The Use of Digital Tools and Modern Music Computer Technologies for Dialect Correction in Online Bel Canto Instruction

Irina B. Gorbunova, Ji Yuchi

***Abstract*—** An 11-week online teaching experiment was conducted to examine the role of digital tools in addressing dialect-related challenges in bel canto instruction. Sixteen music students from Guizhou Province participated in the study. During the diagnostic phase, vocal profiles and risk maps were developed to quantify production-related issues. Acoustic analysis was performed using Praat, while emotional expression was evaluated via the AAID platform. Results indicate a 37.5% expansion in vocal range, a 75-percentage-point increase in theoretical knowledge, and a reduction from 25% to 12.5% in students reporting significant dialectal interference. Praat analysis revealed a marked decrease in nasalization among high-risk participants; for student S01 (Xiao Haiyun), energy at 2500 Hz dropped from -1.4 dB to -7.7 dB. These findings suggest that digital tools can effectively support the identification and correction of dialect-related vocal issues and offer a replicable model for vocal education in under-resourced regions.t.

***Keywords*—** Bel Canto; China; digital tools; dialect correction; music computer technologies (MCT); online instruction; Praat; vocal pedagogy.

I. Introduction

Guizhou Province, located in southwestern China, has historically faced limitations in educational infrastructure. Research by Yang Shuanghong [6] documented the considerable influence of local dialects on vowel clarity in bel canto training. Earlier work by the present author introduced the concept of "dual cognitive poverty," which captures two coexisting challenges: widespread phonetic interference among students (with 82% demonstrating involuntary vowel nasalization) and insufficient technical preparation among instructors (only 9% proficient in bel canto technique, and 67% relying on unscientific "folk-academic" mixed methods) [13]. These interrelated factors have constrained the quality of vocal education in the region.

Digital technologies offer potential solutions to these challenges. Platforms such as DingTalk enable instruction across geographical distances, facilitating access to quality pedagogical resources. Acoustic analysis software like Praat converts abstract vocal phenomena into quantifiable data, while AI-driven platforms such as AAID permit systematic evaluation of emotional expression in performance. The present study reports on an 11-week online teaching experiment designed to assess the efficacy of digital tools for dialect correction in bel canto instruction.

Manuscript received May 11, 2026.

Irina B. Gorbunova. She is now with the Herzen State Pedagogical University of Russia, St. Petersburg

Ji Yuchi Shi is now with the Herzen State Pedagogical University of Russia, St. Petersburg

II. Methods and Tools

2.1 *Participants*

The sample comprised 16 music students from Guizhou Province (8 male, 8 female), aged 19 to 25 years. Seventy-five percent were raised in Southwestern Mandarin-speaking environments, and 93.75% attended institutions at the prefectural level, consistent with the study's focus on resource-limited settings.

2.2 *Diagnostic Tools*

Individual vocal profiles were constructed for each participant, documenting three quantitative indicators: nasalization rate, amplitude of laryngeal displacement, and tongue retraction index. The inclusion of tongue retraction as a diagnostic parameter draws on Dmitriev's (1996) observation that "the tongue is the primary articulatory organ; its positional shifts determine the spatial conditions required for formant generation."

Risk values were derived using the following formula:

Risk Value = (Nasalization Rate × 0.5) + (Laryngeal Displacement Weight × 0.3) + (Tongue Retraction Index × 0.2)

Based on these values, participants were assigned to high-risk (6 students), medium-risk (5 students), or low-risk (5 students) categories, forming the basis of individual risk maps.

2.3 *Digital Tools*

The analytical phase employed several digital instruments:

- Praat: Used to measure energy levels at 2500 Hz in participants' [a] vowels, serving as a quantitative proxy for nasalization [3; 4; 5].
- AAID: Applied to assess emotional expression in vocal performances, generating quantitative scores across five dimensions: happiness, sadness, relaxation, aggressiveness, and danceability.
- Audacity and mobile spectral applications: Utilized by students for real-time spectral observation during class sessions.
- Doubao: Employed as a supplementary self-study tool to support students' comprehension of the contextual and emotional dimensions of musical works.

