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Technology in the Singing Studio:

**An Action Research Study Investigating
Adolescent Singers' Experiences of Using
Visual Feedback Technology Within Singing Tuition.**

Extended Work-Based Learning Project

BMPF 7010

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PROJECT PROPOSAL

Context

As a one-to-one singing teacher working in secondary schools, my pedagogic priority is to build techniques to support adolescent students through what Brunssen (2018, p.62) recognises can be a “vulnerable period in their singing lives” due to potentially significant physiological, psychological, and sociological developments. Vocal changes such as decreased range, pitch instabilities, and increased breathiness, which can occur when growth of the larynx outpaces the adaptation of motor skills (Dienerowitz, et al., 2021), can often induce negative emotions (Gackle, 2019). Studies by researchers such as Orton and Pitts (2019) and Sweet (2018) suggest that these negative emotions may lead to impaired self-confidence, decreased enjoyment, and withdrawal from singing activities. Considering this, vocal pedagogues such as Coates (2022) and Sweet (2020a) have questioned how teaching techniques could be expanded to build adolescent singers’ resilience, motivation, and positivity.

Voice researchers such as Nair, et al. (2019) and Angelakis, et al. (2021) and pedagogues including Erickson (2021) and McQuade (2020) have suggested that using visual feedback technology (hereafter VFT) to display a singer’s acoustic output may help students build stronger associations between their intrinsic feedback, aural perceptions, and motor coordination. Investigations into the integration of VFT within singing tuition by researchers such as Berglin, et al. (2022) and Lã and Fiuza (2022) also suggest it could provide a beneficial additional platform for pedagogic communication, which may improve student engagement and motivation towards singing goals.

Justification

Despite the potential benefits outlined above, my previous module BMPF7013 literature review revealed a deficit of research investigating the use of VFT with adolescent singers (Watson, 2022b). Additionally, although quantitative experimental studies have demonstrated significant positive outcomes across child and adult singers from novice to professional, particularly when using VFT to enhance pitch accuracy (Berglin, et al., 2022; Paney and Kay, 2015), few studies have examined the experiences of singers themselves to assess the subjective value of using VFT within vocal tuition (Watson, 2022b).

With rapid technological advancements improving the accuracy and accessibility of VFT applications (Lã and Fiuza, 2022), and recent studies recognising the potential of exploring technology with young musicians who already use applications to enhance many aspects of their daily lives (Hu, et al., 2022; Chang, 2022), the use of VFT may have increasing relevance for adolescent vocal pedagogy (Shi, 2021). However, as Besch (2021) notes, practical guidance for integrating it within teaching is currently limited. Considering this, I used my recent independent study module BMPF7013F (Watson, 2023) to develop resources that integrate VFT within current best practice vocal techniques for adolescent singers. This research now aims to trial these resources with my current adolescent singers and redress the methodological balance of recent research by prioritising their experiences and opinions in determining the potential value of VFT in adolescent vocal tuition.

Intended Impact

Through collaboration with my current adolescent singing students, I aim to generate practical knowledge to further the development of my VFT resources and ascertain whether they have value within my future pedagogy (Clark, et al., 2020). This research therefore seeks to improve the effectiveness of my teaching practice (Efron and Ravid, 2020) by fostering student-centred techniques to encourage singers to explore their developing voices.

Although the small-scale, practice-based context of this research will prevent generalisations (Denscombe, 2021), findings may prove relevant to other teachers working with adolescent singers. It is intended that future action research cycles will work collaboratively with a larger community of teachers and singers to enhance critical evaluation and provide peer validity (Whitehead and McNiff, 2006). By engaging in these research cycles and sharing findings (Clark, et al., 2020), it is intended that this research will contribute to a knowledge base in effective practices for adolescent singers (Parker, 2010) and may have wider implications in providing practical guidance for singing teachers who wish to consider incorporating VFT within their practice.

The Outlined Intention

Methodology

This research will be approached through the framework of the pragmatic paradigm, following my ontological belief that reality is both personally constructed and informed by experiences of the environment (Dewey, [1920] 1982) and that knowledge is consequential and can be generated by action and reflection on action (Hammond, 2013). Driven by my motivation to effect positive change within adolescent vocal pedagogy and find effective practical solutions for integrating VFT within vocal tuition (Kouneiher and Barbachoux, 2017), my research design will be informed by an integrated mixed method action research methodology (Ivankova, 2015). Emphasis will be given to qualitative data collection, with the subjective experiences and opinions of participants prioritised through a research diary and focus group discussion (Chilisa and Kawulich, 2012). Attitudinal surveys incorporating quantitative Likert-type scales will also be used to provide a comprehensive, multidimensional approach to inquiries (Clark, et al., 2020). Greatly utilised within educational research for improving the quality of educative processes (Clarke and Visser, 2018), action research has been used successfully by Howard, et al. (2007) and Welch, et al. (2005) to engage and empower singers and teachers during previous VFT investigations.

Participants

I will invite singing students from my school teaching practice aged between twelve and thirteen to participate, aiming to recruit six volunteers.

Methods

1. Research Diary.

VFT resources developed during my previous independent study module BMPF7013F (Watson, 2023) will be trialled over five weekly 20-minute one-to-one sessions with participants. Observations, participant responses, and researcher reflections will be documented in a research diary to provide rich contextual qualitative data and stimulate reflective thinking (Phillippi and Lauderdale, 2018).

2. Attitudinal Survey.

Post-trials, participants will be asked to complete an online survey, which will use combinations of qualitative open questions and quantitative Likert-type scale responses to fully investigate their experiences (Fink, 2017).

3. Focus Group.

Participants will then be invited to take part in a semi-structured group discussion to expand on their survey responses. Focus groups are popular within educational research due to the benefits of student interaction and reflection, which can foster a wide range of responses (Cohen, et al., 2018). Observation of comparisons between participants and interpersonal communication will aim to provide a complete record of attitudes (Clark, et al., 2020). Trial sessions and the focus group will be video recorded and transcribed the following day.

Triangulation

Cross-verification of evidence across the three methods will aim to establish trustworthiness of the data and expose researcher bias (Efron and Ravid, 2020), thus improving reliability of findings (Merriam and Tisdell, 2016) and enabling more rigorous, comprehensive evaluations (Ivankova, 2015). Themed data analysis will inform a written report and presentation, which will be made available to participants post-study.

Ethical Considerations

I must carefully consider my ethical obligations to respect and protect my child participants' interests, safety, and well-being throughout this research (Gross-Manos, et al., 2021; Powell, et al., 2016). During design, the school's safeguarding and child protection policies and codes of practice were closely followed. Signed permission to conduct the research was obtained from the school (appendix 3, p.76) and the research was approved by the ethics committee for the University of Wales Trinity Saint David (appendix 4, p.78).

Consent

Information sheets detailing the research purpose, procedures, potential risks and benefits will be emailed to prospective participants and their parents. Following this, verbal consent will be gathered from volunteers alongside signed parental consent (Graham, et al., 2015). Participants may become self-conscious or uncomfortable analysing vocal performances using VFT (Callaghan, et al., 2003) or during video recordings (Easterby-Smith, et al., 2012). It will therefore be emphasised that participation is voluntary, and that participants have the right to omit questions or withdraw from the research at any time (Gallagher, et al., 2010). School pastoral staff will be informed of the research in case participants need to be referred for follow-up care

and information sheets will signpost the school's mental health and wellbeing services and links to helplines (Kay, 2020).

Data Protection

Data will be kept confidential and stored securely in password-protected cloud storage. Code names will be used to ensure anonymity, the key to which will be encrypted (Bell and Waters, 2018).

