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Addressing Microaggressions: The Anti-Oppressive Case Conceptualization Framework in Counselor Education

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Abstract

Transgender and gender-expansive (T/GE) youth, who are Black, Indigenous, and Persons of Color (BIPOC), are at the crux of multiple marginalized identities and experience multiple forms of marginalization stress. Microaggressions are particularly potent, often covert acts of oppression that activate the stress response, and occur both in the counseling environment and in the counselor education classroom. Counselors-in-training (CIT) may benefit from a structured case conceptualization framework that integrates antioppressive pedagogy (AOP) with an approach to case formulation that is concrete and accessible to CITs. This teaching brief provides counselor educators with an antioppressive case conceptualization framework (ACCF) for use during fieldwork. Readers are also provided with classroom strategies to model antioppressive practices and address microaggressions in the classroom.

Keywords: Antioppressive, Microaggression, Case Conceptualization, Advocacy, Counselor Education

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Introduction

Transgender and gender-expansive (T/GE) youth (aged three and 18 years) who are Black, Indigenous, and Persons of Color (BIPOC) are at the intersection of multiple oppressed identities and experience high rates of minority stress (Human Rights Campaign, 2019; Price--Feeney et al., 2020). Crenshaw (1989) described the experience of discrimination for persons with multiple oppressed identities as analogous to a traffic intersection. These individuals are at the crossroads of multiple lanes of discrimination and thus experience the crash together of prejudice. This creates a complex pallet of experiences for each individual according to their unique intersections.

Relevant Research

Microaggressions are a common form of oppression experienced by T/GE BIPOC youth. Microaggressions are brief statements or behaviors that "communicate hostile, derogatory, or negative slights or insults" (Sue et al., 2007, p. 271) toward the individual and their identit(ies). These aggressions can be categorized as microassaults, microinsults, or microinvalidations. Microassaults include conscious beliefs communicated through verbalizations, behaviors, or other cues. Microinsults are interpersonal in nature and often unintentional, with the individual's behavior or statements perpetuating stereotypes. Microinvalidations are considered the most covert form of microaggressions, as they invalidate the experiences of marginalized people and groups in insidious ways (Sue et al., 2007).

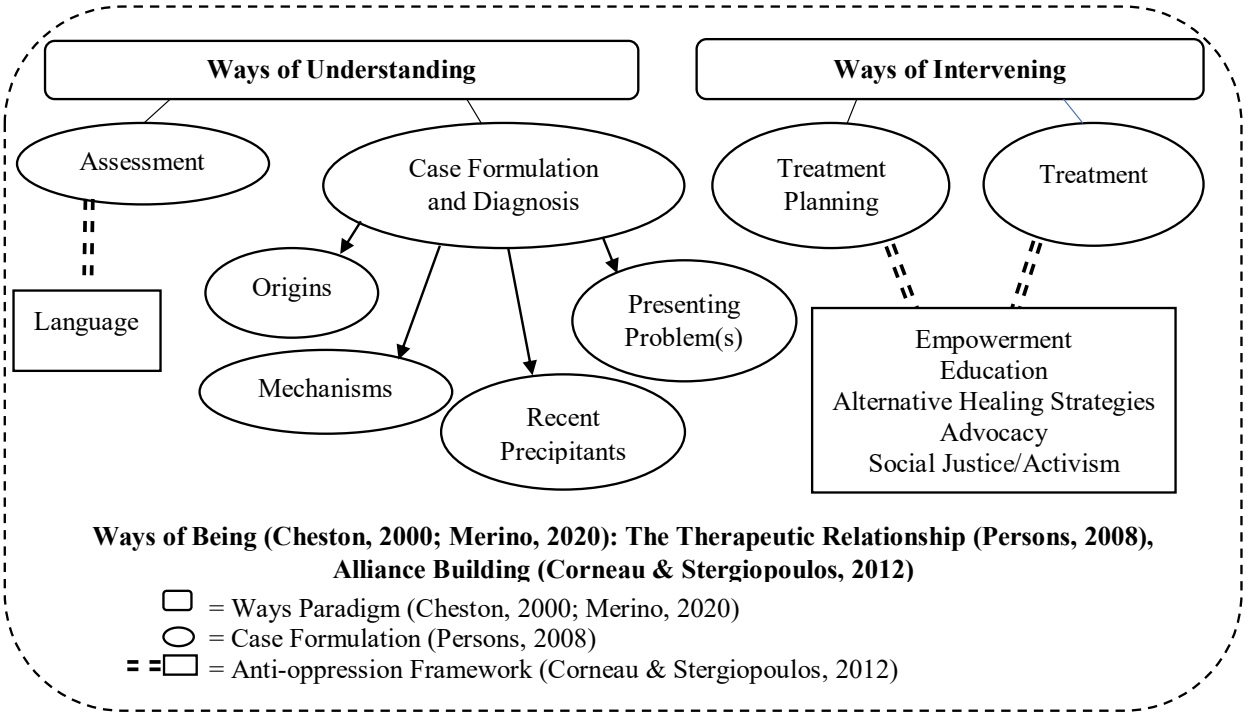
Political news in the United States (U.S.) is rife with examples of all three forms of microaggressions (Ross, 2015), particularly against Lesbian, Gay, Bisexual, Transgender, Queer and others (LGBTQ+) and BIPOC persons. The correlations between these microaggressions and adverse impacts on health are significant, with 90% of LGBTQ youth reporting that recent politics have adversely impacted their well-being (Trevor Project, 2024). Youths who are T/GE and BIPOC often experience higher rates of mental health symptoms, homelessness, discrimination in healthcare (Human Rights Campaign, 2019), and harassment in schools (Price-Feeney, Green, & Dorison, 2020; The Trevor Project, 2020) and are four times more likely to be victims of violent crimes than cisgender people are (Flores et al., 2021).

Despite disproportionally high rates of mental health symptoms, these youth are less likely to access health-related services (Smedly et al., 2003; Takeuchi et al., 1999). The reasons why members of this community fail to access behavioral health services or do not persist in treatment include previous negative experiences with counselor(s) (Crawford, 2011), counselor perpetration of microaggressions (Constantine, 2007), and counselors' lack of cultural humility (Hook et al., 2016).

Rationale

The use of AOP may help clinicians avoid prejudicial attitudes and behaviors in sessions and improve T/GE BIPOC clients' experience with behavioral health services. The use of this lens requires an understanding of power and privilege, prejudice, and discrimination (Corneau & Stergiopoulos, 2012; Harlow & Hearn, 1996; Mallison, 1995), as well as the ongoing self-development of a clinician's awareness and skills. Fieldwork courses are a particularly impactful time for implementing AOP, as CITs are actively practicing and developing their professional counselor identity and cultural selves. We propose the use of the following structured ACCF with CITs during fieldwork. The framework integrates the case formulation approach (Persons, 2008) with AOP (Corneau & Stergiopoulos, 2012) and the ways paradigm (Cheston, 2000; Merino, 2020) and provides a process that focuses on minority stressors, system considerations, and the treatment needs of T/GE BIPOC youth clients. Figure 1 provides an illustration of each variable addressed when this framework is utilized.

Figure 1. The Anti-Oppressive Case Conceptualization Framework



Teaching Innovation

Application to Counselor Education

The Case Formulation Approach

The application of evidence-based practices with diverse communities requires flexible decision-making, attention to the mechanisms of distress (e.g., minority stress and environmental factors), and evaluation of the efficacy of interventions (Pachankis & Safren, 2019). Clients who are BIPOC and T/GE face particular challenges when seeking behavioral healthcare, as the training of providers is steeped in a euro-centric lens, and existing research regarding interventions is most often normed with white, heterosexual, cisgender, middle to high socioeconomic status, middle-aged individuals (Remley & Herlihy, 2020). The case formulation approach (Persons, 2008) views evidence-based practice as a "template" for the treatment process. This approach provides a flexible and ethical framework for the individualization of care and hypothesis testing throughout the therapeutic process (Persons, 2006). We propose integrating the case formulation approach (Persons, 2006; 2008) with the ways paradigm (Cheston, 2000; Merino, 2020) and AOP (Corneau & Stergiopoulos, 2012) to cultivate an ACCF.

Antioppressive Pedagogy

The implementation of AOP in the classroom includes the exploration of 1) the realities of oppression and 2) the strategies and policies needed to effect change. Educators may focus on educational practices that directly support multiple marginalized students; teach about different identities (e.g., ethnicity, gender identity, and sexual identity); promote critical evaluation of the "privileging" of groups and "othering" of certain communities; and support reflective practice and advocacy (Kumashiro, 2000). When providing mental health services from an anti-oppressive lens, helping strategies align with seven primary categories. These categories include language, rapport building, empowerment, psychoeducation, alternative or complementary treatment modalities, social justice/activism, advocacy, and reflective practice (Corneau & Stergiopoulos, 2012). These categories

are outlined in Table 1. The proposed model focuses on each of these strategies over the course of the therapeutic process.

Table 1. *Categories of Anti-Oppressive Strategies (Corneau & Stergiopoulos, 2012)*

Language	Practitioners utilize language that is nonstigmatizing, and avoid using ranks, titles, or positions, thus fostering a more egalitarian relationship.
Rapport or alliance building	Practitioners cultivate connections between oppressed groups and recognize that these relationships are critical to challenging racist and discriminatory discourses, stereotypes, and negative public perceptions of stigmatized groups.
Empowerment	Practitioners encourage client participation with decision-making for all aspects of their care, and validate client's beliefs, life experience, and strengths.
Psycho-education	Practitioners educate themselves and others about the relationship between power and equity, and perpetuation of oppression through policy and institutional structures. To be considered anti-oppressive or anti-racist, this knowledge and awareness must include advocacy and activism.
Alternative or Complementary Treatment Modalities	Practitioners employ a holistic approach to treatment, distancing themselves from the medical model. Client distress is viewed as significantly influenced by their ecological context.
Social Justice/Activism; Advocacy	Practitioners pursue positive change at the individual, and systems-levels by advocating with, and on behalf of their clients.
Reflective Practice or Fostering Reflexivity	Self-examination of practitioner's relationship to the dominant systems of power, as well as their social position, and own cultural biases and blind spots are critical to reflective practice.

Ways of Understanding

Assessment. Merino (2020) and Cheston (2000) describe CITs' knowledge regarding theories, case formulation, diagnosis, and assessment as "ways of understanding" how mental health concerns emerge. The "ways of understanding" aid CITs in conceptualizing how client change occurs and identifying benchmarks of optimal functioning. This process can inadvertently lead to oppressive sentiments in therapeutic relationships and clinical processes. Counselor educators employing the ACCF attend to the tenets of critical race theory (CRT), supporting CITs, as they consider how whiteness and "color blindness" impact the assessment process and formulate the client's case (Haskins & Singh, 2015). Furthermore, CRT informs how we understand the client's view of the counseling process and the counselor's role (Trahan & Lemberger-Truelove, 2014).

Understanding case formulation via an anti-oppressive lens also requires the use of queer theory. CITs utilizing the ACCF with T/GE BIPOC youth clients must reconsider their beliefs about gender identities. Counselor educators support their CITs in critically evaluating their taken-for-granted beliefs about gender, ethnicity, and other identities.

Ways of Being: the Therapeutic Relationship & Alliance Building

Unfortunately, T/GE individuals do not always have a positive experience in therapy (Benson, 2012). The most commonly cited barrier to a positive therapeutic relationship was clients having to educate their counselors on T/GE issues (Benson 2012). Additionally, T/GE and BIPOC clients report multiple levels of invalidation from counselors, including misgendering, misuse of pronouns, avoidance of discussing gender issues, and visible discomfort in their counselor while they share their stories (McCullough et al., 2017).

Positive factors that contribute to the therapeutic relationship include affirming T/GE language and acknowledging systemic barriers and advocacy to remove such barriers (McCullough et al., 2017).

Several studies regarding counseling T/GE and BIPOC Lesbian, gay, bisexual, transgender, queer, intersex, asexual, and other (LGBTQIA+) populations emphasize advocacy as a crucial component in a therapeutic relationship (McCullough et al., 2017; Parker-Barnes et al., 2022).

During their education, CITs learn how to cultivate "ways of being" with clients that convey warmth, empathy, unconditional positive regard, and congruence (Rogers, 2003). Ways of being also include one's cultural awareness, ability to engage in perspective taking, and ability to understand intersectionality (Tormala et al., 2018). This cultivation of "ways of being" is also known as "cultural formulation" (American Psychiatric Association, 2022). Cultural formulation and core therapeutic conditions, coupled with the appropriate use of attending skills, enable CITs to cultivate an effective therapeutic relationship (Cheston, 2000; Merino, 2020). Counselor educators support cultural formulation when they employ AOP in the classroom by addressing power imbalances in the helping relationship and supporting students as they challenge discriminatory dialog and stereotypes (Corneau & Stergiopoulos, 2012). Counselor educators also encourage CITs to engage in bidirectional learning during client-counselor relationship building; this enables the clinician to address the inherent power imbalance associated with the helper-helpee relationship (Fisher-Borne et al., 2015).

Case Formulation and Diagnosis

Origins

When implementing this framework, counselor educators support CITs in considering the role of minority stress (Keuroghlian, 2018), historical trauma and colonization (Styrker, 2017), racial oppression (Helms, Nicolas, & Green, 2010), and prejudicial acts (Anti-Defamation League, 2003) in the context of client experience. These systemic factors play a significant role in T/GE BIPOC youth clients' development, ability to achieve success (e.g., in academics, socially, and/or professionally), and access resources. One example of the impact of these factors is the ill effects of stereotype threat, a phenomenon where BIPOC and women experience lower scores on standardized tests (among other measures), particularly in the fields of science, technology, engineering, and mathematics ([STEM]; Steele, 2010).

Experiences of discrimination, transphobia, and being "othered" may contribute to T/GE clients' experience of social isolation and impede their ability to experience social belonging (Austin & Craig, 2015). The origins of T/GE BIPOC youth client distress are closely connected to the mechanisms, or recent precipitants, of current mental health symptoms and presenting problems.

Mechanisms

Counselor educators assist CITs in considering those specific mechanisms that are at the core of T/GE BIPOC clients' distress. These mechanisms include internalized transphobia, as clients assume the negative biases imposed upon them by cisnormative societal moors. The internalization of transphobia may contribute to self-hate, decrease client resilience, and negatively impact their ability to cope with other stressors (Hendricks & Testa, 2012; Pachankis et al., 2008). Clients who experience assumptions of transphobic beliefs and behaviors may be prone to rejection sensitivity, a phenomenon where a T/GE person experiences hypervigilance around the expectation of rejection. Rejection sensitivity is correlated with higher rates of anxiety and depression (Feinstein, 2019).

T/GE persons also experience difficulties with presenting as their authentic selves when connecting with the community. Engagement with the community is associated with resilience, yet many T/GE individuals must conceal their gender identity due to safety concerns (Austin & Craig, 2015; Hendricks & Testa, 2012). T/GE youth clients may also experience dysphoria associated with a lack of alignment between external presentation and internal gender identity. Gender dysphoria and weight concerns are risk factors for suicidal ideation and attempts and self-harming behavior in T/GE youth (Peterson et al., 2016).

Internalized racism may also impact T/GE BIPOC youth clients' mental health and wellbeing. The internalization of racism is characterized by the adoption of White culture's negative stereotypes about one's ethnicity and the rejection of African ideas and culture (Bailey et al., 2011; Sosoo et al., 2019). Sosoo et al. (2019) describe internalized racism as "a form of psychological slavery that is potentially more pernicious than physical slavery has been associated with" (p. 4). Specifically, this assumption of racist beliefs and actions often falls within 4 categories: "internalization of negative stereotypes…belief in the biased representation of history…alteration of physical appearance…and hair change" to prefer straight hair (Sosoo et al., 2019, p. 4). A higher incidence of internalized racism is associated with increased anxiety, particularly in situations where the BIPOC experiences discrimination (Sosoo et al., 2019).

Ways of Intervening

The "ways of intervening" portion of the ways paradigm is where the "techniques grounded in theory are utilized in helping the client reach their therapeutic goals" (Merino, 2020, p. 497). When providing services from an anti-oppressive lens, helping strategies align with the following: empowerment, psychoeducation, alternative or complementary treatment modalities, social justice/activism, and advocacy (Corneau & Stergiopoulos, 2012).