2.4 *Course Design*

The 11-week curriculum was organized into three sequential phases: foundational reconstruction (weeks 1–4), technical

deepening (weeks 5–8), and artistic development (weeks 9–11). Instruction was delivered via the DingTalk platform in twice-weekly sessions of 120 minutes each. Course design emphasized the transformation of abstract vocal concepts into measurable parameters, reflecting principles of scientific rigor and operational clarity."

III. Music Computer Technologies and Vocal Training in China's Professional Musical Education System

We would like to emphasize that vocal singing training for students of Chinese universities according to the developed methodology is carried out both in full-time format (directly in the process of their studies in China) and in remote form, taking into account the use of modern distance learning systems for musical disciplines. For this purpose, the forms and methods developed by the staff of the research and methods laboratory *Music Computer Technologies* (RML *Music Computer Technologies*) at the Herzen State Pedagogical University of Russia, as well as methods created by graduate students and doctoral students from China who carry out research under the supervision of Professor I. B. Gorbunova (see, for example, in [10; 11]).

It is also planned to use the developed tasks for the system of vocal education and training in Chinese universities within the framework of Ji Yuchi's dissertation research *Vocal Training in the System of Professional Musical Education in China* to develop an intelligent cataloging and analysis system for the music of the peoples of Russia and the world. The work in these areas is currently being carried out jointly by scientists from the Russian Federation and the Republic of Azerbaijan: employees of the RML *Music Computer Technologies* of the Herzen State Pedagogical University of Russia and researchers from the laboratory *Research of Azerbaijani Professional Music of Oral Tradition and Their New Directions: Organology and Acoustics* of the U. Hajibeyli Baku Music Academy under the scientific guidance of member of the Union of Composers of Azerbaijan, Doctor of Philosophy in Art History Imina G. Aliyeva. The relevance of developments in this scientific and practical field of activity is also due to the need to take urgent measures to preserve traditional creative work in the context of globalization, and interdisciplinary dialogue creates conditions for developing a common strategy in solving scientific problems associated with research conducted in this area [12].

A number of issues discussed in this section were voiced by Ji YuChi in the report *Vocal Training in China's Professional Musical Education System: Problems and Development Paths*, presented at the 23d International Research and Practical Conference *Contemporary Musical Education: Creative Work, Research, Technology — 2025* [13].

IV. Main Results

3.1 *Vocal Range Expansion*

Pre-test data indicated that only 25% of participants could reliably sing "one octave plus a fifth" or beyond. Post-test results showed an increase to 62.5%, representing a 37.5-percentage-point gain that substantially exceeded the 15% target. This outcome provides empirical support for Dmitriev's (1996) assertion that "a properly trained voice should flow without interruption across the entire range."

3.2 *Theoretical Knowledge Improvement*

At the pre-test stage, no participants rated their theoretical understanding as "good" or above (56.25% reported "average," 43.75% "below average"). Post-test results revealed that 75% of participants attained "good" or "excellent" ratings, reflecting a 75-percentage-point improvement.

3.3 *Reduction in Dialectal Interference*

The proportion of participants reporting "significant" or "very significant" dialectal interference declined from 25% to 12.5%. Notably, no participants selected "unaware of obvious problems" in the post-test (compared to 12.5% in the pre-test), indicating a cognitive shift from problem unawareness to problem identification.

3.4 *Acoustic Analysis: Representative Case*

High-risk participant Xiao Haiyun (S01) exhibited a reduction in 2500 Hz energy values for the [a] vowel from -1.4 dB (pre-test) to -7.7 dB (post-test), a decrease of 6.3 dB indicative of substantially reduced nasalization. This acoustic finding aligns with her self-reported perception of vocal production shifting from "constricted" to "rounder and clearer."

3.5 *Diagnostic Tool Acceptance*

93.75% of participants rated the vocal profile and risk map diagnostic methods as "very helpful" or "moderately helpful," with 68.75% selecting "very helpful—it allowed me to 'see' my problems for the first time." 87.5% of participants characterized the "dialect correction" concept as "very innovative."