Insider Research

Working with current students will enable me to draw from previously established relationships, shared understandings, and trust (Saidin and Yaacob, 2016). Consequently, natural interactions may help elicit more truthful, valuable data (Cohen, et al., 2018). However, my resultant position of power as researcher and teacher combined with participants' awareness of the research process may undermine the validity of the data, with participants potentially offering what they believe to be correct or desired responses in seeking favour or fearing recrimination (Costley, et al., 2010). To address this concern, surveys will be administered via email away from the learning environment and it will be reiterated that all opinions will be valued without repercussions (Denscombe, 2021).

Personal Learning Outcomes

- To become proficient at interpreting data from voice analysis applications, and thus, improve my confidence using them within educational contexts.
- To further my skills at collecting, analysing, and presenting qualitative and quantitative data.
- To use the collaborative process of action research to strengthen my pedagogical communication with adolescent singers and foster improved student-centred practices.
- To use research findings and experience gained to further the development of my VFT resources in preparation for future action research cycles with a wider range of participants.

Project Timeline

The following GANTT chart indicates the intended research timeline:

Project Start - End Date: 10/07/2023 - 08/03/2024	July			August				September				October				November				December				January				February				March	
TASK	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2				
Research Planning and Design																																	
- Finalise research problem/questions.																																	
- Develop research design.																																	
- Compose research proposal.																																	
Literature Review																																	
- Search and synthesise relevant literature.																																	
- Draft literature review.																																	
Methodology																																	
- Write up methodological approach.																																	
- Compose/deliver participant information sheets and consent forms.																																	
Data Collection and Analysis																																	
- Conduct 5-week research trials.																																	
- Transcribe and code research diary.																																	
- Develop and trial survey.																																	
- Send survey to participants.																																	
- Analyse quantitative survey results.																																	
- Conduct focus group.																																	
- Transcribe and code focus group.																																	
- Analyse qualitative findings.																																	
Writing Up																																	
- Write up findings.																																	
- Compose discussion.																																	
- Draw up conclusions and recommendations.																																	
Full draft: due 12th February.																																	
Time allowed for re-writes.																																	
Final report submission: 1st March																																	
Write and create presentation																																	
Project Presentation: 8th March																																	

PROJECT REPORT

Introduction

Rapid developments in digital technologies have revolutionised many areas of our lives (Aksoy, 2023). Within voice tuition, a plethora of accessible, inexpensive applications can now provide singers with accurate visual feedback of vocal characteristics such as pitch, loudness, and timbre (Angelakis, et al., 2021). As Lã and Fiuza (2022) have noted, this has led to a corresponding increase in vocal pedagogues such as Bozeman (2021), McQuade (2020), and McCoy (2019) recommending the use of visual feedback technology (hereafter VFT) for improving the efficiency of identifying vocal behaviours and the accuracy of pedagogical feedback. However, as Besch (2021) asserts in his review of VFT integration within singing tuition, limited practical guidance has been proffered regarding how VFT can actively be used with students. There is also a deficit of research investigating the use of VFT within one-to-one music teaching, with existing evidence tending to be “anecdotal or out-of-date relative to the quickly changing world of technology (Waddell and Williamon, 2019, p.2). Additionally, although quantitative experimental studies investigating the use of VFT to enhance vocal skill acquisition have demonstrated significant positive outcomes (Berglin, et al., 2022; Paney and Tharp, 2021), limited research has examined the experiences of singers themselves to assess the subjective value of using VFT within vocal tuition. Meyer, et al. (2021) highlight that this is a particularly vital concern when considering the practical application of VFT within real-world contexts. This combination of factors may explain why the use of VFT has been slow to transfer to mainstream singing studios, as found in survey research investigating music teachers’ attitudes towards VFT tools by Acquilino and Scavone (2022), Waddell and Williamon (2019), and Gerhard and Rosow (2016).

As a one-to-one singing teacher working predominantly in secondary education, I am constantly seeking to build techniques to support adolescent students through what Baker, et al. (2022) identify can be a period of significant physiological, psychological, and sociological change. Vocal pedagogues such as Brunssen and Ballantyne (2018) and Erickson (2021) have suggested that the use of VFT may help adolescent singers build stronger associations between their intrinsic feedback, aural perceptions, and motor coordination during periods of vocal change. Researchers investigating the use of VFT tools in music tuition such as Shi (2021), Hu, et al.

(2022), and Chang (2022) have also indicated that their use may increase the engagement and motivation of adolescent musicians who already use applications to enhance many aspects of their daily lives. Considering these potential benefits and to address the need for practical strategies as recognised by Besch (2021) above, I used my recent independent study module BMPF7013F (Watson, 2023) to develop resources that integrated VFT within best practice vocal techniques for adolescent singers. Working in collaboration with my current students, this research, informed by a mixed methods action research methodology, now aims to trial these resources and redress the methodological balance of recent research by prioritising adolescent singers' experiences and opinions in determining the potential value of using VFT in adolescent vocal tuition.

Personal Learning Outcomes:

This research is designed to generate knowledge relevant for improving my practice with adolescent singers and fostering my professional growth regarding the use of VFT tools. Through trials of my previously designed VFT resources, I aim to ascertain the following:

- whether VFT tools can provide an engaging, accessible platform for encouraging adolescent singers to explore their developing voices.
- what types of VFT may be most beneficial for use with adolescent singers.
- how students may like to use VFT in the future, specifically regarding the frequency and context of use.

Through investigating these practical questions, I aim to produce conclusions that subsequently can be fed back into further development of my resources.

Although the small-scale, situational context of this research will prevent generalisations, findings may prove relevant or relatable to other singing teachers working with adolescents (Denscombe, 2021). By engaging in this research and sharing findings, I aim to contribute to a broader knowledge base in effective practices for adolescent singers (Clark, et al., 2020). This research may then have wider implications in providing practical guidance for teachers wishing to consider incorporating VFT within their practice.

Literature Review

Defining the Issue for Adolescent Singers

As Lã and Fiuza (2022) note, due to the internal situation of the larynx, singers face unique challenges when learning to assess their intrinsic physical and perceptual feedback, received primarily through auditory and proprioceptive sensations, to help support the muscular coordination needed for singing. This process is further complicated for adolescents as they experience significant physical growth due to the influx of pubertal hormones (Sataloff, et al., 2017). Rapid and inconsistent laryngeal growth often outpaces the adaptation of motor skills (Brunssen, 2018), which can lead to vocal changes such as increased breathiness, pitch instabilities, and decreased and inconsistent range capabilities (Dienerowitz, et al., 2021). Research has indicated that adolescents' awareness of such vocal changes can induce negative emotions (Sweet, 2018), which may result in impaired self-confidence and decreased enjoyment and motivation towards singing goals (Orton and Pitts, 2019). Considering this, vocal pedagogues such as Sweet (2020a) and Holding (2020) have highlighted the importance of providing adolescent singers with meaningful extrinsic feedback to help them understand and interpret their changing intrinsic feedback and build resilience, motivation, and positivity during this period of physiological and psychological adjustment (Baker, et al., 2022b).

Moving Towards Investigating the User Experience

Findings from my module BMPF7013 literature review (Watson, 2022b) indicated that VFT may provide a valuable source of extrinsic feedback for adolescent singers. This review was built on quantitative findings from experimental research investigating the use of VFT to enhance vocal skill acquisition. Significant gains, particularly regarding intonation accuracy, have been documented across child (Paney and Kay, 2015; Stavropoulou, et al., 2014) and adult singers from novice (Berglin, et al., 2022; Paney and Tharp, 2021) to professional (Angelakis, et al., 2017). However, as Nijs and Leman (2014) recognised during trials of the VFT application 'music paint' within clarinet tuition, "assessing the effectiveness of such tools should not be merely a question of objectively measuring learning outcomes with and without the technology" (Nijs and Leman, 2014, p.54). Vitally, they suggest that empirical evaluations should consider the subjective educational value and transformative impact for the students. As Nix, et al. (2017) highlight, without considering the practical element of user experience, findings may be limited in their application to real-world singing contexts.