Resources for Implementation

Counselor educators employing the ACCF facilitate class discussion regarding how interventions might encourage client participation in decision-making processes (empowerment) and encourage CITs to educate themselves and others about equity, power imbalances, and institutional discrimination (psychoeducation). Educators also support CITs, as they develop a holistic model of treatment (alternative or complementary treatment modalities). In practice, counselor educators may provide their students with copies of Table 1 and verbally proceed through how each step and strategy apply to the client case. Educators may also utilize the provided case and Table 2 as examples of this framework in practice. The final ACCF focuses on the practitioner's advocacy efforts with and on behalf of the client to effect individual and systems-level change (social justice/activism; advocacy). Learning how and when to implement this strategy requires a paradigm shift from the individualized westernized view of behavioral health to an ecological perspective that acknowledges the necessity of advocacy (Pickover et al., 2020).

Evaluation of the effectiveness of teaching innovation

The ACCF supports CITs' development of a "way of being" that is associated with increased positive outcomes and client engagement (Mosher et al., 2017). The efficacy of this teaching innovation may be measured via a structured self-report measure administered at the beginning of the fieldwork course and again at the end of the course. This measure uses the themes associated with CITs' cultural formulation (Tormala et al., 2018) to inform key areas of growth associated with the ACCF. Administering this assessment as a pre- and postintervention measure may assist counselor educators in assessing the efficacy of this innovative strategy. See Table 2 for a copy of this evaluation tool.

Table 2. The Anti-Oppressive Case Conceptualization Framework: Case Formulation Assessment Tool

Instructions: Review each of the items listed below, and indicate how strongly you agree with each statement as applies to your work with T/GE and BIPOC youth.					
Case Formulation – Areas of Assessment	**Strongly Agree**	**Agree**	**Neither Agree nor Disagree**	**Disagree**	**Strongly Disagree**
Cultural self-awareness: I am aware of how my "ways of being" in the therapeutic space may impact the client. Specifically, I understand how the following factors may impact the client -					
My cultural background.					
My power and privilege in relation to the client.					
How I demonstrate my understanding of the clients' possible discomfort with our cultural differences.					
Intersectionality & Perspective taking:					
I recognize how my "ways of understanding" are influenced by my own intersecting identities.					
I understand how my clients' multiple marginalized identities intersect, with these clients experiencing numerous forms of discrimination, and prejudice.					
Evidence-based Practices:					
I employ evidence-based practices in my "ways of intervening" with clients with multiple marginalized identities.					
I understand the role of clinician-client rapport in positive outcomes and treatment efficacy, and prioritize alliance-building.					
I am aware of the significant impact of minority stress, historical oppression, institutional discrimination, and microaggressions on the health and wellbeing of my multiply marginalized clients.					
Implicit biases:					
I am actively working to identify my own biases, and unsupported beliefs about specific cultures and identities, and how these beliefs impact my counseling practice, and my multiply marginalized clients.					
Power/privilege differential:					
I recognize the power differential between myself, and my multiply marginalized clients.					
I engage in intentional deep self-reflection regarding my own privilege, and experiences of oppression, and how my privileged identities might impact the power differential in session.					
In an effort to empower clients and neutralize this power imbalance, I view my client as the expert in their own life, honor my clients' unique cultural experience, and aim to practice with cultural humility.					
I continuously advocate with, and on behalf of my multiply marginalized clients to pursue positive social and institutional changes that might reduce discrimination and oppression.					
These items adapted from Tormala et al. (2018) themes in counselors' cultural formulation when working with marginalized clients, and integrated with those models included in the anti-oppressive case conceptualization approach.					

Case Vignette: The Case of "Mari"

Adam (he/him/his), a CIT intern has just completed his 3rd session with client Mari. Mari is 15 years old, uses them/them pronouns, and describes their self as "nonbinary", "multiracial…Cuban and

Hispanic", pansexual, and "not religious…but my family is very Christian". They describe living in a single parent household, with their mother as their primary financial support and their close friends and siblings as their social and emotional support. Mari identifies their goals for treatment as 1) creating a plan for accessing gender-affirming medical care (specifically testosterone), 2) improving communication with mothers and 3) processing grief and loss associated with the loss of best friends who died by suicide.

In the internship class, Adam shares that he considers himself an ally for the T/GE folx, but he is unsure of how to support Mari with the goals of accessing testosterone and facilitating conversations with Mari's mom. The internship instructor elects to use the ACCF to support Adam, and the other students conceptualize Mari's case and Adam's ways of "being", "understanding", and "intervening".

The instructor's first step is to provide the students with a visual representation of the conceptualization process; Adam's instructor provides classes with a print out of Figure 1. She then asks Adam to identify those aspects of the model that seem most relevant to his experience with Mari. Adam identifies the core areas in Table 3, and the instructor writes them on the white board at the front of the classroom. The class then engages in open discussion regarding how each of these foci might be addressed.

Table 3. Applying the Anti-oppressive Case Conceptualization Framework (ACCF) with the Case of "Mari"

ACCF: CIT Identified Focus Areas	Recommendations for Addressing Focus Area
Way of Understanding - Assessment - Case formulation and diagnosis o Origins, Mechanisms, Recent precipitants, Presenting problem	Assess for gender dysphoria; consider – mom's awareness of and ambivalence and/or support of Mari's identities, Mari's distress in different situations and settings Mari's presenting problems include anxiety, and depression, with symptoms most severe when around mom, and certain peers at school (origins). Symptoms started approximately 2 years ago, about the time they started puberty and their friend died by suicide (mechanisms). Mari says peer-based bullying and gender harassment at school, and mom's belief that their gender identity is a "phase" and that "God didn't make me that way" are "what make things truly tough" (recent precipitants).
Ways of Intervening - Treatment (specifically identifying objectives, and achieving the treatment plan) o Empowerment, Education, Advocacy, Social Justice/Activism	Adam considers: Referral letter (in line World Professional Association for Transgender Health (WPATH) standards of care 7 and 8) for Hormone Replacement Therapy (HRT) Support Mari with self-advocacy with bullying, and mom's rejecting behaviors and statements. Educating Mari's mom about the role of family acceptance and support in Mari's wellbeing

The instructor then asks Adam to consider his responses to the questions covered in the "Case Formulation Assessment Tool" that was administered during week 1. Adam shares that he sees the questions about "Intersectionality & Perspective Taking" as most applicable to his experience with Mari, as he is trying to better understand "what it must be like to live in a home, with a parent who doesn't believe me when I say who I am, who doesn't seem able to accept me as I am". He noted that his identities as a white, cisgender, heterosexual man from a middle-class background might limit his understanding of how the client's Cuban and Hispanic heritage and culture influence how their parent sees gender and views their role as a parent. Adam also shares that he is worried that the client's mother may "want me to be the expert" and that his person-centered approach to counseling "might not meet her needs". The instructor provides a succinct summary of Adam's disclosures and thanks him for his vulnerability in sharing his thoughts and feelings. The instructor then asks Adam to identify specific areas of follow-up where Adam needs to do additional research to improve his understanding of Mari's needs. Furthermore, Adam is asked to consider being transparent with Mari about his current level of competence in serving T/GE and BIPOC folx and that he is doing additional

research in this area but may provide referrals if Mari would like to work with a clinician with additional experience and expertise.

During class discussion, classmate Sam asks, "but what if the counselor doesn't agree with the client wanting to access hormones? I have no problem with people doing things to their body once they are adults, but kids shouldn't be able to make lasting changes to their body until they are 18." The instructor affirms that discussing political topics is a critical component of the social justice approach in counselor education (Chopra et al., 2024) and that students' beliefs about T/GE rights in healthcare settings impact how they conceptualize T/GE client care in counseling (Morris et al., 2020). The instructor then brings the World Professional Association for Transgender Health (WPATH) standards of care-8 up on the projector and reviews best evidence-based practices for adolescents. She then asks Sam how he might bracket his beliefs to ensure that he is able to provide someone such as Mari with counseling that aligns with best practices. Sam says he "will have to think about it." Mari responded that she revisits this topic during the next class session.

Implications & Future Directions for Research

While the adaptation of the Anti-Oppressive Case Conceptualization attempts to address and highlight many of the identified minority stressors that can impact T/GE BIPOC clients, many unanswered questions remain. One of the greatest limitations is the lack of research regarding evidenced-based interventions (EBIs) specifically targeting youth at the intersection of both T/GE and BIPOC identities. The inherent systemic racism, power imbalances, and underrepresentation of marginalized groups within research must be addressed as the field moves forward (Chae et al., 2022). Counselors and CITs can advocate for their clients by critically reviewing the research and models they incorporate into their practice (Chae et al., 2022; Parker-Barns, et al., 2022).

The implementation of the ACCF integrates several concepts of how counselors conceptualize the self. Conceptualizing our ontology as having multiple axes and plural expressions theoretically grounds this model in contemporary foundations of understanding oppression. To acknowledge a plural self and affirm ontological ambiguity is to reject the reductionist concepts of persons (Cooper, 2015; 2021; de Beauvoir, 1947). Integrating a complex and intersectional understanding of oppression leads counselors to work within the inseparability and simultaneity of identity dynamics.

Limitations in the training of counselors regarding culturally responsive practices have been identified as barriers to treatment for T T/GE BIPOC youth (Benson, 2012; Mosher et al., 2017). Counselors need to consider their own education, background, and training and how it may impact their "ways of understanding" and "ways of being". Counselor education may not fully equip CITs to address and understand the impacts of systemic racism and racial trauma that BIPOC youth experience (Ieva et al., 2021). A recent study on gender-affirming care revealed that of the 200+ mental health providers sampled, only 20% were exposed to information on gender-affirming care during their graduate courses (Stryker et al., 2022). Having a framework to conceptualize a client's intersectional identity is a strong foundation, but counselors must continue to critically examine their own education and implicit biases and continue to educate themselves in these areas to best serve their clients.

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The Use of Intelligent Tutoring Systems in Primary School Mathematics Education: A Systematic Literature Review

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Abstract

This study aims to establish a framework for the use of Intelligent Tutoring System (ITS) in primary school mathematics education based on the existing literature and to reveal its role in the learning process. To this end, a systematic literature review was conducted. Following the PRISMA approach, a total of 24 articles published between 2005 and 2025 in the WoS, Scopus, EBSCOhost, and ERIC databases were analysed. The results indicate that the use of ITS in primary school mathematics education predominantly focuses on the Numbers and Operations learning domain. It was determined that a majority of the studies were conducted using quantitative and design based research designs. The results demonstrate that the integration of ITS enhances students' academic achievement, problem-solving skills, and learning motivation. Furthermore, individualized, and adaptive learning opportunities were identified as the most significant advantages of use of ITS in primary school mathematics education. However, some of the studies reported that the competitive features embedded in the system occasionally led to decreased student motivation. Additionally, the results suggest that ITS contribute to reducing teachers' workload.

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Keywords: Intelligent Tutoring Systems, Mathematics Education, Primary School Students, Systematic Literature Review.

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Introduction

The changing learning needs of the digital age increase the use of artificial intelligence. The different learning pace, styles and interest areas of students has increased the need for individualized learning and artificial intelligence has come to the fore as a technology which produces string solutions for this need (Isidori et al., 2024; Salido et al., 2024). A more individualized learning environment can be provided by artificial intelligence technologies to students by analysing students' data, however the learning process can be made more interactive and accessible through feedback (Suttrisno and Yulia, 2024; Zhang and Arslan, 2021).

One of the widely used applications of artificial intelligence in education is Intelligent Tutoring Systems (ITS). Intelligent Tutoring Systems are defined as computer programs which provide individualized learning by modelling students' psychological states (Ma et al., 2014). These systems serve as a teacher which knows what they teach, who they teach and how they teach through the use of artificial intelligence techniques (Nwana, 1990). ITS are designed to meet the individualized learning needs of students and are intended for situations where they apply their knowledge, learn from mistakes and by structuring information (Murray, 1998). ITS, which are also referred to as knowledge based teachers, bring automated teaching closer to an ideal level, by incorporating content, learning process and computational models (knowledge bases) of the learning state of the student and by more closely simulating realistic situations (Wenger, 1987). When students engage in educational activities through ITS, they can receive individualized support based on various factors such as skill level, content knowledge, help-seeking behaviour, and self-regulation. This makes the learning process both more productive and more engaging (Kooken et al., 2021). Studies show that use of ITS produces greater success compared to teaching large groups under the leadership of the teacher, computed based teaching without ITS and textbooks or workbooks (Ma et al., 2014).

Intelligent Tutoring Systems have been developed in various disciplines to help students acquire cognitive and metacognitive information unique to the subject matter (Ma et al., 2014). One of these areas is mathematics. For instance, Lu (2005) has developed an ITS called InfoMap with the "Finding Nemo" theme in his study to teach arithmetic to primary school students, with the belief that enriching educational games with ITS will support students to learn in a more effective manner. Sarrafzadeh et al. (2008) adapted teaching strategies by perceiving the emotions and biological signals of students during learning mathematics with the Easy with Eve system they have developed. Keleş et al. (2009) have developed a system called "ZOSMAT" which can be used both in individual learning and in classroom environment under the guidance of the teacher. Similarly, Jaques et al. (2013) introduced a web-based algebra ITS called PAT2Math. This system, which has been developed with Java teaches linear and second degree equations and can be used in devices with internet connection. In addition, Özyurt et al.'s UZWEBMAT study provides qualitative findings on students' individual learning experiences and mathematical discovery processes in the probability unit.

According to the studies, the use of Intelligent Tutoring Systems (ITS) in mathematics education develops students' problem solving skills (Çetin, 2022), supports their reasoning skills (Paneque et al., 2016) and increases students' success in subjects such as rational numbers which are difficult to learn (Bush, 2021; Chu et al., 2021). In addition, it was shown that the use of ITS has positive effects on students' success and motivation in mathematics (Zafari et al., 2022; Moltudal et al., 2020; Annus and Kmet, 2024; Özyurt et al., 2014; Keleş, 2007; Aguilar et al., 2011; Rau et al., 2014). Additionally, students evaluate the use of ITS in mathematics education as an accessible, engaging and beneficial learning tool as well (Shih et al., 2023).

The use of Intelligent Tutoring Systems (ITS) in mathematics education affects primary school students' success in mathematics positively as well. Chen (2025) states that the use of ITS increases the performance of students as well as having positive effects on the interaction between students. Similarly, Pathaia et al. (2025) have reported that the dramatized and adaptable approach which they suggest for learning and evaluation of mathematical concepts at the primary school level both improves learning outcomes and increase the participation of students. In addition, Lin and Yang's

study (2021) concluded that the self-organizing learning models which is supported by multi scaffolding provides higher student performance compared to traditional teaching models.

There are various literature reviews which aim at presenting the empirical evidence related to the use of Intelligent Tutoring Systems (ITS) in mathematics education in a holistic manner. When these studies are analysed, it is seen that two systematic compilations which directly deal with the use of ITS in mathematics education come to the fore. Niño-Rojas et al. (2024) analysed 43 studies published between 2012 and 2022 to identify trends related to the use of ITS in mathematics education in higher education. Similarly, in Son's study (2024) studies published between 2003 and 2023 were analysed on the basis of the SAMR model (Substitution, Augmentation, Modification, Redefinition) to determine how ITS are positioned in mathematics education and at which SAMR levels they are used in different educational stages. Although the years dealt with in these studies cover a long time period, the educational levels they focus on are different. While Niño-Rojas et al. (2024) have analysed the current state of the use of ITS in mathematics education in higher education institutions, Son (2024) has analysed the distribution of SAMR (Substitution, Augmentation, Modification, Redefinition) states to educational stages. In this respect, it was seen that the systematic literature reviews which were carried out do not involve the use of ITS in primary school mathematics education.

