table 4.6 shows that the group receiving Web instruction reported more vocal experience than the comparison group.

Table 4.6

Vocal Experience (1=Most Experience, 7=Least Experience)

Group	n	M	SD
Web	4	3.0	2.0
None	4	4.0	1.4
Total	8	3.5	1.7
Pilot	6	3.5	0.6
Combined	14	3.5	1.3

Attitude Questions

Tables 4.7 through 4.10 show reaction to questions asked only in the Week 2 postsurvey. The questions were meant to measure differences in attitude toward the technology and implementation of the McClosky Technique. Table 4.7 shows that those students who viewed the Web pages during lessons had a more positive reaction to the McClosky Technique, despite the fact that the technique does not include a technological component. The scores parallel results from the pilot test, whose members all received the Web pages and had a positive reaction to the pages.

Table 4.7

Reaction to the McClosky Technique (1=Most Positive, 7=Least Positive)

Group	n	M	SD
Web	4	2.0	0.0
None	4	3.0	0.0
Total	8	2.5	0.5
Pilot	6	2.0	0.0
Combined	14	2.3	0.5

Table 4.8 shows that students who did not view the pages during lessons practiced the technique negligibly more than those who viewed the pages during lessons did. This result does not agree with results from the pilot test, whose members practiced slightly more than the comparison group.

Table 4.8

How Often the Student Practiced (1=More Often, 7=Less Often)

Group	n	M	SD
Web	4	3.0	0.8
None	4	2.8	0.5
Total	8	2.9	0.6
Pilot	6	2.7	1.4
Combined	14	2.8	1.0

The group receiving Web pages during the lesson showed a stronger positive reaction to the presentation of the Web pages, but not as strong as the pilot group (see Table 4.9).

Table 4.9

Reaction to the Presentation of the Pages (1=Most Positive, 7=Least Positive)

Group	n	M	SD
Web	4	2.8	0.5
None	4	3.0	0.8
Total	8	2.9	0.6
Pilot	6	2.0	1.1
Combined	14	2.5	0.9

Table 4.10 shows that the Web group had a slightly more positive reaction when asked whether the Web pages were effective in teaching the McClosky Technique.

Table 4.10

How Effective Were the Pages in Teaching the McClosky Technique? (1=Most Positive, 7=Least Positive)

Group	n	M	SD
Web	4	2.8	0.5
None	4	3.0	0.0
Total	8	2.9	0.4
Pilot	6	3.0	0.6
Combined	14	2.9	0.5

Table 4.11 shows that the Web group had a slightly more positive response to the incorporation of Web pages as a primary teaching tool.

Table 4.11

How Should Pages Be Used? (1=Used Most, 7=Used Least)

Group	n	M	SD
Web	4	3.3	0.5
None	4	3.5	0.6
Total	8	3.4	0.5
Pilot	6	3.7	0.5
Combined	14	3.5	0.5

Tables 4.12 and 4.13 show the responses to questions that were repeated throughout the semester concerning attitudes toward technology. Table 4.12 shows the changes in attitude of the groups toward educational technology over the first two weeks of the semester.

Table 4.12

Mean Attitude Toward Educational Technology (1=Most Positive, 7=Least Positive)

Group	n	Pre	SD	Week 3	SD	Change	SD
Web	4	2.0	0.0	2.0	0.0	0.0	0.0
None	4	2.5	0.6	3.0	1.4	0.5	1.3
Total	8	2.3	0.5	2.5	1.1	0.2	0.9
Pilot	6	2.0	0.0	2.7	0.5	0.7	0.5
Combined	14	2.1	0.4	2.6	0.8	0.4	0.8

The Web group started with a very high attitude toward technology (perhaps unrealistically high) which did not change over the week's experiences. The comparison group started with a slightly less positive view which deteriorated over the intervening week (a positive number in the Change column reflects a deterioration in attitude). This deterioration was not as large as experienced by the pilot test group.

When asked about their attitude toward the potential of technology for teaching voice, the scores of all groups declined over the first two weeks of the semester. The scores for those using the Web pages in their lesson deteriorated less (Table 4.13).

Table 4.13

Mean Attitude Toward Technology for Teaching Voice (1=Most Positive, 7=Least Positive)

Group	n	Pre	SD	Post	SD	Change	SD
Web	4	2.0	0.0	2.3	0.5	0.3	0.5
None	4	2.3	0.5	2.8	1.0	0.5	0.6
Total	8	2.1	0.4	2.5	0.8	0.4	0.5
Pilot	6	2.3	0.8	2.8	0.4	0.5	0.8
Combined	14	2.2	0.6	2.6	0.6	0.4	0.6

When asked whether the participants preferred a paper version, an on-line version, or had no preference, all the students except one preferred the on-line version of the materials. This result differed greatly from previous repetitions of the test, in which the results were more mixed (see Table 4.14).

Table 4.14

Percentage of Participants Preferring Paper and On-line Versions

Group	n	On-line	None	Paper
Web	4	75	25	0
None	4	100	0	0
Total	8	88	12	0
Pilot	6	33	33	33
Combined	14	64	21	14

Because of the small sample size, statistical significance for the data was extremely difficult to obtain. Table 4.15 shows that none of the differences shown in the previous tables were significant when independent-samples t tests were performed. The data therefore may not be generalizable to the general population, but can still be used to compare differences within the population subgroups.

Table 4.15

Web Group vs. Comparison Group t Values (df=6)

Variable	t	p
Technical Experience	1.00	.36
Vocal Experience	.82	.45
How Often the Student Practiced	-.52	.62
Reaction to the Presentation of the Pages	.52	.62
How Effective Were the Pages in Teaching the McClosky Technique?	1.00	.36
How Should Pages Be Used	.65	.54
Change in Attitude Toward Educational Technology	.77	.50
Change in Attitude Toward Use for Teaching Voice	.65	.54

Note. The standard deviations of both groups for Reaction to the McClosky Technique are 0, so this analysis cannot be performed.

Table 4.16 shows the average scores for all the attitude measures. The total attitude for the group receiving the Web pages during class was more positive than the group not using the Web pages, however this difference was not statistically significant. (t=.92, df=6, p=.39).

Table 4.16

Total Score for McClosky Survey (1=Most Positive, 7=Least Positive)

Group	n	M	SD
Web	4	3.0	0.7
None	4	4.1	2.2
Total	8	3.5	1.6
Pilot	6	3.8	0.9
Combined	14	3.7	1.3

Also of note was the Table 4.17, which reflected the attitude of the participants toward the McClosky Technique at the final survey, which occurred some two months later. Those students who had used the computer in lessons found the technique slightly more positive than the comparison group.

Table 4.17

Attitude Toward McClosky Technique from Final Survey (1=Most Positive, 7=Least Positive)

Group	n	In Lesson	SD
Web	4	1.5	0.6
None	3	1.7	0.6
Total	7	1.6	0.5

Comments from the Second Week's Form

The forms from the second week contained text blocks in which the participants could enter open-ended responses. These responses added to the materials presented in the student questionnaires. Several students chose to comment on the McClosky Technique itself. Linda writes, "[the technique] relaxes my face, but so far I don't see it helping much with my voice. But hopefully it will. :) So far, this is very interesting to me and I am interested in seeing how the McClosky Technique can aid me in my vocal abilities." Brenda also had positive comments, "The technique makes sense to me . . . and I think becoming aware of tension places will be beneficial and will help singing." Jane stated she was "still having trouble loosening [her] jaw muscles."

Kevin had further suggestions for improvements to the pages, "The Web pages describing the technique flow together rather well, although much more could be done in the way of presentation of the material on the Web."

Mark had no preference between using materials on-line or in print form, stating "I would use either," but the rest of the participants preferred the on-line version. Comments on the preference for the on-line version included, "An on-line version of the instructions is universally accessible, whereas a printed version is only where you take it. Also there are concerns such as paper waste and such." . . ."I could access [the Web pages] anytime and I know I could never lose it. I could also practice the technique while it is on the screen, rather than having to read from a page and then practice it." . . ."On-line material is easier for me to read for some reason. Besides, I can never lose it as long as I'm connected." . . ."[An on-line document offers] easy access and doesn't take up any space. I'm on-line quite often anyway, so it would be more convenient to have it on-line personally." . . ."I prefer a sort of graphical, interactive interface." . . ."It is easy to access since I have a computer where I practice. It's easy to review." . . . and "[There are] fewer pages to lose."

Results from Spectral Analysis Questionnaire

During the fourth week of the semester, participants who had been exposed to the spectral analysis software completed an on-line survey to judge the influence of the process. The questionnaire was originally designed by Miller and Doing (1996), and was kept intact so that comparisons could be made with their data. Miller and Doing had divided their population into three groups: one group that used the software for every lesson, one that used the equipment "one or two times," and one group that had only a technical explanation of the procedures. The data from the group that used the equipment one or two times are included here because this group was most similar to the experiences of the present study. (Note that participants in the Miller and Doing study who accessed the equipment more often usually had a more positive response to the process.) Results from the pilot test are also compared to the present study (labeled "Main"). The row labeled "Total" is the sum of the pilot test and the Main group. Please note that these data are presented differently than the data for the first set of questionnaires in that a low score indicates a negative reaction and a high score indicates a positive reaction. This sub-section is divided into two parts, as dictated by Miller and Doing. The first is general questions and the second refers to separate components of the system. (Note that Miller and Doing did not publish standard deviation data for their experiment, so this missing data are indicated with a * designation.)

How Helpful Do You Find the Equipment?

The participants had a generally positive reaction to the use of the software for their own singing (see Table 4.18). These results were consistent with the data from the pilot test, but the scores were higher than in the Miller and Doing study.

Table 4.18

How Helpful Do You Find the Equipment for Your Own Singing? (1=Not at All, 5=Extremely)

Group	n	M	SD
Main	4	3.8	1.9
Pilot	6	3.5	0.6
Total	10	3.6	1.2
Miller	4	3.0	*

Curiously, the participants did not feel that the process would be beneficial for the singing of others (see Table 4.19). This low score was consistent among all groups.

Table 4.19

How Helpful Do You Find the Equipment for the Singing of Others? (1=Not at All, 5=Extremely)

Group	n	M	SD
Main	2	2.5	2.1
Pilot	3	2.7	1.5
Total	5	2.6	1.5
Miller	4	2.5	*

The Main group felt that the process was helpful to the teacher's effectiveness (see Table 4.20). The Main group had slightly higher scores than the pilot group, and a much higher score that the Miller and Doing study. This difference is interesting because since Miller and Doing had designed the software and hardware, one would expect their proficiency with the equipment to be greater, and thus their students' reactions would be more positive. Other factors certainly must account for the discrepancy.

Table 4.20

How Helpful Do You Find the Equipment For Your Teacher's Effectiveness? (1=Not at All, 5=Extremely)

Group	n	M	SD
Main	4	3.8	1.3
Pilot	6	3.2	1.2
Total	10	3.4	1.2
Miller	4	2.0	*

Differences among potential effectiveness for other teachers varied among groups. When comparing data from Table 4.20 and Table 4.21, the Main group did not feel the equipment would be as effective in the hands of other teachers. The pilot group felt on the average that the effectiveness would be about the same, while the Miller and Doing group thought that the equipment would actually be more effective for other teachers.

Table 4.21

How Helpful Do You Find the Equipment (Potentially) For Other Teachers' Effectiveness Assuming a User-Friendly Format? (1=Not at All, 5=Extremely)

Group	n	M	SD
Main	4	2.5	1.3
Pilot	6	3.2	0.8
Total	10	2.9	1.0
Miller	4	2.8	*

The main group did not have a high opinion for the equipment of their own potential teaching as compared with the pilot test and the previous study (see Table 4.22). However, the fact that the main group had less teaching experience than the pilot study could have been a factor.

Table 4.22

How Helpful Do You Find the Equipment for Your Own (Potential) Teaching? (1=Not at All, 5=Extremely)

Group	n	M	SD
Main	4	2.5	2.1
Pilot	6	3.0	1.2
Total	10	2.9	1.3
Miller	4	2.8	*

This comparatively low score again was repeated by responses toward use of the equipment for increasing the exchange of information among teachers (see Table 4.23), and in increasing cooperation among teachers (see Table 4.24).

Table 4.23

How Helpful Do You Find the Equipment In Increasing the Exchange of Information Among Teachers? (1=Not at All, 5=Extremely)

Group	n	M	SD
Main	3	2.7	1.2
Pilot	5	4.0	1.2
Total	8	3.5	1.3
Miller	4	2.8	*

Table 4.24

How Helpful Do You Find the Equipment in Increasing Cooperation Among Teachers? (1=Not at All, 5=Extremely)

Group	n	M	SD
Main	3	3.0	1.0
Pilot	5	3.6	1.3
Total	8	3.4	1.2
Miller	4	2.5	*

How Helpful Do You Find the Separate Components of the Feedback?

When asked about the separate components of the feedback, the scores for the EGG (see Table 4.25) were lower, with the EGG score from the Miller and Doing group being particularly low.

Table 4.25

How Helpful Do You Find the Electroglottograph (1=Not at All, 5=Extremely)

Group	n	M	SD
Main	4	2.8	1.5
Pilot	6	2.5	1.2
Total	10	2.6	1.3
Miller	4	1.3	*

Scores for the spectral analysis were more positive (see Table 4.26). Again, both of the comparison groups outscored the Miller and Doing responses.

Table 4.26

How Helpful Do You Find the Spectrum Analyzer? (1=Not at All, 5=Extremely)

Group	n	M	SD
Main	4	3.8	1.9
Pilot	6	3.5	0.8
Total	10	3.6	1.3
Miller	4	3.0	*

The Main group reported a greater understanding of the equipment than the Pilot group (see Table 4.27).

Table 4.27

How Much Understanding of the Signals Do You Have? (1=None, 5=Great)

Group	n	M	SD
Main	4	3.5	1.0
Pilot	6	2.3	1.2
Total	10	2.8	1.2
Miller	4	2.5	*

This discrepancy could have come about because I had greater proficiency with the equipment than the previous semester, or from the greater technical experience of the main group.

These differences are of note when compared to the following question (see Table 4.28), which asks how much understanding would be necessary to make use of the reinforcement. The Main group felt they had enough understanding (the mean score for the two questions was identical), while the Pilot group would have preferred more understanding. Although the Miller and Doing group had the least amount of reported understanding, they felt that the understanding needed was more than adequate.

Table 4.28

How Much Understanding of the Signals Does a Singer Need to Make Use of the Feedback? (1=None 5=Great)

Group	n	M	SD
Main	4	3.0	1.4
Pilot	6	3.5	1.0
Total	10	3.3	1.2
Miller	4	2.3	*

Table 4.29

How Much Understanding of the Signals Does a Teacher Need to Make Use of the Feedback? (1=Not at All, 5=Extremely)

Group	n	M	SD
Main	4	4.5	0.6
Pilot	6	4.2	0.8
Total	10	4.3	0.7
Miller	4	3.3	*

All groups felt the teacher needed much more understanding than the student (see Table 4.29), with a slight difference between the pilot study and the main study, and a lesser score reported by the Miller and Doing respondents.

Results from SmartMusic Questionnaires

During the sixth week of the semester the participants were administered a questionnaire to determine their attitudes toward the SmartMusic system (Coda Music Technology, 1999). During the final questionnaire at the end of the entire process, these questions were repeated. They helped to determine whether the factors of performing with a human accompanist (rather than the SmartMusic system), and the participation in the spectral analysis would change the responses to the questions.

Table 4.30

Explanation of Group Labels

Group Label	n	Explanation
Spectral/Software	3	Students who participated in spectral measurements and had software accompaniment for the concert
None/Human	4	Students who did not participate in spectral measurements and had human accompaniment for the concert
Total	7	Sum of "Spectral/Software" and "None/Human"

The following data reflect the answers of the respondents divided into the two groups described in Table 4.30, and reflect the changes over the last few weeks of the project only. Most of the results are not statistically significant; the significance of each of the questions can be found in Table 4.42.

The following data (see Table 4.31) reflects the question regarding student attitude toward educational technology in general, which was asked repeatedly throughout the semester. The group that received the spectral analysis improved their scores on this measure by .3 points (a negative number indicates an improvement in attitude). The group that worked with a human accompanist and received less technology showed no improvement in attitude over the last few weeks of the semester.

Table 4.31

Mean Attitude Toward Educational Technology (1=Most Positive, 7=Least Positive)

Group	n	Week 6	SD	Post	SD	Change	SD
Spectral/Software	3	2.3	0.6	2.0	0.0	-0.3	0.6
None/Human	4	2.5	0.6	2.5	0.6	0.0	0.8
Total	7	2.4	0.6	2.3	0.5	-0.2	0.7

During the last few weeks of the semester, both comparison groups showed a slight increase in attitude toward the use of technology to teach voice (see Table 4.32). The reaction of the group that received spectral analysis improved, while the reaction of the group that used a human accompanist stayed the same.

Table 4.32

Mean Attitude Toward Technology for Teaching Voice (1=Most Positive, 7=Least Positive)

Group	n	Week 6	SD	Post	SD	Change	SD
Spectral/Software	3	2.7	0.6	2.3	0.6	-0.4	0.6
None/Human	4	2.5	0.6	2.5	0.6	0.0	0.8
Total	7	2.6	0.5	2.4	0.6	-0.2	0.7

At this point, the questions were divided to determine whether the participants would report a change in attitude toward the components of the system differently for their in-lesson experience or for their personal practice using the technology. After either performing with the SmartMusic system or observing others performing, the attitude toward the SmartMusic system in general for use within their lessons improved for both groups. The group that actually performed with the software (labeled Spectral/Software) increased more (see Table 4.33). This group had used the software more than its comparison group during the last few days of the semester.

Table 4.33

Attitude Toward SmartMusic in General in Lessons (1=Most Positive, 7=Least Positive)

Group	n	Week 6	SD	Post	SD	Change	SD
Spectral/Software	3	2.3	1.5	1.7	1.1	-0.6	0.6
None/Human	4	2.8	1.0	2.5	0.6	-0.3	1.3
Total	7	2.6	1.1	2.1	0.9	-0.5	1.0

The differences in attitude improvement were even more striking when the participants were asked about their attitude toward the system for their own personal practice (see Table 4.34). All of the students who had performed with the SmartMusic system gave the most positive possible score (1) for the SmartMusic system, and showed an improvement of 1.0 units.

Table 4.34

Mean Attitude Toward SmartMusic in General for Personal Practice (1=Most Positive, 7=Least Positive)

Group	n	Week 6	SD	Post	SD	Change	SD
Spectral/Software	3	2.0	1.7	1.0	0.0	-1.0	1.7
None/Human	4	3.3	1.3	3.0	2.0	-0.3	1.0
Total	7	2.7	1.5	2.1	1.8	-0.6	1.3

Interestingly, the attitude toward the accompaniment feature of the system did not show as striking a difference (see Table 4.35).

Table 4.35

Attitude Toward Accompaniments in Lessons (1=Most Positive, 7=Least Positive)

Group	n	Week 6	SD	Post	SD	Change	SD
Spectral/Software	3	1.7	0.6	1.3	0.6	-0.3	0.6
None/Human	4	2.8	1.0	2.5	1.0	-0.3	1.3
Total	7	2.3	1.0	2.0	1.0	-0.3	1.0

The difference was more pronounced when the question of the use of accompaniment was applied to the students' personal practice (see Table 4.36). We again see the group that had performed with the software giving the accompaniments a perfect score for their personal practice, and showing an improvement of one complete unit on a seven-point scale.

Table 4.36

Attitude Toward Accompaniment for Personal Practice (1=Most Positive, 7=Least Positive)

	n	Week 6	SD	Post	SD	Change	SD
Spectral/Software	3	2.0	1.7	1.0	0.0	-1.0	1.7
None/Human	4	3.3	1.3	2.8	1.7	-0.5	0.6
Total	7	2.7	1.5	2.0	1.5	-0.1	1.1

Attitudes toward the tuner function of the SmartMusic system did not show the improvements as other functions of the SmartMusic system (see Table 4.37).

Table 4.37

Attitude Toward Tuner in Lessons (1=Most Positive, 7=Least Positive)

Group	n	Week 6	SD	Post	SD	Change	SD
Spectral/Software	3	2.0	1.0	2.3	0.6	0.3	0.6
None/Human	4	2.0	1.2	2.0	1.2	0.0	1.6
Total	7	2.0	1.0	2.1	0.9	0.1	1.2

When queried about the use of the intonation feature within lessons, the group that had received spectral analysis showed deterioration in attitude of .3 points while the comparison group showed no change. This deterioration could have been because the intonation feature was not stressed with the spectral analysis group because of the limited amount of time available. This trend reversed itself when the participants were asked about the use of the tuner for personal practice (see Table 4.38). The group that received the spectral analysis showed no change while the comparison group showed a marked decline of .5 points.

Table 4.38

Attitude Toward Tuner for Personal Practice (1=Most Positive, 7=Least Positive)

Group	n	Week 6	SD	Post	SD	Change	SD
Spectral/Software	3	2.0	1.0	2.0	1.0	0.0	0.0
None/Human	4	2.3	1.5	2.8	1.5	0.5	1.0
Total	7	2.1	1.2	2.4	1.3	0.3	0.8

When queried on the use of the warm-up feature in lessons, both groups showed a slight deterioration in attitude over the last two weeks, with the spectral analysis group showing a slightly greater deterioration (see Table 4.39).

Table 4.39

Attitude Toward Warm-up in Lessons (1=Most Positive, 7=Least Positive)

Group	n	Week 6	SD	Post	SD	Change	SD
Spectral/Software	3	1.3	0.6	1.7	0.6	0.4	0.6
None/Human	4	2.3	1.0	2.5	0.6	0.2	1.0
Total	7	1.9	1.0	2.1	0.7	0.3	0.8

This deterioration could be influenced by the fact that I preferred using the piano keyboard for warm-ups, and therefore did not continue with the warm-up feature in lessons during the last few lessons. (To do so would have been impossible, as the room with the spectral analysis hardware was not equipped with the SmartMusic system.)

The trend was different, however, when the students were asked about their attitude toward the warm-ups for personal practice (see Table 4.40). Both groups improved, with the spectral analysis group improving an entire unit.

Table 4.40

Attitude Toward Warm-up for Personal Practice (1=Most Positive, 7=Least Positive)

Group	n	Week 6	SD	Post	SD	Change	SD
Spectral/Software	3	2.3	1.5	1.3	0.6	-1.0	1.7
None/Human	4	2.6	1.3	2.5	1.0	-0.3	1.0
Total	7	2.6	1.3	2.0	1.0	-0.6	1.3

All of the above measures were summed and averaged to produce the data below (see Table 4.41). The group that had received spectral analysis and used the SmartMusic software in the concert showed both more positive attitudes toward the SmartMusic system and a greater improvement in attitude over the last few weeks of the semester ($t=-1.2$, $df=5$, $p=.27$).

Table 4.41

Average Score for Week 6 (1=Most Positive, 7=Least Positive)

Group	n	Week 6	SD	Post	SD	Change	SD
Spectral/Software	3	2.1	0.6	1.7	0.2	-.4	0.5
None/Human	4	2.6	0.6	2.6	0.6	-.1	0.8
Total	7	2.4	0.6	2.1	0.7	-.2	0.7

Table 4.42 shows the significance of each of the differences of the "Change" columns between the two comparison groups. Due to the small sample size, none of the measures was statistically significant, but since most of the measures show similar trends, the data are still worthy of inspection.

Table 4.42

Significance of Change in Scores of Spectral/Software vs. None/Human (df=5)

Feature	t	p
SmartMusic in Lesson	-.52	.62
SmartMusic on Own	-.74	.49
Accompaniment in Lesson	-.10	.92
Accompaniment on Own	-.55	.60
Tuner in Lesson	.33	.75
Tuner on Own	-.85	.44
Warm-up in Lesson	.13	.90
Warm-up on Own	-.74	.49
Breath Management	1.00	.58
Educational Technology Attitude	-.60	.58
Voice Technology Attitude	-.60	.58
Average Score	-1.20	.27

Results from Final Survey

After the final concert, the participants were administered a comprehensive post-survey to determine attitude changes over the semester. These data are divided into categories determined from the breakdown of the participant group. Each group is reported separately, and then in combination with other groups which received similar treatments. For example, data from groups A and C combined, which both had the advantage of the use of Web pages within the lesson, are compared with data from groups B and D combined, which had no Web pages. Similarly, data from groups A and B combined, which received spectral analysis and performed with the SmartMusic system, are compared with groups C and D combined, which received no spectral analysis and performed with a human accompanist (see Table 4.43). In addition, data from the pilot study are included when appropriate for comparisons. Because of the small size of the individual groups, analysis of the group pairings is more useful and will be stressed here. Significance of the individual measures is discussed later in Table 4.54.