V. Conclusion

This 11-week online teaching experiment yielded the following outcomes regarding the application of digital tools for dialect correction in bel canto instruction:

1. Vocal range expansion: A 37.5% gain was achieved, meeting the predetermined target.
2. Theoretical knowledge improvement: 75% of participants reached "good" or above.
3. Dialectal interference reduction: Self-reported significant interference decreased by 12.5 percentage points.
4. Diagnostic tool acceptance: 93.75% of participants affirmed the pedagogical value of the instruments employed.
5. Online instruction feasibility: The approach proved viable, although platform-based data storage constraints emerged as a primary technical limitation.

These findings demonstrate that effective vocal education can be accomplished in resource-limited settings through the integration of scientifically grounded teaching methods and digital tools. Future work will focus on developing standardized video resources based on core course content and making these materials openly accessible via internet platforms to extend educational reach.

REFERENCES

[1] Dmitriev L.B. Fundamentals of Vocal Methodology. Moscow: Muzyka, 1996.

[2] Ji Yuchi. On Teaching Bel Canto Technique to Music Students in Chinese Universities. Pedagogical Scientific Journal. 2025. Vol. 8. No. 8. Pp. 65–75.

[3] Fang Qiang, Li Aijun. A Study of Nasalized Vowels in Mandarin // Proceedings of the Sixth National Conference on Modern Phonetics. Tianjin, 2003. Pp. 1–6.

[4] Havel M., Sundberg J. Effects of Nasalization on Vocal Tract Response Curve. Rhinology. 2025. [In press].

[5] Lee A.S.-Y., Ciocca V., Whitehill T.L. Acoustic Correlates of Hypernasality. Clinical Linguistics & Phonetics. 2003. Vol. 17. No. 4–5. Pp. 259–264. https://doi.org/10.1080/0269920031000080091

[6] Yang Shuanghong. Dialect Problems of Guizhou Vocal Students in Bel Canto Learning. Journal of Anshun Teachers College. 2004. No. 4. Pp. 40–41.

[7] Mazzini J. Philosophy of Music. Aesthetics and criticism. Selected articles. Moscow, 1976.

[8] Heine H. Reisebilder. Band 7/1, vol. 3. Reise von München nach Genua. Hamburg, 1986. https://doi.org/10.1524/9783050053080.7

[9] Asioli B. Maestro di composizione, ossia seguito del Tratto d'armonia. Opera postuma di Bonifazio Asioli da Correggio. Milano, 1830.

[10] Gorbunova I.B., Liu G. On the Experience of Implementing Distance Learning Technologies in Teaching Piano Playing. *Anthropological Didactics and Education*. 2025. Vol. 8. No. 1. Pp. 102-116.

[11] Gorbunova I.B., Liu G. Distance Musical Education: Advantages and Disadvantages (On the Example of Learning to Play the Piano). *Art and Education*. 2025. No. 1 (153). Pp. 76-87.

[12] Gorbunova, I. B., Alieva, I. H. Concerning the Project of Intelligent System of Cataloguing and Analysing of the World's Peoples Music. *Society: Philosophy, History, Culture*. 2016. No. 9. Pp. 105-108.

[13] Ji Yuchi. Vocal Training in China's Professional Musical Educational System: Problems and Development Paths. *Contemporary Musical Education: Creative Work, Research, Technology — 2024*: Proceedings of the 23d International Research and Practical Conference / Under the general editorship of I. B. Gorbunova. Moscow: International Centre for Art and Education. 2024. Pp. 349-352.

Irina B. Gorbunova was born in Saint Petersburg (Leningrad), Russia.

DipMus, Special Music Higher School of the St. Petersburg State Conservatory named after N.A. Rimsky-Korsakov; BSc in Computer Science: Information Technology, Computer Science and Multimedia, Leningrad State University, Ussurisk State Pedagogical University; MA in Education, the Herzen State Pedagogical University of Russia; PhD in Information Technology and Pedagogical Sciences, the Herzen State Pedagogical University of Russia, St. Petersburg; Doctor degree: Doctor of Pedagogical Sciences and Information Technology, the Herzen State Pedagogical University of Russia, St. Petersburg.

Dr., Full University Professor, Chief Researcher of the Education and Methods Laboratory *Music Computer Technologies* at the Herzen State Pedagogical University of Russia, St. Petersburg; hold the degree of Honorary Worker of Higher Professional Education of the Russian Federation.