It is known that Intelligent Tutoring Systems (ITS) are in particular widely used in mathematics education in primary school mathematics education (Son, 2024). However, the number of studies which analyse to what extent and how ITS are applied at this level are limited. This study aims to fill the existing gap in the literature by identifying the current state, opportunities, and challenges regarding the use of Intelligent Tutoring Systems in primary school mathematics education, thereby offering original contributions to the field. The findings are expected both to help teachers use ITS more effectively from a pedagogical perspective and guide future instructional design practices. In this context, the study aims to establish a framework for the use of Intelligent Tutoring System in primary school mathematics education based on existing literature and to reveal its role in the learning process. The research questions are as follows:

1) In the literature on primary school mathematics education, how is the use of ITS distributed according to:
   a) mathematics learning domains,
   b) research methods,
   c) research findings?
2) In the literature on primary school mathematics education, regarding the use of ITS:
   a) what opportunities,
   b) what challenges have been identified?
3) In the literature on primary school mathematics education, how have the effects of the use of ITS on students and teachers been presented?

Method

In this study, a systematic literature review was carried out on the use of Intelligent Tutoring Systems in primary school mathematics education. The systematic review method was chosen as it aims to collect evidence based on explicitly defined eligibility criteria to answer the research question, provides a replicable methodology, and ensures that the studies included in the research are selected through systematic procedures, thereby enabling the acquisition of reliable findings and conclusions (Chandler et al., 2019). In this respect, this study analysed research articles published between 2005 and 2025. The reporting of these studies were prepared with PRISMA (The Preferred Reporting Items for Systematic Reviews and Meta-analysis) flow chart developed by Moher et al. (2009). This diagram consists of four stages: Identification, Screening, Eligibility, and Inclusion. Figure 1 presents the literature search and review process based on the PRISMA framework.

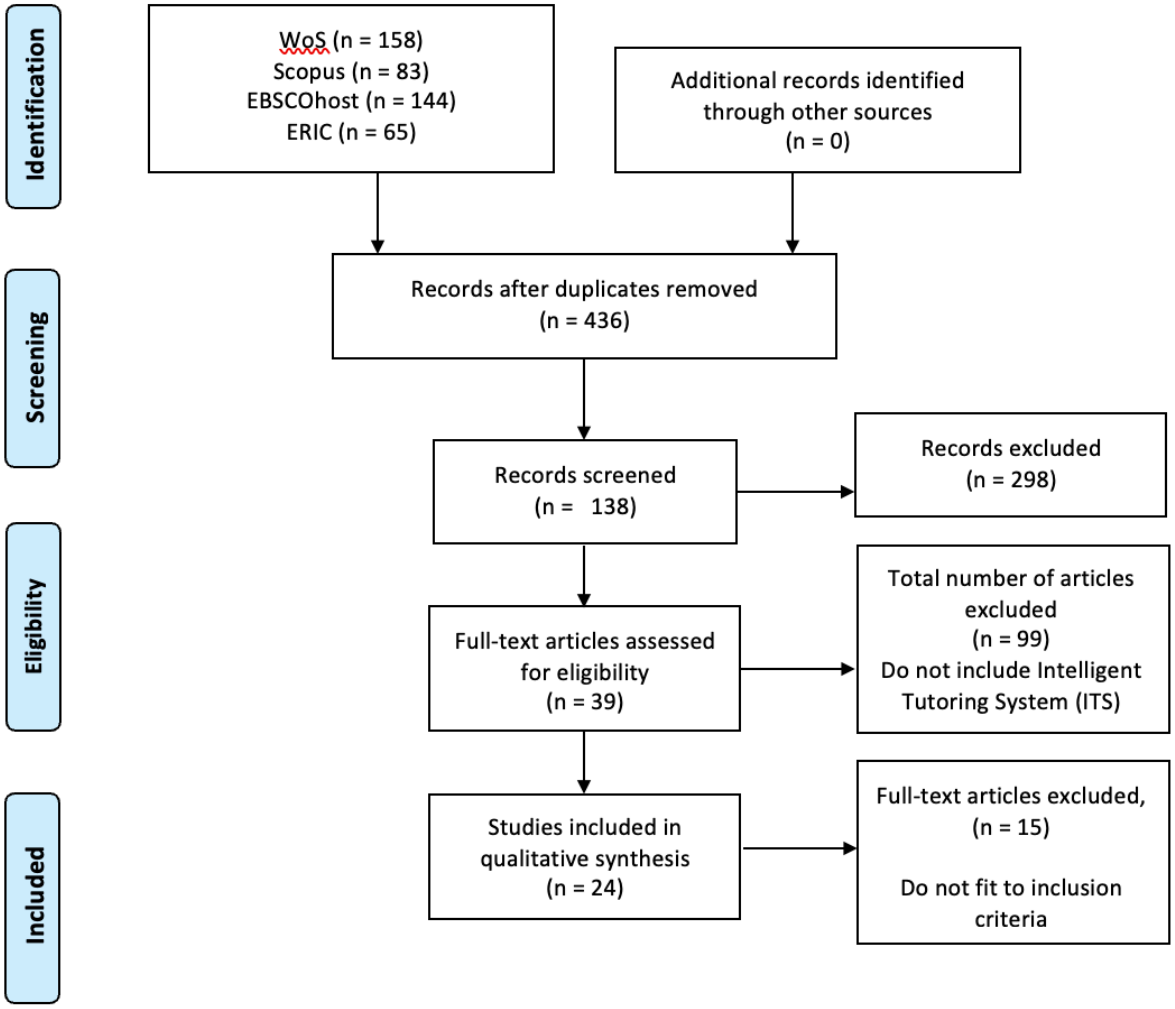

Figure 1. PRISMA flow diagram

Systematic Review Process

Identification

The Identification stage of the PRISMA process was conducted using the WoS, Scopus, EBSCOhost, and ERIC databases. Specific search terms were established to identify studies aligned with the aim of this research. Synonyms and related terms were expanded using Boolean operators to retrieve a broader range of studies. The search terms were as follows: ((“artificial intelligence”) OR (“machine intelligence”) OR (“intelligent support”) OR (“personal tutor”) OR (“expert system”) OR (“intelligent system”) OR (“intelligent tutor”) OR (“intelligent tutorial system”) OR (“adaptive learning”)) AND ((“Math”) OR (“Maths”) OR (“Mathematics”) OR (“Mathematical”) OR (“Math education”) OR (“Mathematics education”) OR (“Mathematical sciences”) OR (“learning of mathematics”) OR (“Mathematics teaching”)) AND ((“primary school”) OR (“primary education”) OR (“elementary school”) OR (“elementary education”) OR (“early years”)). A total of 450 results were obtained from the databases using these search terms.

Screening

At the Screening stage of the PRISMA process, specific inclusion and exclusion criteria were applied (Table 1). Studies published prior to 2005 were not included. Additionally, studies focusing on

ITS applications in educational levels other than primary school, or in disciplines other than mathematics, were excluded. In addition, books, book chapters, conference papers, and review articles were excluded from the study as well. As a result of applying these criteria, 298 articles were eliminated. Furthermore, 14 studies with overlapping content were identified and were excluded from the study as well. Consequently, 138 articles were considered eligible for further evaluation.

Eligibility

During the eligibility stage, the titles, abstracts, methods, and results of the 138 articles were examined in detail in accordance with the predefined inclusion and exclusion criteria. Studies that were inconsistent with the scope and objectives of this research were excluded As a result of the evaluation, 114 articles were excluded from the study as they were both not in line with the aims of the study or able to meet the identified criteria. Therefore, 24 articles were chosen for analysis.

Inclusion

Titles and abstracts of all studies retrieved from the databases were screened, and duplicate or overlapping studies were removed. Subsequently, criteria such as publication year, education level, mathematics discipline, and research article status were applied to identify studies relevant to the research purpose. The full texts of the remaining studies were read and 24 articles were identified to be included in the study as a result of the evaluation.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Articles published between 2005-2025	Articles published prior to 2005
Studies addressing ITS applications at the primary school level	Studies addressing ITS applications at other education levels
Studies utilizing ITS in mathematics teaching or learning	Studies utilizing ITS in disciplines other than mathematics
Research articles	Books, book chapters, conference papers, or review articles

Results and Interpretation

In this section, the findings based on the analysis of the data obtained from 24 studies published between 2005 – 2025 are presented. The findings are discussed under the headings determined in line with the research questions.

1. What is the distribution of the use of ITS in the literature on primary school mathematics education?

Mathematics Domain

The reviewed studies indicate that Intelligent Tutoring Systems (ITS) used in primary school mathematics education are most frequently applied in the Numbers and Operations learning domain. The mathematics learning domains addressed in these studies are presented in Figure 2.

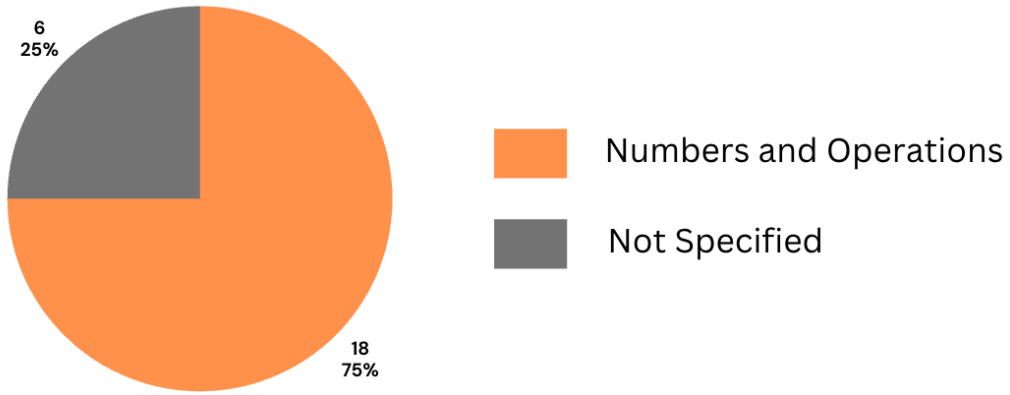

Figure 2. The distribution of the studies by mathematics domain

When Figure 2 is analysed, it can be seen that 18 studies (75%) were carried out in the Numbers and Operations learning domain (Lu et al., 2005; Sarrafzadeh et al., 2008; Pavlekoviç et al., 2010; Aguilar et al., 2011; Pareto, 2014; Rau et al., 2014; Xin et al., 2017; Bush, 2021; Chu et al., 2021; Bolsinova et al., 2022; Gocheva et al., 2022; Sperling_ et al., 2022; Knoop-van Campen et al., 2023; Levy et al., 2023; Annus and Kmet, 2024; Rodrigues et al., 2024; Sachisthal et al., 2024; Pathania et al., 2025). It was found that no mathematics domains or sub-learning domains were indicated in the 6 studies which were analysed (25%) (Chen, 2025; Joaquim et al., 2022; Moltudal et al., 2020; Karumbaiah et al., 2022; Tasdelen and Bodemer, 2025; Lin and Yang, 2021).

Some of the studies which addressed the Numbers and Operations learning domain were found to cover multiple subdomains simultaneously. Figure 3 shows the distribution of subdomains studied within the Numbers and Operations learning domain.

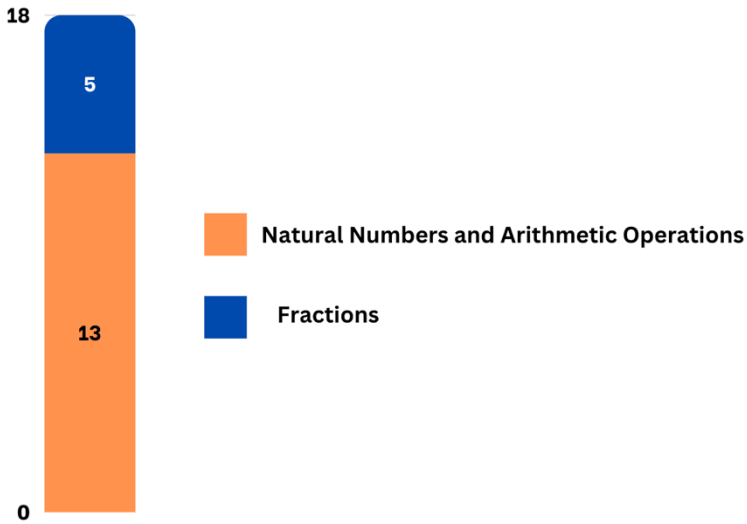

Figure 3. Subdomains studied within the Numbers and Operations learning domain

When Figure 3 is analysed, it can be seen that natural numbers and arithmetic operations with natural numbers are the most studied sub-learning domains (n=13, 72.22%) (Lu et al., 2005; Sarrafzadeh et al., 2008; Pavlekoviç et al., 2010; Aguilar et al., 2011; Pareto, 2014; Xin et al., 2017; Bolsinova et al., 2022; Gocheva et al., 2022; Sperling_ et al., 2022; Annus and Kmet, 2024; Rodrigues et al., 2024; Sachisthal et al., 2024; Pathania et al., 2025). In addition, 5 studies on the fractions sub-learning domain (27.78%) were identified (Rau et al., 2014; Bush, 2021; Chu et al., 2021; Knoop-van Campen et al., 2023; Levy et al., 2023). These findings show that ITS studies focus on a limited number of mathematics learning domains. The evaluation of the contributions of ITS on primary

school mathematics education over a certain learning domain might limit the generalization of the obtained data. Therefore, there is a need for further studies on other mathematics learning domains such as geometry and quantification.

Research Method

In some of the reviewed studies, the research method was not explicitly stated (Aguilar et al., 2011; Rau et al., 2014; Bolsinova et al., 2022; Gocheva et al., 2022; Karumbaiah et al., 2022; Annus & Kmet, 2024; Sachisthal et al., 2024; Pathania et al., 2025). For these studies, the methods were inferred from the descriptions and data analyses presented in the articles. Accordingly, studies that evaluated the architecture and effectiveness of ITS developed for use in primary school mathematics education were classified as design-based research (Aguilar et al., 2011; Gocheva et al., 2022; Bolsinova et al., 2022; Annus & Kmet, 2024; Pathania et al., 2025). Studies employing correlation analyses were categorized as quantitative research (Karumbaiah et al., 2022). In addition, studies that examined both quantitative (e.g., student achievement scores, Bayesian Knowledge Tracing analyses) and qualitative (e.g., students' problem-solving processes in think-aloud sessions, observations regarding conceptual transfer) data were classified as mixed-method research (Rau et al., 2014).

One study collected qualitative statements from students. However, these statements were converted into numerical data through coding and analysed using quantitative methods (Sachisthal et al., 2024). Therefore, it was categorized as a quantitative research. In another study, although an experimental design was reported, quantitative data were collected solely to support qualitative findings, and Framework Analysis was employed during data analysis (Joaquim et al., 2022). Thus, this study was classified as a qualitative research. Figure 4 shows the distribution of research methods used in the analysed studies on the use of ITS in primary school mathematics education.

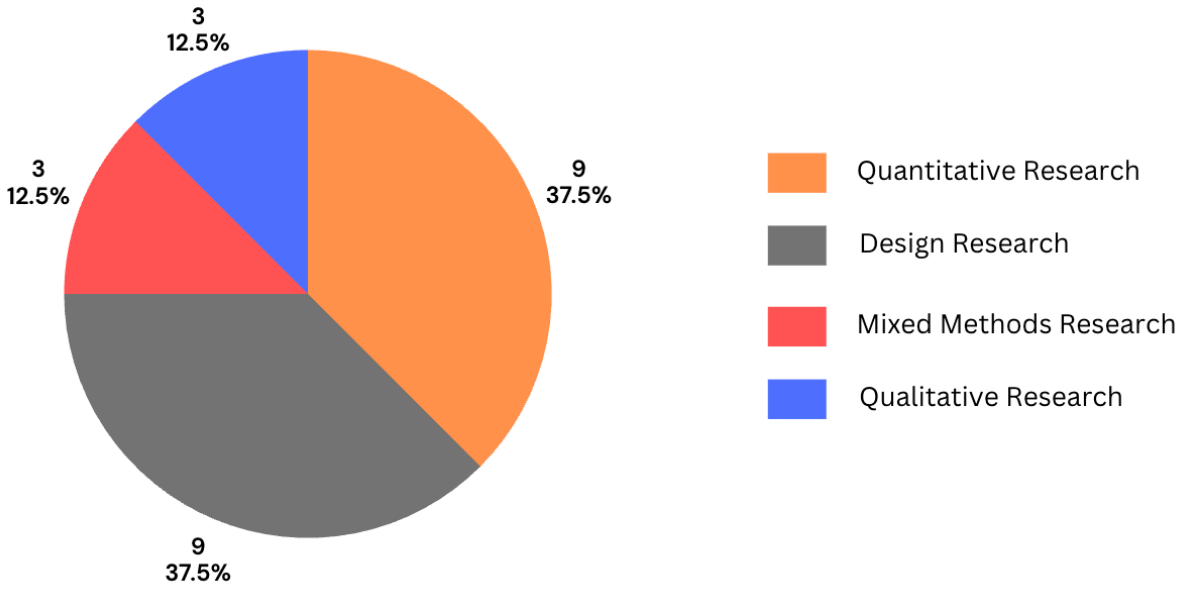

Figure 4. Distribution of research methods

When Figure 4 is analysed, it can be seen that the research methods in the studies vary. The findings show that a majority of the studies adopted the quantitative study (n=9, 37.5%) and design study approach (n=9, 37.5%). In addition, 3 of the studies made use of the mixed research design approach (12.5%) and 3 of the studies the qualitative research approach (12.5%). The dominance of quantitative and design research approaches in the studies related to the use of ITS in primary school mathematics education show that there is a strong tendency to both measure the effects of ITS on students' success and to develop the systems. However, there is a need for studies which make use of qualitative and mixed methods to be able to present the in-class interactions, pedagogical harmony and teacher and student experiences related to ITS in a more in-depth manner.