Table 4.43

Breakdown of Participant Group

Group	A (n=2)	B (n=1*)	C (n=2)	D (n=2)	Pilot (n=6)
Voice analysis	yes	yes	no	no	yes
Web page	yes	no	yes	no	yes
Accompaniment	software	software	human	human	software

*Note: One participant did not complete the study.

Table 4.44 shows the attitudes of the participant groups toward educational technology in general. This question was asked several times during the process, but the following data reflect the change in attitudes from the very first presurvey to the final survey after the final concert. Please note that a negative number again indicates an improvement in attitude, while a positive number indicates deterioration in attitude. Overall, the attitude of all the participants deteriorated slightly, but this deterioration did not occur equally across groups. The groups that received spectral analysis and performed with the software accompaniment (A & B) improved slightly in attitude, while the comparison group (C & D) deteriorated slightly in attitude. Similarly, reported attitudes of those who used the Web pages in the lesson (A & C) did not change while attitude of those who did not deteriorated slightly. Thus, in both instances, the groups receiving the more technology-centered lessons improved in attitude or did not change, while the comparison groups deteriorated slightly.

Table 4.44

Final Mean Attitude Toward Educational Technology (1=Most Positive, 7=Least Positive)

Group	n	Pre	SD	Post	SD	Change	SD
A	2	2.0	0.0	2.0	0.0	0.0	0.0
B	1	3.0	0.0	2.0	0.0	-1.0	0.0
C	2	2.0	0.0	2.0	0.0	0.0	0.7
D	2	2.0	0.0	3.0	0.0	1.0	0.0
A & B	3	2.3	0.6	2.0	0.0	-0.3	0.6
C & D	4	2.0	0.0	2.5	0.6	0.5	1.0
A & C	4	2.0	0.0	2.0	0.0	0.0	0.0
B & D	3	2.3	0.6	2.7	0.6	0.4	1.2
Total	7	2.1	0.4	2.3	0.5	0.2	0.8
Pilot	6	2.0	0.0	2.7	0.5	0.7	0.5

The attitude of participants toward technology for teaching voice was not as positive, but followed similar trends (see Table 4.45). The overall score for this measure deteriorated or stayed the same almost across the board, with the exception of Group B. The groups that received spectral analysis and performed with the software accompaniment (A & B) showed a slight deterioration in attitude, while the comparison group (C & D) deteriorated .5 units in attitude. Those who used the Web pages in the lesson (A & C) showed a slight deterioration in attitude (.3), while those who did not deteriorated slightly more (.7). Thus, in both instances, the groups receiving the more technology-centered lessons deteriorated less in attitude than the comparison groups.

Table 4.45

Final Mean Attitude Toward Technology for Teaching Voice (1=Most Positive, 7=Least Positive)

Group	n	Pre	SD	Post	SD	Change	SD
A	2	2.0	0.0	2.5	0.7	0.5	0.7
B	1	2.0	0.0	1.0	0.0	-1.0	0.0
C	2	2.0	0.0	2.0	0.0	0.0	0.0
D	2	2.0	0.0	3.0	0.0	1.0	0.0
A & B	3	2.0	0.0	2.3	0.6	0.3	1.0
C & D	4	2.0	0.0	2.5	0.6	0.5	0.6
A & C	4	2.0	0.0	2.3	0.5	0.3	0.5
B & D	3	2.0	0.0	2.7	0.6	0.7	1.2
Total	7	2.0	0.0	2.4	0.5	0.4	0.8
Pilot	6	2.3	0.8	2.8	0.4	0.5	0.8

Table 4.46

Preference for Human or Computer Accompaniment (1=Perference for Human, 7=Preference for Computer

	n	M	SD
Spectral/Software	3	3.7	0.6
None/Human	4	2.0	0.8
Total	7	2.7	1.1

One factor of interest was whether using the software accompaniment in the concert situation would influence a preference for the human experience. Table 4.46 shows that those students performing with a human accompanist showed a strong preference for the experience, while those using the software accompanist had only a very slight preference. This difference proved to be statistically significant. (t=2.99, df=5, p=.03). (Note: Because

use of the Web pages in lessons was not considered a factor, analysis of the other groups was not attempted.)

Another factor under study was whether the students who had spent more time with the spectral analysis felt less prepared for the final concert. Table 4.47 shows that those who participated in the spectral analysis (A & B) felt slightly less prepared for the concert.

Table 4.47

Perceived Preparedness for the Final Concert (1=Most Prepared, 7=Least Prepared)

Group	n	M	SD
A	2	2.0	0.0
B	1	2.0	0.0
C	2	1.5	0.7
D	2	2.0	1.4
A & B	3	2.0	0.0
C & D	4	1.8	1.0
A & C	4	1.8	0.5
B & D	3	2.0	1.0
Total	7	1.9	0.7

The one factor under consideration in the final survey that was not directly attached to a technology was the attitude toward the McClosky Technique. Scores for the McClosky Technique were high, particularly within the lesson setting. The groups that had the advantage of the Web pages in the lesson (A & C) scored slightly higher than their counterparts (B & D) when queried about the use of the technique within the lesson. However, this trend reversed itself when these groups were asked about the techniques for their personal practice (see Table 4.48).

Table 4.48

Final Mean Attitude Toward McClosky Technique (1=Most Positive, 7=Least Positive)

Group	n	In Lesson	SD	Outside Lesson	SD
A	2	2.0	0.0	2.5	0.7
B	1	2.0	0.0	2.0	0.0
C	2	1.0	0.0	1.5	0.7
D	2	1.5	0.7	1.5	0.7
A & B	3	2.0	0.0	2.3	0.6
C & D	4	1.3	0.5	1.5	0.6
A & C	4	1.5	0.6	2.0	0.8
B & D	3	1.7	0.6	1.7	0.6
Total	7	1.6	0.5	1.9	0.7

Table 4.49

Attitudes Toward Components Used Outside of Lesson

Group	n	SM	SD	Acc.	SD	Tuner	SD	Warm	SD	Web	SD
A	2	1.0	0.0	1.0	0.0	2.5	0.7	1.5	0.7	2.5	0.7
B	1	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	2.0	0.0
C	2	4.0	2.8	3.5	2.1	3.5	2.1	3.0	1.4	1.0	0.0
D	2	2.0	0.0	2.0	1.4	2.0	2.0	0.0	0.0	2.0	0.0
A & B	3	1.0	0.0	1.0	0.0	2.0	1.0	1.3	0.6	2.3	0.6
C & D	4	3.0	2.0	2.8	1.7	2.8	1.5	2.5	1.0	1.5	0.6
A & C	4	2.5	2.4	2.3	1.9	3.0	1.4	2.3	1.3	1.8	1.0
B & D	3	1.7	0.6	1.7	1.2	1.7	0.6	1.7	0.6	2.0	0.0
Total	7	2.1	1.8	2.0	1.5	2.4	1.3	2.0	1.0	1.9	0.7
Pilot	6	1.3	.52	1.5	0.8	1.7	0.8	2.0	1.1	2.2	1.0

Table 4.50

Attitudes Toward Components Used in Lesson (1=Most Positive, 7=Least Positive)

Group	n	Smart-Music	SD	Acc.	SD	Tuner	SD	Warm	SD
A	2	1.0	0.0	1.0	0.0	2.5	0.7	1.5	0.7
B	1	3.0	0.0	2.0	0.0	2.0	0.0	2.0	0.0
C	2	2.0	0.0	2.0	0.0	2.0	1.4	2.5	0.7
D	2	3.0	0.0	3.0	1.4	2.0	1.4	2.5	0.7
A & B	3	1.7	1.2	1.3	0.6	2.3	0.6	1.7	0.6
C & D	4	1.5	0.6	2.5	1.0	2.0	1.2	2.5	0.6
A & C	4	1.5	0.6	1.5	0.6	2.3	1.0	2.0	0.8
B & D	3	3.0	0.0	2.7	1.2	2.0	1.0	2.3	0.6
Total	7	2.1	0.9	2.0	1.0	2.1	0.9	2.1	0.7
Pilot	6	2.0	0.6	1.7	0.8	1.7	0.8	2.3	0.5

Group	n	Web	SD	EGG	SD	Snapshot	SD
A	2	2.5	0.7	2.5	2.1	2.0	1.4
B	1*	N/A	N/A	2.0	0.0	2.0	0.0
C	2*	1.0	0.0	N/A	N/A	N/A	N/A
D	2*	N/A	N/A	N/A	N/A	N/A	N/A
A & B	3*	2.5	0.7	2.3	1.5	2.0	1.0
C & D	4*	1.0	0.0	N/A	N/A	N/A	N/A
A & C	4*	1.8	1.0	2.5	2.1	2.0	1.4
B & D	3*	N/A	N/A	2.0	0.0	2.0	0.0
Total	7*	1.8	1.0	2.3	1.5	2.0	1.0
Pilot	6	2.5	1.1	3.0	1.6	2.3	1.2

Note. Since not all participants took part in all treatments, the n* values do not apply.

Table 4.49 and Table 4.50 show the scores for each of the separate technologies both within lesson and for personal practice. (Note that the spectral analysis and the EGG were not available outside of lessons.) The absolute scores of each of the technologies are less important than their relative rankings, which will follow.

The information from Table 4.49 and Table 4.50 was translated into rankings for easier comparison. Table 4.51 shows the relative effectiveness of each of the technologies and the McClosky Technique when used for personal practice.

Table 4.51

Rankings of Components Used Outside of Lesson (1=Most Positive, 7=Least Positive)

Group	n	Smart-Music	Acc.	Tuner	Warm-up	Web	McClosky
A	2	1 *	1 *	4 *	3	4 *	4 *
B	1	1 *	1 *	1 *	1 *	1 *	6
C	2	5	4 *	4 *	3	1	2
D	2	2 *	2 *	2 *	2 *	2 *	1
A & B	3	1 *	1 *	4	3	5 *	5 *
C & D	4	6	4 *	4 *	3	1 *	1 *
A & C	4	5	3 *	6	3 *	1	2
B & D	3	1 *	1 *	1 *	1 *	1 *	6
Total	7	5	3 *	6	3 *	2	1
Pilot	6	1	2	3	4	5	N/A

Note. A * indicates a tie score.

Of interest is the difference in ranking of the SmartMusic system and its components for those students using the SmartMusic system at the concert. Those students who did use the SmartMusic system (A & B) ranked the SmartMusic system and the accompaniment feature as the best technology used, while those who had used the human accompanist ranked the technologies near to last. The students who received spectral analysis (A & B) also ranked the more mundane technologies of the Web lower and had a less positive reaction to the McClosky Technique.

Those students who did not use the Web pages in lessons showed very little deviation on these measures, so the data comparing groups "A & C" and "B & D" is difficult to analyze. The most surprising result was that overall, the students found the McClosky Technique, which had no technological component, and the Web pages, which were the least advanced of the technologies available, to be the most beneficial. Results also varied greatly from the pilot group, which had ranked the SmartMusic system, and particularly the tuning feature, much higher.

Rankings within the lessons showed similar trends for the technologies shown above, but contained data on additional technologies (see Table 4.52).

Table 4.52

Rankings Components Used In Lesson (1=Most Positive, 7=Least Positive)

Group	n	Smart-Music	Acc.	Tuner	Warm	Web	McClosky	Spectral	EGG
A	2	1 *	1 *	6 *	3	6 *	4 *	4 *	6 *
B	1	7	1 *	1 *	1 *	N/A	1 *	1 *	1 *
C	2	2 *	2 *	2 *	6	1	2 *	N/A	N/A
D	2	4 *	4 *	2	3	N/A	1	N/A	N/A
A & B	3*	2 *	1	6 *	2 *	8	4 *	4 *	6 *
C & D	4*	3	5 *	4	5 *	1	2	N/A	N/A
A & C	4*	1 *	1 *	7 *	5 *	4	1 *	5*	7 *
B & D	3*	6	7	2 *	5	N/A	1	2 *	2 *
Total	7*	5 *	3 *	5 *	5 *	2	1	3 *	8
Pilot	6	3	1 *	1 *	4 *	6	N/A	4 *	7

Those students who received spectral analysis and used the SmartMusic system in their performance continued to give the accompaniment feature of SmartMusic high marks when contrasted with their comparison groups. Again, these groups inverted their opinions of the less impressive Web technology, with the spectral analysis group ranking the Web last and the comparison group ranking the Web first. The group that received spectral analysis placed the process in a tie for fourth, with the score for the EGG relatively very low.

The group that received Web pages within their lessons (A & C) ranked their use in the middle of the grouping, preferring the SmartMusic system.

Again, the technology of the Web and the non-technology of the McClosky Technique scored much higher than other components of the lesson overall. (These data are slightly suspect because not all participants could rank all of the technologies in this grouping.) The SmartMusic system again ranked much more poorly than in the pilot test. The EGG again proved to be the least effective technology reported by students.

The difference between the technologies used in the lesson compared with those used outside the lesson was not apparent, as had been the case in the pilot test. When the above technologies that were used in both situations were summed, the difference between the means (.035 points) was smaller than the statistical certainty of the measurements. It therefore was considered to be no difference ($t=.08$, $df=5$, $p=.94$).

The participants were asked to rate the total experience of the voice lessons, and not simply the technologies used (see Table 4.53). All students rated the experience extremely high, with an average of 1.6 on a seven-point Likert-type scale. Those students who had the experience of performing with a human accompanist (B & D) rated the total experience more positively than those who received spectral analysis and performed with the SmartMusic system did. Those students who had the Web pages in their lessons (A & C) reported a slightly more positive total experience than their comparison group did.

Table 4.53

Rating of Total Experience (1=Most Positive, 7=Least Positive)

Group	n	M	SD
A	2	2.0	0.0
B	1	2.0	0.0
C	2	1.0	0.0
D	2	1.5	.71
A & B	3	2.0	0.0
C & D	4	1.3	.50
A & C	4	1.5	.58
B & D	3	1.7	.58
Total	7	1.6	.54

Table 4.54 shows the significance of the differences for the groups above as determined by an ANOVA measure. Again, statistical significance was difficult to achieve due to small sample size.

Table 4.55 shows the average of all of the measures for the above groups that pertain to all respondents. The scores for the groups that received spectral analysis and used SmartMusic for the final concert (A & B) are slightly more positive than the comparison group. The group that received Web pages (A & C) in the lesson had a very slightly more positive total score than its comparison group. Overall, the total average score of 2.1 on a 7-point scale with 1.0 being the highest possible score shows that the respondents reported an overwhelmingly positive experience.

Table 4.54

Significance of Final Data (ANOVA) Among Groups A, B, C, D (df=3)

Feature	SS	F	p
SmartMusic in Lesson	4.9	*	*
SmartMusic for Own Practice	10.9	1.4	.40
Accompaniment in Lesson	4.0	2.0	.29
Accompaniment for Own Practice	7.5	1.2	.46
Tuner in Lesson	0.4	0.1	.97
Tuner on Own	4.7	1.0	.52
Warm-up in Lesson	1.4	0.9	.53
Warm-up for Own Practice	3.5	1.4	.39
Human vs. Computer	5.0	2.0	.30
Web in Lesson	2.3	9.0	.10
Web for Own Practice	2.4	4.7	.12
Spectral Analysis	0.0	0.0	1.00
EGG	0.2	0.0	.88
Educational Technology Attitude	3.5	7.0	.07
Voice Technology Attitude	2.9	5.9	.09
McClosky in Lesson	1.2	2.4	.24
McClosky for Own Practice	1.4	0.9	.53
Perceived Preparedness	0.4	0.1	.93
Total Experience	1.2	2.4	.24
Average Score	0.3	0.5	.67

Table 4.55

Total Final Attitude Score (1=Most Positive, 7=Least Positive)

Group	n	M	SD
A	2	1.8	0.2
B	1	1.8	0.0
C	2	2.3	0.8
D	2	2.3	0.2
A & B	3	1.8	0.1
C & D	4	2.3	0.5
A & C	4	2.0	0.5
B & D	3	2.1	0.3
Total	7	2.1	0.4

CHAPTER 5

CONCLUSIONS

This chapter contains conclusions based on all the material presented in the previous four chapters. I begin with summaries of each of the first three chapters, including the background of the problem, research literature related to the topic, and the methodology of the study. I then summarize the Results chapter, highlighting the results that proved to be meaningful. I then use the data to reach conclusions on each of the three main technologies under discussion. These results led me to develop specific strategies for the incorporation of technology into voice lessons. Finally, I present suggestions on how the results of this study could be incorporated into future research projects.

Review

During the 1998-1999 school year, I set out to study the relative influence of selected technologies in the voice lessons of undergraduates. Because of the traditional nature of vocal pedagogy, some teachers have shown an aversion to the incorporation of modern technology, although some voice teachers have worked to incorporate technology into their lessons throughout recent history. Early experimentation into the use of technology and the voice was more likely to come from the medical community than from teachers of singing. In fact, a dichotomy existed in the profession between those teachers who supported a scientific view of teaching the voice and those who supported an experiential view based on tradition.

The field of music education has traditionally been more accepting of the use of technology for pedagogical purposes. Voice teachers can learn from the many experiences and studies published by music educators, as technology has developed from very rudimentary forms into today's still evolving media.

Because of the large number of technologies available to the modern practitioner, I narrowed my study to three technologies that I felt had excellent potential for the teaching of voice. The first technology explored in depth was the use of World Wide Web pages to supplement lessons. The second technology focus was the use of spectral analysis to measure the students' voices and provide visual reinforcement to the learner. The final technology investigated was the use of auto-accompaniment software (SmartMusic by Coda Music Technology, 1999) as an aid to lessons, practice, and performance.

I saw a need for a study that investigated the technologies available to the voice professional, a study which was undertaken from the perspective of a voice teacher and music educator rather than a medical professional or voice scientist. The purpose of the study was to observe and measure the influence of the technologies on the lessons, practice habits, and performance of students. Points of view included the perspective of both student and teacher. In order to fulfill the purpose, I designed an eight-week set of voice lessons that incorporated the various technologies in differing levels. Fourteen undergraduate students took part in the study. Six served as subjects for a pilot test during the fall semester of 1998 and eight participated in the main study in the spring of 1999.

The specific research goal was to observe and measure the extent to which the use of varying levels of technology influenced the teacher’s ability to provide a viable voice lesson, the participants’ attitudes toward the process, and which combination of technologies was the most feasible.

<u>Sub-questions</u>

1. How did students and the teacher adapt to the use of auto-accompaniment software and its peripheral components

    a.) in rehearsal and

    b.) in performance situations,

    and did the transition from auto-accompaniment software to a human accompanist influence

    c.) student preparedness or

    d.) student attitudes?

2. Did the combination of World Wide Web pages and electronic mail as information sources
    a.) facilitate the day-to-day needs of the lesson structure?
    b.) Are such pages useful within lessons themselves, or simply as a tool for outside reference?
    c.) Were students exposed to on-line materials within the lesson more positively disposed toward technology?
3. Did spectral analysis and the EGG support voice lessons?
    a.) Were measurements of acoustical phenomena useful pedagogically;
    b.) Did the process influence student attitudes?
    c.) Was the time spent on such measurements worthwhile as compared to instruction that is more traditional?

All research questions were addressed by the analysis of weekly logs, observations, and test questions in the form of Likert-type responses.

Review of Related Literature

Before undertaking the study, a thorough search of the literature germane to the investigation took place. Historically, I found that some teachers of voice have traditionally shown a bias against scientific method. This aversion is enhanced with the presence of strange, untested technologies that find their way into the modern voice lesson.

Although some research exists in the use of technology and voice science, a need for a study which incorporates the technologies into voice lessons still exists. Voice pedagogues (i.e., Reid, 1984; Rubin, 1988) call for a way to incorporate voice science and technology into the training of voice without sacrificing basic technique. Titze, (1986) surmised that the value of all the "charts, graphs, gadgets, and gismos in the studio" (p. 22) will not be solved until research is undertaken from the standpoint of someone trained in voice education rather than voice science. Cleveland (1994) reflects the growing acceptance with these comments:

> A few short decades ago, science received a bad name among the practical users of voice because they could not see that science was helping them at all. . . . Today, we are witnessing a greater trust from the singing teachers that science may have valid information to be shared in the studio and the education of teachers, as well. (p. 23)

A good deal of literature exists on the use of technology by medical professionals and voice scientists. In his history of laryngeal investigation, Moore (1937) provides an early view of the scientific study of the voice. Development of the laryngoscope began in 1807 with Buzzoni, but the first "real success" (p. 267) was by the singing teacher Manuel Garcia, who used a dental mirror to view the larynxes of his students. In his report on the evolution of the discipline, Von Leden (1990) provides another first-hand account of voice science in the middle part of the 20th century. In 1994, Cleveland concluded that the preceding 25 years had been the most productive period for the study of the singing voice. Brewer (1989) constructed a descriptive matrix to reflect voice research that shows the interrelation of the unsolved problems, academic disciplines, and research tools pertinent to the profession. Sataloff (1997) provides a compendium of scientific method in the study of voice. Before undertaking the research, many systems of voice measurement were considered, including electroglottography (EGG), inverse filtering, spectral analysis of factors such as jitter, shimmer, and closed quotient (CQ), and pitch-recognition software.

Much of the consideration for the design of the study was taken from the music education literature. Higgins (1991) notes the lack of good research in the area due to poor research design, lack of treatment time, lack of expertise of experimenters, poor quality of treatment, and lack of internal validity of experiments. Reasons for the poor research methodology include: the rapid change in technology, the delay of acceptance in the classroom, a traditionally narrow view of instruction, reluctance to extend the research by applying new technology to old problems, and the lack of qualified researchers. He suggests future research follow the action research paradigm. Berz and Bowman (1995) point out the debate over the validity of feasibility and effectiveness in research studies that compare traditional teaching and computerized instruction. They suggest claims by these researchers could be due to a novelty effect or media advocacy as a bias for the investigators.

> To balance the present technocentric orientation, research should also address the broad issues of using technology in learning. Development and feasibility studies are needed, but researchers should also be encouraged to give more attention to ways of integrating technology into teaching/learning environments that result in optimal learning by each individual. . . . At this juncture, greater consideration should be given to the broad musical, educational, and technological contexts in which technology-based instruction is to be implemented, and more attention should be directed toward development of appropriate instructional models and practical teaching strategies. (Berz & Bowman, 1995, p. 22)

These considerations have been addressed in the design of this study, which occurs in the naturalistic setting of a voice lesson.

Rudolph, Richmond, Mash, and Williams (1997) suggest specific strategies for adaptation of technology to the National Standards. Williams and Webster (1996) produced a compendium of applications of technology to music. Central to the philosophy behind the book is the Systems Perspective (cf. Reese & Davis, 1998), in which the people who use the computers and the tasks they perform are considered more important than the software and hardware used.

Three studies exist concerning the auto-accompaniment software SmartMusic, formerly named Vivace, used in the present experiment. All of the studies centered on instrumental music. Ouren (1997) documented the effect of Vivace on the playing skills, musicality, and attitude of eight middle school students. Tseng (1996) investigated qualitatively the interaction of 10 college flute students with the Vivace system. Sheldon, Reese, and Grashel (1997) investigated differences in performance quality among three groups of instrumental music education undergraduates who received no accompaniment, live accompaniment, or digital accompaniment. Wu (1997) explored the influence of karaoke, a technology with some common characteristics.

In addition, many studies exist on the use of computer-based visual reinforcement and the voice. Miller and Schutte (1990) discuss the role of reinforcement from spectral analysis as applied to the singing voice. In their development of a computer-based biofeedback device, Rossiter and Howard (1996) considered real-time visual reinforcement for voice development in prospective professional voice users. Welch, Howard, and Rush (1989) used real-time display to develop a computer-based system of providing reinforcement for pitch detection. Ester (1994) developed a HyperCard stack called Hyper Vocal Anatomy to teach laryngeal anatomy to undergraduate music majors. Freeman, Syder, and Nicolson (1996) designed a multimedia tutorial for students of voice therapy. Some of the techniques and questions from the spectral analysis portion of the present research have been adapted from Miller's and Doing's (1996) research.

Although literature on the use of the Internet is more prevalent in the general education literature than in the music literature, a few pertinent studies exist. Coan (1992) used the Internet for his survey study. Nord (1998) investigated the use of the Internet for professional development for teachers. Repp, Reese, Meltzer, and Burrack (1999) also investigated on-line professional development for music teachers, but with an emphasis on technology skills.

