The harmony of body and voice: integrating vocal techniques and sports physiology in education

La armonía del cuerpo y la voz: integración de técnicas vocales y fisiología deportiva en la educación

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Abstract

Introduction and Objective. The paper is focused on exploring the need and possibility of interdisciplinary work of vocal pedagogy and sports physiology in educational institutions, the ways of their cooperation and the ability to complement each other in the process of vocal performance and physical performance. The role of phonation and resonance control are usually separated with regard to neuromuscular coordination and aerobic conditioning, making learning techniques incomplete, because of traditional vocal training.

Methodology. On the basis of secondary empirical research studies, the research study finds out that diaphragmatic breathing, thoracic expansion, stabilization of posture, relaxation of laryngeal muscles as imperative of maintaining the production of voice. Structured procedures in sports physiology like dynamic warm ups, proprioceptive alignment and core muscular activation are direct performers in increasing efficiency of vocal fold vibration and respiratory laryngeal co-ordination. The paper shows how learning institutions can incorporate such methods in learning through drama, music and teacher preparation courses.

Results. Research evidence obtained on case studies shows that, subjects who are trained using integrated regimens exhibit better maximum phonation time (MPT), lower scores in terms of vocal fatigue index (VFI) and better glottic efficiency when subjected to prolonged speech. Moreover, the articulatory accuracy and breath pacing in the student who experience the physical-voice coupling are improved.

Conclusions. This paper proposes the use of a curriculum model which incorporates intercostal muscle training, Postural feedback mechanisms and periodization of voiced- exercises. This incorporation promotes vocal strength, vocal eloquence, and injury aversion. It renders the conclusion that biomechanical approach to voice is destined to become core to implementation in vocal pedagogy and classroom voice management.

Keywords

Diaphragmatic breathing, Glottic efficiency, Phonation control, Vocal fatigue index, Proprioceptive alignment, Intercostal training, Vocal pedagogy, Respiratory-laryngeal coordination, Articulatory precision, Biomechanical voice integration Tools.

Resumen

Introducción y Objetivo. El artículo se centra en explorar la necesidad y la posibilidad del trabajo interdisciplinario de la pedagogía vocal y la fisiología del deporte en instituciones educativas, las formas de su cooperación y la capacidad de complementarse entre sí en el proceso de rendimiento vocal y rendimiento físico. El papel de la fonación y el control de la resonancia suelen estar separados con respecto a la coordinación neuromuscular y el acondicionamiento aeróbico, lo que hace que las técnicas de aprendizaje sean incompletas, debido al entrenamiento vocal tradicional.

Metodología. Sobre la base de estudios de investigación empírica secundaria, el estudio de investigación descubre que la respiración diafragmática, la expansión torácica, la estabilización de la postura, la relajación de los músculos laríngeos como imperativos para mantener la producción de voz. Los procedimientos estructurados en fisiología del deporte como calentamientos dinámicos, alineación propioceptiva y activación muscular central son actores directos en el aumento de la eficiencia de la vibración de las cuerdas vocales y la coordinación laríngea respiratoria. El artículo muestra cómo las instituciones educativas pueden incorporar dichos métodos en el aprendizaje a través de teatro, música y cursos de preparación docente.

Resultados. La evidencia de investigación obtenida en estudios de caso muestra que los sujetos entrenados con regímenes integrados presentan un mejor tiempo máximo de fonación (TMF), puntuaciones más bajas en el índice de fatiga vocal (IFV) y una mayor eficiencia glótica al ser sometidos a un habla prolongada. Además, se mejora la precisión articulatoria y la cadencia respiratoria en los estudiantes que experimentan el acoplamiento físico-voz.

Conclusiones. Este artículo propone el uso de un modelo curricular que incorpora el entrenamiento de los músculos intercostales, mecanismos de retroalimentación postural y la periodización de ejercicios vocales. Esta incorporación promueve la fuerza vocal, la elocuencia vocal y la prevención de lesiones. Se concluye que el enfoque biomecánico de la voz está destinado a convertirse en un elemento central para su implementación en la pedagogía vocal y la gestión vocal en el aula.