Research Results

The reviewed studies revealed that the use of ITS in primary school mathematics education made positive contributions to the learning process. A majority of the studies show that ITS increase academic achievement (n=14, %58,33) and motivation (n=7, %29,16). In addition, the studies indicate that ITS contribute to the students' problem solving skills (n=2, %8,33) and their self-sufficiency (n= 1, %4,16), develop cooperation among the students (n=2, %8,33) and increased interaction (n=1, %4,16). Furthermore, the studies indicated that the use of ITS improved collaboration among students (n=2, 8.33%) and increased interaction (n=1, 4.16%). Additionally, ITS applied in primary school mathematics education were reported to have a positive effect on knowledge retention (n=1, 4.16%). Some of the studies concluded that ITS were more effective for high-achieving students (n=2, 8.33%) and that frequency and continuity of interaction with these systems contributed positively to learning outcomes (n=2, 8.33%).

Certain studies presented noteworthy findings regarding the effects of ITS. One study reported that ITS had positive effects on all students and reduced the number of students performing below the class average (Chen, 2025). Another study emphasized that differences between school levels affected the relationship between motivation and achievement (Karumbaiah et al., 2022). Moreover, Moltudal et al. (2020) reported a decrease in motivation among students using ITS. Rau et al. (2014) highlighted that students' prior knowledge levels were a determining factor in the contribution of ITS to the learning process.

2. What opportunities and challenges have been identified in the literature regarding the use of ITS in primary school mathematics instruction?

Opportunities

Opportunities related to the use of Intelligent Tutoring Systems (ITS) in primary school mathematics instruction were classified under six themes: individualized and adaptive learning, instructional support and feedback, teacher role and workload, cognitive development, motivation, and digital literacy. The opportunities associated with the use of ITS are presented in Table 2.

Table 2. Opportunities related to the use of Intelligent Tutoring Systems

Theme	Code	f	(%)
Individualized and Adaptive Learning	Knowledge gaps	3	12.5
	Eliminating individual learning differences	16	66.66
	Providing adaptive content	3	12.5
	Manage their own learning processes	4	16.66
Instructional Support and Feedback	Enhance learning efficiency	3	12.5
	Development of students' self-regulation skills	1	4.16
Teacher Role and Workload	Reduces teachers' workload	5	20.83
	Identifying student characteristics	8	33.33
	Providing learning support	6	25
	Complementing traditional instruction	1	4.16
Cognitive Development	Conceptual understanding	6	25
	Support higher order thinking skills	2	8.33
Motivation	Increased motivation	4	16.66
Digital Literacy	Improve their digital skills	1	4.16

Table 2 shows that the opportunities primarily focus on the theme of individualized and adaptive learning. In this context, ITS contributes to addressing students' knowledge gaps (n=3, 12.5%), eliminating individual learning differences (n=16, 66.66%), providing adaptive content (n=3, 12.5%), and enabling students to manage their own learning processes (n=2, 8.33%).

Under the theme of instructional support and feedback, ITS is found to enhance learning efficiency by providing immediate feedback (n=3, 12.5%) and to support the development of students' self-regulation skills through instructional support (n=1, 4.16%). In terms of teacher role and workload, the system reduces teachers' workload (n=5, 20.83%), helps identify students' strengths and weaknesses (n=8, 33.33%), and enables timely support through feedback (n=6, 25%). Furthermore, its complementary role to traditional instruction is also identified as an opportunity (n=1, 4.16%).

Within the cognitive development theme, ITS is reported to contribute to students' conceptual understanding rather than rote memorization (n=6, 25%) and to support higher-order thinking skills (n=2, 8.33%). The motivation theme is associated with increased student motivation through making learning more enjoyable (n=4, 16.66%). Finally, in terms of digital literacy, ITS is found to help students improve their digital skills (n=1, 4.16%). The obtained data show that the use of ITS in primary school mathematics education contributes to both the learning and the teaching processes positively.

Challenges

Challenges related to the use of Intelligent Tutoring Systems (ITS) in primary school mathematics instruction were examined under six main themes: lack of social and pedagogical support, restrictive effects of the system, teacher competence, technical and design issues, student competence, and infrastructure deficiencies. These themes encompass both the practical obstacles encountered during implementation and the factors affecting the pedagogical integrity of the system. The challenges associated with the use of ITS are presented in the Table 3.

Tablo 3. Challenges related to the use of Intelligent Tutoring Systems

Theme	Code	f	(%)
Lack of Social and Pedagogical Support	Unsupervised use	1	4.16
	Lack of emotional support	1	4.16
	Limited interaction	1	4.16
	Lack of teacher support	1	4.16
	Risk of not being able to learn independently	1	4.16
Restrictive Effects of the System	Evaluating performance solely through ITS	1	4.16
	Same instructional strategy for all topics	3	12.5
Teacher Competence	Changing role of teachers	1	4.16
	Insufficient teacher preparation	5	20.83
Student Competence	Low literacy skills	2	8.33
	Negative effects of prior knowledge on learning new topics	2	8.33
	Lack of digital experience	2	8.33
	Absence of legal authorization	1	4.16
Technical and Design Issues	Effects of the system interface on achievement	1	4.16
	Mandatory system directives	3	12.5
	Programming errors	1	4.16
	Performance of the system	1	4.16
	Lack of a notes section	1	4.16
Infrastructure deficiencies	Inadequate technology and equipment	2	8.33

According to Table 3, issues such as unsupervised use (n=1), lack of emotional support (n=1; 4,16%), limited interaction (n=1, 4.16%), lack of teacher support (n=1, 4.16%), and the risk of

students being unable to learn independently (n=1, 4.16%) were reported under the theme of lack of social and pedagogical support. Under the restrictive effects of the system, challenges include evaluating student performance solely through ITS (n=1, 4.16%) and the system's application of the same instructional strategy for all topics (n=3, 12.5%). Teacher competence is linked to the changing role of teachers (n=1, 4.16%) and insufficient teacher preparation (n=5, 20.83%). The student competence theme includes factors such as low literacy skills (n=2, 8.33%), negative effects of prior knowledge on learning new topics (n=2, 8.33%), lack of digital experience (n=2; 8,33%), and absence of legal authorization for data protection consent (n=1, 4.16%). Technical and design issues were reported as limitations in the system interface affecting student performance (n=1, 4.16%), the impact of mandatory system–student interaction on performance (n=3, 12.5%), miscalculations caused by programming errors (n=1, 4.16%), slowing down of the system performance in multithreading (n=1, 4.16%) and a lack of notes section for teachers (n=1, 4.16%). Infrastructure deficiencies include difficulties caused by the problems experienced due to inadequate technology and equipment (n=2, 8.33%). These findings show that the use of ITS in primary school mathematics education presents certain challenges such as social, pedagogical, teacher and student competencies and technical and infrastructure related difficulties. In this context, it can be stated that there is a need for improvement in pedagogical guidance, teacher training and technical infrastructure to be able to increase the efficiency of the system.

3. In the literature on primary school mathematics education, how have the effects of the use of ITS on students and teachers been presented?

Effects on Students

In the reviewed studies, the effects of the use of ITS in primary school mathematics education on students were grouped under two themes: positive and negative effects. The effects of the use of ITS on students are presented in the Table 4.

Table 4. Effects of ITS usage on students

Theme	Code	f	(%)
Positive Effects	Academic development	13	54.16
	Increased motivation	10	41.66
	Learning environments that consider individual differences	11	45.83
	Experiences of independent learning	5	20.83
	Collaborative learning	3	12.5
	Learning through enjoyment	3	12.5
	Learning through multiple representations	2	8.33
	Development of digital literacy skills	1	4.16
	Increasing self-sufficiency	1	4.16
Negative Effects	Decrease in motivation caused by gamification features	2	8.33
	Feeling as though they have not learned	1	4.16
	Inappropriate use of instructional support	1	4.16
	Lack of consideration for language and cultural factors in system design	1	4.16
	Low literacy skills hindering system use	1	4.16

When Table 4 is analyzed, it can be seen that academic development (n=13, 54.16%), learning environments that consider individual differences (n=11, 45.83%) and increasing motivation (n=10, 41.66%) come to the fore the most under the positive effects of the use of ITS on students theme. In addition, effects such as independent learning experience (n=5, 20.83%), collaborative learning

experience (n=3, 12.5%), learning through enjoyment (n=3, 12.5%), learning though multiple representations (n=2, 8.33%), development of digital literacy skills (n=1, 4.16%) and increasing self-sufficiency (n=1, 4.16%) were underlined in the studies. Among the negative effects of the use of ITS on students in primary school mathematics education, the most notable is the decrease in motivation caused by gamification features (badges, stars) (n=2, 8.33%). Other reported negative effects include students feeling as though they have not learned (n=1; 5.5%), inappropriate use of instructional support (n=1, 4.16%), lack of consideration for language and cultural factors in system design (n=1, 4.16%), and low literacy skills hindering system use (n=1, 4.16%).

The obtained data show that ITS in primary school mathematics education have significant contributions such as increasing academic achievement and motivation and presenting individualized and adaptable learning experiences. Additionally, loss of motivation, design-learner incompatibility and usage difficulties due to low digital literacy skills reported in certain studies indicate that the effects of ITS rely on the characteristics of the learner, context of application and system design.

Effects on Teachers

The effects of Intelligent Tutoring Systems on teachers in primary school mathematics education were dealt with in various dimensions in the analysed studies. Figure 5 shows the distribution of the use of ITS in primary school mathematics education on teachers.

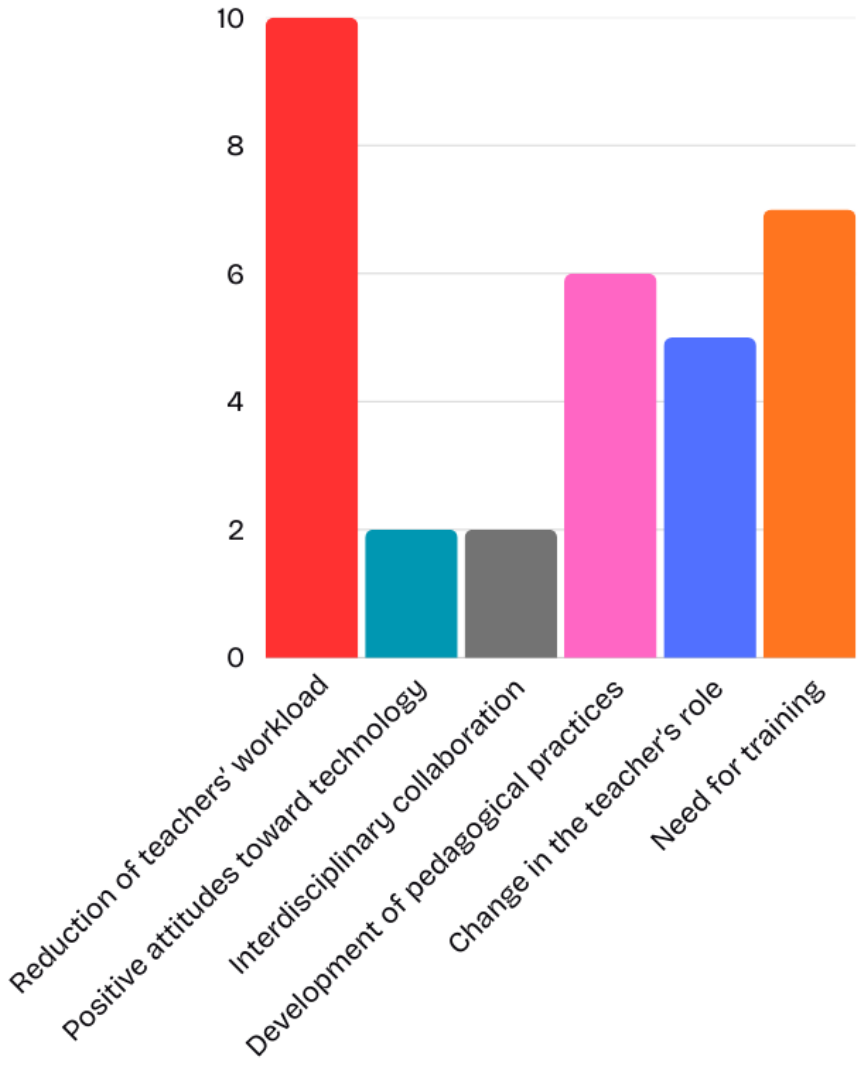

Figure 5. Effects of ITS usage on teachers

When Figure 5 is analyzed, it can be seen that the most notable effect of the system is reducing work load (n=10, 41.66%). ITS automates certain routine instructional and assessment tasks, enabling teachers to use their time more efficiently. This process also supports the development of teachers' positive attitudes toward technology (n=2, 8.33%). Additionally, the system encourages teachers to engage in interdisciplinary collaboration (n=2, 8.33%) and provides opportunities to improve their pedagogical practices (n=6, 25%). However, the use of ITS changes the teacher's role in the learning process (n=5, 20.83%) as well, shifting it toward guidance and facilitation while supporting students' independent learning. The studies emphasize that teachers need specialized training to maximize the benefits of the system (n=7, 29.16%). These findings show that ITS come to the fore as a tool which reduce teachers' workload, transform the role of teaching and support occupational development. However, it seems that the sustainability of the positive effects depends on providing quality teacher training.

Conclusion and Discussion

This study aimed to establish a framework for the use of Intelligent Tutoring Systems (ITS) in primary school mathematics education based on the existing literature and to reveal their role in the learning process. In this context, the literature review indicates that there is a limited number of studies on the use of ITS in primary school mathematics education between 2005 and 2025.

Research conducted on the use of ITS in primary school mathematics education focuses mainly on the Numbers and Operations learning domain. Accordingly, most studies on the use of ITS in mathematics education concentrate on arithmetic operations, while there are examples of applications in the subdomains of numbers and fractions as well. However, no studies were identified in the geometry, measurement, or data processing domains. This may be attributed to the fact that the subdomains of natural numbers and fractions are more suitable for ITS design (Son, 2024).

It was observed that most of the reviewed studies employed quantitative and design-based research methods, whereas qualitative approaches were scarcely represented. This indicates a gap in the literature in relation to in-depth exploration of the effects of ITS on the primary mathematics learning process and understanding the experiences of students and teachers. Han et al. (2019), in their study aiming to identify long-term trends in ITS research, also concluded that quantitative research methods were used more frequently than mixed and qualitative methods. In this respect, the findings of the present study align with the general trends in the literature.

The reviewed studies demonstrate that ITS generally makes positive contributions to the learning process in primary school mathematics education. The use of ITS has been found to significantly improve students' academic achievement, problem-solving skills, and learning motivation. Furthermore, the system supports collaboration and interaction within the learning environment and contributes to learning retention. However, some studies show that the results vary depending on individual learner characteristics and implementation conditions. It was particularly emphasized that ITS tends to be more effective for high-achieving students, and that the frequency and continuity of interaction with the system play a determining role in learning outcomes. Nevertheless, findings such as decreased motivation or the limiting effect of prior knowledge on the benefits derived from the system suggest that ITS may not be equally effective for all students (Taub & Azevedo, 2019).