The present research has grown out of several previous studies. In 1995, I completed a study that explored the various avenues for research in voice that were available on the Internet. In addition to Internet exploration, I used a series of interviews and on-line research to determine the attitudes of voice users toward Internet resources. In 1997 I completed a report on the extent which the attitudes of pre-service music teachers were affected by an Internet-based presentation of a voice relaxation process known as the

McClosky Technique for Vocal Relaxation. Materials from the 1997 study have been incorporated into the present research. Results from the pilot test for this study were published separately (Repp, 1999a). In addition, a report gleaned from the literature review of this project on the historical use of the voice was also published separately (Repp, 1999b).

Despite the research mentioned here, I felt studies specifically concerning singing and voice production were not prominent enough to make broad generalizations or influence the teaching profession.

Review of Methodology

After reviewing the literature available and finding that the standards of technology use for the teaching of voice had not yet been firmly established, I determined the best possible research model was an exploratory comparative study of the technologies available for the teaching of voice. I therefore chose a descriptive paradigm with an emphasis on comparison of eight in-depth case studies. This research design allowed for a real-world context for the study as suggested by Berz and Bowman (1995) and adequate treatment time in a realistic setting, as suggested by Higgins (1991).

Four men and four women were chosen from a pool of volunteers who responded to messages posted on flyers and Internet newsgroups. The requirements for acceptance included an age within the traditional range for undergraduates and a willingness to both use e-mail communication and access the Web outside of lessons.

The participants were divided into four comparison groups so that I could contrast the relative influence of the individual technologies. The breakdown of the participant groups (see Table 5.1) was designed so that one participant of each gender was represented in each group. Names used throughout represent pseudonyms of the participants. Group A, the most technologically saturated group, received spectral analysis within their voice lesson, had access to Web pages within their lessons, and performed at a final concert with the SmartMusic accompaniment system. Group B received spectral analysis within their voice lessons, did not have access to Web pages within their lessons, and performed at a final concert with the SmartMusic accompaniment system. Group C received no spectral analysis, had access to Web pages within their lessons, and performed at the final concert with a human accompanist. Group D, the least technologically saturated group, received no spectral analysis, did not have access to Web pages within their lessons, and performed at the final concert with a human accompanist.

Table 5.1

Breakdown of Participant Group

	A (n=2)	B (n=2)	C (n=2)	D (n=2)
Treatment				
Voice analysis	yes	yes	no	no
Web page	yes	no	yes	no
Accompaniment	software	software	human	human
Gender				
Male	Mark	Jack	Kevin	Tony
Female	Brenda	Jane	Tina	Linda

Because in the pilot testing I had determined that the use of the SmartMusic system within lessons had been effective for all participants, all participants had the advantage of using the SmartMusic accompaniment system within their lessons.

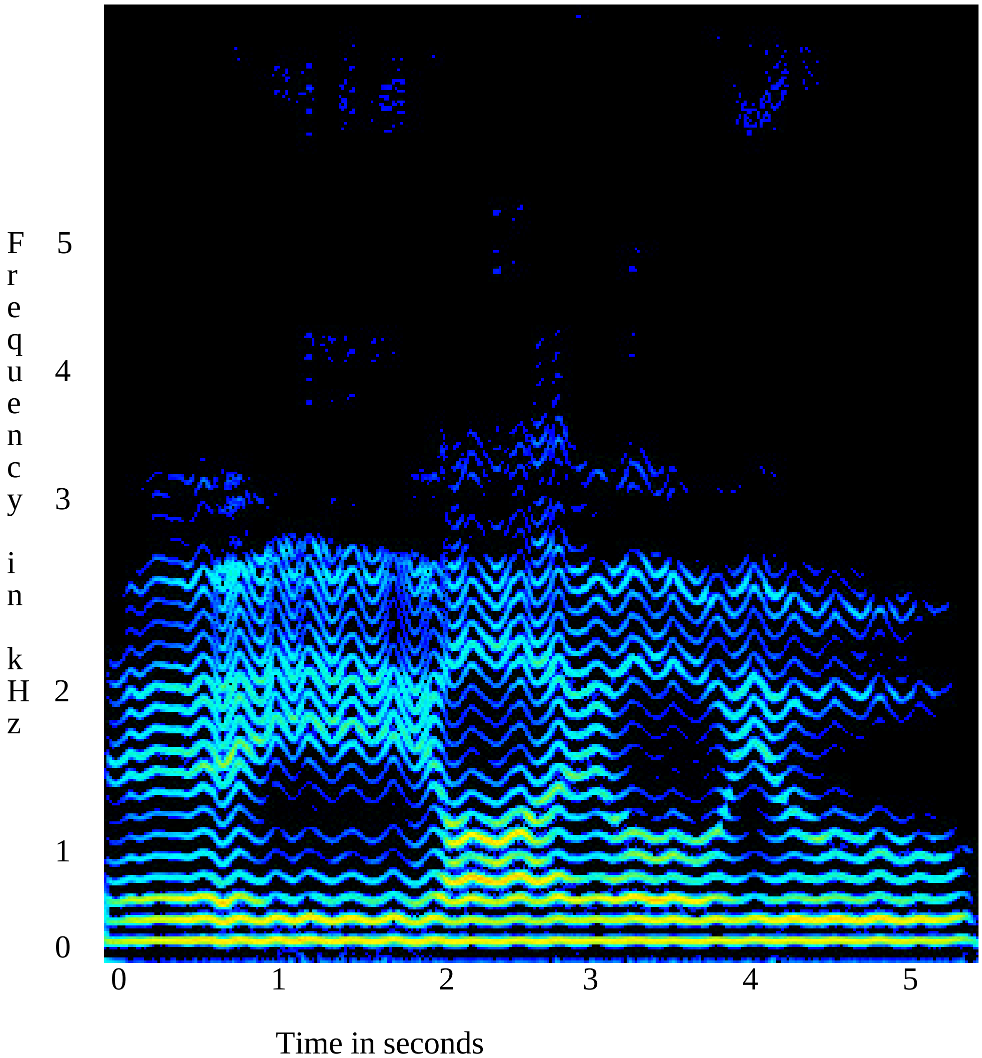
Comparison of the individual groups was less important than the comparison of groups that receive similar treatments—for example, data from groups A and C, which had the advantage of the use of Web pages within their lessons, were compared with data from groups B and D, which did not. The other major comparison is twofold: data from groups A and B, which both received spectral analysis, were compared with data from groups C and D, which did not receive spectral analysis. Similarly, since groups A and B performed with the SmartMusic system at the concert, their data could be compared with data from groups C and D, which performed with the human accompanist.

The study took place in two separate studios at the University of Illinois. One studio was equipped with a computer that had both the SmartMusic accompaniment system and Netscape Navigator (an Internet browser) installed. The other studio contained an EGG and specialized hardware necessary to take spectral readings of the students' voices (i.e., Miller, Schutte, & Doing, 1996).

The larger structure of the eight-week study was broken into three parts to test the individual technologies. The first issue was an investigation of whether the inclusion of Web pages within the lesson was worth the time and effort. I had determined in the pilot test that the use of Web pages was an excellent source of information for students outside of lessons. The use of comparison groups allowed me to judge whether incorporation of Web pages within lessons was worthwhile. In order to judge the effectiveness of the Web, I used pages I had previously developed for another study (Repp, 1997), pages which present information on the McClosky Technique for Vocal Relaxation (McClosky, 1978). These Web pages were presented as a supplement to the lessons of groups A and C, while the comparison groups received traditional lessons without the use of the Web pages for visual support.

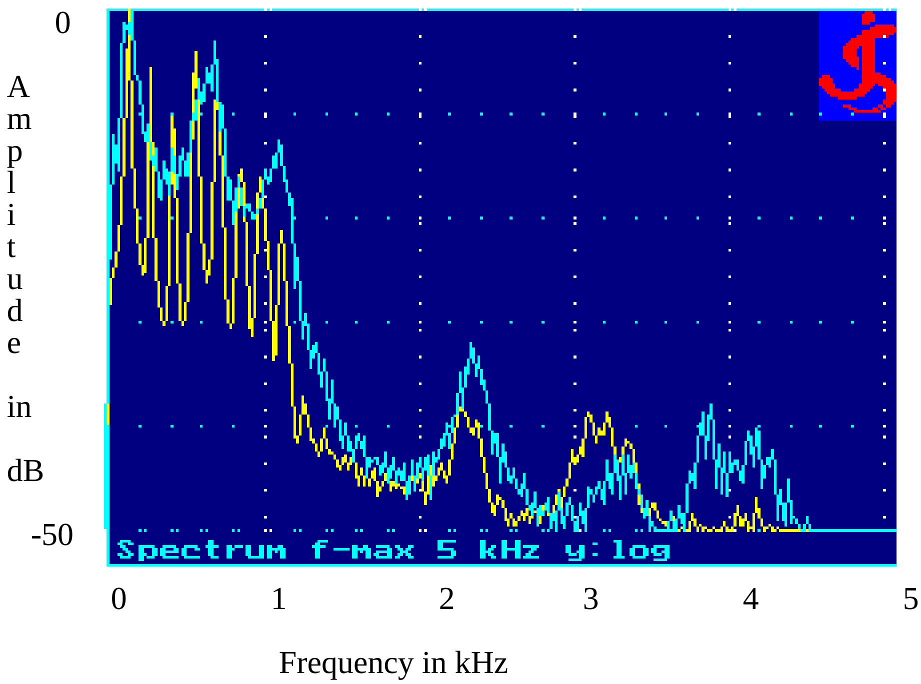
The second section under study was the use of spectral analysis software and the EGG. Half of the students received spectral analysis twice during the semester, once during the third week (serving as a pretest) and once during the seventh week (serving as a posttest). The procedure for the lessons was to have the students see visual representations of their voices in three different ways. First, a student would speak and sing various phrases in differing pitch levels into a microphone. Using the software Spectrogram 4.2 (Shorne, 1999), the process allowed for a spectrogram showing the spectral makeup of their voices over time (see Figure 5.1). The student could then compare the various peaks in the spectrum caused by formant differences and pitch changes.

Figure 5.1. Spectrogram of sung vowels [e i a o u].



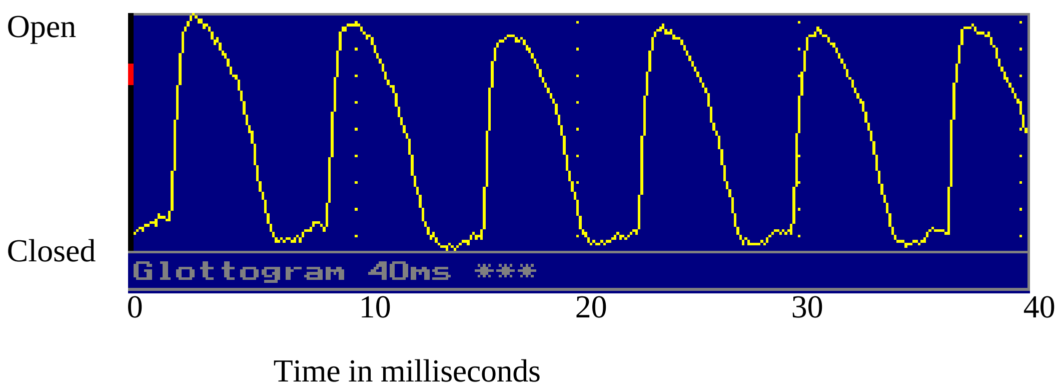
Next, the student performed a technique devised by Miller and Doing (1996). First, a student produced a "fry" tone, which approximated the theoretical perfect vowel formation (as indicated by the darker line in Figure 5.2), and then the student attempted to approximate this vowel form while singing. The software used was VoceVista (Miller, Schutte, & Doing, 1996). With both of the spectral readings, students were encouraged to condition the singer's formant, around 3000 Hz.

Figure 5.2. Spectrograph of the [a] vowel.



Third, the student used an EGG (Figure 5.3), which consisted of two electrodes placed on either side of the larynx. The EGG produced a graphical representation of the opening and closing of the vocal folds.

Figure 5.3. EGG reading.



Data from these techniques were used to determine progress over the semester, both from comparison of graphical images and recordings made possible by the Spectrogram software package (Shorne, 1999). Data from the comparison groups were used to determine whether the process was worth the extra time and effort necessary.

The third section of the study was a determination of whether the SmartMusic accompaniment system, which had been shown to be very effective within lessons and as a practice tool in the pilot test, was effective as a performance tool. Data from students who performed at a final concert with the SmartMusic system were compared with data from the students who performed with a human accompanist. In addition, various components of the SmartMusic system, such as the tuner function and the warm-up function, were analyzed to determine whether they were effective both within the lesson and as an outside practice tool.

Data were collected in three ways. First, students completed a weekly journal in response to open-ended questions. Second, each student completed on-line questionnaires in the form of Likert-type responses, which yielded quantitative data. Third, each lesson and the final concert were recorded in either audio or video format, and the observations were analyzed.

During the pilot test, several sources of bias were found which required attention for the final project. (See Gall, Borg, and Gall (1996) for a discussion of research bias.) Since the participants were volunteers, a researcher would expect their responses to be more positive than the general population's responses would. This source of bias was minimized through careful selection of participants with all levels of technology use and vocal experience. Another potential source of bias was a novelty effect, in which participants tend to rate newer experiences more favorably. My attempting to downplay the novelty of the technologies used and referring to them as commonplace minimized this bias source. A third source of bias was the Hawthorne effect, or the tendency of participants to perform better because they know they are being studied. Hawthorne effect was minimized by my referring to the research only when necessary, and my attempting to present the project as voice lessons rather than a research project. Another source of bias was the experimenter effect. Because only one teacher existed, improvements could have come about because of my teaching method rather than the treatment.

Summary of Results

The results of the study were analyzed in two ways. First, the student responses and teacher observations were analyzed using content analysis in order to determine individual reactions to the process. Next, quantitative data from the on-line questionnaires were compared to show statistical trends for the responses.

Case Studies

Summaries of each of the detailed case studies from chapter 4 are presented here, from greatest integration of technology to least. Pseudonyms are used to protect the confidentiality of participants.

Mark

Mark was an 18-year-old math and computer science major with a good deal of vocal experience and a great deal of technical training. He received Web support within lessons, spectral analysis, and performed with software at the final concert. Initially he found the Web pages useful in lessons and appreciated the visual reinforcement, but found them not as helpful in his personal practice because he had remembered most of the information presented from the lessons themselves. He successfully incorporated the materials from the Web pages into his practice routines. He preferred using e-mail to communicate rather than the Web forms that I had designed for data collection. He also appreciated having the Web materials on line later in the semester as a reminder.

Because of his strong technical background, he was the most appreciative of all of the students when asked about the use of spectral analysis. The explanations of the spectral makeup of his voice were of great interest to him due to his technical expertise. I was able to show which vowels were more efficient than others were. The EGG readings were also accomplished successfully. The recordings inherent in the system and the graphical representations of his voice showed improvement when compared to previous readings.

When we accessed the SmartMusic system, I did not have, comparatively, as much time to work on the tuner and warm-up functions because of the extra time the spectral analysis had taken. He was able to use the software on his own without difficulty when tested. Although he did not access the SmartMusic system extensively in his own practice, he responded with positive comments. The SmartMusic system was not adequate in helping him find missed notes and rhythms, so I reverted to the piano keyboard often.

In preparation for the final concert, Mark gave me mixed messages. He was apprehensive about his level of preparation for the concert, but he stated that the use of the spectral analysis software had been worth the time spent. He made excellent progress throughout the semester and performed well at the final concert, despite his prior reservations about his preparedness. He found the use of the software accompanist for performance purposes to be acceptable.

Brenda

Brenda was an 18-year-old music education major with an instrumental emphasis. Because of her choice of major, she had experienced a good deal of musical training before lessons began, including participation in voice ensembles, but had no formal training in solo voice. Her technical experience had been limited to simple applications such as e-mail, word processing, and the World Wide Web. In her lessons, she received spectral analysis, Web pages within lessons, and she performed with the software accompanist.

During the lessons with Web support, she reported appreciating the visual reinforcement the pages provided, and she found the pages useful outside of lessons as a reminder for what had occurred in lessons. She was able to incorporate into her singing the information presented on the Web pages. She stated no preference for communicating via e-mail over using the Web for data collection.

During the spectral analysis phase of the lessons, she reported that the information presented was "interesting," but she had doubts whether the process actually helped her singing. Collection of spectral data was hindered because she had a difficult time producing the "fry" tone necessary for the comparisons, and we were unable to produce a meaningful EGG signal. During the follow-up use of the software, we were able to hear differences in her tone from the recordings of the sound files. However, the visual representations of the sounds did not always reflect that improvement, with the notable exception of her [o] vowel, which had begun muffled and without high overtones. She felt that the initial experience with the process had been interesting, but that she would have rather spent more time preparing for the concert rather than participating in the follow-up session.

When we experimented with the SmartMusic software, she was able to work with its various components on her own after a brief demonstration. She found the intonation exercises particularly challenging, appreciated the ability of the software to accompany her warm-ups, and found the accompaniments "fun" for songs she knew well, but more challenging for repertoire which was new to her. She also commented on the convenience of the software as compared to her past experiences with human accompanists.

She showed great improvement over the semester, both in technique and performance ability. The performance at the end of the semester went extremely well, although during the concert, the amount of time necessary to set up her accompaniment led to an awkward pause beyond her control. She stated that she had preferred to use the software to a human accompanist because of the limited time available and her knowledge that the software would produce a consistent result.

Jack

Jack was an 18-year-old freshman who was majoring in percussion performance. He had significant musical experience, but his only voice training had been in aural-skills classes. His technical experience was minimal, but he was comfortable using e-mail and the Web. His goal for the lessons was to improve his grades in aural-skills classes. He participated in spectral analysis, and did not have access to Web pages during his lessons.

Initially Jack was frustrated with the slow pace of lessons because he did not see progress toward his goal of immediate improvement in his aural skills. He did not access the Web pages at all in his outside practice because he felt that Web pages could not compare to traditional lessons. He also stated that he would have appreciated having such materials in the lesson as other students had. He answered my e-mail queries, but refused to access the Web forms that provided quantitative data. I was forced to either have him fill out printouts of the forms within lessons or read him the forms over the telephone and have him relate his answers verbally.

Because Jack did not attend lessons regularly, I was forced to change the order of lessons so that he participated in the spectral analysis during his fourth lesson rather than the third lesson. The process yielded little useful results pedagogically because he naturally produced a tone that was high in spectral energy around the singer's formant, and so I could not suggest any improvements. We were also unable to schedule a follow-up session.

When we experimented with the SmartMusic system he had positive comments about the accompaniments, but found the intonation exercise frustrating, and preferred to use the piano for warm-ups. Although I felt his morale had improved by the fourth week, in which we were concentrating more on singing, he chose not to attend lessons after mid-semester. Jack was the only participant who did not complete the study.

Jane

Jane was an 18-year-old freshman majoring in microbiology. She had experience singing in choirs all her life and had played piano and trumpet for a short while. Her technical experience had been limited to end-user applications such as Microsoft Word, Excel, and the Internet. During her lessons, she did not have access to Web pages, she received spectral analysis, and she performed with the software accompaniment.

She was very open to the material presented in her first two lessons because of an interest in music therapy. However, she did not find the Web pages themselves particularly useful outside of her lessons because she did not feel they added anything to the information she had learned in the lessons. She had a difficult time incorporating the material, particularly the postural exercises, into her singing.

She found the process of spectral analysis stimulating and was particularly intrigued by hearing her voice played through the computer, as she had never heard a recording of her singing voice. The time-based spectrogram was effective in representing her harsh glottal attacks, which I felt could be meliorated. The snapshot spectrographic analysis was less effective, because she naturally sang with energy in the area of the spectrum that I was attempting to improve with the spectral analysis. I was able to produce a meaningful reading on the EGG. During the follow-up session, we were able to hear differences in her voice through the recordings, but the graphical representations showed less meaningful changes. In her journals she initially had very positive comments about the spectral analysis process, but stated that the experience had not helped her prepare for the final concert.

When we experimented with the SmartMusic system, she was able to use the equipment on her own after a brief demonstration. She preferred to use the keyboard for warm-ups rather than the software function. When we experimented with the tuner function, she was able to match pitch when the computer produced a reinforcement tone for support. When I eliminated the reinforcement, she had a difficult time making the needle on the tuner move to the center. She felt that the accompaniments gave her "more freedom that a human accompanist," but wished that the software would provide the option of playing the melody line for songs she did not know well. (Note that the software does have this ability, but she was unaware of the proper setting.) She also commented that the timbres for the software sounded "fake," but appreciated having the accompaniments available because she did not have the piano skills necessary to play along with her singing.

She made excellent progress throughout the semester and was singing well by the end, but she had some unnecessary doubts about her preparedness for the concert. Her performance at the concert was delayed slightly because I had placed the wrong accompaniment disk in the disk drive at first, so I spent extra time finding the correct song. Part of the accompaniment necessitated my triggering the software within the piece rather than her triggering the software with her voice, and although this section had been problematic in rehearsal, in performance everything went well.

Kevin

Kevin was a 21-year-old junior majoring in chemical engineering whose musical experience had been minimal and who was very apprehensive about learning to sing. He had significant experience with technology, including programming experience. During his lessons, he had the Web pages available for support, and he performed with the human accompanist at the concert.

Because he was a true beginner, the initial lessons were slow and deliberate, and I appreciated the Web pages as an effective supplement to the lessons. He found the pages useful as a reference outside of lessons, but found the use of the pages in lessons to be only minimally effective. With his extensive programming experience, he was able to provide excellent suggestions for improvement of the pages. These included the use of frames, allowing the student to change Web pages, and placing the student closer to the computer screen. He appreciated the convenience of the Web forms for data collection, but preferred the versatility of his e-mail journals.

The use of some of the components of the SmartMusic system was effective because of his limited vocal skill. The use of the tuner function was effective in giving him a visual reinforcement when he was experiencing difficulties in matching pitch. Singing his entire piece into the tuner was an effective method for helping him learn the pitches of his song. He also preferred using the software for warm-ups because he was comfortable with using computers in other aspects of his life. However, when we began to use the accompaniment feature of the SmartMusic system he found the process frustrating because with his limited sight-reading ability, he found determining entrances and finding pitches in pieces to be very difficult. In his practice session with the computer, he missed the personal reinforcement from lessons.

During the last lesson, in which we switched from software accompanist to a human accompanist in preparation for the upcoming concert, Kevin was quite tentative and made many mistakes on the first run-through of the piece with the new accompanist. The initial intimidation with having another person hearing him sing lessened as he became comfortable with the new accompanist. The accompanist made adjustments to his playing, including doubling the melody line and stressing Kevin's entrance notes, adjustments which improved Kevin's ability to match pitches. Kevin reported that he appreciated the human element of the last lesson and the accompanist's ability to react to his singing. He also noted that since the accompanist was louder than the computer, he was forced to sing more forcefully, and the added breath support improved his tone and confidence.

He performed well with the human accompanist and did not display the pitch-matching difficulties he had shown in rehearsal. One potential problem occurred in the concert because the accompanist played the introduction to the piece differently than he had in rehearsals, causing Kevin to enter late. However, the accompanist realized what had happened and adjusted without anyone in the audience noticing any problems. After the concert, he stated a strong preference for the human accompanist in the performance situation.

Of all of the students in the study, Kevin's improvement was by far the most significant. He stated that the technology used in the lessons was integral, and the lessons "would have been a completely different experience without the technology."

Tina

Tina was a 21-year-old junior who majored in music education with an instrumental emphasis. She had a great deal of musical experience including singing in choirs, but no individual voice lessons. She had used music software in the past and was familiar with e-mail and the WWW. In her lessons, she had access to Web pages and she performed with the human accompanist at the final concert. The progress of her lessons was hindered because she suffered a serious illness during the semester, and therefore had to skip some lessons and make them up all at once.

She felt that the Web pages were useful for informational purposes both within lessons and as an outside resource because of their use as a visual aid, their simplicity, and their sequential organization. Because of her experience in education, she was able to make excellent suggestions for improvement in the use of the Web pages. Suggestions included a suggestion that the student be able to control the Web pages within the lesson and a suggestion to include problem-solving strategies. She had a difficult time incorporating the information presented into her own singing, however. She also felt the use of the Web-based forms to be redundant, but appreciated their organization.