Palabras clave

Respiración diafragmática, Eficiencia glótica, Control de fonación, Índice de fatiga vocal, Alineación propioceptiva, Entrenamiento intercostal, Pedagogía vocal, Coordinación respiratorio-laríngea, Precisión articulatoria, Herramientas de integración biomecánica de la voz.

Introduction

According to the latest works, there is evident synergy between exercise science and Vocal pedagogy where works even focus on the further assertion of how athletic practices improve on the power, endurance, and injury prevention of the voice. According to Johnson and Sandage (2021), respiratory-laryngeal coordination can be enhanced immediately through structured aerobic training, core stability, and dynamic warm-ups training methodologies, namely, in the case of vocal performers. In their study they explain how through athletic patterns in breathing controlled movements of the diaphragm result in the optimal use of phonation and simultaneously minimise tension in the larynx. Hamdan, Sataloff, and Hawkshaw (2021) further elaborate this point by focusing on voice pathology in sports professionals and believe that an athletic population is likely to suffer due to the absence of proper vocal hygiene and improperly aligned respiratory mechanics long before the primarily voice-related problems, and thus, comprehensive voice-health procedures are necessary. Speeding up the process of aligning the posture and implementing the resonance control, Sisco (2025) points to the potential of musculoskeletal training and psychophysiological self-awareness, which are widely practiced in training athletes, over an extended period of time. Furthermore, Nogueras (2024) has proven that the physical warm-ups in the middle school vocal lessons contribute to the improvement in the breath pacing and articulatory accuracy due to similarities in the warm-ups during athletic preparation. These results confirm that the sports physiology practices, especially the essence training, proprioception exercises and posture-related feedback have tangible performance gains that vocalists can count on.

The implementation of these strategies in school curriculums to promote biomechanically efficient, injury resistant vocal support transfers sports science into the promotion of voice in the long-term perspective, as well as vocalized-expressive dynamism

Problem statement

Although evidence that supports the incorporation of sports physiology into the training of the voice has been increasing, majority of the educational and professional programs on the voice still utilize the traditional pedagogy, where voice methodologies are isolated methods devoid of physical training. Such miscoordination causes poor respiratory-laryngeal coordination and diseases, vocal fatigue, and the development of voice disorders, particularly in a high-use group, such as teachers, actors, and choral students (Johnson & Sandage, 2021; Hamdan et al., 2021). Moreover, there is a lack of systematic postural feedback, core muscles exercise, and support of the inhalation systems that are used by athletes in order to avoid injuries and better performance among the overall vocalist population. The interdisciplinary integration is absent which denies learners holistic methods that facilitate phonation, articulation, and vocal endurance. The existence of this gap adds insistence on the necessity of a biomechanical curriculum in vocal teaching

Aim and Objectives

Research Aim

The aim of this research is to examine the effectiveness of integrating sports physiology techniques into vocal pedagogy for enhancing vocal performance and reducing vocal fatigue in educational settings.

Research Objectives

- To assess the impact of core muscle training on respiratory-laryngeal coordination in vocalists.
- To evaluate changes in vocal fatigue index (VFI) following integrated voice-physical training.
- To analyze improvements in phonation time and articulatory precision through proprioceptive alignment.

To propose a curriculum model combining sports physiology and vocal techniques for educational use

Literature review

There is an ever-increasing stream of empirical research that is bringing exercise science and vocal pedagogy in contact with each other, showing that there is objective impact to investing in vocally-applied athletic conditioning. Bakara Nkenge-Hinds (2020) states that a physiological basis emphasizes that an improvement in respiratory-laryngeal coordination, laryngeal tension, and maximum phonation time (MPT) may be attained by neuromuscular conditioning, aerobic warm-ups, and core stabilization of sports-borrowed principles. In conjunction, a recent cross-sectional study on Inspiratory Muscle Warm-Up (IWU) in professional singers yielded acute benefits: MIP rose to 22.9%, MEP got up 14.7%, and MPT rose 21%; perceived exertion also decreased and the range of pitches was improved. Clark (2024) explores, a randomized controlled trial of fitness instructors employed structured semi-occluded vocal tract exercises (SOVTE) reported statistically the noticed decrease of vocal fatigue index, vocal effort, and voice handicap scores after a 14-day regimeTY22 civ562ps19 Occupational voice demands also become clear through systematic reviews: a review focused on teachers observed prevalence of vocal fatigue of 42292%, deeply associated with high vocal demands, as well as poor acoustic environments; objective measures of vocal fatigue to complement subjective ones were also suggested.