The opportunities identified in the use of ITS in primary school mathematics education revolve around the theme of individualized and adaptive learning. This feature of ITS is regarded as a major advantage, as it helps to address knowledge gaps, eliminate individual learning differences, provide adaptive content, and allow students to manage their own learning processes. Indeed, many studies have discussed the role of individualization and adaptability in enhancing learning with ITS (Kim et al., 2013; Knoop-van Campen et al., 2023; Kulik & Fletcher, 2015; Mousavinasab et al., 2018; Taub & Azevedo, 2019). Therefore, it can be said that the findings of this study are consistent with the literature. Moreover, the opportunities offered by ITS in primary mathematics education are

not limited to individualization and adaptability; they also include instructional support and feedback, teacher role and workload, cognitive development, motivation, and digital literacy. The results of Niño-Rojas et al.'s systematic literature review (2024) and results obtained from this study's literature review are in line with each other.

The reviewed studies also identified several challenges associated with the use of ITS in primary school mathematics education. Among these are teacher competencies, such as the changing role of teachers and insufficient preparation, and student competencies, such as low literacy skills, the negative impact of prior knowledge on learning new topics, lack of digital experience, and absence of legal authorization for data protection consent. These competencies pose challenges to the effective use of ITS in the learning process. Additionally, the restrictive effects of the system, such as a lack of social and pedagogical support, assessment of student performance solely through ITS, and the use of the same instructional strategy for all topics, as well as technical and design problems, are significant challenges in ITS implementation. Alkhatlan and Kalita (2018) noted that although ITS can standardize and implement certain aspects of human cognition and learning processes, certain limitations persist. Furthermore, infrastructural deficiencies in schools hinder both the widespread and effective use of ITS. Kulik and Fletcher (2015) also emphasized that advancements in computer hardware, software, networking, and cognitive science would influence the future structure and appearance of instructional systems.

It was determined that the use of Intelligent Tutoring Systems (ITS) in primary school mathematics education has various effects on both students and teachers. The effects on students were analysed under two main themes: positive and negative. While academic development and motivational gains were the most prominent among the positive effects, the negative effects primarily involved a decline in motivation due to gamification elements (such as badges and stars).

It was found that the most notable effect of the use of ITS for teachers was reduction of workload. This outcome supports the development of more positive attitudes toward technology among teachers. The use of ITS was reported to have a positive impact on improving teachers' pedagogical practices as well. Furthermore, it was underlined that teachers need specialized training to obtain maximum benefit from these systems. The results of this study are consistent with the commonly held view that the success of technology in mathematics education in large depends on the teacher (Drijvers, 2015).

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Integration of Fascial Exercises Into The Ministry of National Education Individual Voice Training Curriculum

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Abstract
This study examines the extent to which fascia-based exercises can be pedagogically integrated into the Ministry of National Education (MoNE) Individual Voice Training curriculum, with particular focus on the "Teaching–Learning Practices" related to preparing the body for singing. The primary aim is to analyze existing curricular practices through the lens of contemporary fascia science and movement-based pedagogy, and to propose a structured, sustainable integration framework aligned with international literature. Using a qualitative document analysis design, official MoNE Individual Voice Training curricula implemented from Grades 1 to 8 were systematically reviewed. Preparatory practices related to bodily warm-up, posture, breathing, diaphragm use, vocal warm-up, and articulation were examined through predefined analytical criteria and interpreted using descriptive analysis.Findings indicate that while the curriculum consistently emphasizes preparing the body for singing, these practices are not conceptualized within an explicit fascia-based or movement-oriented pedagogical framework. In particular, the interpretation of "upright posture" as static and rigid poses potential risks for breath coordination, bodily fluidity, and vocal resonance. However, the strong emphasis on breathing and diaphragmatic work provides a viable entry point for fascia-based integration. The study proposes a concise, four-stage fascia-based preparation protocol, dynamic mobilization, breath–movement coupling, multi-planar/cross-body coordination, and transition to phonation, that preserves existing curricular goals while enhancing effectiveness, vocal health, and sustainability. This research contributes to voice pedagogy by offering the first literature-informed, fascia-based integration model for primary and lower secondary voice education within the Turkish national curriculum (Grades 1–8).

Keywords: Fascia-based pedagogy; Voice education; Movement-based learning; Breathing and posture; Curriculum integration
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Introduction

Individual voice training constitutes a multidimensional pedagogical process that, from early childhood onward, aims not only to develop musical skills but also to foster the healthy, sustainable, and embodied use of the voice. Particularly for students in developmental stages, voice education must be conducted with an approach that respects the anatomical and physiological limits of the larynx, prioritizes bodily awareness, and places vocal health at the center of pedagogical practice (McCoy, 2012).

An examination of the Individual Voice Training curricula issued by the Turkish Ministry of National Education (MoNE) reveals that, beginning in the first grade, explicit emphasis is placed on activities designed to "prepare the body for singing." The curriculum systematically highlights practices such as stretching the arms and shoulders, neck rotations, spinal flexibility exercises, demonstrations of correct postural alignment, bodily relaxation, and the regulation of internal dynamics. At higher grade levels, this approach is further expanded to include vocal and breathing exercises, physical warm-up movements, and postural awareness practices (MoNE, 2025).

However, despite the presence of these bodily preparation statements within the curriculum texts, their practical implementation is often characterized by a mechanical, fragmented, and muscle-centered understanding. In many instructional contexts, students are directed toward static, rigid, and movement-restricted positions under the notion of "proper posture." Contemporary anatomy and somatic education literature, however, demonstrates that voice production does not operate solely through isolated muscular activity but rather through the holistic organization of the fascial system (Schleip, Findley, Chaitow, & Huijing, 2012).

Fascia is a living connective tissue network that envelops muscles, organs, and skeletal structures within a three-dimensional continuum, playing a decisive role in force transmission, postural organization, and respiratory coordination. In the context of voice training, the fascial lines identified as the Deep Front Line and the Spiral Line are of particular significance due to their functional relationships with the diaphragm, pelvic floor, spinal stability, trunk rotation, and breath–voice coordination (Myers, 2014). Within this study, the Deep Front Line and Spiral Line are employed not as prescriptive anatomical claims, but as pedagogical mapping tools to structure breath–movement–posture coordination.

The Deep Front Line is directly associated with the depth, continuity, and efficiency of breathing through its anatomical connections with the diaphragm, psoas muscle, pelvic floor, and anterior cervical structures. The Spiral Line, on the other hand, contributes to three-dimensional postural balance, rotational movement capacity, and postural elasticity. The integrated and functional operation of these two fascial lines provides a fundamental basis for the fluidity, resonance, and dynamic balance required in healthy voice production (Stecco et al., 2014).

During childhood, the high plasticity of fascial tissue allows this system to be effectively supported from an early age through conscious, developmentally appropriate, movement-based exercises. Empirical studies indicate that practices grounded in movement, breath, and fascial awareness reduce postural rigidity, enhance respiratory capacity, and exert positive effects on vocal performance (Koch, Morlinghaus, & Fuchs, 2016).

Within this framework, restructuring the learning outcomes related to "preparing the body for singing" in the MoNE Individual Voice Training curricula through exercises grounded in fascial anatomy, particularly those targeting the Deep Front Line and Spiral Line and integrating these exercises with movement and breath may contribute to a more efficient, sustainable, and health-oriented voice training process for students.

Accordingly, this study aims to examine the Individual Voice Training curricula of the Ministry of National Education through document analysis and to propose a fascia-based exercise integration model aligned with the existing learning outcomes.

The Individual Voice Training curriculum analyzed in this study is situated within the framework of the Türkiye Yüzyılı Maarif Model and is designed not for general public middle schools, but for talent-oriented and specialized educational environments, including Science and Art Centers (BİLSEM) and conservatories that admit students at the primary and lower secondary levels. These contexts encompass selective or enrichment-based programs that provide individualized or small-group instruction for students with identified musical aptitude.

Purpose of the Study

The aim of this study is to examine the learning outcomes related to "preparing the body for singing" in the Ministry of National Education Individual Voice Training curriculum from a fascia-based perspective, and to propose pedagogical frameworks and instructional approaches for integrating fascia-oriented exercises, particularly those centered on the Deep Front Line and Spiral Line fascial pathways, into the national voice education curriculum.

Significance of the Study

This study is significant in that it offers an alternative to muscle-centered and static postural approaches in voice pedagogy; reinterprets the MoNE curricula through the lens of somatic education and fascial anatomy; and presents a literature-supported pedagogical framework for integrating fascia-based exercises aimed at protecting vocal health and supporting efficient voice production from the primary school level onward. Moreover, to the best of the author's knowledge, this study represents one of the first pedagogical proposal in Türkiye to address primary and lower secondary voice education through a fascia-based approach.

Problem Statement

Although the Ministry of National Education Individual Voice Training curricula include practices and activities aimed at preparing the body for singing, these practices are not structured within a fascia-based or movement-oriented framework. In classroom implementation, students are frequently directed toward static, rigid, and movement-restricted postural positions (MoNE, 2025). Such approaches may negatively affect essential components of healthy voice production in children, including breath coordination, bodily fluidity, and resonance capacity. Consequently, the need to examine and develop the integration of fascia-based exercises into the Individual Voice Training courses, first implemented in the 2025–2026 academic year, has been identified as a pedagogical priority.

Research Question

What pedagogical frameworks and approaches are most effective, health-oriented, and sustainable for integrating fascia-based exercises into the "Teaching–Learning Practices" that include body preparation for singing within the Ministry of National Education Individual Voice Training curricula implemented in the 2025–2026 academic year?

Sub-Questions

1. Which body-preparation practices for singing are defined within the "Teaching–Learning Practices" section of the Ministry of National Education Individual Voice Training curricula?
2. How can these body-preparation practices be evaluated from the perspective of the fascial system and movement-based pedagogical approaches?

3. What are the potential effects of directing students toward static and rigid postures on breath coordination, bodily fluidity, and resonance capacity in individual voice training?
4. What pedagogical contributions can fascia-based exercises, particularly those targeting the Deep Front Line and Spiral Line, offer to the individual voice training process?
5. To what extent do the existing "Teaching–Learning Practices" in the Ministry of National Education Individual Voice Training curricula allow for the integration of fascia-based exercises?
6. Which fundamental principles should be considered to ensure that fascia-based exercises applicable from the primary and lower secondary school level onward are structured in an effective, healthy, and sustainable manner within the process of preparing the body for singing?

Methodology

Research Design

This study was conducted using a qualitative research design based on document analysis. Document analysis is a qualitative research approach that aims to systematically examine, interpret, and make meaning of official documents, curricula, and written materials (Bowen, 2009).
The primary aim of the study is to evaluate the teaching–learning practices related to preparing the body for singing in the Individual Voice Training curricula issued by the Turkish Ministry of National Education, through fascia-based and movement-oriented perspectives. Based on the findings, the study seeks to propose a literature-supported pedagogical framework and approach for integrating fascia-based exercises into the existing curriculum. The study does not include an experimental intervention or effect measurement; rather, it is grounded in curriculum analysis and theoretical interpretation.

Data Sources

The primary data sources of the study consist of the Individual Voice Training Course Curricula published by the Ministry of National Education. Within this scope, particular attention was given to the curricula implemented beginning in the 2025–2026 academic year. The sections examined as focal documents include explanations under the following headings:

- "Teaching–Learning Practices"
- "Preparing the Body for Singing"
- "Voice and Breathing Exercises"
- "Posture, Alignment, and Use of the Body"

The secondary data sources comprise peer-reviewed journal articles, academic books, and theoretical studies published in the fields of voice education, vocal pedagogy, fascia science, somatic approaches, and movement-based learning. These sources were used to support the evaluation of the curricula and to ground the proposed integration framework within the existing literature.

Data Collection Process

In this study, data collection was carried out through the systematic examination of official curricula documents, without the use of any measurement instruments. The curricula were reviewed in line with the research problem and sub-questions, based on the following criteria:

- The scope and content of statements related to preparing the body for singing
- The emphasis placed on movement, relaxation, and breathing practices
- Whether posture is addressed in a static or dynamic manner
- Pedagogical guidance related to students 'use of the body

These criteria functioned as an analytical framework guiding the data collection process.

Data Analysis

In this study, descriptive analysis was employed as the overarching analytical strategy, while a hybrid deductive–inductive coding process was used within this framework to refine and elaborate the thematic structure. Descriptive analysis is a qualitative data analysis method that aims to organize, summarize, and interpret data according to both predetermined and emergent themes (Yıldırım & Şimşek, 2021).

Accordingly, the data analysis process was conducted through the following stages:

1. Practices related to preparing the body for singing within the curricula were identified.
2. These practices were examined within the context of fascia-based and movement-oriented pedagogical approaches.
3. The findings were interpreted with reference to the literature, particularly in relation to the roles of the Deep Front Line and Spiral Line fascial pathways in breathing, posture, and voice production.
4. Based on the analysis results, a pedagogical framework and approach were developed for the integration of fascia-based exercises into the existing curriculum.

The analytical framework was developed through a hybrid coding strategy combining deductive and inductive approaches. Initial thematic categories were derived deductively from the research questions and the theoretical framework of fascia science, movement-based pedagogy, and voice education literature (e.g., posture, breathing, movement, diaphragm use, and bodily preparation). Subsequently, an inductive process was applied during close reading of the curriculum documents to identify recurrent patterns, emphases, and omissions that were not fully captured by the preliminary categories. This iterative process allowed themes to be refined, expanded, and reorganized to reflect both the structure of the curriculum texts and their alignment with contemporary fascia-informed pedagogical principles.

To enhance analytical rigor and trustworthiness, the coding and interpretation process followed principles of qualitative transparency and reflexivity. The analytical decisions, theme development, and interpretive steps were systematically documented to create an audit trail. This documentation enabled continuous comparison between the curriculum texts, emerging themes, and the theoretical framework, reducing the risk of interpretive drift and supporting analytical consistency. Preliminary thematic interpretations and the proposed fascia-based integration framework were reviewed through peer debriefing with experts in voice pedagogy, somatic education, and movement-based learning. Feedback was used to refine conceptual clarity, ensure terminological accuracy, and strengthen alignment between curriculum analysis and contemporary fascia literature.

Development of the Pedagogical Framework

In the final stage of the study, a pedagogical framework for integrating fascia-based exercises into the teaching–learning practices of Individual Voice Training courses was developed based on the findings of the document analysis and the relevant literature. This framework aims to propose an approach that:

- Preserves the existing learning outcomes of the curricula,
- Is appropriate to students ’age and developmental characteristics,
- Holistically integrates movement, breathing, and bodily awareness, and
- Prioritizes sustainable practices that support vocal health.

FINDINGS

Findings Related to the First Sub-Question

Which body-preparation practices for singing are defined within the "Teaching–Learning Practices" section of the Ministry of National Education Individual Voice Training curricula?

An examination of the Individual Voice Training curricula issued by the Ministry of National Education across grade levels from Grade 1 to Grade 8 reveals that practices aimed at preparing the body for singing are systematically included under the heading "Teaching–Learning Practices," with increasing intensity across grade levels. While these practices remain largely similar in content throughout the grades, their scope expands progressively at higher grade levels.
Based on the document analysis, the practices related to preparing the body for singing were identified and categorized under the following thematic headings:

1. Bodily Warm-Up, Stretching, and Relaxation Movements

The curricula explicitly include bodily warm-up, stretching, and relaxation movements as part of the preparation process for singing, particularly from Grades 1, 3, and 5 onward. Within this scope, the following practices are defined as fundamental preparatory activities prior to vocalization:

- Stretching of the arms and shoulders,
- Rotations of the neck to the right and left, and upward and downward,
- Circular movements of the shoulders,
- Stretching movements involving raising the arms upward and extending them laterally,
- Spinal stretching and general body relaxation exercises.

These practices are intended to facilitate students 'physical readiness before vocal performance.