After a brief demonstration of the SmartMusic system, she was able to control the software. She preferred to use a tuner she had at home rather than the SmartMusic's tuner function because of convenience. She also did not immediately see how working with the tuner would transfer to her vocal prowess. With her piano skills, she also found using a piano for warm-up exercises to be more convenient than using the SmartMusic system was. When we experimented with the accompaniment feature, she had difficulty triggering the mechanism because her voice was not strong enough to register. She also found the piece she had chosen to be frustrating because it necessitated her triggering the software manually with a tap of the foot pedal, and she found the process distracting. She did not use the software extensively because she had limited time available because of her illness.

The transfer from the software accompaniment to a human accompanist proved to have a positive effect, particularly on her ability to sing musically and dramatically. She was very comfortable singing along with the human accompanist, having performed with pianists in the past. Despite differences in tempo and volume level, she had a strong preference for the use of the human accompanist, citing the "natural" feel of the process and the fact that she had found the software cumbersome and stagnating. She did feel that the software had been an acceptable practice tool. She performed her piece with the human accompanist well at the concert, despite the fact that she was not able to run through her piece with the performance accompanist until the concert itself. Differences in this particular interpretation of her piece did not influence her performance.

Tony

Tony was a 19-year-old sophomore majoring in materials science and engineering. He had little musical training, but had great interest in learning to sing because he had recently joined a rock band. He had some technical experience, including some rudimentary programming courses. He received the least technology-saturated lesson, having no Web pages in his lessons and performing with a human accompanist.

Tony had appreciated having the Web pages for his practice sessions, citing their function as a reminder and their use of graphics, but he saw no need to add the pages to his lessons. He also noted a preference for personal reinforcement. He had a difficult time incorporating information from the Web pages into his practice sessions. He also felt the on-line survey mechanisms were efficient, but did not feel they gave him as much of a chance to elaborate on his thoughts as his e-mail journals did.

He did not have trouble in learning to use the SmartMusic system. He found the intonation exercises challenging because of his limited vocal experience. He also felt the warm-up exercises had been convenient because he did not possess piano skills. He had positive comments on the accompaniments in the software, but he did not access the practice room very often during the semester.

During his first run-through with the human accompanist, he made some atypical mistakes and was not aware he had erred until I pointed them out. Because the piano was louder than the computer had been, he had a tendency to push his voice when singing with the piano. He also noted that he could rely on the computer to play the same every time (particularly tempo), and that he was slightly nervous around another person.

Tony made good improvement throughout the semester, but could have made more progress on fundamental technique. At the final concert, he performed well with the human accompanist, although he felt he had performed the piece better in lessons. He was the only subject performing with a human accompanist who did not have a strong preference for the experience, stating that using the software was almost as useful.

Linda

Linda was a 20-year-old junior who majored in biology. She had limited musical experience, with three years of piano lessons, and no voice training. She had a good deal of technical experience, having previously been a computer science major. She received the least technology-saturated lessons, having no Web pages and performing with a human accompanist.

She found that the Web pages were inferior to the personal lessons, but served as a good supplement, although she stated she did not need to use the Web pages to remember what had happened in lessons. I felt that I could have given a more effective lesson had I access to the graphics on the Web page dealing with posture, and she also felt the pages would have added to the lesson experience. She gradually incorporated the techniques from the lessons into her singing. She stated no preference between on-line forms and e-mail journals.

After a brief demonstration, she was able to access the features of the SmartMusic system without much prompting. The tuning feature was received well because of its visual reinforcement, and the experience helped her pitch-matching ability. She stated no preference between warm-ups on the computer compared to the piano. Use of the accompaniments in lessons was hampered because she did not know many of the songs available, so choosing pieces as experimental songs was difficult. The software did not give her enough reinforcement for pitches, so I was forced to switch to the piano in order to teach her the correct pitches to sing. In her personal practice, she had some difficulty with the system because of hardware setup challenges. She also had difficulty in learning new songs with the accompaniment because she was not aware of how to make the system give a response as to what note she should sing or what lyric should be sung. As she became more accustomed to the software, these challenges diminished.

When we switched to the human accompaniment, on the first run-through she made atypical mistakes of which she was unaware until I pointed them out later. Because the piano was at a higher volume level than the software, she tended to over-sing some of her notes. She also felt slightly uncomfortable with the new person in the practice room at first, and noted interpretation differences, such as tempo changes. However, she stated a strong preference for the human accompanist, citing the added realism, challenge, enjoyment, and satisfaction of performing with another person.

Linda made great improvement over the semester both in performance ability and fundamentals of singing. At the concert, she performed well with the human accompanist and seemed to be enjoying the performance. Of all of the participants, she had the most positive comments about the entire experience and was very complimentary about the lessons and my teaching.

Quantitative Comparisons

This section contains brief summaries of the four sets of questionnaires used throughout the semester and conclusions about how the data, together with teacher observations and student responses, helped support conclusions.

Early Surveys

Early in the semester, students were given a presurvey and postsurvey (after one week's teaching) to measure the short-term influence of having the Web pages used in lessons. Table 5.2 shows the initial short-term (over the first two weeks of the semester) changes in attitude toward educational technology. The "Web" group, which had access to Web pages in the lesson, started with a very high attitude toward technology (perhaps unrealistically high), which did not change over the one-week's experiences. The comparison group, which did not have access to Web pages during lessons, started with a slightly less positive view, which deteriorated over the intervening week (a positive number reflects a deterioration in attitude). This difference was not statistically significant (t=.77, df=6, p=.50).

Table 5.2

Short Term Attitude Toward Educational Technology (1=Most Positive, 7=Least Positive)

Group	n	Pre	SD	Post	SD	Change	SD
Web	4	2.0	0.0	2.0	0.0	0.0	0.0
None	4	2.5	0.6	3.0	1.4	0.5	1.3

When asked about their attitude toward the potential of technology for teaching voice, the scores of both groups declined over the first two weeks of the semester. The scores for those using the Web pages in their lesson deteriorated less (see Table 5.3). (t=.65, df=6, p=.54).

Table 5.3

Short-Term Attitude Toward Technology for Teaching Voice (1=Most Positive, 7=Least Positive)

Group	n	Pre	SD	Post	SD	Change	SD
Web	4	2.0	0.0	2.3	0.5	0.3	0.5
None	4	2.3	0.5	2.8	1.0	0.5	0.6

Table 5.4 shows the average scores for all the attitude measures in the second survey.

Table 5.4.

Total Score for McClosky Survey (1=Most Positive, 7=Least Positive)

Group	n	M	SD
Web	4	3.0	0.7
None	4	4.1	2.2

The total attitude score for the group receiving the Web pages during class was more positive than score for the group not using the Web pages, however this difference was not statistically significant. (t=.92, df=6, p=.39).

Also of note was the following data (Table 5.5) which reflected the attitude of the participants toward the McClosky Technique, data taken at the final survey, which occurred some two months later. Those students who had used the computer in lessons found the technique slightly more beneficial than the comparison group did (F=2.4, df=3, p=.24).

Table 5.5

Attitude Toward McClosky Technique from Final Survey (1=Most Positive, 7=Least Positive)

Group	n	M In Lesson	SD
Web	4	1.5	0.6
None	3	1.7	0.6

McClosky questionnaire conclusions. All of the measurements of attitude taken in the McClosky questionnaire in the first few weeks (including additional questions but available in Tables 4.8-4.14) show the same general trend. The group having the Web pages within their lessons improved slightly more in attitude measures than the group which did not have access to Web pages in their lessons did. I conclude that the statistical data supports my observations that the use of Web pages within lessons had a positive short-term influence on the learning and attitude of the population. I take into account the fact that generalizable conclusions cannot be firmly established because of the lack of statistical significance.

Spectral Analysis Questionnaire

During the fourth week of the semester, participants who had been exposed to the spectral analysis software completed an on-line survey to judge the influence of the process. The questionnaire was originally designed by Miller and Doing (1996) and was kept intact so that comparisons could be made with their data. Miller and Doing had divided their population into three groups: one group that used the software for every lesson, one who used the equipment "one or two times," and one group that had only a technical explanation for the procedures. The data from the group that used the equipment one or two times are included here because this group was most similar to the experiences of the present study. This questionnaire was not given to the groups that did not receive spectral analysis, since they would not have been able to make judgments about a process with which they were unfamiliar. The data were not meant to show differences within groups for the present study, but to determine any differences from my use of the equipment compared to Miller's and Doing's use of the equipment.

When asked their attitude toward the process, those students in my study reported significantly more positive results than those in the previous study did, despite my relative unfamiliarity with the process. The Miller and Doing group reported an average score of 2.6 (with 1 being the least positive rating and 5 being the most positive rating) while the group in the present study reported an average score of 3.2. This difference was statistically significant (t=3.15, df=11, p=.01). Because the population samples differed, one should not infer from these data that my use of the hardware was more expert than the original study. I do conclude from these data that my use of the procedure was viable and comparable to the use of the Miller and Doing group that had access to the software one or two times during the semester.

SmartMusic Questionnaire

During the sixth week of the semester the participants were administered a questionnaire to determine their attitudes toward the SmartMusic system. During the final questionnaire, which took place after the final concert, these questions were repeated. They helped to determine whether the factors of performing with a human accompanist rather than the SmartMusic system and the participation in the spectral analysis would change the responses to the questions. The following data reflect the changes over the last few weeks of the project only.

The following data (see Table 5.6) reflect the question regarding student attitude toward educational technology in general, a question that was asked repeatedly throughout the semester. The group which received the spectral analysis improved their scores on this measure by .3 points (a negative number indicates an improvement in attitude), while the group which worked with a human accompanist and received less technology showed no improvement in attitude over the last few weeks of the semester (t=.60, df=5, p=.58).

Table 5.6

Late Short-Term Attitude Toward Educational Technology (1=Most Positive, 7=Least Positive)

Group	n	Week 6	SD	Post	SD	Change	SD
Spectral/Software	3	2.3	0.6	2.0	0.0	-0.3	0.6
None/Human	4	2.5	0.6	2.5	0.6	0.0	0.6

During the final few weeks of the semester, the comparison groups showed a similar attitude toward the use of technology to teach voice (see Table 5.7). The group which received the spectral analysis improved their scores on this measure by .3 points, while the group which worked with a human accompanist and received less technology showed no improvement in attitude over the last few weeks of the semester (t=.60, df=5, p=.58).

Table 5.7

Late Short-Term Attitude Toward Technology for Teaching Voice (1=Most Positive, 7=Least Positive)

Group	n	Week 6	SD	Post	SD	Change	SD
Spectral/Software	3	2.7	0.6	2.3	0.6	-0.3	0.6
None/Human	4	2.5	0.6	2.5	0.6	0.0	0.8

All of the data from the individual questions on the form were summed and averaged to produce the data in Table 5.8. The group that had received spectral analysis and used the SmartMusic software in the concert showed both more positive attitudes toward the SmartMusic system and a greater improvement in attitude over the last few weeks of the semester. The post-concert measure of attitude was not significant, however ($t=-1.2$, $df=5$, $p=.27$).

Table 5.8

Average Score for SmartMusic Attitude (1=Most Positive, 7=Least Positive)

Group	n	Week 6	SD	Post	SD	Change	SD
Spectral/Software	3	2.1	0.6	1.7	0.2	-0.4	0.6
None/Human	4	2.6	0.6	2.6	0.6	0.0	0.8
Total	7	2.4	0.6	2.1	0.7	-0.2	0.7

SmartMusic questionnaire conclusions. The data above corroborate the teacher observations and student responses. Open-ended data showed that those students who participated in a more technology-saturated environment (i.e., took readings with the spectral analysis equipment and performed with the SmartMusic system) had a more positive attitude toward the technologies and the use of technology in general.

Final Questionnaire

After the final concert the participants were administered a comprehensive post-survey to determine attitude changes over the semester. These data are reported divided into categories determined from the breakdown of the participant group (see Table 5.1). Each group is reported in combination with other groups that received similar treatments. For example, data from groups A and C combined, which both had the advantage of the use of Web pages within the lesson, are compared with data from groups B and D combined, which had no Web pages. Similarly, data from groups A and B combined, which received spectral analysis and performed with the SmartMusic system, are compared with data from groups C and D combined, which received no spectral analysis and performed with a human accompanist.

Table 5.9 shows the attitudes of the participant groups toward educational technology in general. This question was asked several times during the process, but the data reflects the change in attitudes from the very first presurvey to the final survey after the final concert. The groups that received spectral analysis and performed with the software accompaniment (A & B) improved slightly in attitude, while the comparison group (C & D) deteriorated slightly in attitude. Similarly, those who used the Web pages in the lesson (A & C) had no change in attitude, while those who did not deteriorated slightly in attitude (F=7.0, df=3, p=.07). Thus, in both instances, the groups receiving the more technology-centered lessons improved in attitude, while the comparison group's attitude deteriorated slightly.

Table 5.9

Final Mean Attitude Toward Educational Technology (1=Most Positive, 7=Least Positive)

Group	n	Pre	SD	Post	SD	Change	SD
A & B	3	2.3	0.6	2.0	0.0	-0.3	0.6
C & D	4	2.0	0.0	2.5	0.6	0.5	1.0
A & C	4	2.0	0.0	2.0	0.0	0.0	0.0
B & D	3	2.3	0.6	2.7	0.6	0.3	1.2

The attitude of participants toward technology for teaching voice was not as positive, but followed similar trends (see Table 5.10). The groups that received spectral analysis and performed with the software accompaniment (A & B) showed a slight deterioration of .3 units in attitude. The comparison group (C & D) deteriorated .5 units in attitude. Those who used the Web pages in the lesson (A & C) showed a slight deterioration in attitude (.3), while those who did not deteriorated slightly more (.7) (F=5.9, df=3, p=.09). Thus, in both instances, the groups receiving the more technology-centered lessons deteriorated less in attitude than the comparison groups.

Table 5.10

Final Mean Attitude Toward Technology for Teaching Voice (1=Most Positive, 7=Least Positive)

Group	n	Pre	SD	Post	SD	Change	SD
A & B	3	2.0	0.0	2.3	0.6	0.3	1.0
C & D	4	2.0	0.0	2.5	0.6	0.5	0.6
A & C	4	2.0	0.0	2.3	0.5	0.3	0.5
B & D	3	2.0	0.0	2.7	0.6	0.7	1.2

One factor of interest was whether using the software accompanist in the concert situation would influence a preference for the human experience. Table 5.11 shows that those students performing with a human accompanist showed a strong preference for the experience, while those using the software accompanist had only a very slight preference for a human accompanist. This difference proved to be statistically significant. (t=2.99, df=5, p=.03). (Note: because use of the Web pages in lessons was not considered a factor, analysis of the other groups was not attempted).

Table 5.11

Preference for Human or Computer Accompaniment (1=Perfer Human, 7=Prefer Computer)

Group	n	M	SD
Spectral/Software (A & B)	3	3.7	0.6
None/Human (C & D)	4	2.0	0.8

Another factor under study was whether the students who had spent more time with the spectral analysis felt less prepared for the final concert. Table 5.12 shows that those who participated in the spectral analysis (A & B) reported feeling slightly less prepared for the concert than their comparison group, but the difference was not significant (t=.44, df=5, p= .68).

Table 5.12

Perceived Preparedness for the Final Concert (1=Most Prepared, 7=Least Prepared)

Group	n	M	SD
A & B	3	2.0	0.0
C & D	4	1.8	1.0

Table 5.13 shows the relative effectiveness of each of the technologies and the McClosky Technique when used for personal practice. Of interest is the difference in ranking of the SmartMusic system and its components for those students using the SmartMusic system at the concert.

Table 5.13

Rankings of Components Used Outside of Lesson (1=Most Positive, 7=Least Positive)

Group	n	SmartMusic	Acc.	Tuner	Warm-up	Web	McClosky
A & B	3	1 *	1 *	4	3	5 *	5 *
C & D	4	6	4 *	4 *	3	1 *	1 *
A & C	4	5	3 *	6	3 *	1	2
B & D	3	1 *	1 *	1 *	1 *	1 *	6
Total	7	5	3 *	6	3 *	2	1

Note. A * indicates a tie score.

Those students who used the SmartMusic system (A & B) ranked the SmartMusic system and the accompaniment feature as the best technology used, while those who had used the human accompanist ranked SmartMusic near to last. The students who received spectral analysis (A & B) also ranked the more mundane technologies of the Web lower and had a less positive reaction to the McClosky Technique.

Those students who did not use the Web pages in lessons showed very little deviation on these measures, so the data comparing groups "A & C" and "B & D" is difficult to analyze. The most surprising result was that overall, the students found the McClosky Technique, which had no technological component, and the Web pages, which were the least advanced of the technologies available, to be the most beneficial. Results also varied greatly from the pilot group, which had ranked the SmartMusic system, and particularly the tuning feature, much higher.

Rankings for technologies used within the lessons showed similar trends for the technologies shown above, but also contained data on new technologies (see Table 5.14).

Table 5.14

Rankings of Components Used In Lesson (1=Most Positive, 7=Least Positive)

Group	n	Smart-Music	Acc.	Tuner	Warm	Web	McClosky	Spectral	EGG
A & B	3	2 *	1	6 *	2 *	8	4 *	4 *	6 *
C & D	4†	3	5 *	4	5 *	1	2	N/A	N/A
A & C	4	1 *	1 *	7 *	5 *	4	1 *	5*	7 *
B & D	3†	6	7	2 *	5	N/A	1	2 *	2 *
Total	7†	5 *	3 *	5 *	5 *	2	1	3 *	8

Note. A * indicates a tie score.

N/A. This group did not receive this treatment.

† Since not all participants received all treatments, the n value is variable.

Those students who received spectral analysis and used the SmartMusic system in their performance continued to give the accompaniment feature of SmartMusic high marks when contrasted with their comparison groups. Again, these groups inverted their opinions of the less impressive Web technology, with the spectral analysis group ranking the Web last and the comparison group ranking the Web first. The group that received spectral analysis placed the process in a tie for fourth, with the score for the ranking EGG very low.

The group that received Web pages within their lessons (A & C) ranked their use in the middle of the grouping, preferring the SmartMusic system. Again, the technology of the Web and the non-technology of the McClosky Technique scored much higher than other components of the lesson overall (although these data are slightly suspect because not all participants could rank all of the technologies in this grouping.)

The difference between the technologies used in the lesson compared with those used outside the lesson was not apparent, as had been the case in the pilot test. When the above technologies which were used in both situations were summed, the difference between the means (.035 points) was smaller than the statistical certainty of the measurements, and therefore was considered to be no difference (t=.08, df=5, p=.94). This result differed from the pilot test, in which students rated technologies to be more effective outside of lessons.

The participants were asked to rate the total experience of the voice lessons, and not simply the technologies used (see Table 5.15).

Table 5.15

Rating of Total Experience (1=Most Positive, 7=Least Positive)

Group	n	M	SD
A & B	3	2.0	0.0
C & D	4	1.3	0.5
A & C	4	1.5	0.6
B & D	3	1.7	0.6

All students rated the experience extremely highly, with an average of 1.6 on a seven-point Likert-type scale. Those students who had the experience of performing with a human accompanist (B & D) rated the total experience more positively that those who received spectral analysis and performed with the SmartMusic system. Those students who had the Web pages in their lessons (A & C) reported a slightly more positive total experience than their comparison group did.

Table 5.16 shows the average of all of the measures that pertain to all respondents. The scores for the groups that received spectral analysis and used SmartMusic for the final concert (A & B) are slightly more positive than the scores for the comparison group. The group that received Web pages (A & C) in the lesson had very slightly more positive total score than its comparison group. Overall the total average score of 2.06 on a 7 point scale (with 1.0 being the highest possible score) shows that the respondents reported an overwhelmingly positive experience (F=.54, df=3, p=.67).

Table 5.16.

Total Final Attitude Score (1=Most Positive, 7=Least Positive)

Group	n	M	SD
A & B	3	1.8	0.1
C & D	4	2.3	0.5
A & C	4	2.0	0.5
B & D	3	2.1	0.3

Final questionnaire conclusions. The results from attitude questions asked before the lessons began and repeated after the conclusion of the lessons show longer-term trends in the attitudes of the participants. These measures suggest that reported attitude toward technology is proportional to the amount of technology incorporated into the lessons. Whether use of spectral analysis software or Web pages in lessons is the factor under consideration, the attitudes of the groups with more technology integration either increased more or deteriorated less than their comparison groups. However, those students who took the extra time to participate in spectral analysis reported feeling less prepared to perform at the final concert.

One difference from this trend occurred when students had the opportunity to perform with a human accompanist rather than the software accompanist. Those students with access to a human accompanist had a strong preference for performing with a person, and they rated the total experience of the lessons more positively. Those students who did not use a human accompanist did not feel cheated, however, and did not state that they would have necessarily preferred to perform with a person.

When asked to rank the effectiveness of various technologies, those students who used technologies more often tended to rank the components more positively. Despite the glowing comments the students provided for the SmartMusic accompaniment system, the system did not rank among the leaders in technologies. The students ranked the use of Web pages very highly, a deviation from the students in the pilot test, who had ranked the SmartMusic system very high and the Web pages relatively low. Of special note was the fact that the ranking of the McClosky Technique, which was the subject of many of the Web pages, but is not a technology, per se, ranked higher than any of the technologies did.

Final Conclusions

Having reviewed the results from the journals, observations, and statistical data separately, I will now present a synthesis of all data and make conclusions. I will begin by answering each of the sub-questions that address the influence of the individual technologies on the lesson. I will then summarize general trends in the use of technology within the lessons.

Auto-accompaniment Software

Sub-question 1 asked:

How did students and the teacher adapt to the use of auto-accompaniment software and its peripheral components

a.) in rehearsal and

b.) in performance situations,

and did the transition from auto-accompaniment software to a human accompanist influence c.) student preparedness or

d.) student attitude toward technology?

The SmartMusic system proved to be a valuable asset within the lesson structure, for personal practice, and for performance, with varying degrees of effectiveness. The influence of the software as a whole can best be analyzed by a discussion of the various features of the system.

One often-ignored part of the SmartMusic system is its ability to play warm-up patterns over which a student can vocalize. In my role as a teacher, I found that using the warm-up feature, which allows for ascending or descending chords or notes to be triggered through the tap of a foot pedal, allowed me to monitor student performance directly without a loss of eye contact. However, the system had several drawbacks. Since the software is programmed to play chords, single notes, or arpeggios, I was not able to play other scale patterns, such as a five note descending scale, to illustrate the exercise being used. Since I was unable to play each individual note, I could not control the tempo of the exercise (as I would have with a piano). Often the student either rushed a legato exercise or slowed an exercise designed to produce flexibility. I do not possess perfect pitch, and the software does not provide reinforcement as to what pitch is being performed. Therefore, I would lose track of what portion of the student's range (and its relationship to the student's passaggio and optimum range) in which the student happened to be singing at the time. Even with these limitations, the software was adequate to the task and would be an excellent resource if no piano were available; however, I preferred to use the piano keyboard, which gave me more control.

From the student's point of view, the software allowed warm-up exercises to be performed without the use of a piano keyboard. Since many of the students were beginners and had limited piano proficiency, they appreciated the fact that they could perform the vocalises with their hands free. Those students with piano skills usually preferred the traditional warm-up methods, and I believe with all the students the warm-up feature was not used extensively. In the rankings of the components of the system, the relative score of the warm-up feature was mediocre, although the pilot test group had found the warm-ups very effective.

The tuning feature of the SmartMusic system proved to be a surprisingly effective teaching tool. The tuner's inherent visual-reinforcement mechanism made pitch discrimination easier to demonstrate with students. I could graphically show the student the amount of difference between the sung pitch and the desired pitch, and the students were more receptive to the readings on the screen than they were to my verbal cues. Use of scale patterns to establish the students' aural skills was effective, but a more useful exercise was to have the students sing excerpts from their concert pieces into the microphone and tune individual notes.

Students found the intonation process useful and challenging, but often frustrating. The students appreciated the visual support given by the software, but quickly became frustrated at the lack of precision of the instrumentation and the difficulty of singing perfectly in tune (a difficulty of which many had been previously unaware). Some students preferred having the aural reinforcement of the computer playing the notes while the students sang them. With some students, a noticeable deference was apparent when the reinforcement was disconnected. This led me to believe that these students had learned to match pitch, but had not internalized pitch relationships to a point where they could reproduce scale patterns without outside reinforcement. Despite the comments suggesting that the students found the tuner helpful to their singing, this function was not widely accessed outside of lesson times. The population ranked the tuner feature relatively low, although, again, the pilot group had ranked this feature higher.