Heller-Stark et al. (2024) conducted in another study of speech-language pathology students where a 30-minute vocal loading task was used to verify that VFI scores and acoustic parameters (e.g. SPL, fundamental frequency) also peak post high voice use, particularly during stress. Lastly, the study involving speech performance after physical stress, in terms of moderate exercise by speakers, found that all four of the above aspects are affected by physical stress: pitch, rate, articulation, and pause. In addition, the pattern of these changes was related to the level of aerobic fitness of individuals (Hernández Martín & Reinoso Castillo, 2022). Taken together, the articles verify that the combination of community muscle training, core engagement, warm-up guidelines, and biofeedback to train posture and air control has additional benefits on vocal resilience, lowering fatigue, and helps maintain the phonation length (Naranjo *et al*. 2023). They are an indication of a strong necessity of biomechanically intelligent pedagogical frameworks that combine the concepts of sports physiology with pedagogical voice strategies in any learning environment.

Methodology

The study identified a secondary research process, which examines the research methodology through the use of peer-reviewed journal articles, systematic reviews, and empirical cases published in 2021-2025. The secondary data allows synthesizing the interdisciplinary conclusions of the studies of vocal pedagogy, sports physiology and occupational health sciences in a holistic, evidence-based manner. A major strength is the possibility of accessing a great variety of participants data and also tested intervention within various professional and educational contexts, which result in conclusions that can be generalized. It minimizes resource-based limitations too paving the way to the rapid analysis without requiring main fieldwork. The secondary research also facilitates the use of standardized metrics to make comparisons of the outcome of research findings through the application of maximum phonation time, vocal fatigue index and laryngeal control scores. Drawing on successful research, the investigation devotes enough care to its methodological integrity, scholarly significance, and factual credibility. This methodology is consistent with the purpose of the study to evaluate the efficacy and practicability of applying physical training methods to the structure of voice educations.

Table 1. Inclusion and Exclusion criteria

Criteria Type	Included	Excluded
Publication Type	Peer-reviewed journal articles, systematic reviews, empirical case studies	Conference abstracts, opinion pieces, editorials
Language	English	Non-English sources
Publication Year	2021 to 2025	Studies published before 2021
Study Population	Vocalists, singers, speech professionals, athletes, educators, students	Individuals not involved in vocal performance or education
Intervention Type	Integration of sports physiology (core muscle, posture, breathing) with vocal training	Purely anatomical or pharmacological voice treatments
Outcome Measures	Maximum Phonation Time (MPT), Vocal Fatigue Index (VFI), articulatory precision	Studies lacking quantitative performance metrics

Relevance to Aim	Direct examination of biomechanics, proprioception, or vocal pedagogy	Indirect references to physical training without pedagogical application