2. Proper Posture and Body Alignment

Across all grade levels, proper posture and body alignment are emphasized as essential components of preparing the body for singing. The curricula specify that:

- When singing in a standing position, the shoulders should remain relaxed, the spine upright, the chest open, and the jaw positioned appropriately;
- When singing in a seated position, the spine should be upright, the feet should be placed flat on the floor, and overall bodily balance should be maintained.

Furthermore, it is stated that establishing correct posture prior to vocalization contributes to the effective use of the voice in terms of appropriate pitch and loudness.

3. Voice and Breathing Exercises

Another prominent practice consistently emphasized across all grade levels involves voice and breathing exercises. Within this context, the curricula highlight:

- The implementation of breathing exercises prior to vocalization,
- Exercises aimed at enabling students to use their voices at appropriate pitch and dynamic levels,
- The integration of breathing exercises with students 'prior learning experiences.

These practices are identified as indispensable components of the body preparation process for singing.

4. Exercises Targeting Diaphragmatic Use

Beginning particularly from Grade 4, the curricula explicitly incorporate exercises aimed at activating and utilizing the diaphragm. Diaphragmatic exercises are described as serving the purposes of:

- Establishing breath control,
- Supporting the appropriate tempo and dynamic level of vocal output,
- Promoting bodily relaxation and facilitating internal balance.

5. Bodily Relaxation and the Regulation of Internal Dynamics

One of the recurring emphases across all grade levels involves activities designed to promote bodily relaxation and the regulation of internal dynamics. These activities are presented as preparatory practices that encompass both the physical and internal dimensions of preparing the body for singing.

6. Articulation and Facial Exercises

From Grade 5 onward, articulation- and facial-area-focused exercises are incorporated into the body preparation process. These include:

- Lip exercises,
- Tongue exercises,
- Jaw opening and closing movements,
- Lip trill exercises,
- Closed-mouth humming practices.

These applications are aimed at enhancing articulatory readiness prior to vocal performance.

7. Holistic Pre-Vocal Preparation Practices

At upper grade levels (Grades 5–8), the preparation process for singing is addressed in a more holistic manner. Bodily relaxation, proper posture, diaphragmatic and breathing exercises, and vocal exercises are considered collectively, emphasizing that students should undergo a comprehensive preparatory process before performing pieces from their repertoire.

Table. 1 *Body Preparation Practices for Singing in the Ministry of National Education Individual VoiceTraining Curriculum by Grade Level*

Grade	Stretching / Mobilization (Neck–Shoulder–Arm–Lower Back)	Posture / Position (Standing–Seated)	Breathing Exercises	Vocal Warm-up / Phonation (Trills, Humming, etc.)	Diaphragmatic Exercises	Relaxation / Internal Dynamics – Balance	Articulation (Lips–Tongue–Jaw)	Body Language (Gestures–Facial Expression)
1	Arm–shoulder stretching, neck rotations, lower back stretching	Open chest, shoulders back, "upright and relaxed"	–	–	–	Implicit: "preparing the body"	–	–
2	–	–	Voice–breathing exercises	–	–	Relaxation, internal dynamics	–	–
3	Neck and shoulder circles, arm stretching and release	Distinction between standing and seated positions	✓	Lip trills, arpeggios, closed-mouth humming	–	Relaxation, stretching, internal dynamics	–	–
4	–	–	✓	–	Exercises targeting diaphragmatic use	Relaxation, internal balance	–	–
5	Emphasis on stretching and relaxation	Repetition of correct posture	✓	–	✓	✓	Lips–tongue–jaw	Gestures and facial expressions
6	–	Emphasis on correct posture	✓	–	✓	✓	–	–
7	–	Emphasis on correct posture	✓	–	✓	✓	–	–
8	–	Emphasis on correct posture	✓	–	✓	✓	–	–

Based on the document analysis, it was determined that the practices aimed at preparing the body for singing in the Ministry of National Education Individual Voice Training curricula are structured around bodily warm-up and relaxation, proper posture, voice and breathing exercises, diaphragmatic use, the regulation of internal dynamics, and articulation work. These practices demonstrate a recurring and progressively expanding structure across grade levels, with similar core components being revisited and elaborated as students advance through the curriculum.

Findings Related to the Second Sub-Question

How can these body-preparation practices be evaluated from the perspective of the fascial system and movement-based pedagogical approaches?

Unlike the first sub-question, which focuses on the *presence* of preparatory practices in the curriculum, this sub-question requires an evaluation of their adequacy and alignment with contemporary scientific conceptualizations of the fascial system and with the functional interrelationship among movement, breathing, and posture. The document-analysis findings are presented below through a set of evidence-informed thematic interpretations.

Theme 1: The curriculum's "preparatory" practices provide a foundation that is broadly compatible with fascia-informed frameworks; however, fascia is not conceptually articulated

The stretching–relaxation activities, postural adjustments, breathing practices, and diaphragmatic work described in the MoNE curriculum are, in principle, congruent with the fascial system's role as a body-wide network involved in force transmission, postural organization, and respiratory coordination (Adstrum et al., 2017; Bordoni & Zanier, 2013; Stecco & Schleip, 2016). In the contemporary literature, fascia is not defined merely as a passive "wrapping tissue," but as a system functionally interrelated with musculoskeletal, visceral, and neural components, contributing to movement and postural regulation (Adstrum et al., 2017; Stecco & Schleip, 2016). Moreover, fascia has been described as a richly innervated sensory network that may be implicated in perceptual and interoceptive processes (Schleip et al., 2014).

Despite this conceptual compatibility, the curriculum does not explicitly refer to fascia, and the recommendations related to movement and relaxation remain general and fragmented in scope (Ministry of National Education, 2025). Accordingly, while the curriculum's approach to "preparing the body" appears to contain latent potential for fascia-informed pedagogical development, it does not operationalize this potential within an explicit fascia-based pedagogical framework (Adstrum et al., 2017).

Theme 2: The emphasis on "upright posture" may constrain functional voice production if interpreted through a static/rigid lens

If the Grade 1 emphasis on "upright and correct posture" is enacted in practice as a fixed and rigid postural set, it may conflict with the elastic tensioning and dynamic adaptability that support efficient fascial function (Huijing, 2009; Stecco & Schleip, 2016). Evidence syntheses on the posture–voice relationship indicate that effective posture, whether in stillness or in motion, may facilitate redistribution of intermuscular tension and support laryngeal freedom; conversely, rigid and "frozen" postural concepts may introduce pedagogical risk (Cardoso et al., 2019).

The literature also reports associations among posture, voice production, and dysphonia, including evidence that posture can influence voice and that voice-production mechanisms may, in turn, modify postural organization (Cardoso et al., 2019). Complementing this, a case report documenting improvements in selected vocal parameters following postural rehabilitation in a classical singing student suggests that postural interventions can be meaningfully linked to vocal outcomes in certain contexts (Staes et al., 2011).

Therefore, unless the curriculum's postural statements are reframed through principles of fascial elasticity, mobility, and adaptable alignment, the risk emerges that "upright posture" may be pedagogically translated into a counterproductive static stance (Cardoso et al., 2019; Stecco & Schleip, 2016).

Theme 3: The curriculum's emphasis on breathing and the diaphragm constitutes a strong entry point for fascia-informed integration

The systematic recurrence of "voice–breathing exercises" beginning in Grade 2 and explicit "diaphragm work" beginning in Grade 4 represents the most robust integration opportunity from a fascia-informed perspective (Ministry of National Education, 2025). The literature emphasizes that the

diaphragm should not be treated solely as an isolated muscle; rather, it functions as a critical "intersection" structure within connective tissue continuity, with extensive anatomical and functional interconnections across regions (Bordoni & Zanier, 2013).

Additionally, research on myofascial force transmission indicates that tension generated by muscles can be transmitted to adjacent tissues and fascial structures, challenging the assumption that muscles act in isolation (Huijing, 2009). These findings suggest that the curriculum's breath–diaphragm–relaxation triad could be systematically structured through fascia-informed exercises that support deep anterior connections (e.g., diaphragm–trunk organization relationships) (Bordoni & Zanier, 2013; Huijing, 2009). Supporting this perspective, randomized controlled trial evidence indicating acute effects of myofascial diaphragm release on outcomes such as chest-wall mobility and posterior-chain flexibility further strengthens the rationale for conceptualizing the breath–mobility interface within a fascial framework (Marizeiro et al., 2018).

Theme 4: Movement is present in the curriculum, yet it is not specified at an operational level (movement type, purpose, and targeted functional pathways)

Movements such as neck–shoulder–arm stretching and release in Grades 1 and 3, together with the relaxation emphasis in higher grades, offer a positive starting point for fascia-informed pedagogy (Ministry of National Education, 2025). However, because these movements are not defined in terms of goals, dosage, sequencing, breath-coupling, or safety criteria, the curriculum provides limited guidance for reducing the risk of unsystematic or ad hoc implementation (Adstrum et al., 2017).

Fascia literature underscores the importance of conceptual and terminological clarity when fascia is described as a "system," particularly for translating scientific frameworks into practice (Adstrum et al., 2017). Moreover, systematic reviews on myofascial continuity and meridian-based models synthesize evidence for anatomical connections while emphasizing that functional interpretation remains an active research agenda, thereby reinforcing the need for greater clarity at the curriculum level regarding "which movement, for what purpose" (Wilke et al., 2016). Consequently, although the curriculum's existing practices create a foundation for fascia-informed integration, they require operational elaboration, particularly in terms of fascial awareness and breath-coupled dynamic preparation, to support consistent pedagogical enactment (Adstrum et al., 2017; Wilke et al., 2016).

Theme 5: Articulation and facial-region practices introduced in Grade 5 provide an opportunity to connect "local" and "global" coordination through fascial continuity

The inclusion of articulation (lips–tongue–jaw) and gesture/facial expression work in Grade 5 supports not only local motor control but also the integration of head–neck coordination with phonation and postural organization (Ministry of National Education, 2025). Recent experimental findings examining relationships between oral/articulatory posture and pitch perception/performance suggest that mouth posture can influence pitch judgments even during "inner singing" tasks (Körner et al., 2023). This finding indicates that articulation-focused practices in the MoNE curriculum may be particularly amenable to integration with fascia-informed approaches that address head–neck–thorax coordination in conjunction with breathing and phonation (Bordoni & Zanier, 2013; Körner et al., 2023).

Synthesis of Findings for the Second Sub-Question

Overall, the document-analysis findings indicate that the MoNE Individual Voice Training curricula include preparatory practices (stretching–relaxation, posture, breath–diaphragm work, vocal warm-up, and articulation) that contain components potentially compatible with fascia-informed frameworks. However, these practices are not structured within an explicit pedagogical model grounded in fascia concepts, breath–movement coupling, and dynamic postural organization (Ministry of National Education, 2025; Adstrum et al., 2017; Stecco & Schleip, 2016). Scientific definitions of

fascia (Adstrum et al., 2017; Schleip et al., 2014; Stecco & Schleip, 2016), together with review-based and clinical evidence on posture–voice relationships (Cardoso et al., 2019; Staes et al., 2011), suggest that a static interpretation of "upright posture" may be pedagogically risky, whereas the curriculum's sustained emphasis on breathing and diaphragmatic work offers a particularly strong gateway for fascia-informed integration (Bordoni & Zanier, 2013; Huijing, 2009; Marizeiro et al., 2018).

Findings Related to the Third Sub-Question

What are the potential effects of directing students toward static and rigid postures on breath coordination, bodily fluidity, and resonance capacity in individual voice training?

1) Potential Effects on Breathing Coordination

A fixed/rigid posture may challenge respiratory mechanics, the primary "motor" of voice production, through two main pathways: (i) restricting rib cage–abdominal coordination and (ii) reducing the efficiency of expiratory control (airflow and subglottal pressure regulation). Research in the speech-breathing literature demonstrates that body position (e.g., standing and postural organization) can modify chest wall and abdominal movement patterns, with measurable implications for respiratory tasks (Hoit et al., 1995).

In the context of singing, when goals such as "activating the diaphragm" or performing "breathing exercises" are pursued within a static trunk/thorax configuration, students may be more likely to rely on superficial and compensatory breathing strategies (e.g., elevation of the shoulder girdle, increased activity in cervical and upper thoracic musculature). This risk is consistent with review findings suggesting that postural dysfunction may be associated with increased muscular resistance/tension and voice-related problems (Cardoso et al., 2019).

Furthermore, in musician–singers facing posturally demanding conditions (e.g., singing while accompanying themselves on an instrument), posture has been reported to influence expiration and phonation. Indicators such as maximum phonation time (MPT) and selected resonance-related measures may vary as a function of postural organization (Longo et al., 2020). Such findings suggest that a "locked" posture may indirectly compromise breath management and respiratory efficiency during vocal tasks (Longo et al., 2020).

2) Potential Effects on Bodily Fluidity (Dynamic Posture) and Phonatory Efficiency

In voice education, "fluidity" is not merely an aesthetic attribute; it refers to the capacity of the larynx and the integrated respiration–posture system to perform fine-grained micro-adjustments. A fixed/rigid posture may reduce these adjustments, thereby decreasing phonatory efficiency and increasing perceived effort. An experimental study in healthy individuals demonstrated that alterations in head position (anterior/posterior) and postural configuration can increase perceived phonatory effort even during short-duration phonation (Gilman & Johns, 2017).

In addition, clinical and observational work that considers postural deviations and muscular hypertonicity alongside vocal outcomes suggests that as postural components of imbalance increase, voice quality may be negatively affected. For example, among teachers, postural patterns and extrinsic laryngeal muscle tension components have been reported to relate to voice handicap scores and indicators of dysphonia severity (Kooijman et al., 2005).

Similarly, findings of differences in thoracic sagittal alignment measures (e.g., kyphosis indices) in dysphonic adults support the premise that the posture–voice relationship should be conceptualized not solely at the level of the neck, but across whole-trunk organization (Franco et al., 2014).

3) Potential Effects on Resonance Capacity

Resonance capacity is closely associated with the configurability of the vocal tract, the vertical position of the larynx, and head–neck alignment. Evidence indicates that head flexion/extension can significantly alter acoustic measures in singing—particularly indices such as the singing power ratio (SPR), which is often used as a proxy for singer's formant-related efficiency (Knight & Austin, 2020). This provides direct support for the claim that a rigid, uniform postural approach may constrain the fine adjustments required for optimal resonance (Knight & Austin, 2020).

Moreover, body position has been reported to influence acoustic and morphological characteristics of the vocal tract, with potential downstream effects on formant organization and resonance outcomes (Vorperian et al., 2015). In musician–singers, posture has also been shown to affect resonance-related indicators such as singer's formant amplitude, further supporting the notion that posture can influence resonance not only indirectly but in measurable acoustic terms (Longo et al., 2020).

Summary of Risks Identified in the Literature

Taken together, directing students toward fixed and rigid postures during individual voice training may entail the following risks:

- **Breathing coordination:** Reduced rib cage–abdominal synchrony and less efficient expiratory control (Hoit et al., 1995; Longo et al., 2020).
- **Bodily fluidity and phonatory efficiency:** Increased perceived phonatory effort and tension-based compensations due to reduced dynamic adjustability (Gilman & Johns, 2017; Kooijman et al., 2005).
- **Resonance capacity:** Constrained head–neck configuration and reduced vocal-tract adjustability, potentially reflected in changes in acoustic indices such as singer's formant/SPR (Knight & Austin, 2020; Vorperian et al., 2015).

Findings Related to the Fourth Sub-Question

What pedagogical contributions can fascia-based exercises, particularly those targeting the Deep Front Line and Spiral Line, offer to the individual voice training process?

1) Literature-Based Framework: How Should the "Line" Approach Be Positioned?

The terms Deep Front Line (DFL) and Spiral Line (SL) originate from the conceptual mapping proposed within the *Anatomy Trains* model, which is widely used in movement pedagogy and body literacy contexts (Myers, 2020). However, the academic literature does not provide uniform levels of empirical support for all myofascial continuity or "chain/line" claims. For instance, cadaver-based evidence suggests moderate support for spiral-line-like continuities, while reporting weaker evidence for certain other lines (Wilke et al., 2016). More recent reviews similarly indicate moderate evidence for the Spiral Line, alongside varying levels of support, stronger or weaker, for other proposed lines (Kalichman, 2025).