The main feature of the SmartMusic system is its ability to play accompaniments with students, reacting to the temporal nuances of performance. As a teacher, I found the SmartMusic system to be extremely useful within the lesson situation. Since my piano proficiency does not allow me to perform accompaniments to many pieces, the software gave me the opportunity to expose students to the accompaniments of the pieces without the expense and effort of hiring a human accompanist. I was also able to apply my total concentration to the student without worrying about playing piano parts. The software also allowed me to transpose pieces into keys that I felt were appropriate to the individual student. The repertoire available for the system contains most of the voice repertoire books that are aimed at the beginner, but advanced repertoire, including the major operatic selections, is not available at the time of this writing.

Negative aspects of the accompaniment from a teacher perspective include the initial cost and setup of the equipment. Although the cost of the software itself is very reasonable, and many teachers already have the computer and sound systems necessary to house the system, the cost of the individual repertoire books could be prohibitive to some. While a piano is quite reliable and requires no set-up, I had to make sure I arrived early at lessons to boot the computer and check the sound system. The software itself proved to be relatively trouble-free. However, at times the hardware setup lost its connection from the computer to the SmartMusic unit. The sound system had the tendency to blow fuses that needed to be replaced before the start of the lessons. (The blown fuses were not the fault of the SmartMusic system). These hardware problems caused a delay in the start of lessons.

Although the software is an excellent accompanist compared to previous software attempts, some challenges to its use still exist. The software itself is easy to use and understand, but for beginners, finding their place in music that is unfamiliar was often troublesome. One major asset to the system is that a note sung into the microphone can trigger the entrance of the software, so the singer need not follow the accompaniment, but lead. Unfortunately, the triggering mechanism is often not reliable if the student does not sing on-pitch or at a high enough volume level, so the software does not always follow the performer. Once students learn to trigger the software, often the tendency to make sure the software has registered an entrance causes the student to adjust the way in which the song is performed. In addition, on some songs the software will not continue unless the student or teacher presses the foot pedal to continue. This feature was distracting to some students. Students also reported that the timbres in the system were unconvincing.

Despite these challenges, most students had positive comments on the use of the software once the song had been learned. The students appreciated the convenience of the software compared to the trouble in scheduling a human accompanist, and the opportunity to work out parts on their own. Most students found the software user-friendly, with the exception of the hardware problems, and its use had become transparent in the lessons and practice sessions by the end of the semester. Some students also appreciated the fact that the accompaniments were the same every time, while others found this lack of variation stagnating.

In the pilot test, I had determined that the SmartMusic system was effective in the lesson setting. An important aspect of this portion of the study was an exploration of whether the software would be viable in a performance setting and whether a change from software to human accompanist would be troublesome. With students who switched from computer as a practice tool to a human accompanist at the concert, the experience with the human accompanist was overwhelmingly positive.

At the rehearsal with the human accompanist, at first students were tentative in their initial performances as shown by atypical mistakes, nervous gestures, and a diminished volume level. However, once students became accustomed to the human accompanist, students noted the addition of the accompanist's ability to react to the needs of the performer, the added musicality of the performance, and the ability of the pianist to add suggestions for the performer. The feeling of a more genuine experience in an ensemble also added to their total experience. Students noted differences in playing with a person who included different tempo choices, volume levels, and variability from performance to performance. Negative aspects of the human experience included lack of practice time, questionable reliability of the accompanists, and the cost of securing accompanist. (Two accompanists had agreed to perform at the concert, practiced with the performer, and then could not attend the concert, so students performed with a new accompanist at the concert.)

Despite the advantages of the human accompanist, the SmartMusic system performed surprisingly well at the concert. The students appreciated the fact that since they performed with the same accompaniment they had used in lessons, the performance contained no surprises. The addition of the harpsichord and cello timbres to those pieces with continuo also added to the performance.

However, use of the software was not transparent in the performance. The amount of time necessary to set up the equipment would not be acceptable in many situations. The necessity of changing accompaniment disks during the concert led to several uncomfortable pauses, and volume levels of the sound system were difficult to adjust during the concert. Several potential problems, such as computer crashes and missed entrances, did not occur, but were a source of worry. However, the performances of the student reflected their awareness that they needed to trigger the software, and this tendency led to some moments that were not musical. The placement of the microphone was also distracting and blocked some of the non-verbal communication inherent in performance of classical music.

When queried about whether they preferred the human experience or the software, the students who had used the human accompanist had a strong preference for the experience. However, since those students who used the software did not feel any preference, I felt that those students did not feel cheated and had undertaken a realistic experience. Those students who used the software for the concert had a more positive attitude toward technology, but their evaluation of the entire experience was significantly less positive. Even those students who preferred the human accompanist at the concert felt that using the software for practice purposes had been viable, although some still had qualms about its use for their own individual practice. The accompaniment feature received high scores in the rankings of technology.

Internet

Sub-questions 2 asked: Did the combination of World Wide Web pages and electronic mail as information sources

a.) facilitate the day-to-day needs of the lesson structure?

b.) Are such pages useful within lessons themselves, or simply as a tool for outside reference?

c.) Were students exposed to on-line materials within the lesson more positively disposed toward technology?

Web pages were successfully integrated into the lessons of the participant group. From the point of view of the teacher, the Web pages provided a way to present material to students in a striking visual manner. At any time via the Internet, students could gain access to materials presented in lessons. The use of the Web pages necessitated extra time in preparing the lessons because of the amount of time necessary to construct and edit the pages. Since I had significant experience building Web pages, the added time was not a hardship for me, but teachers without these skills would need to budget extra time to learn the process. I also had available a Web server which was free and easily accessible.

Use of the Web pages in lessons caused me to adjust my teaching methods. The placement of the computer screen or other projection is important because the students need to be able to see the teacher and the computer at the same time. Since I am accustomed to judging student attention and understanding from eye contact and other non-verbal cues, at first having the student break eye contact to observe the computer screen was distracting. Another distraction was my breaking concentration in order to change Web pages during the lesson, and my occasional tendency to forget to do so. These challenges lessened as I became more comfortable using the computer in lessons over time.

Since all the students would be accessing the same Web pages, I was less able to adjust my teaching to the individual needs of each student. The material presented on these particular pages was rudimentary information on breathing and posture, which differs less from student to student than many other aspects of teaching voice do. Thus, this limitation was not as significant as I would have experienced if I had been teaching advanced students with varying needs.

In lessons, most of the students felt that the Web pages had been a valuable asset because of the addition of visual aids. Those students who had negative comments stated that the pages were difficult to read because of the distance from of the computer screen, and that they had difficulty in reading the text while concentrating on the lessons. Some students also commented that viewing the Web pages had been distracting and did not present the information any better than my verbal lecture did. I observed that the students who had the Web pages for support during the lessons were more likely to be able to repeat the information presented more accurately, but this knowledge gain was short term.

The natural question about use of the Web pages in lessons is: Why go to the extra effort when more traditional media could provide the same function? Indeed, with most of the media presented in this project, the average teacher would probably find traditional visual aids to be more feasible. However, the use of Web pages provides the opportunity to add media not possible in other forms, such as embedded sound files and movies. The use of Web pages in the lesson also provides the student a model of the teacher using the Web pages and legitimates their purpose as a teaching tool. The students have already been exposed to the pages during lessons before they access them for their personal practice, so any questions that might have arisen could be addressed in the lesson itself.

Students agreed generally that the use of the Web pages was more effective outside of lessons than it was in lessons. Students appreciated the fact that they could access the information presented in class at other times and locations without having to worry about losing printed materials. None of the students reported that accessing the Web had been difficult, with the exception of one student who was bed-ridden and could not use her computer. Although the students appreciated having the Web pages available, they did not access the pages very often. The pages did not add immediate information to the lesson experience, but they felt the information would be a useful reference tool in the future.

In deciding the format of the Web pages, I presented the information in two ways. One set of Web pages contained detailed information, while another was in a bullet-point format and contained little additional information. The bullet-point format was more useful to students within their lessons, as they had complained that reading large amounts of text had been difficult and distracting. However, outside of lessons the students preferred using the Web pages that contained more information.

When asked whether the Web pages were useful in lessons (or should have been added to lessons for the comparison group), the reactions from the respondents were mixed. Some students who had the pages in their lessons felt the pages were effective, while others felt that the added visual support did not negate the distractions noted above. Similarly, some of those students who did not have access to the Web pages in lessons felt their lesson experience would have been improved with the Web pages. Others felt that the lecture they had received had been adequate.

When queried as to whether they preferred to communicate with me through e-mail or Web forms, again the reaction was mixed. The students found the Web forms easier to complete, but did not like the fact that they had to make a special effort to access the Web pages when e-mail was ubiquitous and convenient. The students also appreciated their e-mail journals' allowance for open-ended responses to questions. The use of Web forms provided excellent quantitative data for analysis, but also necessitated specialized software and added setup time, and the data collection software was unavailable at times. Students were more likely to answer their e-mail journal questions in a timely manner. With some students I was forced to bring printed copies of the Web forms to their lessons or call them on the telephone in order to ensure that the forms were completed within the time limits of the experiment.

All of the students, with varying degrees of success, were able to incorporate the techniques taught on the Web pages. Their progress as singers over the long term was not measurably affected by the use of the Web pages in the lessons. However, quantitative data suggested that the use of the Web pages had a positive effect on both the students' attitudes toward technologies used and their attitude toward lessons. Those who used Web pages also reacted to the McClosky Technique, the subject of the Web pages, in a more positive manner. When asked to rank the various technologies used throughout the lessons, the students ranked the use of Web pages surprisingly high as compared to the ranking of the more sophisticated technologies.

So, although the student reaction to the use of Web pages within lessons was mixed, I noted as a teacher the positive phenomena related to the use of Web pages. The phenomena would cause me to use such Web pages in my future teaching and to recommend their use to other voice professionals.

Spectral Analysis

Sub-questions 3 asked: Did spectral analysis and the EGG support voice lessons?

a.) Were measurements of acoustical phenomena useful pedagogically?

b.) Did the process influence student attitudes?

c.) Was the time spent on such measurements worthwhile as compared to instruction that is more traditional?

The use of the spectral analysis software was instrumental in imparting information about the physics of sound and information about the acoustic makeup of the students' voices. I was able to demonstrate phenomena such as formants, overtones, and vocal fold closure with visual examples that did not come from static pages within a textbook, but from actual readings from the students' own voices. The use of the software, particularly its ability to record student voices, also gave me an objective way of measuring student improvement throughout the semester. Although the information the students received was useful, as a voice teacher I did not see this information translate into actual improvement in voice technique.

From the students' point of view, spectral analysis proved to be an excellent motivational tool. The students were struck by the novelty of the situation and appreciated the appearance of the inclusion of a scientific method in their study of a process which often seemed ethereal and ambiguous. Initial student reaction was most positive. The students cited both the use of visual reinforcement to judge their progress and the fact that the screen shots were put on line to show to friends and family as positive aspects of the experiences. Students initially felt that the experience would help them pedagogically, but as the semester progressed, the students were more likely to cite increased knowledge as its main benefit rather than improvement in singing ability. Some students thought that the second session with the software added little to their experience, while others appreciated the chance to see the progress they had made during the semester.

The time-based spectrograph was the most useful tool to explain the knowledge-based information such as the use of formants. Unfortunately, the graphical representations of the sound lacked enough precision to make meaningful judgments about whether improvements had taken place over the semester. However, the audio recordings from the software played back through the computer were the best method to judge and demonstrate student improvement.

Because the spectral snapshots had more precision than the time-based spectrogram, through these graphics I was able to judge improvement for many students, particularly those in the pilot test. The snapshots were also effective in demonstrating to students problem vowels that needed adjustment. I was also able to elicit improvements in these readings by having students experiment with techniques we had used in lessons, such as improved breath support or manipulation of the McClosky Technique. This visual display of their improvement helped lend credibility to the information I presented.

The EGG was the least successful of all the technologies used in the experiment. Either due to limitations with the hardware or my relative lack of experience with the process, I was unable to take meaningful readings from many of my students, particularly the females. Even when I did get data, the information was difficult to analyze and I was unable to give students suggestions on how to make their readings improve. With some students, the second reading showed improvement from the first, so was able to show the students they had improved, but I was unable to link the readings with any pedagogical techniques or suggestions.

When asked to rank the experience compared to the other technologies, the spectral analysis received lukewarm statistical reaction, ranking in the middle of the technologies. The EGG ranked last among all of the technologies for both the experimental group and the pilot test group.

As an experimenter, I found that the spectral analysis process lacked both reliability and validity. Reliability was questionable because I could record vastly different readings depending on the exact moment I took the spectral readings. Validity was questionable because the graphical representations of the sounds did not always reflect the improvement I heard in the recordings of the students' voices. One might question whether the experience had been genuine. However, statistical analysis of the results from the present study showed a superior reaction to the results from a previous study produced by the inventors of the equipment (Miller and Doing, 1996).

The data from the spectral analysis group were compared with data from a group that did not receive the procedure, but instead spent the extra time preparing for the concert with a human accompanist. I found that the lessons with the spectral analysis group to be rushed at times, and I would have preferred to have spent more time on technique and adding musicality to the students' pieces. The only students who expressed reservations about preparedness for the final concert also came from the group that received the spectral analysis.

The process did prove to be an excellent motivational factor, and the students greatly enjoyed the experience. Those students who received the spectral analysis had a better attitude toward technology than their comparison group did. However, since the students did not have the chance to perform with an accompanist—a factor which improved the total experience of the comparison group—the spectral analysis group missed an important part of the musical experience. Experience with the spectral analysis software was an excellent method of imparting knowledge, but vocal pedagogy courses might present this knowledge better than voice lessons.

General Conclusions

Technology applied to voice lessons had a positive influence on student motivation, knowledge gain, and facilitation of communication within the voice lessons. In most cases, the student attitude toward technology had a positive correlation with the amount of technology included in the lessons. The only exception to this tendency was in the performance setting, when the presence of the human accompanist proved to have a positive influence on the total experience of the participants. Inclusion of technologies that were not as advanced, such as Web pages and tuners, had a more positive effect on students than more cutting-edge technologies. The technologies were also very effective outside of lessons when the students were able to manipulate and experiment with the equipment on their own.

Negative experiences with the technology included the increased effort and time needed to test the equipment before each lesson, the added training and expertise necessary to use the equipment and analyze results from the measurements, and the added cost of the technology. However, in this series of lessons, the challenges in using the technology were far outweighed by the benefits to both teacher and student. From my experiences, I conclude that any bias against the inclusion of technology into voice lessons is unfounded.

Strategies for Incorporating Technology

From my experience with the technologies used in the lessons, I have devised several strategies for incorporation of technology into the lesson process. Of course, these suggestions are limited in that since they have a global scope, individual differences in student learning are not always apparent in the suggestions. One consistent result from the study was that individuals reacted differently to different technologies, so a teacher would need to be aware of these individual tendencies and adjust teaching methods to incorporate differing learning styles.

I begin with the pros and cons of each technology and then provide strategies that I found helpful.

Web

Positive aspect of use of the Web included:

- widespread appeal for this developing technology;
- ease in development of materials;
- ease of use for students;
- widespread access;
- visual support within lessons;
- ability of students to review lessons; and
- ability to promote the program for recruitment purposes.

Negative aspects of the use of Web pages included:

- the amount of time necessary to create and maintain the pages;
- the inability of the pages to adjust to the needs of the individual student;
- the impossibility of providing every possible vocalise or exercise on the Web;
- the distraction from the lesson when used as a visual support;

- inability of students to view the screen during lessons;
- students' unwillingness to access pages in their free time;
- necessity of finding a computer to serve out the pages; and
- access problems for students without computers.

Strategies for incorporating Web pages into voice lessons include:

- Develop Web pages slowly over time and add to them gradually;
- Keep Web pages simple—avoid advanced features which distract from the presentation, such as moving graphics and frames;
- Use the many guides on the Internet for creation of pages;
- Include an abundance of graphics on Web pages.
- Encourage students to access the pages by giving assignments that require the use of the Web;
- Become active in the mailing list Vocalist (www.vocalist.org) and newsgroups pertaining to singing;
- With Web pages used for visual support in lessons, keep the material simple, with large text;
- Include information such as your views on correct breath techniques taught to every student on the Web so that students can learn that material without spending precious lesson time;
- Browse the Web to get ideas about what is possible.

Spectral Analysis

Positive aspects of the use of spectral analysis include:

- the ability of the novel situation to interest and motivate students;
- the ability to collect objective data on student progress;

- the ability to share data and collaborate with colleagues, including voice scientists and medical professionals;
- the ability to publish research-based findings;
- increased opportunities for professional development; and
- increased knowledge of the mechanics and physics of the voice for teacher and student.

Negative aspect of the use of spectral analysis include:

- the amount of specialized training necessary to use the equipment and understand results;
- the added cost of the hardware and software necessary;
- the lack of proven strategies for incorporating the process into lessons;
- the amount of lesson time necessary to accomplish the process;
- the amount of set-up time necessary;
- the difficulty in judging whether the process is helping students' singing; and
- the questionable reliability and validity of results.

Strategies for incorporation of spectral analysis include:

- Read as much research-based material as possible in order to understand the process;
- Seek out advice from voice scientists and medical professionals who use the equipment regularly;
- Seek out other teachers who have had success with the processes;
- Experiment with the technologies on your own voice;

- Incorporate the process into vocal pedagogy classes and the lessons of advanced students;
- Encourage use of equipment across studios or schools to share experiences and costs; and
- Do not invest funds in expensive equipment that you do not understand and that has unproved success.

Auto-accompaniment Software

Positive aspects of using auto-accompaniment software include:

- convenience of having an accompanist available at any time;
- the ability to supply accompaniments for pieces beyond the piano proficiency of the teacher;
- the ability of the teacher to keep full attention on the student rather than playing the piano;
- addition of timbres such as harpsichord to the accompaniments;
- the ability to transpose songs at will;
- the ability of students to practice with accompaniment;
- positive reaction of students to the software;
- relative ease of use of modern software;
- some limited potential for performance opportunities;
- addition of peripherals to software such as the tuner and warm-up functions of SmartMusic; and
- the ability to lower the volume for students with small voices.

Negative aspects of use of auto-accompaniment software include:

- unconvincing timbres in the sound samples;

- relatively limited musicality due to the fact that the software does not react to the singer as well as a human accompanist;
- the tendency of the software to miss entrances;
- low precision of the pitch-to-data converters;
- added cost of repertoire disks;
- increased set-up time;
- preference of students for human accompanists for performance;
- inability to sequence songs not available; and
- limited repertoire.

Strategies for incorporation of the SmartMusic system into lessons include:

- Make the software available to students outside of lessons for personal practice;
- Allow the student to control the software at times during lessons;
- Use the tuner function of the system to test student intonation on vocalises and excerpts from songs;
- Demonstrate the warm-up feature for vocalises and exercises;
- Transpose songs often to find the best key for the individual;
- Practice with the accompaniments yourself so you become aware of quirks within individual songs;
- Learn to adjust tempos and program changes into songs rather than simply accepting the version of the song programmed originally;
- Be aware of places within songs which require the use of the foot pedal to continue;

- Watch for missed entrances by the software and be ready to cue these manually;
- Allow plenty of time for set-up and testing of equipment before a lesson or performance;
- Be familiar with an amplified sound system attached to the computer.

General Strategies

General pros and cons for use of technology mirror those for the individual components listed above. General strategies for the incorporation of technology include:

- Evaluate your own teaching process and decide how incorporation of the technology will improve your teaching, rather than trying to change your style to fit the technology;
- Become an expert with the technologies yourself before you bring them into lessons with students;
- Increase the amount of technology used in your lessons slowly as you become comfortable;
- Encourage student use of technology by answering student e-mail, encouraging students to sequence their own accompaniments, and requiring musical assignments to be completed with a music notation program;
- Tailor the use of technology to the needs of the individual student by seeking out student feedback about the technology;
- Encourage or require students to use CAI software to promote aural skills or other musical knowledge;
- Maintain a presence on the World Wide Web;
- Share experiences with colleagues;

- Apply for technology money available within institutions—occasionally grants are awarded to sources because they are in an area, such as voice training, which is novel to those providing funds;
- Most of all, use technology as much as possible in your daily life, including e-mail for communication, the Web for class syllabi and other materials, electronic databases for student records, and desktop publishing to produce memos and flyers.

Suggestions for Future Research

As technology becomes more ingrained in the lives of the populace, use of new devices to teach voice will no doubt appear. Without research-based strategies for incorporation of new technologies into education, the ability to learn from the experiences of others involved in the process would be limited.

Research in the area would be more beneficial to the practitioner if more practicing voice teachers undertook the process of sharing their experiences with their peers. Since much of the research done with technology comes from either the voice-science community or the medical community, I suggest more research from practitioners or collaborations among groups would be helpful. This research could take on the action research paradigm (Gall, Borg, & Gall, 1996), which is more easily undertaken by practitioners. Because the use of technology to teach voice is still in its early stages, I suggest more broad-based studies of a qualitative nature to help define the problems and strategies of the discipline. Later experimental studies can be conducted to test specific applications and strategies gleaned from the qualitative investigations.

Auto-accompaniment software will no doubt become increasingly prevalent in the near future. From my experience with the software, I would suggest some studies that pertain to its use in the lesson, and other studies that pertain to its use in performance settings. Within the lesson, a researcher could investigate whether a group of students using auto-accompaniment software progresses better than another group taught by the same instructors using traditional accompaniment. An interesting study for the use of the software in performance situation would be an investigation of whether the audience or adjudicators would adjust their ratings of a performance based on the accompaniments used. Once these trends are established, a cost-to-benefit curve based on economic theories could help to determine whether the use of the software is cost-effective. Since the use of auto-accompaniment software proved to be useful in practice situations, feasibility studies of how to implement SmartMusic into a practice situation would also be beneficial.

A great deal of information on the use of spectral analysis exists in the literature. However, practitioners sometimes find the information unapproachable and of limited use in their daily teaching. Given that the use of technology to measure and test the voice has great potential for instruction, we need to promote research that uses the techniques within the lessons of actual practicing teachers in order to develop strategies for incorporating the hardware into lessons. Once clear strategies have been established, a researcher could test the effectiveness of the techniques.

The Internet is fast becoming an integral part of our daily lives. Since the advent of the Internet has been so sudden, educational research in music, and specifically voice, has not been able to provide strategies for using the potential of the new communication system. My research has shown that the Web is an excellent tool for providing information for students, and studies could parallel other educational research on the best way to disseminate information to students. Sophisticated Web pages are being developed in order to facilitate distance learning, and although the thought of people learning to sing over the Web is anathema to some, its potential should be explored. One possible study could evaluate the use of conferencing software to teach students in remote locations.

I investigated the use of Web pages as a visual aid during the lesson itself. Although many teachers use visual aids in lessons, the use of Web pages has the advantage of doubling as an outside resource for students. More research could be performed on whether the use of multimedia such as the Web is feasible in the lesson format, and which multimedia best improves the learning of individual students.

Experimental research into the use of technology in actual voice lessons is difficult because the average teacher does not teach enough students in a given semester, or over a long enough period, to make meaningful statistical conclusions. Therefore, in order to achieve statistically significant results over a meaningful period, voice teachers should band together in their research to test technologies. Then the use of technology could be evaluated for differing types of teachers and across learning styles. An institution could more meaningfully produce a longitudinal study that could test the effectiveness of a particular technology or teaching technique than an individual instructor could.

Most importantly, the research based on the experiences of teachers should be used in the development of new technologies. Unfortunately, experts in computer programming often do not have the time or inclination to become proficient in a discipline as removed from their craft as vocal techniques. An alliance among teachers, researchers, and scientists could lead to technology that best fits the needs of music education.

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APPENDIX A

CONSENT FORMS AND LETTERS OF PERMISSION

Consent Form for Voice Lessons

1) This study involves research.
The purpose of this study is to observe and measure the effect of technology during an eight-week series of voice lessons.

Research Question

How will the presence of technology in the applied voice lesson influence the attitudes and learning of the population group?

Sub-questions

1. How will performers adapt to the use of auto-accompaniment software in rehearsal situations?
2. How will the use of auto-accompaniment software affect the attitudes of participants at a concert of vocal music?
3. Will the combination of World Wide Web pages and electronic mail as primary information sources be effective in facilitating the day-to-day needs of the lesson structure?
4. How will the measurements of acoustic phenomena be of use to the teacher and student?
5. To what extent will the presence and use of technology affect the participant's attitudes toward the process of learning to sing?
6. To what extent will the presence and use of technology affect the participant's attitudes toward singing?