The purpose of this review is therefore to build on the foundation of my previous review by examining research that specifically addresses the subjective experiences of singers and teachers towards the integration of VFT within singing tuition. My aim is to ascertain what elements of the user experience need further exploration and to generate themes for comparative deductive analysis throughout my research process (Clark, et al., 2020).

Search Strategy and Inclusion Criteria

To enhance validity, peer-reviewed journal articles, reviews, and conference proceedings were prioritised (Omazic and Zunk, 2021). Due to their comprehensive, multidisciplinary databases (Indeed, 2023), I searched ProQuest, EBSCOhost, and Google Scholar, using permutations of the keywords and Boolean search operators shown in figure one. As recommended by Kosirnik, et al. (2022) and Snyder (2019), keywords were developed via an initial scoping of key literature identified through my previous module BMPF7013 review (Watson, 2022b) and checked via comparisons of published literature reviews examining the use of VFT within music education by Acquilino and Scavone (2022), Sigrist, et al. (2013), and Hoppe, et al. (2016).

Keyword One	<i>Boolean Search Operator</i>	Keyword Two	Content Searched
Visual <i>OR</i> Real-Time Feedback <i>OR</i> Display Acoustic Spectrograph (Spectro*) Pitch-Tracking Applications (App*) Technology	<i>AND</i>	Sing* <i>OR</i> Voice <i>OR</i> Vocal Adolescent Education <i>OR</i> Pedagogy <i>OR</i> Teaching	Title, Keywords, and Abstract (extended to full text if results did not seem comprehensive)

FIGURE ONE
Keywords and Boolean Search Operators

Titles and abstracts were then screened and assessed for their relevance according to the following inclusion criteria: articles must refer to the use of VFT within one-to-one or class-based singing tuition; research must involve the assessment of singers' and/or teachers' experiences of using VFT via collection of qualitative data or quantitative attitudinal surveys. As my previous

module reviews had revealed few studies specifically involving adolescent singers, potentially due to the issues associated with voice development highlighted above, no boundaries were set regarding the age of participating singers to provide a wide base of opinions for consideration (Boell and Cecez-Kecmanovic, 2015). How these views may relate to adolescent singers will be considered throughout. The language was limited to English and the publication stage was set to final to ensure accessibility of the literature and reduce translational errors or cultural misinterpretations (Dhollande, et al., 2021).

Following this exclusion process, only five papers remained. Callaghan, et al. (1999, 2004) invited four singing teachers to trial their VFT software, “Sing&See” (2023), with 21 students (four adolescents, 17 adults) during a four-week period. Participants were asked about how the VFT had been used, perceived strengths and weaknesses, and suggestions for modifications. Welch, et al. (2005) and Howard, et al. (2007) similarly sought to develop their VFT software, WinSINGAD (Howard, et al., 2003, 2004), through practical trials over three months with two teachers and four adult students. Welch, et al. (2005) reported quantitative analyses of observational data from lesson recordings, while Howard, et al. (2007) discussed qualitative findings from participant interviews and journals. In the fifth paper, Brunkan (2009) used open question surveys to examine the perceptions of 54 children aged seven to thirteen towards the use of the spectral analysis software ‘VoceVista’. Findings from these five studies will now be arranged thematically and critically analysed considering more recent experimental research found during my previous module literature reviews (Watson, 2022b, 2023).

Intrinsic Value

Intrinsic value refers to “the anticipated enjoyment one expects to gain from doing a task and the enjoyment one gets when doing the task” (Eccles and Wigfield, 2020, p. 4). Intrinsic value has been recognised by educationists as a key determinant of adolescent motivation (Raufelder and Kulakow, 2021). Devices such as smartphones, tablets, and laptops have become “pervasive tools used in everyday life, especially among adolescents” (Benvenuti, et al., 2023, p.164). This ubiquity has led voice researchers such as Shi (2021) and Chang (2022) and pedagogues including Erickson (2021) and McQuade (2020) to suggest that technology could provide a relevant, valuable platform for stimulating the interest, enjoyment, and motivation of young singing students. Findings from Brunkan’s (2009) research seem to support this hypothesis. 97% of her child participants responded positively towards the use of VFT, indicating enjoyment via words such as ‘fun’, ‘cool’, and ‘amazing’. Brunkan (2009) concluded that her participants’

enjoyment and subsequent increased engagement may have been due to the inherent motivational value of the technology. Teachers within Howard, et al. (2007) and Callaghan, et al.'s (2004, 1999) studies agreed, one stating that "the use of technology can fire the imagination and keep the student interested simply because it involves the use of a computer" (Howard, et al., 2007, p.32). However, researchers investigating the integration of technology within classroom education such as Benvenuti, et al. (2023) and Hietajarvi, et al., (2019) have warned that teachers should not assume students will become motivated in educational tasks just because they involve technology. As Qazi, et al. (2022) and Philip and Garcia (2015) summarise, the persistent claim that students are interested in technology due to its increasing prevalence erases variation among students and the context specificity of technological interest.

Brunkan's (2009) study also had limitations: results collected during one short 45-minute session; unaddressed ethical concerns relating to her insider positionality; and methodological issues concerning the use of open questions, which can impact the reliability and validity of child responses (Omrani, et al., 2019). As Nijs (2018, p. 2) asserts, studies based on such "one-shot experiences" may lead to inflated positive results due to novelty. Therefore, methodological approaches that address how situational interest and enjoyment towards VFT develop over time could prove vital (Kirschner, 2015; Philip and Garcia, 2015, 2013). Findings from Callaghan, et al. (2004, 1999) and Howard, et al.'s (2007) longer timeframe studies suggested that students' interest and enjoyment towards using the VFT increased as they recognised its potential value within the learning process. Reasons included: improved understanding of singing targets; enthusiasm for the immediacy and precision of the feedback; perceptions of quicker vocal progress; and the ability to monitor progress over time. However, these studies prioritised the views of the teachers, reporting primarily on student engagement through their eyes. The researchers' insider positionalities as developers of the VFT software were also not addressed. As Saidin and Yaacob (2016) suggest, this may have led to erroneous assumptions or a vested interest in obtaining positive results.

Research prioritising singers' experiences could therefore be vital to critically examine assumptions about student interest and enjoyment (Benvenuti, et al., 2023) and help educators make well-considered choices regarding the use of VFT (Van den Beemt, et al., 2010). These findings have led to my first research question: 'Do students find the use of VFT enjoyable and/or interesting?'

Types of Application

Teachers within Callaghan, et al. (2004, 1999), Welch, et al. (2005), and Howard, et al.'s (2007) studies were given full control over the use of two types of VFT: pitch-tracking applications displaying fundamental frequency against time; and spectrographic applications providing more detailed information relating to voice quality and pitch by showing the distribution of energy across the complex frequency components of a sound against time (Sataloff, 2020). The teachers perceived the pitch-tracking displays to be most useful due to their simplicity and accessibility and felt the spectrogram displays were mainly suitable for advanced singers. In direct contrast, the singers perceived the spectrograms to be most valuable, stating that the detailed information aided a fuller understanding of the correlation between their physical coordination and the acoustic result. Callaghan, et al. (2004) also noted that advanced students demonstrated less interest in extended spectrographic analysis compared to novices. Within Brunkan's (2009) study, only one of the 54 participants found the spectrographic feedback distracting or hard to understand. She therefore concluded that the 'VoceVista' spectrogram programme was accessible and interesting for children. This was despite reviewers of the technology at the time such as Hoppe, et al. (2006), Barlow and Brereton (2008), and Sigrist, et al. (2013) asserting that spectrograms may be hard visual displays for younger singers to interpret due to the increased amount of complex information displayed. These studies had limitations, which potentially reduce the validity and transferability of their results: methods of VFT integration may have differed depending on the age or skill level of the students and the differing teaching styles; and Brunkan's (2009) study lacked comparisons across different types of VFT. These factors produce challenges when attempting to compare participant responses or form conclusions as to which type of application may be more relevant or useful within adolescent singing tuition.