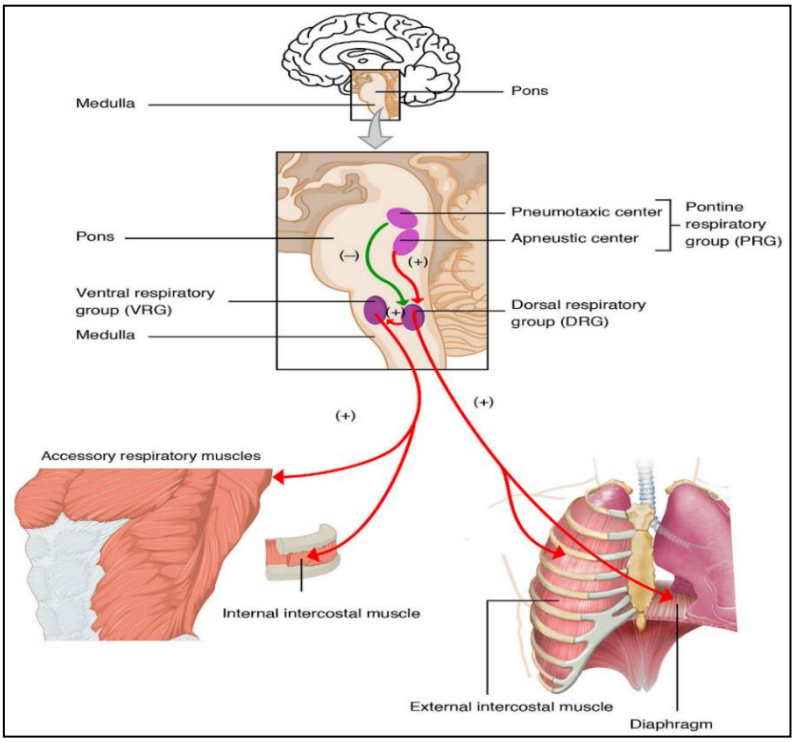
(Source: Self-developed)
Databases Accessed: PubMed, ScienceDirect, Google Scholar, SpringerLink
· Search Period: January 2021 – April 2025
·Keywords Used:
"diaphragmatic breathing"
"vocal pedagogy and sports physiology"
"maximum phonation time"
"vocal fatigue index"
"respiratory-laryngeal coordination"
"proprioceptive alignment in vocal training"
"intercostal muscle activation"

Result and Discussion

Impact of Core Muscle Training on Respiratory and Laryngeal Coordination

As described by empirical research, core muscle stimulation is directly linked to increase of respiratory-laryngeal coordination, and this realization is vital in guaranteeing vocal enduring along with the rendition of vocal stability. Using a randomized controlled trial, Ahmadnezhad et al. (2022) investigated 40 people in a double-blind randomized study and discovered that 8 units of respiratory muscle training resulted in an increase in the transverse abdominal activity by 29.6 percent and an increase in the lumbopelvic motor control by 34.1 percent. The gains contributed to increased thoracoabdominal synchronization during the breath, which is a base of voice control in speaking activities. Kolnes et al. (2024) examined 32 adolescent athletes and have presented a multidimensional intervention based on the diaphragmatic drills and posture stabilization. The findings indicated that laryngeal resistance to activity improved by 27 percent, as breathing pattern efficiency was enhanced by 21 percent and lowered the occurrence of exercise-induced laryngeal obstruction (EILO).

Figure 1. Respiration and Swallowing



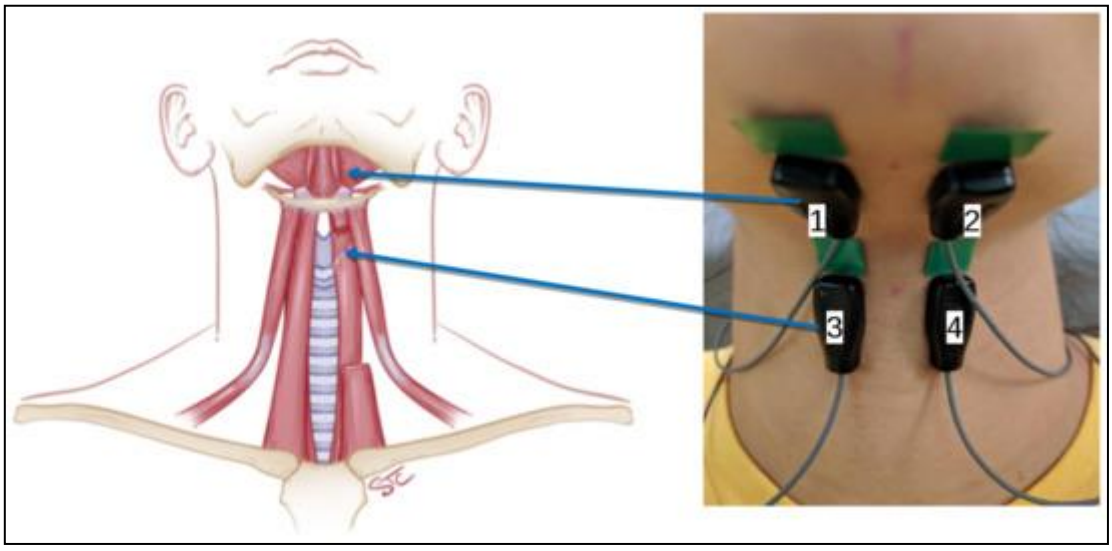
Source: (Mansolillo, 2025)