2) In addition to the 45 minutes a week in the lesson, I am estimating a maximum of 30 minutes a week will be spent on the other activities, probably less most weeks. These activities include e-mail journals and filling out Web forms to help me gather information. Also, at the end of the semester you will take part in an informal, low-pressure concert to show off what you have learned. Performance is optional, but highly recommended.
3) Participation is voluntary, and refusal to participate will involve no penalty. The participant has the freedom to withdraw at any time. Participation or lack thereof, will not affect class grade in any way.
4) All records will remain anonymous in the research reports. The information from the student logs may be included in the final report, but every effort will be made to remove information that might inadvertently identify a particular participant.
5) Part of the research will include the use of an electroglottograph, a device that measures the opening and closing of the vocal folds by placing two electrodes on the side of the neck. The procedure is not dangerous or painful in any way.
6) You may have a copy of this consent form if you wish.
7) The University of Illinois is conducting this research.
5) Contact Richard Repp <rrepp@uiuc.edu>(367-4253) for more information on the study. The Responsible Faculty Investigator is Sam Reese (244-5108).

I have read and understood the above statements. I am at least 18 years of age.

Signed ______________________________________ Date ___________________

Letter of Permission from the McClosky Institute of Voice

THE McCLOSKY
INSTITUTE OF VOICE
140 Boylston Street. Boston, Mass. 02116 (617)350-8980

New Address: 162 Boylston Street, Suite 45

Richard Repp
504 West Elm #7
Urbana IL 61801

June 7, 1997

Dear Mr. Repp:

The McClosky Institute of Voice hereby grants you permission to use elements of the McClosky technique in your project: "An Internet-based Presentation of the McClosky Technique for vocal relaxation: How will the attitudes of Preservice Music Teachers be Affected?"

You may use the techniques learned from hands-on instruction with McClosky teachers, the McClosky seminars you have attended, and material from the book Your Voice at its Best by David Blair McClosky (1978) The Boston Music Company, as a basis of your internet presentation. The members of the Institute will be most interested in the results of your study.

Very truly yours,

Janet W. Alcorn

Janet W. Alcorn, CMVT
President, McClosky Institute of Voice

Institutional Review Board Certification

Approved for use through 7/31/94 OMB No. 9999-0020

Protection of Human Subjects
Assurance Identification / Certification / Declaration
(Common Federal Rule)

POLICY: Research activities involving human subjects may not be conducted or supported by the Departments and Agencies adopting the Common Rule (56FR28003, June 18, 1991) unless the activities are exempt from or approved in accordance with the common rule. See section 101(b) the common rule for exemptions. Institutions submitting applications or proposals for support must submit certification of appropriate Institutional Review Board (IRB) review and approval to the Department or Agency in accordance with the common rule.

Institutions with an assurance of compliance that covers the research to be conducted on file with the Department, Agency, or the Department of Health and Human Services (HHS) should submit certification of IRB review and approval with each application or proposal unless otherwise advised by the Department or Agency. Institutions which do not have such an assurance must submit an assurance and certification of IRB review and approval within 30 days of a written request from the Department or Agency.

1. Request Type
☒ ORIGINAL
☐ FOLLOWUP
☐ EXEMPTION

2. Type of Mechanism
☐ GRANT ☐ CONTRACT ☐ FELLOWSHIP
☐ COOPERATIVE AGREEMENT
☒ OTHER: **Certification of IRB Approval**

3. Application or Proposal **Identification No.** (if known)

4. **Title** of Application or Activity

The Feasibility of Technology Saturation for Intermediate Students of Applied Voice

5. Name of **Principal Investigator,** Program Director, Fellow, or Other

Professor Sam Reese
Richard Repp

6. Assurance Status of this Project *(Respond to one of the following)*

☒ This Assurance, on file with the Department of Health and Human Services, covers this activity:
Assurance identification no. **M-1004 - IRB identification no. 01**
☐ This Assurance, on file with (agency/dept.) ____________ covers this activity
Assurance identification no. ________ IRB identification no. ______ (if applicable)
☐ No assurance has been filed for this project. This institution declares that it will provide an Assurance and Certification of IRB review and approval upon request.
☐ Exemption Status: Human subjects are involved, but this activity qualifies for exemption under Section 101(b), paragraph ________

7. Certification of IRB Review *(Respond to one of the following IF you have an Assurance on file)*

☒ This activity has been reviewed and approved by the IRB in accordance with the common rule and any other governing regulations or subparts on *(date)***November 5, 1998** by: ☒ **Full IRB Review or** ☐ **Expedited Review.**

☐ This activity contains multiple projects, some of which have not been reviewed. The IRB has granted approval on condition that all projects covered by the common rule will be reviewed and approved before they are initiated and that appropriate further certification will be submitted.

8. Comments:

9. The official signing below certifies that the information provided above is correct and that, as required, future reviews will be performed and certification will be provided.

10. Name and Address of Institution
University of Illinois at Urbana-Champaign
404 Swanlund Admin. Bldg.
601 E. John St.
Champaign, Illinois 61820

11. Phone No. **(217) 333-2670** 12. Fax No. **(217) 244-3716**

13. Name of Official
Janet H. Glaser, Ph.D.

14. Title
Executive Secretary, IRB

15. Signature
Janet H. Glaser

16. Date
March 25, 1999

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APPENDIX B

RESULTS OF PILOT TEST

The feasibility of technology saturation for intermediate students of applied voice

Richard Steven Repp

Because the voice is part of the human body, vocalists feel a personal identification with their instrument as a part of themselves, rather than an outside entity that is manipulated to produce music. A bassoon or a piano can be seen as technology, but the larynx of the singer is part of the human anatomy. The nature of the voice lesson is an intimate relationship between the teacher and the student and the tradition of singing has been passed down by word of mouth from teacher to student.

The purpose of this study was to observe and measure the impact of technology during an eight-week series of voice lessons. Six students received eight voice lessons of 45 minutes each. The technology was an integral part of the lesson format, but was not the primary method of instruction, rather the technology functioned as a supplement to hands-on teaching. I suggest which technologies are feasible, and provide research-based strategies for incorporating these technologies.

Pilot Test Research Question

To what extent did the presence and use technology influence the teacher's ability to provide a viable voice lesson and the participant's attitudes toward the learning process? All research questions were addressed by the analysis of weekly logs, observations, and survey questions in the form of Likert-type responses.

Pilot Test Sub-questions

1. How did students and teacher adapt to the use of auto-accompaniment software (SmartMusic) in rehearsal and performance situations?
2. Did the combination of World Wide Web pages and electronic mail as primary information sources have an influence upon facilitating the day-to-day needs of the lesson structure?

3. How were the measurements of acoustic phenomena of use to the teacher and student, and was the time spent on such measurements worthwhile as compared to traditional instruction?

Pilot Test Methodology

The experiment took place in two studios at the University. One studio was equipped with an electronic keyboard and a computer that had the SmartMusic auto-accompaniment system installed. The other studio had a computer with sound analysis software installed and an Electroglottograph (EGG) (a device to measure the opening and closing of the glottal folds) available.

A series of lessons were produced. Each of these lessons was supplemented with at least one of the technologies highlighted in this study. Students were able to access the Web documents through the Internet at any time. The students were also able to access the SmartMusic system outside of lesson time. Spectral analysis was not available outside of lessons.

Data were collected in three ways. First, participants completed a weekly questionnaire of their reactions to the process. This questionnaire was returned by e-mail. Second, the participants completed four on-line Web forms that contained questions relating to the effectiveness of the various technologies. Most questions were Likert-type responses and provided statistical data. Third, I kept logs of my reactions to the process and my observations of the students.

Several sources of bias need to be considered. Members of the participant group all received instruction from the same teacher, who is the experimenter in this case. Care must be taken to observe whether changes in measurable phenomena are due to the presence of technology, or by the effect of the instructor. Another source of bias considered was the novelty effect—the tendency for research subjects to react favorably to a treatment because the treatment is novel—and Hawthorne effect, the tendency of subjects to react favorably because they know they are being observed.

Pilot Test Results

Results of the study are reported in this paper in the following order. First, reactions of the participants and teachers to the individual technologies and their sub-components are reported. The three technologies highlighted for study are the Internet, SmartMusic accompaniment software, and spectral analysis software. Next, the effectiveness of each of the technologies is compared relative to each other. Finally, conclusions of a more general nature, such as the participants' attitudes toward technology in general, are presented.

The Internet is defined for the purposes of this project as a combination of the World Wide Web and electronic mail. Web pages designed for informational purposes were used in lessons to illustrate points and used outside lessons as a reminder of the lesson topic. Examples of what was highlighted in lessons include proper posture, breathing techniques, and the McClosky Technique for Vocal Relaxation (see Repp, 1997). The Web and e-mail were also used as the primary source of communications, including data collection.

The informational function of the Internet proved to have mixed results. I found Web pages awkward to use in lessons because of the loss of eye contact necessary for me to change pages during the lesson. Use of the pages also split student attention, as the student was required to pay attention to the computer screen and the teacher. The ability of the students to access the pages outside of lesson time was well received, but the pages were not accessed extensively.

The use of the Web as a communication tool was effective. Problems included some students not checking their e-mail regularly. Use of Web forms saved time in transferring data to database, but students did not always fill out forms before lesson started. Computer glitches also forced some student to complete the forms more than once.

Spectral analysis took place two times during semester. This equipment was not available outside of lesson time. Use and interpretation of the spectral data required a relatively high degree of training and specialized equipment. The spectrographic analysis was divided into three parts. The first reading, taken through a microphone using a freeware software package called Spectrogram, produced an image with frequency on the vertical axis, time on the horizontal axis, and amplitude represented by color changes on the waveform (see Figure 1). This time-based spectrogram was used to demonstrate the spectral makeup of voice by showing changes over time, such as formant differences, as the singer the changed vowels a, e, i, o, u.

The second spectral reading, using VoceVista hardware, uses a microphone to take a "snapshot" of the voice. The light blue line shows a theoretical [a] (as in father) vowel, while the yellow line shows actual sung vowel (Miller, Schutte, & Doing, 1996). The spectral readings were effective in demonstrating to the student that she needed to increase the spectral energy in the region around 3000 Hz known as the "singer's formant."

The third part of the spectral analysis process was taken through the electroglottograph (EGG) included with the VoceVista hardware. Two electrodes were placed on either side of the student's larynx. The EGG measured the opening and closing of the vocal folds analogous to the changes in a slight current passing through the electrodes. Despite the long research tradition associated with the EGG, the process was difficult to administer and led to questionable results.

One of the most exciting uses of technology in the applied lesson format that has become feasible in the recent past is the use of software as an accompanist. Since a piano accompaniment is standard in most vocal performances, teachers have been forced either to play the accompaniment for the student, a process which has the potential for distracting the teacher, or have the student hire an accompanist if one is not supplied, which can lead to financial difficulty.

I used three parts of the SmartMusic software package in lessons: the accompaniment feature, the tuner, and warm-up feature. The accompaniment feature was well received by students. The accompaniments work well in lessons and alleviate the need for a lesson accompanist. Unlike playing with a tape accompaniment, the intelligent software is able to react to the nuances of the singer to some extent. The ability of the software to change keys on command is particularly effective. Students were able to learn the system and use it on their own without significant difficulty. Some problems occurred with the accompaniment in the performance situation. The software did not always register the student entrances, so we had to start one performance again. The necessity to switch the key-disks of the software also led to delays within the performance.

I used the tuner function of the SmartMusic system with great effectiveness. The software features a tuner which displays the name of the pitch the student is singing along with a pitch wheel which indicates to the student whether the pitch is sharp or flat. The tuner was surprisingly well received by the student. It turned out to be one of the most effective technologies available both in and out of lessons.

The third part of the SmartMusic package used in the research was the warm-up feature. The software plays individual pitches or chords which ascend or descend with a tap of the foot pedal. The software allowed the students without piano skills to practice warm-ups and exercises without having to finger the chords on the piano. As the teacher, however, I preferred to use the piano keyboard so I could more easily monitor the pitch on which the singer reached.

At the end of the semester, I asked each student to fill out an on-line questionnaire that ranked the relative effectiveness of each of the technologies used in the process, both in the lesson and outside the lesson, where appropriate. Results below represent the average response on a seven point Likert-type scale with 1 being the most effective and 7 the least effective (See Table 1).

The measures that related to technologies used both inside and outside of lessons were summed to determine whether students preferred the technologies used in the lesson or on their own. A paired samples $\underline{t}$-test showed that students preferred using the technologies outside of class time by an average of .25 points on a seven-point scale ($\underline{t}$=2.67, df=5, p=.045).

Table 1

Mean Attitude toward Components of Technology

In Lesson	M	SD	Outside	M	SD
Tuning	1.67	0.82	SmartMusic (in general)	1.33	0.52
Accompaniment.	1.67	0.82	Accompaniment.	1.50	0.84
SmartMusic (in general)	2.00	0.63	Tuning	1.67	0.82
Warm-up	2.33	0.52	Warm-up	2.00	1.10
Spectrogram	2.33	1.21	Web	2.17	0.98
Web	2.50	1.05			
EGG	3.00	1.55			

Students were also asked about their attitude toward educational technology and the use of educational technology for the use of teaching voice at the beginning and end of the semester. A paired samples t-test was performed on the data to determine if reports of attitude had changed over the semester. Attitude toward educational technology worsened by .5 on a 7-point scale (t=3.16, df=5, p=.025). Attitude toward the use of educational technology used for purposes of teaching voice was not statistically significant (t=1.46, df=5, p=.21).

Pilot Test Conclusions

The fact that the participants' attitude toward technology worsened over time was disappointing. I believe that the deterioration could have been due to several unrelated sources of bias. The attitudes toward educational technology were unrealistically high at the beginning of the semester (2.0 on a seven-point scale), possibly due to the novelty effect. In addition, because the final survey took place at the end of the semester, attitudes in general were not high in late November in Central Illinois. Unfortunately, no control group data was taken for comparisons.

That fact that students found using technologies outside the lesson situation was more effective than inside is worthy of note. Teachers should make access to technology available to students outside of class as much as is possible.

Use of the SmartMusic software was found the most feasible of all the technologies surveyed. The software is relatively inexpensive, easy to use, and effective from the viewpoint of the student and the teacher. Teachers using the software should make sure to use the portions of the software such as the tuner and warm-up feature, which were found to be particularly effective.

Use of the Internet was found feasible with some limitations. Use of Web pages in the lesson was cumbersome from the teacher’s point of view and relatively ineffective form the student’s point of view. Use of the Web outside of lessons was better received and provided a way to pass on data to the student outside of lesson time. Use of e-mail and Web forms for data collection and communication were effective, but the uses of these technologies are commonplace at the University where the study took place. Teachers at other institutions should judge their students’ use of e-mail before relying on it for the sole method of communication. Because the Web and e-mail are so ingrained in the lives of these particular students, the of novelty effect, which was a factor in this experiment, did not affect this portion of the experiment as much as the newer technologies. Thus, the Web may not have come across as favorable due to bias.

Use of spectral analysis software was found unfeasible. From the teacher's point of view, the analysis calls for hardware not readily available and expertise beyond what can reasonably be expected of the average voice teacher. Although the students found the initial experience with the spectrometer to be extremely positive (probably due to novelty effect), the attitude toward the technology decreased as the novelty wore off. By the end of the semester, the technology did not rank among the leaders in responses. From the experimenter's point of view, the technology lacked reliability, because I could record a great variety of responses from a single individual. It also lacked validity, because the readings of the analysis did not always reflect the changes I noted from recordings of the student.

General conclusions indicate that the integration of technology into the voice lesson was feasible and extremely effective. Even the relatively ineffective technologies received high responses from the participants. From a teacher’s point of view, this group was the best group I have ever taught, even better than students who pay for lessons were. As an example of their hard work, not one student missed a single lesson all semester.

Future Research

This study was the first portion of a two-semester project. During the spring of 1999, I will repeat the process, with the exception that participants will receive differing levels of technology to act as internal control groups. I will also work to limit the sources of bias that occurred in Phase I.

APPENDIX C

DATA COLLECTION

This Appendix is divided into two major sections. The first section contains printouts from the quantitative surveys given throughout the semester. The second section is a report of the questions used to guide the individual e-mail journals.

On-line Surveys

Five surveys are contained here. The first two are a pre- and postsurvey format designed in Repp (1997) and administered before the beginning of lessons and after the first week of lessons, respectively. The third survey was developed by Miller and Doing (1996). The final two surveys are a pre- and postsurvey format administered in the seventh week of the semester and after the final concert, respectively.

Initial Survey

The following survey was administered before any instruction took place. The questions were originally designed for a previous study (Repp, 1997), and kept intact so that comparisons could be made with the original data. The questionnaires were designed in a pre-and postsurvey format and the postsurvey follows immediately.

(See the following page.)

Initial survey

Before you continue, please answer a few questions for my data collection purposes and then press the "Submit" Button

Name:

Email address:

a member of Mr. Norris' 264 class
an interested observer

Sex: Male Female

Age (optional):

How much vocal experience do you have?

Voice performance major or Choral education emphasis	Have sung in many choirs and done solo work	Have sung in some choirs	A few experiences (Church choirs, etc.)	One or two experiences	I refuse to sing at all costs	I am mute
1	2	3	4	5	6	7

How much experience with technology do you have?

extremely knowledgeable (Ex. Music technology emphasis or	very knowledgeable (Ex. Took Music 358)	knowledgeable (Took Music 210)	fairly knowledgeable	limited (Just to write papers)	Occasional video games	This is my first time
1	2	3	4	5	6	7

How much teaching experience do you have?

Several years in the public schools or privately	Some public school or private teaching	I have done my student teaching	Tutored or taught, but not a full time job	Experiences in classes	Almost none	I could not teach my cat to drink milk
1	2	3	4	5	6	7

How do you feel about educational technology?						
The greatest breakthrough in teaching ever	Has a great potential	Can improve education marginally	Will not change education	Has a slight negative effect on education	A waste of time and resources	Very detrimental to the teaching process
1	2	3	4	5	6	7

Do you think aspects of voice production can be taught through technology?						
As good or better than a private teacher	Has a great potential	Can improve education marginally	Will not change voice education	Has a slight negative effect on voice education	A waste of time and resources	Very detrimental to the teaching process
1	2	3	4	5	6	7

If you would like to make any further comments please do so in the box below. If you checked the "interested observer" box, please tell me how you located these pages

Submit Start over

Second Week Survey

This Survey (see the following page) was administered in the second week of the semester. It is the second part of a pre- and postsurvey designed to judge the effectiveness of Web pages in the lesson.

Name:

Email address:

Check these boxes if you have

- Completed the on-line presentation
- Worked with the McClosky technique

If you did not check one or both of the boxes please explain why here:

What is your reaction towards the McClosky technique?						
The greatest breakthrough of my singing career	Has a great potential	Can improve phonation	Will not change my phonation	Has a slight negative effect on phonation	A waste of time and resources	Very detrimental to phonation
1	2	3	4	5	6	7

Comments about the McClosky technique.

How often did you use the technique since you viewed the pages?						
I made it a priority and worked more than once a day	Every day	A little almost every day	Some: 3-5 times	A little: 2 or 3 times	Once	Not once
1	2	3	4	5	6	7

What is your reaction towards the presentation of these pages?

I was very impressed	Has a good potential	I liked them	I could take them or leave them	Has a slight negative effect .	ineffective	Very confusing and ineffedtive
1	2	3	4	5	6	7

Comments about the presentation.

Do you think the McClosky technique was effectively be taught in this manner?

Will eventually replace teachers	Has a great potential	Can improve education	Will not change education	Has a slight negative effect on education	A waste of time and resources	Very detrimental to the teaching process
1	2	3	4	5	6	7

Do you think aspects of voice production can be taught through technology?

Will eventually replace teachers	Has a great potential	Can improve education	Will not change education	Has a slight negative effect on education	A waste of time and resources	Very detrimental to the teaching process
1	2	3	4	5	6	7

How do you think web pages like these should be used?

All by themselves	As the primary teaching method, with occasional teacher help.	As a supplement to hands-on teaching, about equal amounts of time.	As an occasional supplement to hands-on teaching	Only when a teacher is not available	As a one time experience	Never
1	2	3	4	5	6	7

How do you feel about educational technology?

Will eventually replace teachers	Has a great potential	Can improve education	Will not change education	Has a slight negative effect on education	A waste of time and resources	Very detrimental to the teaching process
1	2	3	4	5	6	7

Which do you think you would you prefer,

- a printed version of the McClosky technique
- an on-line version
- no preference

Why?

Additional Comments:

Push Me When You Are Done!!

Spectral Analysis Survey

This survey designed by Miller and Doing (1996) helped determine attitudes of the participants toward the process of spectral analysis. It was administered in the fourth week of lessons, after students had been exposed to the spectral analysis process. (See the following page.)

Spectral Analysis/EGG Questionnaire

Name:

Email

Soprano	Mezzosoprano or Contalto	Tenor	Bass or Baritone
○	○	○	○

Age:

Years of Singing prior to this semster:

Grade Point Average	2.0 ○	2.1-2.5 ○	2.6-3.0 ○	3.1-3.5 ○	3.6+ ○

Technological Understanding	Clueless ○	No Special Affinity ○	Lively Interest ○	Techic ○

Estimate of progress in singing this semester				
Stagnation ○	Small amount of progress ○	Average progress ○	Unusual progress ○	Important Breakthrough ○

How helpful do you find the equipment:

For your own singing?					
Not at all ○	To some degree ○	Moderately ○	Very ○	Extremely ○	No opinion ○

For the singing of others?					
Not at all ○	To some degree ○	Moderately ○	Very ○	Extremely ○	No opinion ○

For your teacher's effectiveness?					
Not at all ○	To some degree ○	Moderately ○	Very ○	Extremely ○	No opinion ○

(Potentially) for other teachers' effectiveness, assuming a user-friendly format?					
Not at all ○	To some degree ○	Moderately ○	Very ○	Extremely ○	No opinion ○

For your own (potential) teaching?					
Not at all	To some degree	Moderately	Very	Extremely	No opinion

In increasing the exchange of information among teachers?					
Not at all	To some degree	Moderately	Very	Extremely	No opinion

In increasing cooperation among teachers?					
Not at all	To some degree	Moderately	Very	Extremely	No opinion

How helpful do you find the separate components of the feedback:

Electroglottograph (the signal showing the opening and closing of the folds)					
Not at all	To some degree	Moderately	Very	Extremely	No opinion

Spectrum analyzer (the signal showing the strength of the various frequency components)?					
Not at all	To some degree	Moderately	Very	Extremely	No opinion

How much understanding of the signals do you have?				
Only a vague idea	Enough to make some sense	A moderate understanding	A rather clear idea	A precise understanding

How much understanding of the signals does a singer need to make use of the feedback?				
Only a vague idea	Enough to make some sense	A moderate understanding	A rather clear idea	A precise understanding

How much understanding of the signals does a teacher need to make use of the feedback?				
Only a vague idea	Enough to make some sense	A moderate understanding	A rather clear idea	A precise understanding

Additional Comments:

New Record

SmartMusic Survey

This survey (see the following page) was administered in the sixth week of the lessons in order to serve as the first part of a pre-and postsurvey judging the effectiveness of the SmartMusic system over the last few weeks of the semester. The postsurvey follows.

Name:

Email address:

Do you think aspects of voice production can be taught through technology?						
Will eventually replace teachers	Has a great potential	Can improve education	Will not change education	Has a slight negative effect on education	A waste of time and resources	Very detrimental to the teaching process
1	2	3	4	5	6	7

How do you feel about educational technology?						
Will eventually replace teachers	Has a great potential	Can improve education	Will not change education	Has a slight negative effect on education	A waste of time and resources	Very detrimental to the teaching process
1	2	3	4	5	6	7

How do you feel about the SmartMusic system as it was used in your lesson? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the SmartMusic system for your practice sessions on your own? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the warmup feature of the SmartMusic system as it was used in your lesson? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the warmup feature of the SmartMusic system for your practice sessions on your own? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the tuning feature of the SmartMusic system as it was used in your lesson? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the tuning feature of the SmartMusic system for your practice sessions on your own? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the accompaniment feature of the SmartMusic system as it was used in your lesson? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the accompaniment feature of the SmartMusic system for your practice sessions on your own? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

New Record

Final Survey

The following survey (see the following page) was administered after the final concert. It serves as a postsurvey for questions asked both at the beginning of the semester regarding general attitudes toward technology, and also serves as a postsurvey for questions asked in the sixth week of the semester regarding the SmartMusic system. Additional questions help gather information on the participants' terminal attitude toward the technology and the process in general.