More recent experimental studies have primarily investigated the use of pitch-tracking applications to assess their impact on the intonation accuracy of singers of different age and ability levels such as those by Berglin, et al. (2022), Paney and Tharp (2021), and Paney and Kay (2015). The only research to investigate the practical use of spectrographic applications has been conducted with professional or undergraduate singers (Jeanneteau, et al., 2022, 2019; Angelakis, et al., 2021, 2019), again making findings challenging to relate to adolescent vocal pedagogy. As previously noted, with Lã and Fiuza (2022) recognising the increase in vocal pedagogical texts advocating the use of spectrographic feedback for informing and improving teaching strategies, it now seems imperative that research should investigate their practical use in singing studios. Additionally, the divergent opinions noted between the teachers and students within Callaghan, et al. (2004) and Howard, et al.'s (2007) studies regarding which type of VFT

application might work best in practice highlights the importance of prioritising singers' experiences to ensure pedagogy specifically addresses their needs and preferences (Clark, et al., 2020), rather than being led by teachers' assumptions. These considerations have led to my second research question: 'Do singers' responses towards VFT change according to the type used (focussing on pitch-tracking and spectrographic displays)?'

Context

As discussed above, teachers within Callaghan, et al. (2004, 1999) and Howard, et al.'s (2007) studies were given freedom regarding the use of VFT within their sessions. The reports did not discuss the context in which it was used, whether within warm-ups, exercises, or repertoire. As Hoppe, et al. (2006) identified in their review of VFT research at the time, different contexts of use may have impacted students' reactions to the VFT, potentially affecting results. Additionally, the teachers within Howard, et al.'s (2007) study only trialled the VFT with four adult students. Considering their future practice, they recognised that acceptance of VFT across a wider variety of students may vary according to the context in which it is used in combination with the different goals or interests of the students. One teacher within Callaghan, et al.'s (2004) study similarly noted that some students may find it challenging to work with VFT in different contexts, particularly within repertoire, where their focus would be split between the VFT and other musical and technical features.

Current vocal pedagogues working to integrate VFT within their practices such as McQuade (2021), Brunssen and Ballantyne (2018), and Erickson (2021) have similarly recognised that the context in which VFT is introduced to students may have a significant impact on their attitudes to it. As voice researchers Besch (2021) and Angelakis, et al. (2021) note, identifying the best context for using VFT may be a particularly important practical consideration for singing teachers, especially when working to find ways to engage and motivate adolescent singers. However, this does not appear to have been addressed in recent research, with experimental studies such as those by Paney and Tharp (2021), Berglin, et al. (2022) and Blanco, et al. (2021) tending to only use short pitch patterns to aid analytical comparisons of results. To address this significant gap in the research, my third research question asks: 'Do singers' responses towards VFT change according to the context in which it is used (focussing on use in vocal exercises or repertoire)?'

Future Use

As previously outlined, Callaghan, et al. (2004, 1999), Welch, et al. (2005), and Howard, et al.'s (2007) research aimed to advance development of their own VFT software. They all recognised the importance of asking participants how they would like to use the technology in the future. However, their reports prioritised teachers' opinions, focussing on how they felt the technology could enhance their future pedagogy. To date, I have found no research investigating the use of VFT within singing or instrumental tuition that has explicitly asked students how they would like to use VFT in the future. Recent studies investigating the integration of technological tools within classroom music education have demonstrated that involving students in decisions regarding how and when they would like to use the tools has led to more personalised learning, greater feelings of independence and autonomy, and improved student involvement, motivation, and learning outcomes (Shi, 2021; Chang, 2022; Hu, et al., 2022). To ensure that my future pedagogy is responsive to my students' needs and interests, my fourth and final research question asks: 'following their experiences with VFT, would students like to use VFT in the future? If so, how often and in what context?' Through investigating the four highlighted practical research questions, I aim to gather evidence to help me make more informed judgements regarding the integration of VFT within my future adolescent teaching practice.

Methodology

Action Research

Concurring with educational philosopher Dewey (1931, [1920] 1982), my ontological belief is that reality is complex and multiple and can be both personally constructed (based on an individual's subjective understanding and experience of the world) *and* informed by empirical discovery (Kaushik and Walsh, 2019). My epistemological perspective is that knowledge is consequential and can be generated during action and reflection on action (Hammond, 2013). These beliefs align with the pragmatic paradigm, which underscores the idea that knowledge that has practical and functional value is ultimately important and valid (Johnson and Christensen, 2019). Driven by my motivation to effect positive change within my adolescent vocal pedagogy and find effective practical solutions for integrating VFT within vocal tuition, I was drawn to a research design

informed by a pragmatic mixed method action research methodology (Ivankova, 2015). Greatly utilised within educational research for improving the quality of educative processes (Clarke and Visser, 2018; Hine, 2013), action research provides a supportive framework for teachers to conduct systematic inquiries within their own settings to generate information to help advance their teaching practice (Mertler, 2017). It also promotes collaboration with participants to enable critical evaluation, enhance validity, and reduce researcher bias (Whitehead and McNiff, 2006). By engaging students in answering my practical research questions, I aimed to foster a student-centred approach, endeavouring to prioritise their needs and interests (Merriam and Tisdell, 2016).

The “dynamic and responsive” model of action research (Mills, 2017, p. 5) allows the researcher to collect multiple data sources from a combination of methods according to their project needs (Mackenzie and Knipe, 2006). This research prioritised the subjective thoughts, feelings, and experiences of participants principally through the collection of qualitative data from observations and participant discussions (Chilisa and Kawulich, 2012). However, attitudinal surveys using quantitative Likert-type scale questions were used to provide a multidimensional approach to inquiries and stimulate reflective thinking (Clark, et al., 2020). This pragmatic approach, using integrated mixed methods to comprehensively address research questions aimed to heighten internal validity (Morse and Neihaus, 2009; Sale, et al., 2002), generate stronger and more cohesive evaluations (Teddlie and Tashakkori, 2009), and build more rigorous, reliable conclusions to inform my future practice (Creswell and Plano Clark, 2018; James, et al., 2008).

Action Research Stages

The research design was guided by Ivankova’s (2015) cyclical action research stages (figure two).

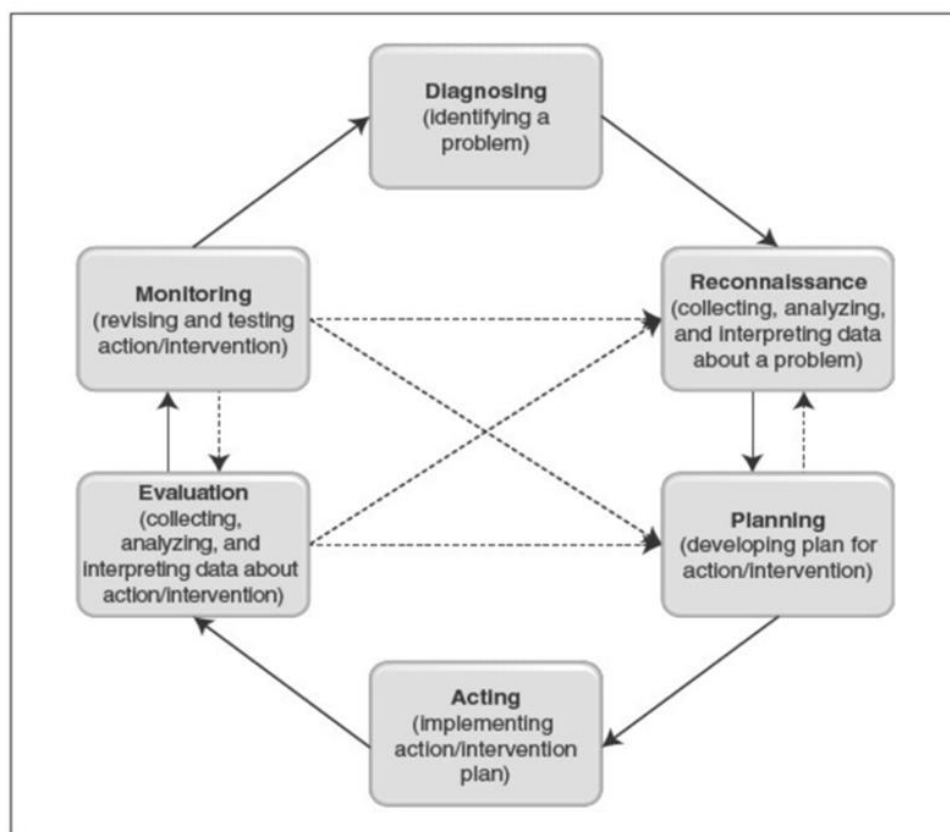


FIGURE TWO
Conceptual Model of Pragmatic Mixed Methods Action Research
(Ivankova, 2015, p.45)