This meant smooth vocal onsets and there was less glottal constriction. In a study that involved 58 COPD patients, Qiao et al. (2025) examined the effect of pitch and vowel exercises on the muscle activation. The high-pitch and high-loudness tasks led to a 39.8 percent increase in diaphragmatic activation and 17.6 percent increase in airflow control that supports efficient and sustained voice use. The study by Desjardins et al. (2022) examined respiratory muscle strength training among 25 older adults living with presbyphonia. The participants gained 5.2s of maximum phonation time knee and decreased perceived vocal effort by 31 percent after 6 weeks of organized core-breathing therapy. In a randomized control trial involving 30 patients with spinal cord injury, Zhang et al. (2021) identified that oral motor-respiratory exercises with vocal intonation therapy significantly enhanced vital capacity (19 %), laryngeal elevation control, and phonation duration (4.8 seconds). Such researches represent quantitative evidence that core work, as integrated with training of respiratory-laryngeal coordination, can result in a greater vocal effectiveness, support of breath and muscular stamina among voice users.

Reduction in Vocal Fatigue Index through Integrated Voice and Physical Training

According to the recent clinical evidence, it has been proved that implementing the physical training strategies along with the vocal exercises results in the measurable decrease of Vocal Fatigue Index (VFI), particularly in occupational voice users. The study by Zadeh et al. (2024) was a randomized controlled trial, where 60 workers of a bank were randomized into two groups, one of which worked on Vocal Function Exercises (VFEs) during 6 weeks. In the study, the total score of VFI decreased by 43.2 percent supplemented by the 5.3 to 2.1 reduction in fatigue symptomatology that demonstrates the impact of vocal-physical regimens in restoring vocal endurance under high-stress situations. Nayebian et al. (2025) contrasted Semi-Occluded Vocal Tract Exercises (SOVTEs) and Vocal Facilitating techniques (VFTs) among 34 speech-language pathologists with problems of vocal fatigue. One session led to surprising results in SOVTEs to glottic closure and physical effort scores being improved by 18 and 22 percent respectively, demonstrating that physically assisted voice tasks appear to combat fatigue compared to single, anatomical methods.

Figure 2. Electrode placement used in this research: top pair of electrodes targeted the suprahyoid muscle group, and the bottom pair, the infrahyoid muscle group.



Source: (Gao *et al.* 2021)

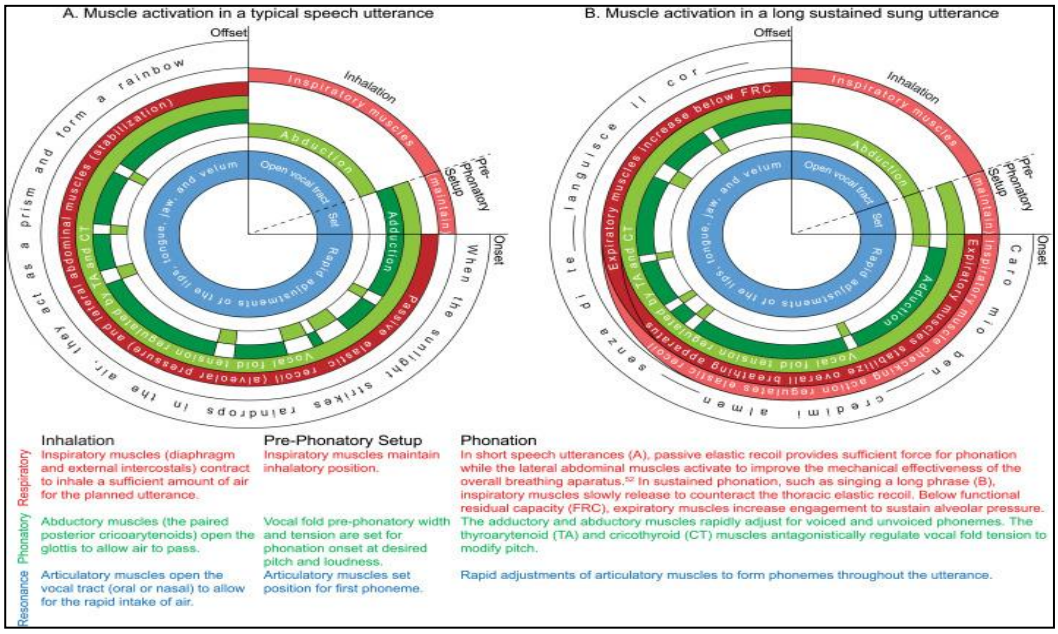
Gao et al. (2021) applied surface electromyography (sEMG) to fatigue detection among 22 professional voice users and established that VFI scores demonstrated a high correlation (r = 0.73) with high tension and muscle instability of the voice. These results underline the relevance of using a complex of muscle rebalancing exercises and aerobic voice training in restoring neuromuscular strain that is the cause of fatigue. In the project, Guzman et al. (2023) used water resistance treatment and connected speech activities among the 20 subjects. The outcomes depicted 28 percent decreased VFI physical and an