Final Survey

Name:

Email address:

Do you think aspects of voice production can be taught through technology?						
Will eventually replace teachers	Has a great potential	Can improve education	Will not change education	Has a slight negative effect on education	A waste of time and resources	Very detrimental to the teaching process
1	2	3	4	5	6	7

How do you feel about educational technology?						
Will eventually replace teachers	Has a great potential	Can improve education	Will not change education	Has a slight negative effect on education	A waste of time and resources	Very detrimental to the teaching process
1	2	3	4	5	6	7

How do you feel about the SmartMusic system as it was used in your lesson? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the SmartMusic system for your practice sessions on your own? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the warmup feature of the SmartMusic system as it was used in your lesson? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the warmup feature of the SmartMusic system for your practice sessions on your own? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the tuning feature of the SmartMusic system as it was used in your lesson? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the tuning feature of the SmartMusic system for your practice sessions on your own? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the accompaniment feature of the SmartMusic system as it was used in your lesson? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the accompaniment feature of the SmartMusic system for your practice sessions on your own? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the Web pages as used in your lesson? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the the Web pages for your practice sessions on your own? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the McClosky Technique as used in your lesson? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the McClosky techniquefor your practice sessions on your own? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the spectral analysis as used in your lesson? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

How do you feel about the EGG used in your lessons? (1 = very effective, 5 = not effective at all)						
1	2	3	4	5	6	7

Other Comments:

New Record Start over

Journal Questions

Reproductions of questions and comments used to guide answers to student journals follow. These questions were e-mailed to students each week.

Initial Questionnaire

I thank you for taking part in my research. I am sure you have been wondering what this is all about, so I thought I would send everyone this e-mail to get you up to speed and to ask you a few questions. I am doing my dissertation research on the use of technology in the applied voice studio. I am seeking information on how the presence and use of computer technology affects the learning and attitude of students. I need students to help me out in order to test my teaching materials and research tools. This is where you come in. In exchange for eight weeks of voice lessons, I will be asking you to help me by taking the lessons, working through the testing materials, and keeping a log of your feelings about the whole process. All of this will take place in some electronic format, either by e-mail, like this message, or through Web pages. In addition to the 45 minutes a week in the lesson, I am estimating a maximum of 30 minutes a week will be spent on the other activities, probably less most weeks. Also, at the end of the semester you will take part in an informal, low-pressure concert to show off what you have learned. Luckily for me, I have gotten a good response, and so I may not be able to take all of the people interested in helping. I have prepared some questions to help me decide who fits my research profiles the best. Please do not be frightened by any of the questions. I am not necessarily looking for the most experienced singers; I need beginners too!

Please respond to this questionnaire and send the reply as soon as possible so that I can begin to schedule lessons. I love to read, so please write a lot!

1. Your name:
2. Your e-mail address:
3. Your telephone number:
4. Age:
5. Major (or occupation for non-students):
6. Year in school (or highest degree earned):
7. How much singing experience do you have (please explain)?
8. Would you categorize yourself as a soprano (high female), alto (low female), tenor (high male), or bass (low male) voice type?
9. How much musical experience in addition to singing do you have (please explain)?
10. How much experience with computers do you have (please explain)?
11. Participation in the experiment would require you to check your e-mail regularly and use the World Wide Web on occasion. Do you have easy access to a computer (computer labs are OK)?
12. I am asking for a firm commitment from you for the eight-week period. Are you sure you can spare the time to complete all aspects on the experiment (45 minutes for lessons, 30 minutes maximum for journals, and practice time each week for the next eight weeks)?
13. Are there any other comments you would like to add?

Rejection Letter

Hello,

You recently contacted me about participating in my research, which included free voice lessons. As you might suspect, I was unable to find a place for you this semester. I had a great response to my search for students, so I was forced to limit the number of people I was able to teach. The decisions were made mostly on scheduling and demographic issues, so please do not feel that anything you said had to do with my not taking you this semester.

I thank you for your help.

First Week Questions

Before you answer these, make sure you have reviewed this week's Web pages.

You also need to answer the form on the Web that is linked from the Web page.

If you forgot the URL, here it is:

http://www-camil.music.uiuc.edu/Projects/tbmi/rrepp/lessons/index.html

Please take some time to follow these questions. The more typing the better!

1. How often and for how long did you practice this week (you should be keeping a log)?
2. How often and for how long did you access the Web pages?
3. How effective were the pages when used in your practice? Why?

For some of you, I did not use the Web pages in the lesson. If you did not see the Web pages in the lesson, skip to question 6.

4. How effective were the pages when used in the lesson itself? Why?
5. How would you suggest I use the Web pages in the lesson to be more effective?
6. How would you suggest I change the Web pages to be more effective?
7. Aside from the Web pages, how would you suggest I change the lesson to be more effective?
8. What are your general impressions from the first lesson?
9. Are there any other comments you would like to make?

Second Week Questions

Please take some time to complete these follow-up questions. The more typing the better!

1. How often and for how long did you practice this week (you should be keeping a log)?

2. What percentage of your practice time was spent on exercises and what percentage on singing/making sounds?

For some of you, I did not use the Web pages in the lesson. If you did not see the Web pages in the lesson, skip to question 5.

3. How effective were the pages when used in the lesson itself? Why?

4. How would you suggest I use the Web pages in the lesson to be more effective?

5. How would you suggest I change the Web pages to be more effective?

6. Aside from the Web pages, how would you suggest I change the lesson to be more effective?

7. What are your general impressions from the second lesson?

8. What were your impressions of the on-line survey you answered last week?

9. Were any of the questions confusing?

10. Do you prefer to answer questions like this by e-mail, or by the on-line survey?

11. Are there any other comments you would like to make?

Third Week Questions

Before you answer these, make sure you have looked at the class Web pages and the links I put to the screen shots we took at the last lesson. You should also have done the on-line survey for this week.

Please take some time to complete these follow-up questions. The more typing the better!

1. How often and for how long did you practice this week?

2. What percentage of your practice time was spent on exercises and what percentage on singing songs?

3. What were your reactions to the use of the voice analysis software?

4. Do you think you understand what was going on?

5. Does putting the graphics on-line help?

6. Do you have any comments on the survey?

7. Are there any other comments you would like to make?

<u>Alternate Third Week Questions for Comparison Group</u>

1. How often and for how long did you practice this week?

2. What percentage of your practice time was spent on exercises and what percentage on singing songs?

3. How many times and for how long did you use the practice room this week?

4. Did you have any problems using the software (explain)?

5. How do you feel about my using the computer as accompaniment when you do the warm-ups (as compared with the keyboard)?

6. How do you feel about the intonation exercise?

7. Are there any other comments you would like to make?

<u>Fourth Week Questions</u>

1. How often and for how long did you practice this week?

2. What percentage of your practice time was spent on exercises and what percentage on singing songs?

3. How many times and for how long did you use the practice room this week?

4. Did you have any problems using the software (explain)?

5. How do you feel about my using the computer as accompaniment when you do the warm-ups (as compared with the keyboard)?

6. How do you feel about the intonation exercise?

7. How do you feel about the accompaniments on the computer?

8. Are there any other comments you would like to make?

<u>Fifth Week Questions</u>

1. How often and for how long did you practice this week?

2. What percentage of your practice time was spent on exercises and what percentage on singing songs?
3. How many times and for how long did you use the practice room this week?
4. Did you have any problems with the counting exercises or isolating the vowels (explain)?
5. How do you feel about the accompaniments on the computer?
6. Did you have a chance to access the Web pages I linked from the class home page? How do you feel about them?
7. Are there any other comments you would like to make?

<u>Sixth Week Questions</u>

1. How often and for how long did you practice this week?
2. What percentage of your practice time was spent on singing exercises and what percentage on singing songs?
3. How many times and for how long did you use the practice room this week?
4. Describe how it feels to use the room now as compared to your first experience.
5. Did you have a chance to access the Web pages I linked from the class home page? How do you feel about them?
6. Please comment on the articulation exercises I put on the Web.
7. Are there any other comments you would like to make?

<u>Seventh Week Questions</u>

1. How often and for how long did you practice this week?
2. What percentage of your practice time was spent on exercises and what percentage on singing songs?
3. How many times and for how long did you use the practice room this week (please elaborate)?

If you did not participate in the spectral analysis, please skip to question 7.

4. What were your reactions to the use of the voice analysis software this time as compared to the first experience?
5. Do you think you understand what was going on better than the first week?
6. Would you rather have spent that time working on your songs or other exercises?
7. Are there any other comments you would like to make?

Eighth Week Questions

1. How often and for how long did you practice this week?
2. What percentage of your practice time was spent on exercises and what percentage on singing songs?
3. How many times and for how long did you use the practice room this week?
4. Do you think you are ready for the concert?
5. How could I have helped you better prepare for the concert?

If you did not practice with the human accompanist, skip to question 9.

6. How did practicing with a person playing the piano differ from using the computer?
7. Did you feel uncomfortable with another person in the practice room?
8. Which do you prefer for practicing (please explain why)?
9. Are there any other comments you would like to make?

Post-Concert Questions

1. How did the use of technology help or hinder your voice lessons this semester?
2. How do you feel about the SmartMusic system (including the accompaniments, warm-ups, and tuner) as a tool for practice and performance?
3. Please comment on whether you would have rather had a human accompanist or the computer for the concert and why.
4. Please comment about the use of the Web pages and whether they should be used in the lessons.

5. Please comment about the use of spectral analysis in your lessons; was it worth the extra time? (If you did not go through the process, look at the Web pages and tell me if this is something you would have liked in your lessons.)
6. Are there any other comments you would like to make?

APPENDIX D

WEB PAGE PRINTOUTS

This Appendix contains printouts of the Web pages used in the lesson sequence.

Main Home Page

This Web page (see the following page) served as a home base for information about the lessons.

Voice Lesson Home Page

These Web pages are intended to support Richard Repp's research.
To read asummary of the results of the pilot test download this file.
(You will need the ability to view an Adobe Acrobat file.)

Week 1 The McClosky Technique for Voice Relaxation The Web Pages describing the technique. Followup Survey Complete when you have had a chance to work with the techniques for a while.	**Week 5** Tips on learning a song Check out Vocalist Home Page
Week 2 Posture and Breathing The Web Pages	**Week 6** Working with text Use of Articulators Survey about Smartmusic Check out SmartMusic Home Page
Week 3 Voice Measurements Check out: Internet Research Tools for Vocalists Followup Survey for week 3	**Week 7** Voice Measurements
Week 4 Possible songs Italian Songs Spirituals Musical Theatre-Soprano Musical_Theatre-Alto Musical_Theater Baritone Bass	**Week 8** Preparing for the concert Final Survey

The URL of this page is:
http://camil40.music.uiuc.edu/Projects/tbmi/rrepp/lessons/index.html

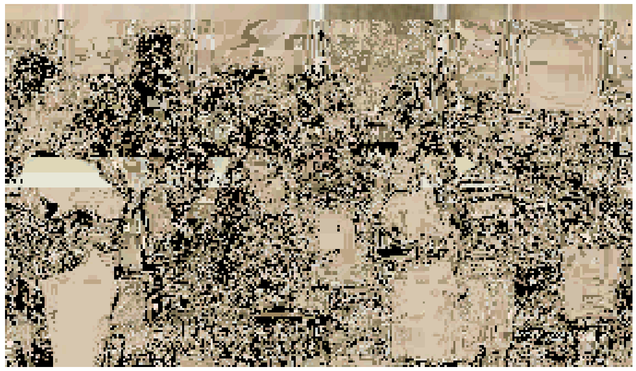
McClosky Relaxation Technique

These Web pages (see the following page), originally designed for Repp (1997), provide information on the McClosky Technique for Vocal Relaxation. The pages were used within in the first lesson of some students and as an outside resource for a comparison group.

McClosky Relaxation Technique

These Web pages (see the following page), originally designed for Repp (1997), provide information on the McClosky Technique for Vocal Relaxation. The pages were used within in the first lesson of some students and as an outside resource for a comparison group.

The McClosky technique for vocal relaxation



Thank you for taking part in my experiment

If you are visiting these pages for the first time

then please follow this link:

Next

If you have already completed the first part,

have begun to use these techniques in your phonation, and are ready to answer the questions, then please follow this link.

Next

This page maintained by Richard Repp
URL: http://camil40.music.uiuc.edu/Projects/tbmi/mcclosky/
Updated: 16 April 1997

The McClosky technique for vocal relaxation

This technique is designed to help you phonate (speak or sing) in a more relaxed manner.

Sit in a comfortable position and try to invite an untroubled state of mind.

Do not hurry. Do not press.

The essence of these exercises is that they be done slowly, deliberately, without clock-watching.

You will work to relax six areas. Work through these steps in order. If you feel you have developed tension in an area you have already passed, then come back to this page to review the area.

The six areas are:

Face (Recommended Next step)

Tongue

Swallowing Muscles

Jaw

Larynx

Neck

Previous Next

The face

Starting at the hairline and working down to the lower neck, gently massage the muscles of the face and throat.

As you stroke downwards, allow the face to fall into as limp a condition as possible.

Rub the fingers over the eyes, closing them.

Let the jaw hang slack.

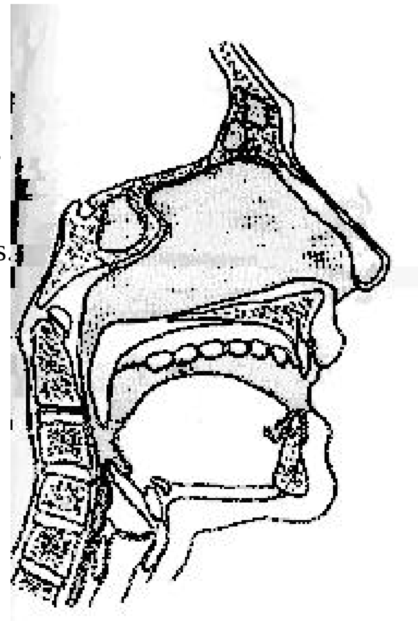
Work slowly and thoroughly before moving on to the next area: The tongue

Previous T. O. C. Next

The tongue

Allow the tongue to fall out over the lower lip as it might if you were unconscious.

This means fall; do not push it.



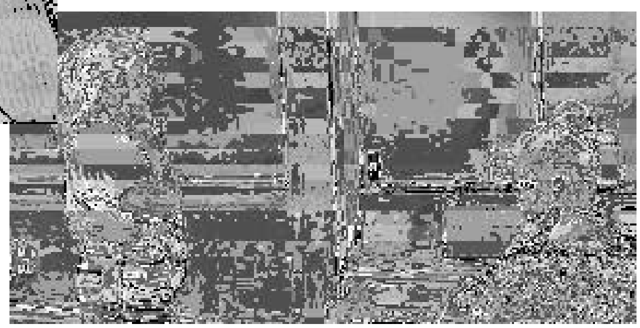
Next: The swallowing muscles

Previous T. O. C. Next

The swallowing muscles

This exercise is to relax the swallowing muscles. These are attached to the mandible (jawbone) from base to tip and converge upon the top of the larynx.

To relax these muscles, use the fingers of both hands to press gently, on one side and then the other, the soft part of the throat between the chin and the Adam's apple, starting under the hinge of the jaw.



until they are soft and pliable, moving the fingers gradually until they are directly under the chin.

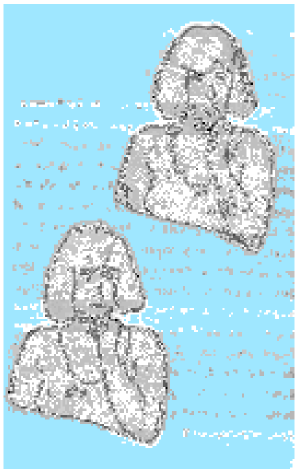
In this position, swallow, and you will feel downward pressure in the throat.

It is vitally important that this area be kept relaxed, soft and pliable during all phases of voice production. This can be checked so easily with the fingers that there is no excuse for tension here.

Next: The jaw

Previous T. O. C. Next

The Jaw



Now take the chin between the thumb and forefinger and move it up and down, at first slowly, then rapidly. If you have been able completely to relax the hinge muscles of the jaw, this exercise will give you no trouble.

On first trying it, most persons find, however, that there is resistance in the jaw, particularly when moving it back to a closed position. Involuntarily their jaw muscles are inclined to stiffen.

Not until you are able to move your chin freely up and down without the slightest resistance will you have accomplished the aim of this exercise.

Maintain all of the relaxation you have established up to this point. Do not permit concentration on one relaxing exercise to cause you to neglect the others.

Above all, take it easy.

Next: The larynx

Previous | T. O. C. | Next

The larynx

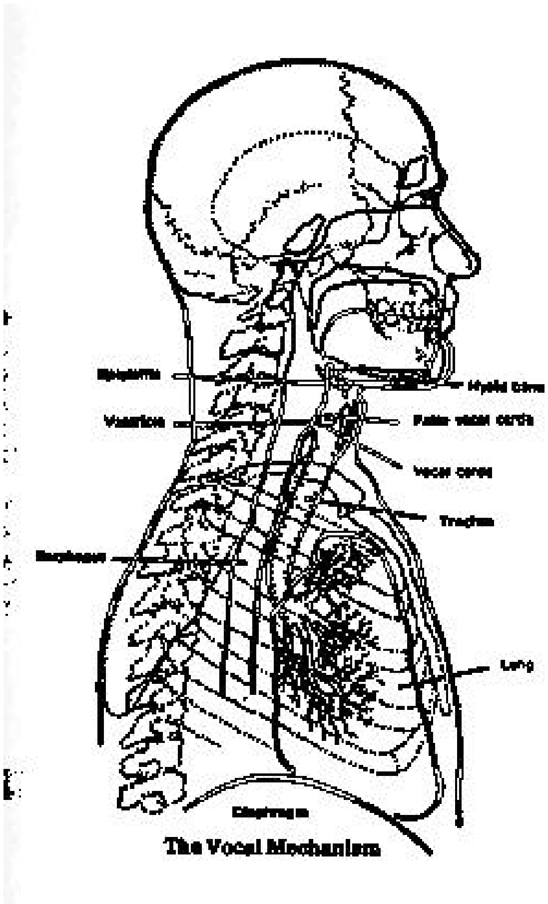
With relaxation of the other areas in mind, take the larynx between the thumb and fingers of one hand and lightly move it from side to side to make sure it floats and does not click.

Rigidity here is usually caused by too low or strident a tone of voice.

Next: The neck

Previous T. O. C. Next

The Neck



The Vocal Mechanism

To be sure that the lower neck muscles are relaxed, allow the head to nod up and down lazily while you are maintaining all the other relaxations.

If you worked these areas is order, you are now finished with the six areas of relaxation. If you wish to review any area you can access all pages from the [Table of Contents](#).

Once you are comfortable with all six areas of relaxation, please go to the [instructions for completing the survey](#).

Previous | T. O. C. | Next

The McClosky technique for vocal relaxation

http://alliance.ed.uiuc.edu/mcclosky

1. Starting at the hairline and working down to the lower neck, gently massage the muscles of the face and throat. As you stroke downwards, allow the face to fall into as limp a condition as possible. Rub the fingers over the eyes, closing them. Let the jaw hang slack.

2. Allow the tongue to fall out over the lower lip as it might if you were unconscious. This means fall; do not push it.

3. This exercise is to relax the swallowing muscles. These are attached to the mandible (jawbone) from base to tip and converge upon the hyoid bone at the top of the larynx. To relax these muscles, use the fingers of both hands to press gently, on one side and then the other, the soft part of the throat between the chin and the Adam's apple, starting under the hinge of the jaw. Gently massage these muscles until they are soft and pliable, moving the fingers gradually until they are directly under the chin. In this position, swallow, and you will feel downward pressure in the throat. It is vitally important that this area be kept relaxed, soft and pliable during all phases of voice production. This can be checked so easily with the fingers that there is no excuse for tension here.

4. Now take the chin between the thumb and forefinger and move it up and down, at first slowly, then rapidly. If you have been able completely to relax the hinge muscles of the jaw, this exercise will give you no trouble. On first trying it, most persons find, however, that there is resistance in the jaw, particularly when moving it back to a closed position. Involuntarily their jaw muscles are inclined to stiffen. Not until you are able to move your chin freely up and down without the slightest resistance will you have accomplished the aim of this exercise. Maintain all of the relaxation you have established up to this point. Do not permit concentration on one relaxing exercise to cause you to neglect the others. Above all, take it easy.

5. With relaxation of the other areas in mind, take the larynx between the thumb and fingers of one hand and lightly move it from side to side to make sure it floats and does not click. Rigidity here is usually caused by too low or strident a tone of voice.

6. To be sure that the lower neck muscles are relaxed, allow the head to nod up and down lazily while you are maintaining all the other relaxations.

These techniques and graphics are taken from McClosky, D. B. (1978). Your voice at its best. Boston: The Boston Music Company. Used with permission.

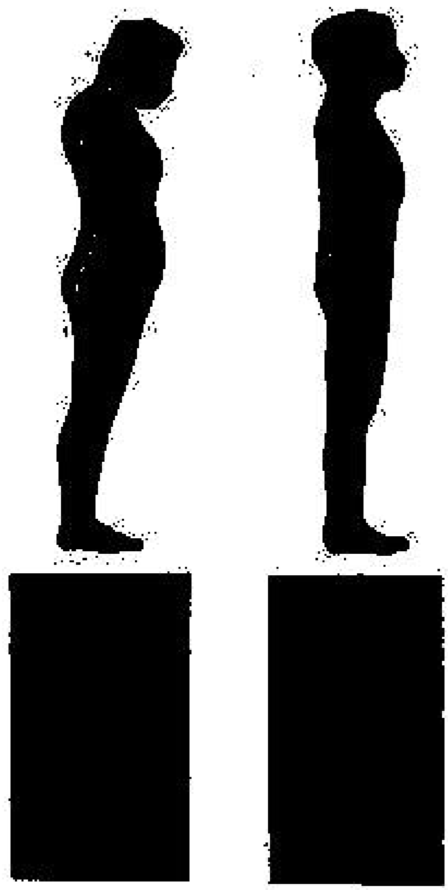
Previous

Posture and Breathing

These Web pages (see the following page), highlighting breathing and posture were used in the second week's lesson for some students and as an outside resource for a comparison group.