Through an initial reconnaissance and planning stage, I aimed to establish which exercises and applications examined during my previous two independent study modules (Watson, 2022b, 2023) would be most beneficial to use with my adolescent participants. These resources were then implemented during the research ‘acting’ stage. Evaluation then involved the collection, analysis, and interpretation of participant data and aimed to gather evidence to critically reflect on the value of the resources and make informed judgements regarding their future use in my practice (Stringer and Aragon, 2021). Due to the short timeframe of this research, multiple cycles of reflection were not possible (Denscombe, 2021). However, through my conclusions, I will endeavour to establish how further monitoring and research cycles could proceed post-study in recognition of the importance of the ongoing, iterative nature of the action research process (Clark, et al., 2020).

Each of the three stages will now be described in detail.

Stage One: Reconnaissance and Planning

The Exercises

During my recent independent study module BMPF7013F (Watson, 2023), I developed a series of vocal exercises that aimed to integrate VFT in accessible and meaningful ways. The exercises were designed following critical evaluation of research investigating the use of VFT within singing training and best practice recommendations by vocal pedagogues working in the fields of adolescent voice, such as Williams (2019) and Brunssen and Ballantyne (2018), and acoustic analysis, including McQuade (2020), and McCoy (2019). Due to the short research timeframe, I chose two exercises from this resource to explore with my participants based on the following criteria: their relevance for adolescent voice training; my participants' previous familiarity with the exercises; the ability to see defining acoustic characteristics clearly with VFT; and their transferability and usefulness within repertoire and across different vocal styles. The exercises chosen were:

1. Onset exercises: exploring the coordination of voicing and airflow needed when starting a sung pitch (Lã and Gill, 2019).
2. Messa di voce exercises: increasing and decreasing volume while holding a single pitch (Titze and Verdolini Abbott, 2012).

Full details of the exercise protocol and rationale for use are given in appendix 1 (p.70). The schedule for implementation is given in figure three.

Week One	Explanation and Exploration of VFT applications
Week Two	Onset exercises
Week Three	1. Repeated onset exercises 2. Exploration of onsets within the context of pieces.
Week Four	Messa di voce exercises
Week Five	1. Repeated messa di voce exercises. 2. Exploration of messa di voce within the context of pieces.

FIGURE THREE
Timetable of Activities During Research Trials

The Applications

In preparation for addressing research question two ('Do singers' responses towards VFT change according to the type used?'), I composed a list of current pitch-tracking and spectrographic applications and their attributes, using previously compiled lists by voice researchers Erickson (2021) and Shi (2021) as a foundation and supplementing with applications found on the App Store (appendix 2, p.75). I then chose three of each type of application to test with participants during the first week of trials based on the following criteria: clarity of the display; ease of use; and ability to clearly show perceived volume via amplitude (waveform display) and/or intensity (colour changes) for use in the messa di voce exercises. Following these trials, two applications were chosen for continued use based on participants' collective preferences, perceived ease of use, and the reliability of the applications. The pitch-tracking application that produced the most positive responses was 'SingScope', which displays volume via an amplitude waveform at the top of the screen and the intensity of the yellow pitch-tracking line. The spectrogram application 'VoceVista' was unanimously preferred by participants due to the clarity of the display, the vibrancy of the colours (indicating acoustic intensity), and the amount of information that it offered for analysis. Examples of each display are given in figure four.

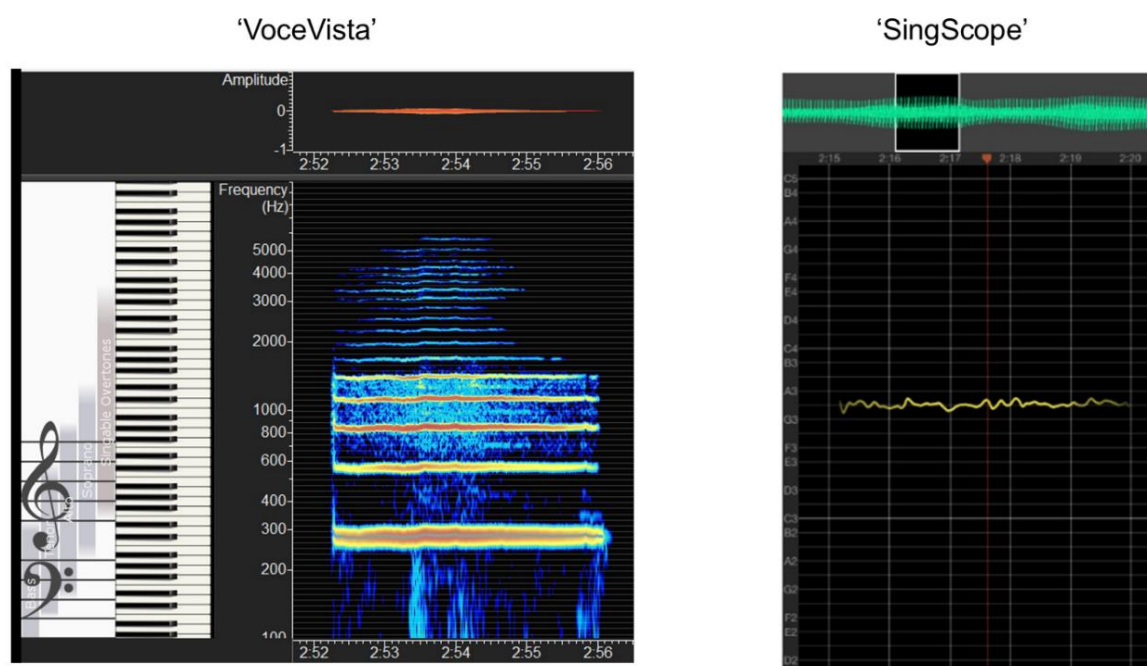


FIGURE FOUR

Examples of 'VoceVista' (left) and 'SingScope' (right) displays during a messa di voce exercise.

On both displays, pitch (or frequency) is displayed on the vertical axis, time (in seconds) is displayed on the horizontal axis, volume (or amplitude) is displayed via the waveform at the top of the screen.

Stage Two: Action

Research Context: Participants

The research took place in an independent preparatory school in Edinburgh, Scotland. My current singing students in year eight (aged twelve to thirteen) were invited to participate, with six volunteering (three female, three male). This age range is identified as early adolescence (Benvenuti, et al., 2023), where significant physiological growth may result in vocal changes (Sweet, 2020a). Through this purposeful sample, I aimed to recruit 'information-rich' cases (Patton, 2015, p. 53), which could provide me with valuable data relevant to my central research questions (Denscombe, 2021). All six participants had been having singing lessons for between one-and-a-half to two years and were of a similar ability level (as defined by their current singing grade level), thus enabling situational comparisons (Cohen, et al., 2018). Two were focussing on contemporary commercial music (CCM), four on western classical music (WCM). Participant characteristics are summarised in figure five.