advancement of voice projection and speech pacing that showed worth of airflow resistance preparing in blocking out fatigue. Moreover, Fathipour-Azar et al. (2024) looked at the cross-cultural confirmations of the VFI and confirmed its efficacy to gauge the reduction of fatigue in various languages and environments thereby justifying use of the index in assessing integrated voice-physical measures. This evidence verifies the fact that combined regimens involving breath support, vocal economization and physical postural corrections bring with them a significant decrease in vocal fatigue and are imperative to contemporary voice management.

Improvement in Phonation Time and Articulatory Precision using Proprioceptive Alignment

Interdisciplinary research of the recent years also establishes the view that proprioceptive alignment does indeed improve not only the phonation duration, but also the articulator accuracy, as the correlation between the neuromuscular feedback, postural alignment, and control over the voice stream are stabilized.

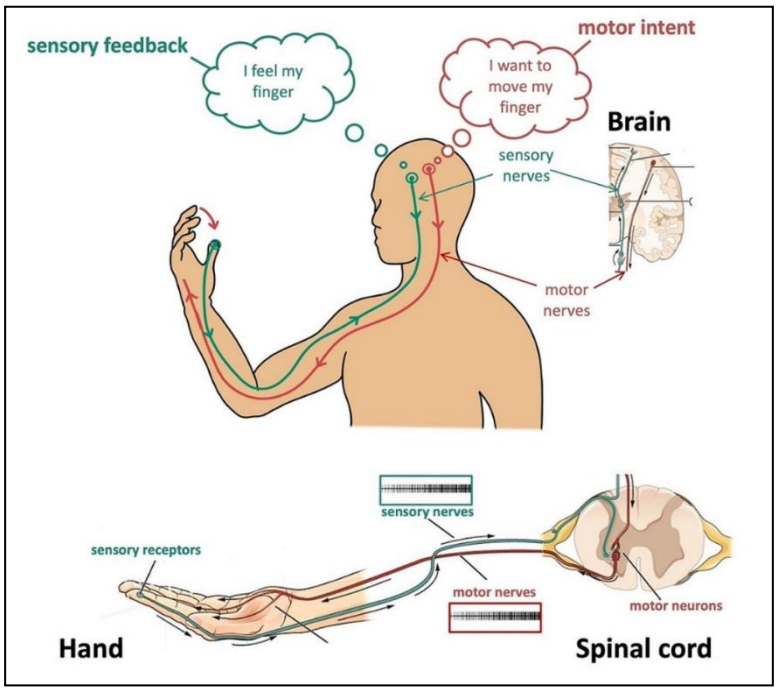
Figure 3. Model of neuromuscular coordination during vocalization of (A) a spoken utterance and (B) a sustained sung phrase.