Work experience; 1990 – 2010 - Associate Professor, Professor of the Department of Music and Department of Information Technology of the Herzen State Pedagogical University of Russia, St. Petersburg; 2010 - present - Full Professor of the Department of Information Technology, Institute of Computer Science and Technological Education of the Herzen State Pedagogical University of Russia, St. Petersburg; 2002 – present - Chief Researcher of the Research and Methods Laboratory Music Computer Technologies at the Herzen State Pedagogical University of Russia, St. Petersburg. She was on a number of business trips abroad, among them: working trips to the USA; lecturing and giving research and practice seminars in; business trips to the UK; working trips to Greece, Germany, Ireland (Dublin) – many times.

Prof. Dr. Gorbunova has developed first ever course in higher music education in Russia Music Computer Technologies, which has been offered under the Bachelors of Arts and Sciences (BASc), which in 2004 carried out student recruitment in different regions and educational institutions of Russia and she also leads post-graduate courses Music Computer Technologies in Education available under the MA in Music Education, since 2006; then, under the leadership of I. B. Gorbunova, the Bachelor's degree program in Information Technology in Music and Sound Design (2023) and the Master's degree program in Digital Technology in Music and Sound Design (2022) were developed and implemented in the educational process of the Russian Federation.

Prof. Dr. Irina B. Gorbunova has more than 550 scientific publications. There are more than 15 monographs among them: Music Computer Technologies: Historical-Theoretical, The Concept of Music Computer Pedagogical Education, Musical Instruments of the Digital Age, Voice and Computer and the Practical Aspects and Music Computer Technologies: The Problem of Modeling the Process of Musical Creativity; a lot of course books: Information Technology in Music, vol. 1 – 4: vol. 1: Architectonics of Musical Sound, vol. 2: Musical Synthesizers, vol. 3: Musical Computer, vol. 4: Music, Mathematics and Computer Science (compiled with participation of Mikhail S. Zalivadny); Musical Sound Engineering and many others, as well as a variety of educational resources and programs (more than 100) developed for educational purposes, including those hosted in specialized distance education systems such as Moodle, Coursera.

Her research activities include such directions as:

MCT in professional musical education (as a means to expand creative opportunities);

MCT in general musical education (as one of the means of education);

MCT as a means of rehabilitation of people with disabilities;

MCT as the new direction in preparation of specialists of humanitarian and technological profile;

MCT in the field of digital arts;

MCT in information technology, psychoacoustics and musical acoustics; system of training arrangements and the art of performing skills on electronic musical instruments.

Her circle of interests also includes the problems of interrelation of natural and technical sciences and humanities, as well as the possibilities of applying the results of such interrelation for the purposes of music education and upbringing. She also takes part in working out the specialized software for computer music devices and in application of this software in pedagogical processes.

Her developments and researches also belong to the field of musical pedagogics and musicology, musical informatics, computer modeling of processes of musical creativity, timbre programming, art of performing skills and arrangement on electronic musical instruments, creative work in the field of computer music, mathematical methods in musicology.

Prof. Dr. Gorbunova is a Chairperson of the annual International Research and Practical Conference Contemporary Musical Education: Creative Work, Research, Technology, held since 2002; Chairperson of the annual International Research and Practical Conference Music Computer Technologies in the System of Contemporary Education, held since 2007; International Research Conference Music of the 21st Century, held since 2017; Chairperson of the annual Intra-University Scientific Congress Higher School. Scientific Research. We are in Science: Physics.pro, Chemistry.lab, Bio&Geo.field, Math.com, IT.park; Chairperson of the annual International Research Conference Interdisciplinary East-West Discourse: The 21st Century. Creative Work. Research. Technology. Education, held since 2020 (St. Petersburg, Russia – Baku, Azerbaijan); member of the organizing committees of many Russian and foreign conferences.

She is a member of Editorial Boards of International journals: Russian Musicology, Music Scholarship, The World of Science, Culture, Education, *Bulletin of the International Centre of Art and Education*, Electronic international scientific journal of music and sound in electronic mass media, film, Internet, and multimedia *Mediamusic*, *Music and Electronics*, *Art and Education*, *ICONI* and others.