Participant Code	Age (years)	Gender	Years of Singing Training	Singing Grade Level	Genre
P1F	12.10	female	2	4	CCM
P2F	13.2	female	1.5	3	WCM
P3F	13.2	female	1.5	3	WCM
P4M	12.7	male	2	3	WCM
P5M	12.7	male	2	3	WCM
P6M	12.10	male	1.5	3	CCM

FIGURE FIVE
Participant Characteristics

Ethical Considerations

By involving children in this research, I aimed to respect their right to participate and give value to their views and experiences, as advocated by Gross-Manos, et al. (2021). However, it was crucial that I carefully considered my ethical obligations to protect their interests, safety, and well-being throughout (Powell, et al., 2016). Therefore, the school's safeguarding and child protection policies and codes of practice were closely followed during design. Following signed permission

from the school (appendix 3, p.76), the research design was approved by the research ethics committee of the University of Wales Trinity Saint David (appendix 4, p.78).

Consent

Information sheets detailing the research purpose, procedures, and potential risks and benefits were emailed to parents (appendix 5, p.92). Prospective participants were given separate sheets using a question-and-answer format to make key information accessible (Graham and Powell, 2015) (appendix 6, p.94). Distribution during lesson time aimed to facilitate discussions regarding involvement (Oulton, et al., 2016; Alderson and Morrow, 2014). It was made clear that participation was voluntary and there would be no consequences following decisions not to participate (Gaunt, 2007). After a week's hiatus to discuss participation with family and peers (Sargeant and Harcourt, 2012), verbal consent was gathered from volunteers alongside signed parental consent (Kay, 2020) (appendix 7, p.95). It was recognised that participants might become uncomfortable analysing vocal performances with VFT (Callaghan, et al., 2003) or during video recordings (Easterby-Smith, et al., 2012). Therefore, it was emphasised that participants had the right to omit questions or withdraw from the research at any time (Gallagher, et al., 2010). School pastoral staff were informed of the research in case participants needed to be referred to them for follow-up care and information sheets signposted the school's mental health and wellbeing services alongside links to helplines (Kay, 2020).

Data Protection

Participants were assured of confidentiality and all data files, analysis, and recordings were stored securely in password protected, two factor authenticated cloud storage. Codes have been used throughout to protect anonymity (Bell and Waters, 2018).

Insider Research

Working with current students enabled me to draw from previously established relationships, shared understandings, and trust (Saidin and Yaacob, 2016), with the aim of eliciting more truthful, valuable data (Cohen, et al., 2018). However, my resultant position of power as both researcher and teacher combined with participants' awareness of the research process may lead to altered responses, potentially undermining data validity (Clark, et al., 2020). It was therefore reiterated that all opinions would be valued without repercussions (Denscombe, 2021). Prior specialist knowledge of the research topic and familiarity with participants can also lead to researcher bias or a loss of objectivity (Easterby-Smith, et al., 2012); therefore, reflexivity was

paramount (Saidin and Yaacob, 2016). Although continued relationships with participants post-study enabled member checks to clarify information and limit misinterpretations or inaccurate data documentation (Merriam and Tisdell, 2016), they were limited due to the short timeframe. Further strategies for establishing data reliability and mitigating bias are outlined within each data collection method below.

Implementation

The applications and exercises were trialled with each participant during five weekly 20-minute one-to-one sessions according to the implementation timetable set out previously in figure three (p.22). Sessions were video recorded and transcribed the following day.

Stage Three: Evaluation

To fully assess participant experiences and attitudes, evaluation was undertaken via triangulation of evidence across three data collection methods, outlined below. Triangulation aimed to establish the trustworthiness and reliability of the data by determining areas of consistency or conflict and exposing researcher bias (Efron and Ravid, 2020; Gray, 2009).

Data Collection Methods

1. Research Diary

Descriptive details of the sessions, transcribed participant responses, and researcher observations and reflections were documented in a research diary (appendix 8, p.96). This first-hand data collection method aimed to provide rich contextual qualitative data, track how the research evolved, monitor changes and trends in participant engagement, and stimulate reflection (Phillippi and Lauderdale, 2018; Creswell, 2013). It also provided space to acknowledge personal preconceptions and monitor biases (Deggs and Hernandez, 2018). This form of “disciplined subjectivity” (Efron and Ravid, 2020, p.76) aimed to increase the validity of the research process and deepen professional learning (Clark, et al., 2020). Findings informed the planning of proceeding sessions (Mertler, 2017) and provided stimuli for the survey and focus group questions (Merriam and Tisdell, 2016), thus creating a cycle of reflection and monitoring as advocated by Ivankova (2015).

2. Attitudinal Survey

Post-trials, a researcher-designed survey consisting of quantitative Likert-type scale questions and qualitative open questions was used to gather a broad range of information relating to the central research questions (Fink, 2017) (appendix 9, p.97). For quantitative questions, participants were asked to respond to a series of statements via a five-point scale consisting of: strongly agree; agree; neither agree nor disagree; disagree; and strongly disagree (Mertler and Charles, 2011). This format was kept consistent to minimise task difficulty (Bell, 2007; Borgers, et al., 2003). Negative statements were included to introduce a broad range of potential opinions, reduce agreement bias, and enhance response reliability (DeVellis, 2016). Although Omrani, et al. (2019) warn that the quantity and quality of open question responses can vary depending on the communication skills and cognitive abilities of child participants, four open questions were included to encourage participants to expand on their experiences in their own words and to stimulate reflection ahead of focus group discussions (Merriam and Tisdell, 2016).

Following suggestions by Omrani, et al. (2019), Bell (2007), and De Leeuw, et al. (2004), the survey was pre-tested by non-participating year eight students to assess readability and reliability and adjusted to improve clarity and aesthetic appeal and reduce completion time to increase participant motivation (Dillman, et al., 2014). The survey was then made available to participants online over their half-term holiday. Although anonymity was prevented to enable comparisons across data collection methods, completing the questionnaire away from the teaching environment aimed to promote honesty and enhance ethical practice (Denscombe, 2021).

3. Focus Group

All six participants volunteered to take part in a group discussion to supplement and substantiate data from the research diary and survey (Clark, et al., 2020). A semi-structured format was used, where open questions guided proceedings, but divergence and expansion were encouraged to foster deeper insights (Efron and Ravid, 2020; Gill, et al., 2008). Focus groups are popular within educational research due to the benefits of student interaction and reflection, which can stimulate a wide range of responses (Hennink, 2014; Morgan, 1996). Cohen, et al. (2018) state that focus groups can be particularly useful with adolescents, allowing them to explore the issues most important to them using their own vocabulary. They may also become more willing to share their views when among friends rather than during individual interviews (Krueger and Casey, 2015; Currie and Kelly, 2012). However, as Denscombe (2021) notes, successful information elicitation depends on group dynamics. With my participants belonging to the same educational year group,

I relied on previously established relationships and rapport to encourage open, honest discussions (Easterby-Smith, et al., 2012). However, I acknowledged Kitzinger (1995) and Fern's (1982) warnings that members of pre-existing groups may alter their behaviour or opinions in response to group norms or be influenced by strong-minded leaders. Therefore, my role as group facilitator and moderator was vital to ensure equal participation (Merriam and Tisdell, 2016). The focus group was videoed and transcribed the following day.