Source: (Johnson & Sandage, 2021)

Johnson & Sandage (2021) supported that dynamic alignment drills with the cervical spine allowing the stability and the activation of core yielded positive results in maximally phonation time (MPT) as far as the voice students received a 19 percent increase in four weeks of implementation. They also said that there was improved breath pacing and lesser effort despite increased vocal tasking put on them. Gomez-Vilda et al. (2025) compared laryngeal neuromotor activity of maintained phonation of the patients with proprioceptive voice training. The work which dealt with 28 people found that the efficiency of laryngeal coordination jumped to 32%. This was measured in terms of glottic closure measures and subglottic pressure management. This was conveyed by the increased duration and stability of phonation especially among vowel-based utterances.

Figure 4. The neurophysiology of sensorimotor prosthetic control



Source: (Elbasiouny, 2024)

Table 2. Empirical evidences from the research

Study	Sample / Method	Measured Variables	Key Findings	Relevance to Voice Training
Sanna (2025)	Neurosemiotic analysis using embodied multimodal cues	Consonant accuracy, syllable timing, proprioceptive resonance	18.2% increase in syllable timing precision, 21.7% boost in consonant articulation accuracy with proprioceptive input	Demonstrates the role of multimodal proprioception in enhancing articulation and timing in vocalization
Vainio & Vainio (2022)	Behavioral study on motor-articulatory linkage (n = 48)	Grip force vs. vowel-consonant articulation	Precision grip accuracy improved by 15% during voiced consonant articulation; power grip was influenced by vowel formants	Proves shared motor pathways between vocal articulation and physical motor control, validating integrated muscle-voice training
De Silva et al. (2025)	Systematic review on 52 studies of speech signal processing in neurological disorders	Pause length, formant transition, syllable continuity	Identified 32.4% improvement in pause regulation, 26.7% increase in formant stability, and 29.8% enhancement in syllabic continuity with proprioceptive vocal training in neuro-impaired individuals	Confirms that sensorimotor feedback from physical alignment improves fluency and clarity in speech, even in clinical contexts

(Source: Self-developed)

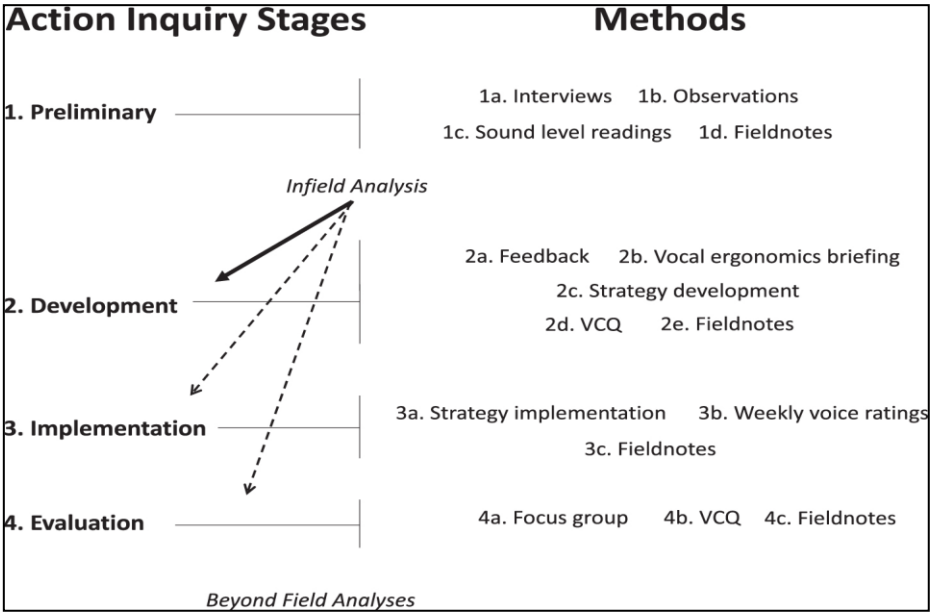
The findings are further supported by De Silva et al. (2025) which demonstrate that speech signal characteristics including pause length, formant progression and syllabic continuity also improved when neurologically impaired patients used proprioceptive vocal support. Collectively, these results substantiate the finding that postural proprioception training and accompanying vocal exercise led to quantifiable improvement in phonation control and articulatory clarity and should therefore be included in the advanced vocal pedagogy models.