Accordingly, in the present study, the DFL and SL are not presented as claims of absolute anatomical reality. Rather, they are framed as pedagogical constructs that render breath–posture–movement coordination more teachable and intelligible within educational contexts. This positioning reflects both scientific caution and a developmentally appropriate language for curriculum design (Kalichman, 2025; Wilke et al., 2016).

2) Pedagogical Contributions (with a Focus on the DFL and Spiral Line)

A) Structuring Breathing Coordination Through "Deep Support" (Aligned with the DFL)

Within individual voice training, emphasis on breathing and diaphragmatic engagement is already prominent in the curriculum. A DFL-oriented perspective enables this breathing instruction to be conceptualized as a holistic organization of pressure and balance across the rib cage, diaphragm, abdominal wall, and pelvic floor. Contemporary anatomical literature conceptualizes the diaphragm not merely as an isolated muscle but as a critical regulatory structure embedded within connective tissue continuity (Bordoni & Zanier, 2013; Liu & Wiedman, 2024).

***Pedagogical implication*:** Instead of interpreting the instruction "take a breath" as an upper-chest-dominant action, students learn to experience effective breath support as a coordinated expansion of the lower ribs combined with abdominal-wall engagement and trunk stability (Liu & Wiedman, 2024).

B) Reframing "Upright Posture" as Dynamic and Adjustable Rather Than Static

The posture–voice relationship is described in the literature as bidirectional: posture may facilitate efficient voice production, yet the direction and magnitude of this relationship vary across contexts (Cardoso et al., 2019). A DFL/SL-informed approach supports teaching "upright posture" not as a locked position but as adjustable balance, emphasizing rib cage–pelvis relationships and head–neck freedom. This pedagogical language reduces the risk of unnecessary tonic activation that may result from rigid commands such as "stand straight" or "pull the shoulders back," particularly in children (Cardoso et al., 2019).

C) Enhancing Resonance Capacity Through Thoracic Mobility and "Spiral Expansion" (Aligned with the Spiral Line)

A Spiral Line focus is particularly functional for teaching the three-dimensional mobility of the thorax, rotation and lateral expansion, which is critical for singing, as well as upper–lower body coordination (e.g., scapula–pelvis cross-patterning). The layered structure of the thoracolumbar fascia and its role in tension distribution provide a conceptual background for understanding the trunk as an integrated "arch-like" system, thereby rendering cross-body movement patterns pedagogically meaningful (Willard et al., 2012).

From a pedagogical standpoint, resonance-related instructions may thus shift from "lift the chest" to more functional and sustainable cues such as "expand the ribs laterally and posteriorly" or "lengthen the trunk spirally."

D) Bodily Awareness and Self-Regulation: The Sensory Role of Fascial Tissue

Fascia is not merely a mechanical container but a richly innervated tissue with sensory and proprioceptive functions that contribute to motor control and bodily awareness (Schleip et al., 2012; Suárez-Rodríguez et al., 2022). This sensory dimension supports the integration of skills such as listening to bodily cues, releasing unnecessary tension, and reorganizing posture, capacities that are particularly relevant for managing performance anxiety and habitual tension in children.

3) DFL- and Spiral-Line-Focused Exercise Proposals Adaptable to the MoNE Curriculum

The following proposals aim to systematize the curriculum's existing practices, warm-up, relaxation, breathing/diaphragm work, and posture, through a fascia-informed instructional language. (Suggested duration: 2–5 minutes. Exercises should be discontinued in cases of pain or dizziness and may be adapted through age-appropriate play.)

A) Deep Front Line–Focused (Breath, Deep Support, Axial Lengthening)

1. **Lower-rib "umbrella breathing" (standing or seated)**
   Hands placed on the lower ribs; during inhalation, the ribs expand laterally, while exhalation is accompanied by gentle abdominal-wall recoil.

Rationale: Supports accurate teaching of diaphragmatic mechanics and holistic breath support (Bordoni & Zanier, 2013; Liu & Wiedman, 2024).

2. **"Lengthening spine" with jaw release (micro postural scan)**
   Neck lengthened, jaw relaxed; shoulders are "heavy and free" rather than locked downward/backward.
   Rationale: Reduces postural "locking" risks associated with voice production (Cardoso et al., 2019).
3. **Half-kneeling breath-supported trunk lengthening (Grades 6–8)**
   Emphasis on anterior hip lengthening combined with lower-rib breathing.
   Rationale: Concretizes hip–pelvis–diaphragm relationships within DFL pedagogy (Bordoni & Zanier, 2013; Willard et al., 2012).

B) Spiral Line–Focused (Cross-Body Coordination, Thoracic Rotation, Resonance Space)

1. **"Open book" thoracic rotation (seated or side-lying; Grades 4–8)**
   Gentle opening and closing of the trunk coordinated with breath.
   Rationale: Teaches spiral/rotational capacity and three-dimensional thoracic movement; anatomical evidence for spiral continuity is moderate (Kalichman, 2025; Wilke et al., 2016).
2. **Standing cross-body reach and gather**
   One arm reaches diagonally upward while the opposite heel remains grounded; sides alternate.
   Pedagogical goal: Organizing the trunk for resonance and "relaxed uprightness" without postural locking (Willard et al., 2012).
3. **Lunge with rotation (upper grades)**
   Simple lunge combined with gentle trunk rotation, synchronized with breath.
   Rationale: Strengthens cross-body coordination and introduces the language of "spiral expansion."
4. **Shoulder circles with spiral trunk wave (gamified; Grades 1–3)**
   Existing shoulder-circle movements are integrated with gentle trunk spiraling.
   Outcome: Curriculum movements are taught as holistic patterns rather than isolated segments.

4) Embedding These Proposals Within the "Teaching–Learning Practices" of the MoNE Curriculum

At the beginning of each lesson, the curriculum's existing "body preparation" component can be transformed into a concise micro-protocol:

- **30–45 s:** DFL-oriented breathing (lower-rib expansion)
- **45–60 s:** Dynamic postural scan (head–neck freedom; rib cage–pelvis balance)
- **60–90 s:** Spiral movement (cross-body reach or thoracic rotation)
- **30–45 s:** Vocal warm-up/articulation (e.g., trills, humming), aligned with curriculum content

This structure preserves the curriculum's intended learning outcomes while operationalizing the breath–movement–posture relationship through a fascia-informed pedagogical framework (Kalichman, 2025; Liu & Wiedman, 2024; Wilke et al., 2016).

Findings Related to the Fifth Sub-Question
To what extent do the existing "Teaching–Learning Practices" in the Ministry of National Education Individual Voice Training curricula allow for the integration of fascia-based exercises?

1) The emphasis on "preparing the body for singing" provides a strong and natural entry point for fascia-based integration

Within the Ministry of National Education (MoNE) Individual Voice Training Curriculum, the behavior of "preparing the body before performing a piece" is explicitly targeted across grade levels. This objective is operationalized through practices such as relaxation and stretching, breathing

exercises, vocal warm-ups, and, at upper grade levels, diaphragmatic work within the teaching–learning practices (MoNE, 2025). Such practices are fundamentally compatible with contemporary conceptualizations of the fascial system as a holistic connective tissue network that actively participates in movement and postural organization rather than serving merely as a passive covering (Adstrum et al., 2017; Willard et al., 2012).

Accordingly, the current curricular orientation does not necessitate the construction of an entirely new instructional structure for fascia-based integration. Instead, it points to the need for re-framing existing preparatory practices through scientifically grounded rationales and principles of movement quality.

2) The relatively general wording of the teaching–learning practices affords pedagogical flexibility for teachers

The "Teaching–Learning Experiences" section of the curriculum emphasizes that the selection of methods and techniques should be aligned with learning outcomes and content, while also being adaptable to the characteristics of the school and classroom context (MoNE, 2025). This flexibility represents a significant advantage for fascia-based integration: fascia-oriented exercises can be incorporated by preserving the intended learning outcome of "preparing the body" while transforming the same instructional time into a more functionally organized preparatory sequence.

Moreover, the curriculum's school-based planning approach provides a structural foundation that enables teachers to make context-sensitive micro-adaptations in line with their students ' developmental and situational needs (MoNE, 2025).

3) The curriculum allows for a high degree of integration; however, two critical gaps shape the quality of implementation

a) Conceptual gap

Because the concept of "fascia" is not explicitly articulated in the curriculum text, teachers ' interpretations of stretching and relaxation practices may remain muscle-centered and segmental. In contrast, fascia-oriented terminology emphasizes movement not as isolated regional stretching, but as load transmission and elastic recoil within a system of tensional continuity (Adstrum et al., 2017; Willard et al., 2012). Without addressing this conceptual gap, integration efforts risk remaining at the level of general warm-up rather than constituting a genuinely fascia-based approach.

b) Operational gap (dosage, sequencing, and breath–movement coupling)

The curriculum does not specify how body-preparation practices should be sequenced, dosed, or coordinated with breathing. Consequently, implementation quality is largely dependent on individual teacher interpretation. However, implementation science literature consistently emphasizes that a program's real-world impact is determined less by written content than by its feasibility and fidelity of application (Carroll et al., 2007; Durlak & DuPre, 2008). Therefore, while leveraging the curriculum's existing flexibility, fascia-based integration requires the clarification of core components, such as breath-coupled dynamic preparation, safe movement principles, and age-appropriate dosage, to ensure instructional quality.

4) The risk of interpreting "upright posture" statically increases the need for re-framing, while simultaneously revealing curricular openness to reinterpretation

Although the curriculum includes references to correct posture, there is a risk that these references may be enacted in practice as rigid or fixed postural positions. Research on posture–voice relationships emphasizes that effective posture is not a frozen alignment but rather an organization capable of redistributing tension dynamically and supporting laryngeal freedom (Cardoso et al., 2019).

Fascia literature similarly conceptualizes posture in terms of load transfer and elastic adaptability within connective tissue continuity (Willard et al., 2012).

From this perspective, the curriculum's "body preparation" components do not require formal rewriting to support fascia-based integration; rather, they can be pedagogically reinterpreted through teacher instructions and exemplar activities that emphasize dynamic posture and fluid alignment instead of postural locking. This indicates that the curriculum is pedagogically open to integration (MoNE, 2025).

5) The integration of a Deep Front Line and Spiral Line focus is feasible through scientific grounding and pedagogical translation

The terms Deep Front Line and Spiral Line do not constitute standardized anatomical nomenclature; rather, they function as modeling language frequently used to translate the concept of myofascial continuity into instructional design. Evidence related to the continuity aspect of this concept is discussed primarily within the cadaver-based myofascial connectivity literature (Wilke et al., 2016).

To ensure curricular compatibility, two guiding principles are proposed:

- **Alignment with curricular language:** The curriculum's existing terminology, such as breathing, relaxation, diaphragmatic work, and vocal exercises, should be retained, with the fascia-based framework introduced as a functional explanatory layer rather than a replacement (MoNE, 2025; Bordoni & Zanier, 2013).
- **Pedagogical translation of movement concepts:** Line/meridian language should be translated into goals related to bodily awareness and coordination. For example, "spiral coordination" may be reframed in age-appropriate classroom language as "cross-body connection and balanced turning."

This approach is compatible with the curriculum's flexible structure; however, it necessitates brief implementation guidelines and a simple instructional checklist for teachers (Carroll et al., 2007; Kershner et al., 2014).

Synthesis of Findings for the Fifth Sub-Question

Overall, the current MoNE Individual Voice Training Curriculum affords a high degree of opportunity for the integration of fascia-based exercises, as it defines "preparing the body for singing" as an inherent component of teaching–learning practices and grants teachers contextual flexibility in method and technique selection (MoNE, 2025). Nevertheless, for such integration to be genuinely fascia-based, three conditions are essential:

1. Clarification of the scientific framework underlying fascia conceptualization (Adstrum et al., 2017; Willard et al., 2012);
2. Reinterpretation of static "upright posture" cues through principles of dynamic postural organization (Cardoso et al., 2019); and
3. Identification of core components and teacher-support mechanisms to ensure implementation quality (Carroll et al., 2007; Durlak & DuPre, 2008; Kershner et al., 2014).

Findings Related to the Sixth Sub-Question
Which fundamental principles should be considered to ensure that fascia-based exercises applicable from the primary and lower secondary school level onward are structured in an effective, healthy, and sustainable manner within the process of preparing the body for singing?

1) Developmental Appropriateness and Safety (age-appropriate, pain-free, play-based)

For primary and lower secondary school children, exercise content should be designed not for "maximal performance" but for developing a safe movement repertoire, enhancing bodily awareness, and fostering consistent habits. Training loads should remain low to moderate, be non-painful, and be implemented under teacher supervision (Faigenbaum et al., 2009; Chaput et al., 2020).

2) Framing "Posture" as Dynamic Organization Rather Than a Static Template

Because the fascial system is conceptualized as a network demonstrating continuity across musculoskeletal structures and participating in load transfer and movement organization, "correct posture" should be taught through principles of adaptable alignment rather than freezing or locking the body into rigid positions (Adstrum et al., 2017).

3) Prioritizing Dynamic Mobilization in Warm-Up and Limiting Static Stretching Dosage

In preparing the body for singing, dynamic mobilization, rhythmic, fluid movements that employ controlled joint range of motion, should be prioritized. If static stretching is used, it should be brief and followed by dynamic activity. This approach is supported by evidence indicating that acute effects of stretching, particularly prolonged static stretching, may exert small-to-moderate negative effects on performance, whereas dynamic approaches tend to be more advantageous in warm-up contexts (Behm et al., 2016).

4) Fascia Adaptation Logic: Low Dose, Consistency, and Gradual Progression

Because fascial tissues may show relatively slow adaptation to loading, a "less, but regular" principle is essential. Weekly planning should incorporate 3–8-minute micro-sequences within each lesson, complemented by 1–2 more structured (yet still developmentally appropriate) repetitions per week. Load should be increased progressively over time (Schleip & Müller, 2013).

5) Using Elastic Recoil and "Spring-Like" Energy Management in Safe Micro-Forms

Elastic recoil and the principle of preparatory countermovement constitute key components of fascia-informed training. At the primary and lower secondary school level, however, this should not take the form of high-intensity plyometrics. Instead, it should be implemented through safe micro-applications such as very small-amplitude rhythmic oscillations, gentle bouncing, and controlled heel-to-toe transitions (Schleip & Müller, 2013).

6) Multi-Planar and Cross-Patterned Movements (consistent with fascial continuity)

A myofascial continuity perspective suggests that multi-planar movements, particularly cross-body patterns and rotational actions, may provide pedagogically meaningful grounding compared with single-joint or single-plane movements (Wilke et al., 2016). This supports structuring "spiral/cross-body integration" through child-appropriate play patterns such as contralateral knee–elbow touches, cross-body reaching, and rotational reaching in a safe manner (Wilke et al., 2016).

7) Breath–Movement Coupling and the Fascial Connections of the Diaphragm

In the preparation phase for singing, breathing should not be taught merely as "inhaling and exhaling" in isolation. Rather, it should be coordinated with movement (e.g., inhalation paired with expansion/lengthening; exhalation paired with softening/gathering). The diaphragm's anatomical and fascial connections across multiple systems provide a robust conceptual framework supporting the role of breathing in whole-body organization (Bordoni & Zanier, 2013).

8) Proprioceptive Awareness: Tactile Cues, Slow Exploration, and Interoceptive Language

Systematic findings on fascial innervation emphasize the importance of fascia's sensory components, rendering a "feel–notice–regulate" pedagogical approach particularly meaningful for children. This may include simple tactile prompts, slow scanning, and guided noticing of load transfer. Proprioceptive refinement is also explicitly emphasized as a principle within fascia-oriented training recommendations (Schleip & Müller, 2013; Suárez-Rodríguez et al., 2022).

9) Implementation Integrity and Sustainability: Teacher Guidance and Adherence-Focused Design

For sustained impact, exercise sequences should be easy to deliver, compatible with classroom management, brief, and amenable to standardization. Teacher competence in delivery and student adherence are primary determinants of effectiveness. Even when neuromuscular training programs demonstrate preventive or rehabilitative benefits in youth, the literature highlights participation and maintenance as critical challenges (Emery et al., 2015). Accordingly, fascia-based sequences require clear instructions, time–repetition parameters, and safety warnings, and they may necessitate in-service teacher training focused on fascia-aware exercise delivery (Emery et al., 2015).