Data Analysis

Coding of qualitative data

The research diary (appendix 8, p.96), open question survey responses (appendix 10, p.105), and focus group transcription (appendix 11, p.109) underwent inductive analysis via manual coding to generate key themes (Creswell, 2014). Descriptive and magnitude coding were used first to identify the frequency and intensity of participant opinions towards themes (Patton, 2015). In vivo and values coding were then used to 'prioritise and honour' participants' voices and experiences, and examine their values, attitudes, and beliefs (Saldaña, 2016, p.158). Using terms and concepts drawn from the words of participants provides a "crucial check on whether [researchers] have grasped what is significant" to participants (Charmaz, 2014, p. 135), thus mitigating bias towards original themes (Burnard, et al., 2008; Jirwe, 2011) and increasing the validity and trustworthiness of interpretations (Efron and Ravid, 2020). Themes and accompanying evidence from participant quotes were manually inputted and organised into Microsoft excel tables to assess patterns and variations across responses (Creswell, 2014) (appendix 12, p.109). Although time-consuming, completing these processes by hand strengthened my familiarity with the data (Merriam and Tisdell, 2016). Analysis was then recursive, involving a "constant moving back and forward between the entire data set, the coded extracts of data, and the analysis" (Braun and Clarke, 2006, p. 86) to ensure interpretations were coherent and reliable (Clark, et al., 2020).

Descriptive analysis of quantitative data

Responses to Likert-type scale survey questions were analysed through basic description, with frequencies calculated to identify patterns across responses (Laidlaw, 2022). Analysis aimed to provide contextual understanding, stimulate reflection, and supplement and support qualitative findings via comparisons to produce stronger arguments for conclusions (Clark, et al., 2020). Compiled quantitative survey responses are given in appendix 13 (p.110).

Findings

Findings for each of the four research questions will be presented separately to aid accessibility of the information as recommended by action researchers Efron and Ravid (2020). Graphs summarising the quantitative survey findings for each research question will be reported first within each of the four sections to provide context for the ensuing qualitative findings, which will be arranged thematically (Ivankova, 2015). Quoted material is attributed to participants by their code as given in the participant characteristics table in figure five (p.24). The abbreviations RD for research diary and FG for focus group will be used to identify the source of quotes if not stated in the accompanying text. Filler words and hesitation markers have been removed from quotes to enhance readability (Lingard, 2019). Fully transcribed versions are provided in the data analysis tables in appendix 12 (p.109). The discussion section will follow the reporting of all findings and will be arranged thematically within the four research question categories (Efron and Ravid, 2020).

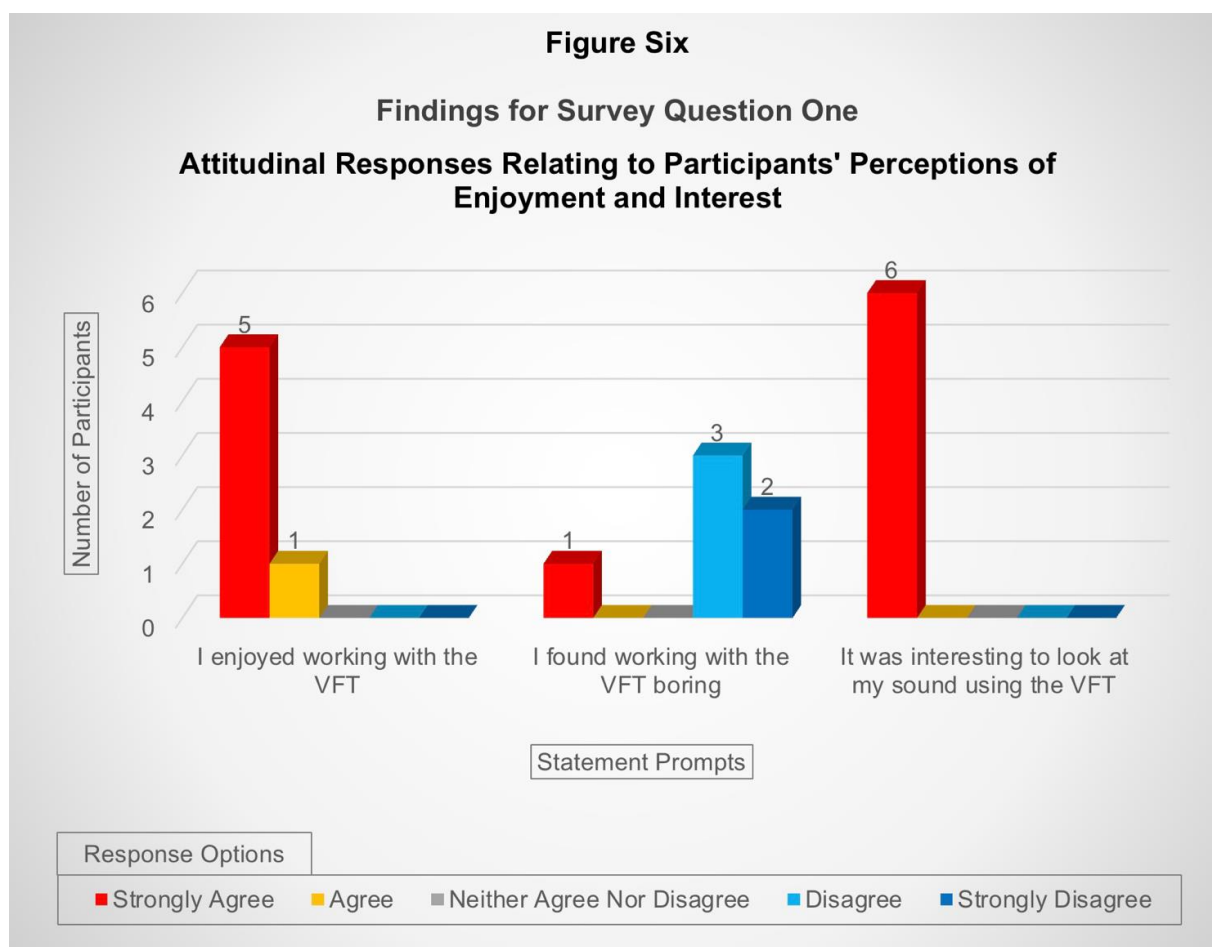
Research Question One: Intrinsic Value

‘Do adolescent students find the use of VFT enjoyable and/or interesting within singing tuition?’

Quantitative Survey Findings

To address research question one, survey question number one asked participants to indicate how much they agreed or disagreed with statements relating to their overall enjoyment and interest towards using the VFT in their singing lessons. Figure six summarises these results.

All participants strongly agreed that it was interesting to look at their sound output with the VFT. Five participants strongly agreed that they enjoyed using the VFT, while P2F agreed. The statement ‘I found working with the VFT boring’ produced divergent responses, with P2F strongly agreeing, while P1F, P5M, and P6M disagreed and P3F and P4M strongly disagreed.



Qualitative Findings

The response statements used in survey question one (reported in figure six) were designed to be simple to aid participants' understanding (Omran, et al., 2019) and to capture a broad overview of their general attitudes towards the VFT, which could then be supplemented via extended qualitative data collection (Laidlaw, 2022). In comparison with the quantitative findings outlined above, findings from the qualitative data sources will now be reported and arranged thematically to indicate how participants' enjoyment and interest towards using the feedback progressed through the research process.

Initial Attitudes

During week one, all participants except P5M were hesitant in their initial interactions with the VFT, observed through quiet responses to questions and a low level of vocal exploration. This observation was confirmed by participants during the focus group discussion, with P4M

explaining: “I was a bit nervous at the start, ‘cause I didn’t know what to expect”. P1F, P2F, and P6M indicated that their initial apprehension was due to their general lack of interest in technology. In contrast, P5M moved immediately into vocal play, responding “that’s so cool!” to every vocal task and application explored. In the focus group he attributed his positive response to previous familiarity with the types of applications and his “high level of interest” in technology.

Progression: Increase

For P1F, P3F, P4M, and P6M, their enjoyment and interest towards using the feedback increased as their familiarity with the applications increased. They stated that a fuller understanding of what the feedback was showing them led to an increased appreciation for its usefulness, relevant to the vocal tasks they were performing and for observing their overall progress. Reflecting in the focus group on how her enjoyment increased through the five weeks, P1F summarised:

“I think it was because I got more used to it and because of that, I found it easier to read... I just understood more about what it was showing me, and then I could see more why it was useful and what it could help me with to improve my singing”.