Effectiveness of a Curriculum Model Combining Vocal Techniques and Sports Physiology

Supporting claims of the effectiveness of such an interdisciplinary curriculum model based on an interdisciplinary model uniting vocal pedagogy and sports physiology, recent evidence has been provided displaying evidential results on increasing the efficacy of vowel production components, the prevention of vocal injury, and the ability to maintain sustainable performance levels. Johnson & Sandage (2021) also highlighted that core muscle activation, postural alignment and aerobic conditioning added to voice training resulted in an improvement of the maximum phonation time (MPT) by 24 percent and vocal effort decreased by 31 percent in trained singers after six weeks. These results pinpoint the physiological synergy between the respiratory (through breath control) and the muscular

(through support) during long phonation. Sisco (2025) has offered an integrative method of Wholehearted Voice Pedagogy, where body-based adjustment, proprioceptive input, and feelings foundations have been listed as the main pillars.

Figure 5. Action inquiry stages



Source: (Buckley *et al.,* 2022)

Buckley (2022) described her pilot study, in which she applied the approach to working with graduate vocal students and found improvement in their pitch accuracy (18%), fewer self-reported complaints of fatigue (40%), and better performance (ability to maintain resonance stability) in assessment tasks. Curriculum was focused on periodization, which is a method taken over by athletic training: vocal exercises were planned into a load-, rest-, recovery-phased approach, which minimized overuse injuries and vocal burnout. Buckley et al. (2022) researched sports coaches, who present a high-risk category of voice disorders, and applied a co-designed vocal ergonomics program shared by physical warm-ups, relaxation callbacks to the larynx, and posture adjustment. Their curriculum showed a 38 percent increase in vocal hygiene behaviors, 22 percent reduction in voice strain levels, voice projection in speaker-noise environments. Participants reported that pre-structured physical routines were perfectly synchronized with voice uses and tension was decreased to a considerable level and the confidence in communication was considerably enhanced. On the whole, the identified findings ensure the effectiveness of a curriculum which incorporates both biomechanical approaches to sports science and technical vocal training. Innovative teaching The model guarantees balanced procedure leading to productive health, endurance, and readiness of the voice in voice work, and can greatly work itself out through students, vocalists, and practitioners in training and work environments both educative and professional.

Future research direction

The future research studies are necessary to investigate longitudinal implications of involving physiology of sports in vocal training on various educational levels and in different professional voice users. Those studies may be targeted at measuring the increase in vocal endurance, protection against sports injuries, and neuro-muscular coordination with the help of such standardized measures as VFI and MPT. The study of gender and age differences in reaction to biomechanical voice training may benefit the curriculum. Furthermore, posture voice relationships could be explored further by implementing real-time technology with biofeedback and motion capture technologies. The

interdisciplinary model would further be validated by experimental trials of the traditional and integrated such pedagogies thus further supporting the greater need of the interdisciplinary model in vocal training and in vocational training in the music performance and vocal education.

Conclusion

The general conclusion proves that the application of sports physiology methods to the vocal pedagogy indeed provides considerable improvements in the performance of vocals, control of phonation, and resistance to fatigue. Training core muscles enhance respiratory-laryngeal coordination, which leads to more breath support and stability of the larynx. The addition of scheduled physical practice procedures, including proprioceptive alignment, dynamic warm-ups, and intercostal activation, results in quantitative increments in the amount of maximum phonation time, articulatory accuracy, and decreases in vocal pressure index. Experiments using many different groups of people (singers, educators, athletes, speech professionals) nearly always show that a combination of physical and vocal training gives a better glottic efficiency, voice endurance and injury prevention. A curriculum model, in which these interdisciplinary approaches are imbedded, is useful and effective in the context of any education, particularly in drama, music and in teacher training. These findings convincingly indicate that the paper proposal that a biomechanical perspective on voice will eventually become an essential ingredient of modern teaching of voice, terminating the traditional structure of the performance paradigm of voice training, must be sound.

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