Dr. Gorbunova is a member of the Jury of national and international competitions of musical creative works, including: *Electronic Palette* (Saint-Petersburg), *Music and Electronics* (Moscow), *Music of the 21th Century* (Moscow / Saint-Petersburg), International Festivals and Competitions *Musical Electronics and Multimedia* (Moscow / Saint-Petersburg), *Clarine of the 21th Century* (Saint-Petersburg), The *World of Art without Borders* (Saint-Petersburg, Russia – Szeged, Hungary), *Bridge of Friendship* (Dortmund, Germany), All-Russian Competition of Electroacoustic Music *DEMO* (Saint-Petersburg).

Dr. Gorbunova is a member of the Jury of national and international competitions of musical creative works, including *Electronic Palette* (Saint-Petersburg), *Music and Electronics* (Moscow), *Music of the 21st Century*

(Moscow / Saint-Petersburg), International Festivals and Competitions *Musical Electronics and Multimedia* (Moscow / St.-Petersburg), *CLARINE of the 21st Century* (St. Petersburg), *The World of Art without Borders* (Saint-Petersburg, Russia - Szeged, Hungary), *Bridge of Friendship* (Dortmund, Germany), All-Russian Competition of Electroacoustic Music *DEMO* (St. Petersburg, Russia).

Professor Dr. Gorbunova directs a number of doctoral and postdoctoral studies (more than 30) and lectures on music computer technology and information technology in music. She directs research in various fields, including: *Theory and history of culture, Musical art, Information systems and processes (in music), Theory and methodology of vocational education, Mathematical modeling in music, Numerical methods and software systems, Theory and methods of teaching and educational work (in music, computer science*). The research results of Prof. Gorbunova has published more than 550 peer-reviewed publications, including more than 50 books and more than 300 articles in various scientific journals.

Awards and honors: 3 Gold medals of the all-Russian Exhibition Centre (former VDNKh); Silver medal of the all-Russian Exhibition Centre (former VDNKh); Diploma of the winner in the nomination «New Educational Technologies in ICT Environment» of the all-Russian creative contest of scientific-technical solutions, educational products and services in the field of Informatization of the innovative-educational complex «Music Computer Technologies in the System of Modern Education»; Grand Prix of International Congress-exhibition «Global Education - Education Without Borders»; Diploma of the 11th all-Russian forum «Educational environment» for the project «Digital educational resources «Music Computer Technologies in Education» in nomination of «Creative Competition of Scientific Developments, Innovative Solutions and Programs in the Field of Higher Vocational Education» and many others; Laureate of the Prize of the Government «For Outstanding Achievements in the Field of Higher and Secondary Professional Education»; Honorary Worker of Higher Professional Education of the Russian Federation

Ji Yuchi was born in Guiyang, Guizhou Province, People's Republic of China. Bachelor's Degree (2015-2019): Guizhou Minzu University, Faculty of Music and Dance (Conservatory of Music and Dance). Major: musical arts. Master's Degree (2019-2022): M. P. Drahomanov National Pedagogical University (Kyiv, Ukraine). Major: musical arts (Field of Study).

Currently, the main focus is on postgraduate studies - PhD Program (starting in 2024) at the Herzen State Pedagogical University of Russia, St. Petersburg under the scientific supervision of Professor I. B. Gorbunova (to study for a doctorate in music education). The topic of the dissertation work is *Vocal Teaching in the Professional Musical Educational System in China*. Specialty: music pedagogy (music education). Attention is also currently being paid to continuing vocal training in order to develop skills and improve professional performance: a scientific internship as an assistant (starting in 2025) at the St. Petersburg Rimsky-Korsakov State Conservatory. Specialty: vocal performance.

She has participated in numerous study tours, including the *New York International Choral Festival* (USA) (2014) and the *Urbania International Song Competition* (Italy) (2017).

Her teaching experience (2022-2024): Vocal Instructor (Vocal Music), Department of Arts, Guizhou University College of Science and Technology.

Ji Yuchi won the Gold Medal at the *New York International Choral Festiva*l (USA) (2014), Third Prize in Opera and Art Song at the *7th Urbania International Song Competition* (Italy) (2017), Third Prize in the *Hong Kong International Vocal Open* (2019), and First Prize in the *V.O. Kochur Competition of the Ministry of Culture of Ukraine* (2021).