Posture and Breathing

Posture



Feet Next

Knees

Hips

Back

Ribs

Head

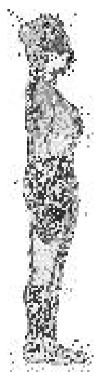
Breathing

Squeeze and release

Slow [s] sounds

Next

Feet



Shoulder width apart

Nice firm base

Previous T. O. C. Next

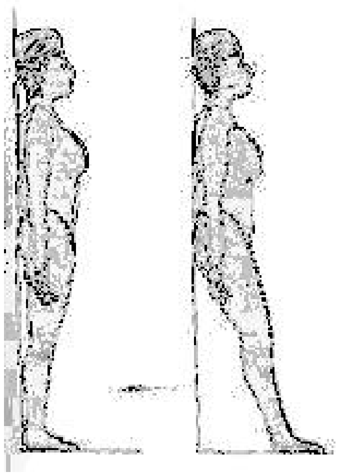
Knees

Slightly Bent

Helps straighten out back

Previous T. O. C. Next

Hips



Tucked Under

Helps straighten out back

This page maintained by Richard Repp
URL: http://camil40.music.uiuc.edu/Projects/tbmi/mcclosky/
Updated: Last Modified Oct 6 05:32:51 1998

Back

No arch in the lower back

Use the wall to help

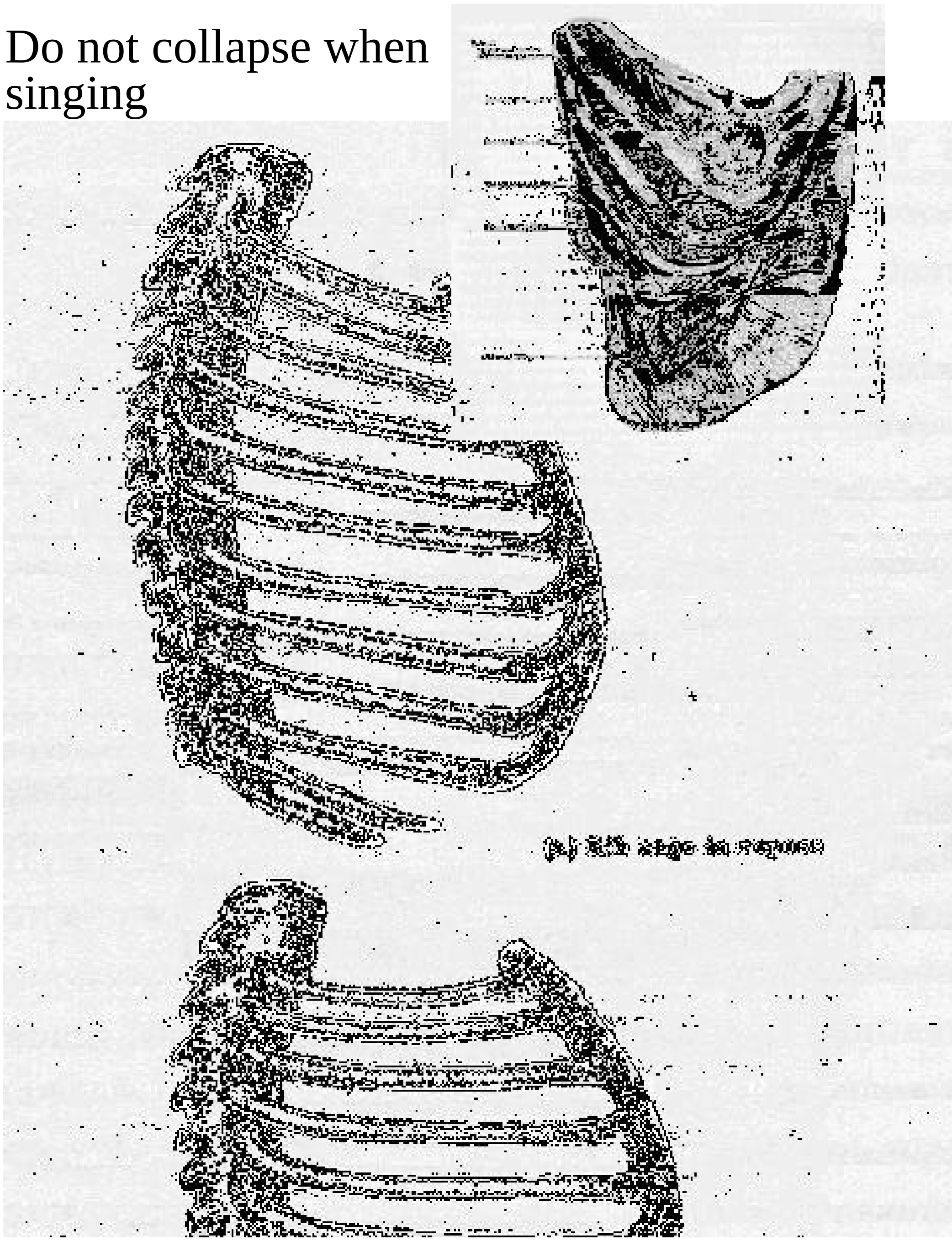
Click on Picture for larger image

This page maintained by Richard Repp
URL: http://camil40.music.uiuc.edu/Projects/tbmi/mcclosky/
Updated: Last Modified Oct 6 05:43:38 1998

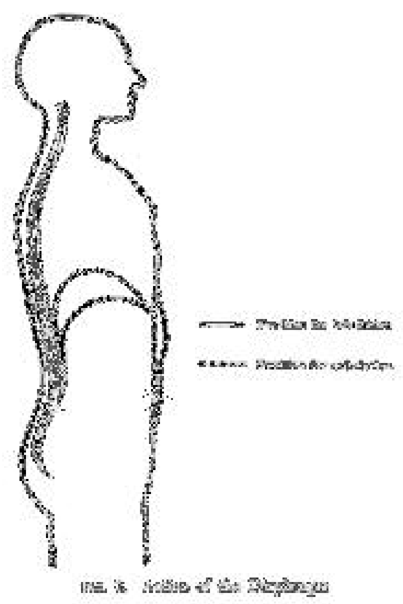
Ribs

Expanded

Do not collapse when singing



Squeeze and Release



Good breathing comes from the diaphragm

No chest raising

No rib collapse

To feel a good breath

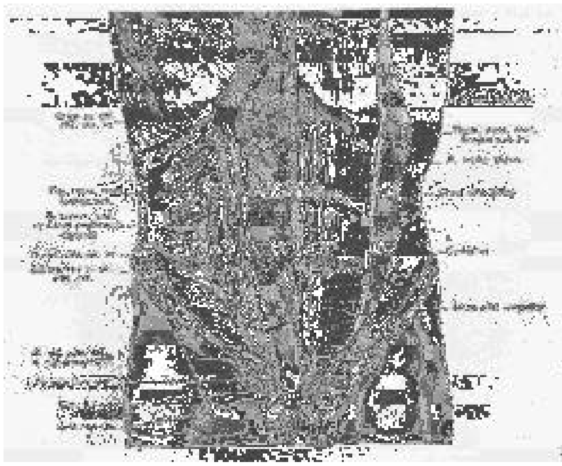
Squeeze the air from your lungs

Release your muscles

Let the air come in naturally, without trying to inhale

Previous T. O. C. Next

Slow [s] sounds



To work on keeping the breath steady

Take a healthy breath

Exhale on an [s] sound

Do not collapse the ribs

Make the breath even throughout the exhale

Try to go as long as possible

(Click on picture for larger image)

Head

Held high

Without tension

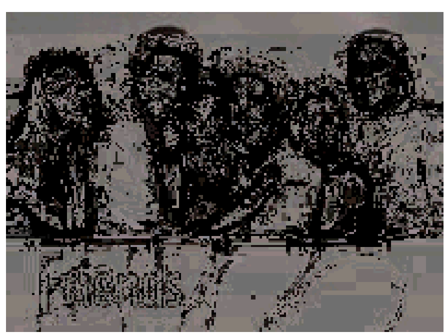
Eyes straight forward

Previous T. O. C. Next

Spectral Analysis

This Web page served as an introduction to the spectral analysis process and a home for screen shots of student results and voice recordings. The majority of Web pages containing spectral analysis data have been omitted because the information is presented in chapter 4.

EGG and "snapshot" spectral Analysis by Pseudonym	Time-based Spectral Analysis and recordings
Spring 1999	**Spring 1999**
Brenda	Brenda
Jane	Jane
Mark	Mark
Jack	Jack
Richard Repp's	Richard Repp's
Fall 1998	**Fall 1998**
ross	ross
phoebe	phoebe
rachel	rachel
monica	monica
joey	joey
chandler	chandler



Techniques for Learning a Song

This Web page contains tips for learning a song. It was incorporated into the sixth lesson.

Tips for learning a song

Start without words

Count out the rhythms without pitch (1 e and a).

Count out the rhythms while singing.

Chant the vowel sounds on a single pitch.

Sing the melody on a single vowel to encourage a legato line.

Sing the song with only the vowel sounds (very important -- do not go on unless you can do this!).

Adding text (second week with the song)

Speak the text out of meter, as if you were reading a poem.

If you are singing in a foreign language, make sure you know what all of the words mean.

Sing the text on a single pitch, like a chant.

Speak the text in rhythm.

Sing the text on a single pitch in rhythm.

Review last week's procedures

Sing the melody on a single vowel using la la la to encourage legato within articulation

Sing the song with words

Decide which words are most important and should be emphasized

Most important -- SING WITH FEELING!!!

Go to voice lesson home page

Available SmartMusic Repertoire

The following Web pages are a summary of the available repertoire I had purchased for the SmartMusic system. Students were asked to review these pages in the fourth and fifth weeks of the semester to help decide on possible concert pieces. The information was adapted from the SmartMusic Web site (Coda Music Technologies, 1999).

Twenty-Six Italian Songs and Arias

Voice	Nina	Anonymous
Voice	Star vicino	Anonymous
Voice	Non posso disperar	Bononcini
Voice	Per la gloria d'adorarvi	Bononcini
Voice	Amarilli, mia bella	Caccini
Voice	Alma del core	Caldara
Voice	Come raggio di sol	Caldara
Voice	Sebben, crudele	Caldara
Voice	Vittoria, mio core!	Carissimi
Voice	Danza, danza fanciulla / Solfeggio	Durante
Voice	Vergin, tutt'amor / Solfeggio	Durante
Voice	Se i miei sospiri	Fétis
Voice	Caro mio ben	Giordani
Voice	O del mio dolce ardor	Gluck
Voice	Che fiero costume	Legrenzi
Voice	Pur dicesti, o bocca bella	Lotti
Voice	Quella fiamma che m'accende	Marcello
Voice	Lasciatemi morire!	Monteverdi
Voice	Nel cor più non mi sento	Paisiello
Voice	Se tu m'ami	Parisotti
Voice	Già il sole dal Gange	Scarlatti
Voice	Le Violette	Scarlatti
Voice	O cessate di piagarmi	Scarlatti
Voice	Se Florinda è fedele	Scarlatti
Voice	Sento nel core	Scarlatti
Voice	Tu lo sai	Torelli

Go to voice lesson home page

The Spirituals of Harry T. Burleigh

Low Voice	Aint' Goin' To Study War No Mo'	Spiritual/Burleigh	
Low Voice	Balm In Gilead	Spiritual/Burleigh	IN, TX
Low Voice	Behold That Star	Spiritual/Burleigh	
Low Voice	By An' By	Spiritual/Burleigh	TX
Low Voice	Couldn't Hear Nobody Pray	Spiritual/Burleigh	WI
Low Voice	De Blin' Man Stood On De Road An' Cried	Spiritual/Burleigh	
Low Voice	De Gospel Train	Spiritual/Burleigh	WI
Low Voice	Deep River	Spiritual/Burleigh	IN, MD, NY, OH, PA, TX, WI
Low Voice	Didn't My Lord Deliver Daniel	Spiritual/Burleigh	TX
Low Voice	Don't Be Weary Traveler	Spiritual/Burleigh	TX
Low Voice	Don't You Weep When I'm Gone	Spiritual/Burleigh	
Low Voice	Ev'ry Time I Feel The Spirit	Spiritual/Burleigh	IN, TX
Low Voice	Give Me Jesus	Spiritual/Burleigh	
Low Voice	Go Down In The Lonesome Valley	Spiritual/Burleigh	
Low Voice	Go Down Moses	Spiritual/Burleigh	
Low Voice	Go Tell It On De Mountains	Spiritual/Burleigh	
Low Voice	Hard Trials	Spiritual/Burleigh	
Low Voice	He's Just De Same Today	Spiritual/Burleigh	
Low Voice	Hear De Lambs a-Cryin'	Spiritual/Burleigh	
Low Voice	Heav'n Heav'n	Spiritual/Burleigh	
Low Voice	I Don't Feel No-Ways Tired	Spiritual/Burleigh	
Low Voice	I Got A Home In A-Dat Rock	Spiritual/Burleigh	TX
Low Voice	I Know De Lord's Laid His Hands On Me	Spiritual/Burleigh	
Low Voice	I Stood On De Ribber Ob Jerdon	Spiritual/Burleigh	
Low Voice	I Want To Be Ready	Spiritual/Burleigh	TX
Low Voice	I've Been In De Storm So Long	Spiritual/Burleigh	
Low Voice	John's Gone Down On De Island	Spiritual/Burleigh	

Low Voice	Joshua Fit De Battle Ob Jericho	Spiritual/Burleigh	TX
Low Voice	Let Us Cheer The Weary Traveler	Spiritual/Burleigh	
Low Voice	Little David Play On Your Harp	Spiritual/Burleigh	
Low Voice	My Lord What A Mornin’	Spiritual/Burleigh	OH, TX
Low Voice	My Way’s Cloudy	Spiritual/Burleigh	
Low Voice	Nobody Knows De Trouble I’ve Seen	Spiritual/Burleigh	MD, NY, OH, PA, TX
Low Voice	O Rocks Don’t Fall On Me	Spiritual/Burleigh	TX
Low Voice	Oh Didn’t It Rain	Spiritual/Burleigh	TX
Low Voice	Oh Peter Go Ring Dem Bells	Spiritual/Burleigh	
Low Voice	Oh Wasn’t Dat A Wide Ribber	Spiritual/Burleigh	
Low Voice	Ride On King Jesus	Spiritual/Burleigh	IN, TX
Low Voice	Sinner Please Doan Let Dis Harves’ Pass	Spiritual/Burleigh	
Low Voice	Sometimes I Feel Like a Motherless Child	Spiritual/Burleigh	IN, MD, NY, OH, PA, TX, WI
Low Voice	Stan’ Still Jordan	Spiritual/Burleigh	WI
Low Voice	Steal Away	Spiritual/Burleigh	TX
Low Voice	Swing Low, Sweet Chariot	Spiritual/Burleigh	MD, NY, PA, TX
Low Voice	‘Tis Me O Lord	Spiritual/Burleigh	
Low Voice	Wade In De Water	Spiritual/Burleigh	IN, OH
Low Voice	Weepin’ Mary	Spiritual/Burleigh	
Low Voice	Were You There	Spiritual/Burleigh	MD, NY, OH, PA
Low Voice	You May Bury Me In De Eas’	Spiritual/Burleigh	

Go to voice lesson home page

Singer's Musical Theatre Anthology, Vol. 1
(Soprano)

Soprano	Far From The Home I Love (from "Fiddler On The Roof")	Bock
Soprano	Summertime (from "Porgy And Bess")	Gershwin
Soprano	The Sacred Tree (from "Treemonisha")	Joplin
Soprano	Bill (from "Show Boat")	Kern
Soprano	Can’t Help Lovin’ Dat Man (from "Show Boat")	Kern
Soprano	Smoke Gets In Your Eyes (from "Roberta")	Kern
Soprano	Somebody, Somewhere (from "The Most Happy Fella")	Loesser
Soprano	I Could Have Danced All Night (from "My Fair Lady")	Loewe
Soprano	I Loved You Once In Silence (from "Camelot")	Loewe
Soprano	Show Me (from "My Fair Lady")	Loewe
Soprano	The Simple Joys Of Maidenhood (from "Camelot")	Loewe
Soprano	So In Love (from "Kiss Me, Kate")	Porter
Soprano	Climb Ev’ry Mountain (from "The Sound Of Music")	Rodgers
Soprano	Come Home (from "Allegro")	Rodgers
Soprano	Falling In Love With Love (from "The Boys From Syracuse")	Rodgers
Soprano	Hello, Young Lovers (from "The King And I")	Rodgers
Soprano	If I Loved You (from "Carousel")	Rodgers
Soprano	Love, Look Away (from "Flower Drum Song")	Rodgers
Soprano	Many A New Day (from "Oklahoma!")	Rodgers
Soprano	Mister Snow (from "Carousel")	Rodgers
Soprano	My Lord And Master (from "The King And I")	Rodgers
Soprano	No Other Love (from "Me And Juliet")	Rodgers
Soprano	Out Of My Dreams (from "Oklahoma!")	Rodgers
Soprano	Something Wonderful (from "The King And I")	Rodgers
Soprano	The Golden Ram (from "Two By Two")	Rodgers
Soprano	What’s The Use Of Wond’rin’ (from "Carousel")	Rodgers
Soprano	Where Or When (from "Babes In Arms")	Rodgers
Soprano	You’ll Never Walk Alone (from "Carousel")	Rodgers
Soprano	I Have To Tell You (from "Fanny")	Rome

Soprano	Much More (from "The Fantasticks")	Schmidt
Soprano	Old Maid (from "110 In The Shade")	Schmidt
Soprano	Under The Tree (from "Celebration")	Schmidt
Soprano	Green Finch And Linnet Bird (from "Sweeney Todd")	Sondheim
Soprano	Not A Day Goes By (from "Merrily We Roll Along")	Sondheim
Soprano	One More Kiss (from "Follies")	Sondheim
Soprano	That'll Show Him (from "A Funny Thing Happened On The Way To The Forum")	Sondheim
Soprano	Barbara Song (from "The Threepenny Opera")	Weill
Soprano	My Ship (from "Lady In The Dark")	Weill
Soprano	Pirate Jenny (from "The Threepenny Opera")	Weill
Soprano	Solomon Song (from "The Threepenny Opera")	Weill
Soprano	Somehow I Never Could Believe (from "Street Scene")	Weill
Soprano	Surabaya Johnny (from "Happy End")	Weill
Soprano	What Good Would The Moon Be? (from "Street Scene")	Weill
Soprano	Goodnight, My Someone (from "The Music Man")	Willson
Soprano	My White Knight (from "The Music Man")	Willson
Soprano	Till There Was You (from "The Music Man")	Willson

Go to voice lesson home page

Singer's Musical Theatre Anthology, Vol. 1
(Baritone/Bass)

Baritone/Bass	I’ve Heard It All Before (from "Shenandoah")	Geld
Baritone/Bass	Meditation I (from "Shenandoah")	Geld
Baritone/Bass	Meditation II (from "Shenandoah")	Geld
Baritone/Bass	A Red Headed Woman (from "Porgy And Bess")	Gershwin
Baritone/Bass	I Got Plenty O’ Nuttin’ (from "Porgy And Bess")	Gershwin
Baritone/Bass	Ol’ Man River (from "Show Boat")	Kern
Baritone/Bass	Come Back To Me (from "On A Clear Day You Can See Forever")	Lane
Baritone/Bass	On A Clear Day (from "On A Clear Day You Can See Forever")	Lane
Baritone/Bass	Dulcinea (from "Man Of La Mancha")	Leigh
Baritone/Bass	The Impossible Dream (from "Man Of La Mancha")	Leigh
Baritone/Bass	The Man Of La Mancha (from "Man Of La Mancha")	Leigh
Baritone/Bass	C’est Moi (from "Camelot")	Loewe
Baritone/Bass	Camelot (from "Camelot")	Loewe
Baritone/Bass	How To Handle A Woman (from "Camelot")	Loewe
Baritone/Bass	I Still See Elisa (from "Paint Your Wagon")	Loewe
Baritone/Bass	If Ever I Would Leave You (from "Camelot")	Loewe
Baritone/Bass	They Call The Wind Maria (from "Paint Your Wagon")	Loewe
Baritone/Bass	Wand’rin’ Star (from "Paint Your Wagon")	Loewe
Baritone/Bass	Were Thine That Special Face (from "Kiss Me, Kate")	Porter
Baritone/Bass	Where Is The Life That Late I Led? (from "Kiss Me, Kate")	Porter
Baritone/Bass	Do I Love You Because You’re Beautiful? (from "Cinderella")	Rodgers
Baritone/Bass	If I Loved You (from "Carousel")	Rodgers
Baritone/Bass	Lonely Room (from "Oklahoma!")	Rodgers
Baritone/Bass	Oh, What A Beautiful Mornin’ (from "Oklahoma!")	Rodgers
Baritone/Bass	Soliloquy (from "Carousel")	Rodgers
Baritone/Bass	Some Enchanted Evening (from "South Pacific")	Rodgers
Baritone/Bass	This Nearly Was Mine (from "South Pacific")	Rodgers
Baritone/Bass	Try To Remember (from "The Fantasticks")	Schmidt

Baritone/Bass	Everybody Says Don't (from "Anyone Can Whistle")	Sondheim
Baritone/Bass	Johanna (from "Sweeney Todd")	Sondheim
Baritone/Bass	Sorry-Grateful (from "Company")	Sondheim
Baritone/Bass	The Road You Didn't Take (from "Follies")	Sondheim
Baritone/Bass	Lost In The Stars (from "Lost In The Stars")	Weill
Baritone/Bass	Mack The Knife (from "The Threepenny Opera")	Weill
Baritone/Bass	September Song (from "Knickerbocker Holiday")	Weill
Baritone/Bass	This Is The Life (from "Love Life")	Weill
Baritone/Bass	Thousands Of Miles (from "Lost In The Stars")	Weill

Go to voice lesson home page

Use of Articulators

These Web pages (see the following page) served as a reminder for students of information presented in the sixth lesson, in which printouts from the pages were used as a support. The information has been adapted from McClosky (1978).

Articulators

(jump to sentences)

1. Those in which the lips alone are used, as in the following examples: w win wh which m meet p pork b bee	2. Those in which the lips are used in conjunction with the teeth: f father v very

The linguals may be divided into four groups:	
1. Those formed by tongue and teeth: th thick that	2. Those formed by the tip of the tongue and the hard palate: t tip d do n no 1 lip r row
3. Those formed by the body of the tongue and the hard palate: s sow z zebra sh show 3 * azure	4. Those formed by the body of the tongue and the soft palate: c cat k king g get ng sing y yes

WHETHER ACCOMPANIED BY VIBRATION OF THE VOCAL CORDS

You have undoubtedly noticed that although some of the above sounds are produced by the same articulators, they nevertheless do not sound alike-- for instance; thick and that. This brings us to the second factor involved in the characterization of consonants: whether they are voiced (sonants) or unvoiced (surds). A voiced consonant is one whose pronunciation is accompanied by vibration of the vocal cords:

b bead	th this	m me	y year
d deed	z zoo	n not	ng sing
g good	3 azure	I lot	
v virtue	w west	r red	

An unvoiced consonant is one which is emitted without any accompanying vibration of the vocal cords:

th thought	s sea	sh shy	wh which	h hot

H is rather special as it is produced simply by breath passing between the vocal cords.

DURATION

The third factor in determining the quality of a consonant is the length of time involved in its emission. Consonants either stop abruptly, in which case they are called stops, or they continue and are therefore called continuants.

Stops:	d date	k kite	g gate

Continuants:

w we	v leave	r rose	3 azure
wh where	th those thistle	s seal s	y you
m music	n nice	h shower	ng song
f fate	l leap	z zealous	h horse

Sentences

To begin with the articulation of the lips, try saying the following sentence clearly and distinctly and slowly at first, being sure to maintain throat relaxation while speaking the words without overexaggerating the movements of the mouth:

l. w A coward weeps and wails with woe when his wiles are thwarted.

Now try this one, observing the difference in effect through lack of vocal cord vibration, although the same articulators are working:

---

2. wh Which whelp whined when he heard the whale wheeze?

Notice that both times the consonant sound was a continuant.

Still employing the lips specifically, say the following sentence, observing that the consonant

(Additional sentences have been omitted and can be found in McClosky, 1978.)

Concert Flyer

The following is a reproduction of the program from the final concert. Names have been removed and pseudonyms have been substituted to protect participant confidentiality. Note that two of my students who were not part of the study also took part in the concert.

Concert
19 April 1999
University of Illinois

Caro mio ben ["Tina"], Soprano [Name removed], Piano	Tommaso Giordani (1730-1806)
Sometimes I Feel Like a Motherless Child ["Kevin"], Baritone [Name removed], Piano	Arr. Harry T. Burleigh (1866-1949)
If I Loved You (Carousel) ["Tony"], Tenor [Name removed], Piano	Music Richard Rogers (1902-1979) Lyrics Oscar Hammerstein II (1895-1960)
I Could Have Danced All Night (My Fair Lady) ["Linda"], Soprano [Name removed], Piano	Music Frederick Loewe (1904-1988) Lyrics Alan J. Lerner (1918-1936)
Amarilli, mia bella (*Le nuove musiche*) [Name removed], Tenor	Giulio Caccini (ca. 1545-1618)
Alma del core (*La costanza in amor vince l'inganno*) ["Brenda"], Soprano	Antonio Caldara (ca. 1670-1736)
Se tu m'ami [Name removed], Mezzo-soprano	Alessandro Parisotti (1853-1913)
Can't Help Lovin' dat Man (Showboat) ["Jane"], Soprano	Music Jerome Kern (1885-1945) Lyrics Oscar Hammerstein II (1895-1960)
The Impossible Dream (Man of LaMancha) ["Mark"], Tenor	Music Mitch Leigh (born 1928) Lyrics Joe Darion (born 1917)

VITA

Richard Steven Repp was born in Chicago, Illinois on January 20, 1964. He began his academic career at the Georgia Institute of Technology in Atlanta, Georgia, where he studied Physics and Mathematics. He began his formal post-secondary musical education at William Rainey Harper College in Palatine, Illinois. There he received both an Associate of Arts degree in 1992 and an Associate of Science degree in 1993. At Harper, he developed an interest in music technology by helping to facilitate the installation of their music technology laboratory.

In 1994, he received a Bachelor of Science degree with a double major in Music and Mathematics from Illinois State University in Normal, Illinois. He went on to receive his Master of Music degree in Performance (Voice) with a concentration in Music Technology. At Illinois State, he had the opportunity to work at the Office of Research in Arts Technology, an internationally recognized center for music technology. In 1997, he was named a Certified McClosky Voice Technician by the McClosky Institute of Voice in Boston, Massachusetts, an organization of voice professionals who promote non-surgical treatment of voice disorders.

While at the University of Illinois, he has had the opportunity to teach courses in technology-based music instruction. He has also created music at the Experimental Music Studios, the world's first academic electronic music studio. He has presented his research in music technology at international conferences and has published articles concerning the World Wide Web and other technologies and their influence on the teaching of music. He presently serves as an Assistant Professor of Music at Terra State Community College, Fremont, Ohio.