10) Monitoring and Adaptation: Individual Differences and Risk Flags

At the primary and lower secondary school level, exercises should be immediately adapted or discontinued in cases such as pain, dizziness, shortness of breath, pronounced hypermobility, or acute musculoskeletal complaints. Child exercise literature emphasizes that appropriate supervision, correct technique, and individualization constitute the backbone of safe implementation (Faigenbaum et al., 2009). Consistent with this principle, it is recommended that these exercises be delivered by teachers trained in fascia-informed practice or, where possible, under the guidance of a qualified fascia specialist.

Answer to the Main Research Question

1) Conceptual Framework: What Does "Fascia-Based Integration" Mean?

In this study, fascia-based exercise integration is defined as moving curriculum-based preparatory practices beyond the level of "general warm-up" and transforming them into a teachable and standardizable micro-protocol grounded in:

1. dynamic posture,
2. breath–movement coordination,
3. multi-planar/cross-body movement,
4. sensory awareness (proprioception), and
5. progressive loading principles.

This approach is anchored in contemporary definitions of fascia as a connective tissue network that actively contributes to movement and postural organization rather than functioning merely as a covering tissue (Adstrum et al., 2017). Furthermore, while myofascial continuity/chain concepts can support the pedagogical rationale for cross-patterned and multi-planar movement design, evidence is not equally strong across all proposed "lines." Therefore, the recommended language should be grounded not in absolute anatomical claims, but in teachable coordination principles and tissue continuity concepts (Wilke et al., 2016).

2) Pedagogical Design Principles: Core Elements for an Effective, Safe, and Sustainable Structure

The curriculum's existing body-preparation elements (relaxation/stretching, breath–voice exercises, diaphragm work, posture) can be translated with high fidelity into a fascia-informed framework (MoNE, 2025). The core design principles include:

- **Dynamic mobilization priority in warm-up:** Controlled rhythmic movements should take precedence over prolonged static stretching; where static stretching is used, it should be brief and followed by dynamic activity (Behm et al., 2016).
- **Breath–movement coupling:** Breathing should be taught through three-dimensional lower-rib expansion and controlled exhalation, synchronized with movement rather than "stacked into the chest" (Bordoni & Zanier, 2013).
- **Teaching posture as dynamic organization:** Posture should be framed as adaptable balance and freedom rather than as a locked alignment; review evidence supports functional organizational language over rigid templates (Cardoso et al., 2019).
- **Multi-planar/cross-body patterns:** Thoracic rotation and cross-body reach–gather patterns can be pedagogically justified through a myofascial continuity perspective (Wilke et al., 2016).
- **Sensory awareness and safety:** Innervation findings support the pedagogical value of "feel–notice–regulate" elements via simple tactile cues and slow scanning (Suárez-Rodríguez et al., 2022).
- **Progressive loading and sustainability:** Fascia-informed training emphasizes regularity, gradual progression, and low-risk dosage for elements such as elastic recoil and proprioceptive refinement (Schleip & Müller, 2013).

3) Integration Architecture: A Framework to Embed Within MoNE "Teaching–Learning Practices"

A) A "Fascia-Based Preparation Protocol" (3–8 minutes) as a stable lesson core

It is recommended that the curriculum's existing "preparing the body for singing" component be standardized as a four-stage routine at the start of each lesson (MoNE, 2025):

1. **Dynamic mobilization (60–90 s):** shoulder girdle mobilization + gentle trunk oscillation + pain-free micro range of motion (ROM) for the neck
   Aim: tissue warming and mobility without locking (Behm et al., 2016).
2. **Breath–movement coupling (60–90 s):**" lower-rib umbrella breathing" with lateral/posterior expansion on inhalation and soft gathering on exhalation
   Aim: diaphragmatic/respiratory organization and pressure–balance coordination before singing (Bordoni & Zanier, 2013).
3. **Cross/spiral patterning (60–120 s):**
   - Grades 1–4: contralateral knee–hand patterns; cross-body reach and gather (play-based)
   - Grades 5–8: standing thoracic rotation; simple lunge with small rotation
     Aim: multi-planar coordination, thoracic mobility, and load transfer (Wilke et al., 2016).
4. **Bridge to vocal warm-up (30–60 s):** lip trill / hum / closed-mouth humming (curriculum-aligned)
   Aim: transition into phonation while preserving postural freedom (Cardoso et al., 2019).

B) Grade-level progression to support sustainability

- **Grades 1–2 (3–4 min):** predominantly play-based mobilization + basic breath coupling
- **Grades 3–4 (4–5 min):** increased thoracic rotation; establishment of "dynamic uprightness" language

- **Grades 5–6 (5–6 min):** varied cross-patterns; breath ratios (short vs. longer exhalation)
- **Grades 7–8 (6–8 min):** breath control and resonance-aligned thoracic mobility and balance emphasis

This progression aligns with the fascia-informed principle of low-dose, consistent practice supporting long-term adaptation (Schleip & Müller, 2013).

4) Implementation Quality: A Teacher-Focused Structure to Ensure Fidelity

When curriculum language remains general, practical outcomes are primarily determined by feasibility and implementation quality. Therefore, integration should not be presented as a simple "exercise list," but as a model that specifies core components and includes brief checklists to support fidelity (Carroll et al., 2007; Durlak & DuPre, 2008).

A minimal implementation checklist for lesson observation/self-review may include:

- Was dynamic mobilization implemented (no prolonged static stretching)? (Behm et al., 2016)
- Was at least 60 seconds of breath–movement coupling completed? (Bordoni & Zanier, 2013)
- Were "upright posture" cues delivered in ways that avoid postural locking? (Cardoso et al., 2019)
- Was at least one cross-body/rotational pattern included? (Wilke et al., 2016)
- Were risk flags (pain, dizziness) monitored and acted upon? (Suárez-Rodríguez et al., 2022; Schleip & Müller, 2013)

In summary, the proposed pedagogical framework for integrating fascia-based exercises into the existing MoNE "preparing the body for singing" practices consists of a brief, four-stage Preparation Protocol applied systematically in each lesson. The protocol is grounded in: 1) dynamic mobilization, 2) breath–movement coupling (lower-rib/diaphragm-oriented), 3) multi-planar cross-patterning, 4) sensory awareness, 5) progressive loading and consistency, and 6) implementation quality assurance through a checklist-based approach (MoNE, 2025; Adstrum et al., 2017; Behm et al., 2016; Bordoni & Zanier, 2013; Cardoso et al., 2019; Carroll et al., 2007; Durlak & DuPre, 2008; Schleip & Müller, 2013; Suárez-Rodríguez et al., 2022; Wilke et al., 2016).

Conclusion

The document analysis conducted in this study demonstrates that the *Learning–Teaching Practices* section of the Ministry of National Education Individual Voice Training curriculum systematically recommends a range of practices aimed at preparing the body for singing, including stretching and relaxation, postural regulation, voice and breathing exercises, diaphragm-focused work, and, at certain grade levels, articulation and facial-region activities (MoNE, 2025).

However, the findings indicate that these practices are not presented within a conceptual framework explicitly grounded in the fascia system or movement-based pedagogical principles. In particular, the emphasis on "correct/upright posture," when interpreted in practice as a static or rigid alignment, may pose a risk of weakening the bodily fluidity that supports functional voice production (Cardoso et al., 2019; MoNE, 2025).

The central outcome of this research is the identification of a feasible approach that preserves the curriculum's existing "preparing the body for singing" components while reorganizing them into a brief, repeatable, four-stage fascia-based preparation protocol. This protocol, consisting of dynamic mobilization, breath–movement coupling, multi-planar/cross-body coordination, and a bridge into phonation, offers a practical framework that supports effectiveness, vocal health, and long-term sustainability (Behm et al., 2016; Bordoni & Zanier, 2013; Schleip & Müller, 2013).

Finally, the study concludes that the success of such integration depends not solely on *which* exercises are selected, but on implementation fidelity and the quality of teacher delivery within the school context. Accordingly, the development of a concise implementation guide, clearly defined core components, and basic monitoring tools should be regarded as integral elements of any fascia-based integration effort (Carroll et al., 2007; Durlak & DuPre, 2008).

Discussion

The document analysis finding that preparatory practices are present, yet not structured within a fascia-based framework gains pedagogical significance when considered alongside contemporary literature that conceptualizes fascia not merely as an anatomical "sheath," but as a multi-component system actively involved in movement and postural organization (Adstrum et al., 2017). From this perspective, the stretching/relaxation and breathing practices included in the MoNE curriculum can be seen as providing a foundational *ground* for a fascia-based approach; however, for this ground to translate into pedagogical outcomes, instructional design parameters such as purpose, sequencing, dosage, and breath–movement coupling must be explicitly articulated.

When the movements recommended in the warm-up and preparation phase remain at the level of "general stretching," classroom practice may drift toward prolonged static stretching and rigid patterns. A comprehensive review comparing the acute effects of static stretching, dynamic stretching, and proprioceptive neuromuscular facilitation (PNF) demonstrates that especially long-duration static stretching can negatively affect performance outcomes, whereas dynamic approaches are more justifiable within a warm-up context (Behm et al., 2016). Accordingly, strengthening the curriculum's "preparing the body" component through a micro-protocol that prioritizes dynamic mobilization would enhance both pedagogical clarity and safety.

The curriculum's strong and recurrent emphasis on breathing and diaphragmatic work constitutes one of the most functional entry points for fascia-based integration. Conceptualizing the diaphragm not merely as a respiratory muscle, but as a *crossroads* with extensive anatomical and fascial connections, supports the proposal to align breath instruction with whole-body organization (Bordoni & Zanier, 2013). In this context, implementing breathing work at the beginning of lessons in a brief, structured, and movement-coupled format may enhance postural freedom and coordination in voice production.

The discussion surrounding the field interpretation of "upright posture" aligns closely with literature that systematically examines posture–voice relationships. The systematic review by Cardoso et al. (2019) emphasizes that effective posture should not be understood solely as static "correctness," but rather as a dynamic organization capable of supporting laryngeal freedom and redistributing tension across muscle groups, both at rest and in motion. This finding places the pedagogical translation of postural cues, away from locking and toward adaptability, at the center of the discussion regarding the MoNE curriculum's posture-related statements.

Within the proposed framework, the inclusion of multi-planar and cross-body movement patterns can be pedagogically justified through the concept of myofascial continuity; however, scientific caution regarding the level of evidence remains necessary. A systematic review on myofascial chains supports the existence of connective tissue links between muscles, while also underscoring the ongoing need for research into their functional implications (Wilke et al., 2016). Consequently, constructs such as the Deep Front Line or Spiral Line may be employed as a mapping language in instructional design, while academic justification is more robustly grounded in concepts such as multi-planar coordination, load transfer, and postural adaptability.

Finally, as this study is based on document analysis, the effects of the proposed integration framework have not yet been empirically tested through student outcome data. This limitation further underscores the importance of the *implementation fidelity* perspective, which is critical when translating educational programs into practice. If implementation does not occur as intended, program

effects may be underestimated or misinterpreted; therefore, integration efforts must be accompanied by monitoring and quality assurance components (Carroll et al., 2007; Durlak & DuPre, 2008).

As a document-based qualitative study, the findings reflect curricular intentions and pedagogical possibilities rather than direct classroom practices; therefore, interpretations are situated at the level of curriculum analysis and theoretical integration.

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Recommendations

1) Curriculum development and instructional materials at the Ministry of National Education (MoNE) level

Micro-protocol supplements for "preparing the body for singing.": Without altering the core curriculum text, supplementary or guidance documents should be developed within the *Teaching–Learning Practices* section, presenting exemplars of a 3–8 minute, four-stage preparation protocol (dynamic mobilization–breath/movement coupling–cross-body patterns–bridge to voice) (MoNE, 2025; Behm et al., 2016).

Clarification of postural language: Instructions referring to "upright posture" should be explicitly framed as *non-locking, dynamic posture*. Teacher guides should include concrete correct/incorrect examples to support consistent pedagogical interpretation (Cardoso et al., 2019).

Short standardized guidelines for breath instruction: Age-appropriate instructional templates should be developed for diaphragm- and lower-rib-focused breathing (360° expansion, controlled exhalation) explicitly coupled with movement, thereby standardizing breath teaching without reducing pedagogical flexibility (Bordoni & Zanier, 2013).

Digital Micro-Protocol Supplements (QR-Code–Based Delivery): To enhance accessibility, standardization, and pedagogical fidelity, it is recommended that the proposed fascia-based preparation protocol be supported through digital micro-supplements embedded within the curriculum materials. Each exercise component (dynamic mobilization, breath–movement coupling, cross-body coordination, and transition to phonation) may be accompanied by a QR code linking to short (30–90 second) video demonstrations.

These videos should present age-appropriate, safety-guided, and classroom-feasible versions of each movement, narrated with pedagogical cues rather than clinical terminology. QR-code integration would allow teachers to rapidly access standardized visual references during lesson preparation or in-class implementation, thereby reducing inter-teacher variability and supporting implementation fidelity.

From a progressive education perspective, this hybrid analog–digital model aligns with contemporary principles of micro-learning, teacher autonomy, and inclusive instructional design. Moreover, it enables iterative curriculum enrichment without necessitating frequent reprinting of official textbooks, thus supporting sustainability and scalability within the national education system.

2) Practice-level recommendations for teachers

Use of fidelity checklists: A brief checklist (6–8 items) should be routinized for the opening protocol of each lesson, addressing duration, dynamic quality, breath–movement coupling, inclusion of cross-body patterns, transition to voice, and safety considerations (Carroll et al., 2007).

Dosage and sustainability: Fascia-oriented practices should follow a *low-dose, high-frequency* principle rather than high-intensity loading, with continuity across the week emphasized as a primary goal (Schleip & Müller, 2013).

Incorporation of sensory awareness prompts: Short (10–15 second) body-awareness questions (e.g., "Where did you feel the breath expand?") should be integrated to support proprioceptive learning. Evidence regarding the sensory role of fascia strengthens the pedagogical value of this approach (Suárez-Rodríguez et al., 2022).

3) Recommendations for future research

Pilot implementation and process evaluation: The proposed protocol should be piloted in one or two schools using designs that assess not only outcomes, but also implementation fidelity and contextual factors influencing application (Durlak & DuPre, 2008).

Mixed-methods research designs: Future studies are encouraged to combine qualitative data on student and teacher experiences with quantitative measures of voice-training outcomes and bodily awareness, thereby capturing both process and effect dimensions (Carroll et al., 2007; Durlak & DuPre, 2008).

Empirical examination of movement components: Research focusing on the functional effects of cross-body and multi-planar movement patterns could help address the current gap in the myofascial chains literature regarding functional significance, thereby generating higher-level evidence within educational contexts (Wilke et al., 2016).

Teacher Training and Professional Development for Fascia-Informed Delivery: The successful implementation of fascia-based preparatory practices depends not only on curricular design, but also on the professional competencies of teachers.

At the foundational level, in-service training modules (8–12 hours) should be developed to introduce core principles of fascia science, breath–movement coupling, dynamic posture, and age-appropriate mobilization strategies. These modules should emphasize pedagogical translation rather than clinical or therapeutic depth, thereby ensuring accessibility for non-specialist educators.

At an advanced level, optional certification programs may be offered for teachers who wish to specialize in fascia-informed voice pedagogy. These programs could be developed in collaboration with somatic education institutes or university departments specializing in movement science, physiotherapy, or vocal pedagogy.

To ensure implementation fidelity, teacher-training materials should include standardized movement descriptors, safety guidelines, age-specific contraindications, and lesson-integration templates. This professionalization pathway would allow fascia-informed practices to be scaled sustainably within the national education system without requiring all music teachers to function as clinical practitioners.

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Credit Author Statement:

Author 1: Conceptualization: Formulation of research aims; Data Curation: Organization and preservation of data; Formal Analysis; Visualization: Preparation of tables, and data presentation;

Writing – Original Draft: Preparation of the initial draft; Writing – Review & Editing: Revision and critical evaluation.

Joint contributions of Author 1 and Author 2: Investigation: Data collection; Methodology: Method development and model design; Project Administration: Management of the research process; Resources: Provision of materials or analytical tools; Supervision: Oversight of the research process; Validation of results.

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