Progression: Decrease

During the focus group discussion, P3F, P4M, P5M, and P6M stated that their enjoyment and interest towards using the VFT decreased towards the end of the trial period due to what they perceived to be the repetitive nature of the trials. P3F said: “after a while, it started to get just a bit repetitive, because we were almost doing the same sort of things, so I was a bit like, ‘oh, can we move on to something else now?’”. P5M agreed, saying: “coming towards the end I felt a little bit less interested in it because we’d been doing it for a while”.

While P2F stated in the focus group that her interest and enjoyment towards using the VFT initially increased for similar reasons to P1F, P3F, and P4M, she voiced the strongest negative attitudes overall. Her primary reason for her decreased enjoyment was because she “really likes singing freely”, which she voiced a total of six times in the focus group and four times during the trials. During week three of the trials, she further explained that looking “so closely” at the feedback conflicted with her preference for “just wanting to sing”. During week three and five of the research trials she also stated that she found using the VFT “quite boring” and “annoying” due to her lack of interest in technology in general, confirming her survey responses to question one above.

Participants' interest in technology and the subsequent influence of this on their opinions and enjoyment during the VFT trials will now be reported.

Technological Interest

P5M was the only participant to declare a high level of interest towards using technology at home or in school. The other five participants responded negatively, stating that in general they find technology to be stressful (P3F), confusing (P6M), or annoying (P2F). Despite these negative opinions, participants stated positive attitudes towards the use of technology within the context of the research trials, apart from P2F as outlined above. Reasons given included their increased level of understanding regarding how to use the VFT and the perceived usefulness and value for helping them achieve vocal targets and observe progress. P3F summarised:

"I feel like it's more reassuring than other technology can be. Especially because I know how to use it a bit more and because I found it really useful to help my singing. It definitely had a more positive impact for me compared to how much I actually like technology in general". (FG)

In conversation with P1F during week four of the trials she echoed these opinions:

P1F: "I like this a lot more than I thought I would".

Researcher: "It's interesting isn't it, because your initial reaction was more, 'urgh... technology', but then it seems to have grown".

P1F: "Yes, it definitely has. I just think it's really useful. It really helps me understand what I need to do to improve my singing. I mean, I know you tell me, but seeing it really helps confirm what I need to do and what the result is when I do it".

Within the focus group, P1F expanded further by saying:

"It was just really useful to see what was going on and work out how I could change things. So, yeah, I liked using it way more than I like using technology usually".

P5M, who declared the most interest in technology in general, asserted that his interest in the applications was not simply sparked by his interest in technology but rather by the value that they provided as additional feedback sources. In the focus group he said:

“I didn’t really think of it as technology... It just felt natural in our lessons. It felt like the technology was literally just another person in the room saying: ‘hallo, yes [clap clap clap] that sounded good””.

P3F agreed, saying:

“When I got used to it, it wasn’t like I was thinking ‘oh this is technology’ or anything. I was just thinking it’s another useful way to see what you were saying and understand what I needed to do”.

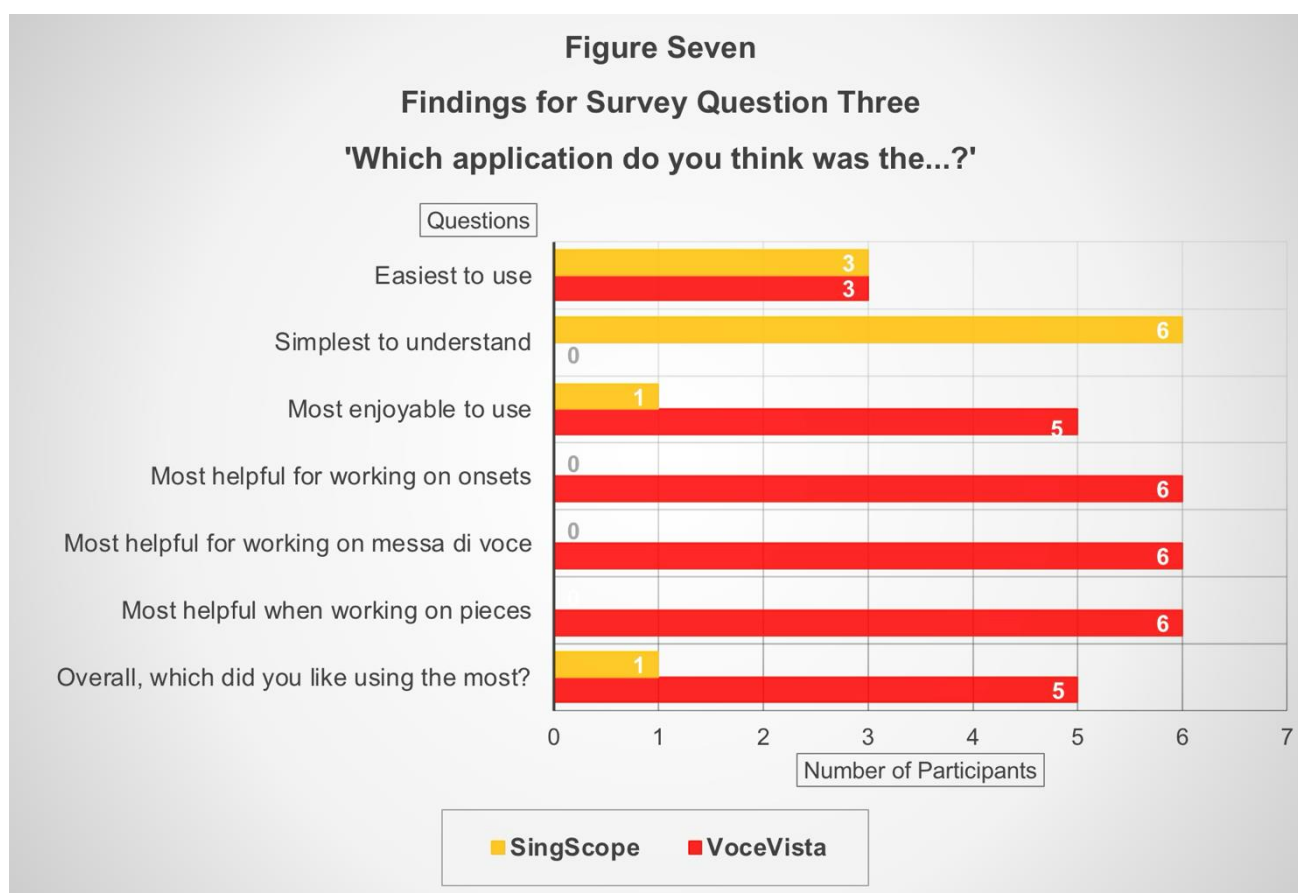
Research Question Two: Types of Display

‘Do singers’ responses towards VFT change according to the type used?’

Quantitative Survey Findings

To address research question two, survey question number three asked participants to indicate which of the two applications (the pitch-tracking application ‘SingScope’ or the spectrogram application ‘VoceVista’) was, in their opinion: easiest to use; simplest to understand; most enjoyable to use; most helpful for working on their exercises and pieces; and, overall, which application they liked using the most. Figure seven below summarises these results. (For examples of the displays, please refer to figure four, p.23 and appendix 1, p.70)

Although ‘SingScope’ was voted the simplest application to understand by all six participants and there were equal numbers of votes for both applications regarding ease of use, ‘VoceVista’ received a significant percentage of votes overall (73%), with all participants stating it was the most helpful for working on the two exercises and repertoire and five of the six participants stating it was both the most enjoyable application to use and the application they liked using the most (P1F being the participant who favoured ‘SingScope’ for these two categories).



Qualitative Findings

Focus group discussions confirmed participants' overall preference for 'VoceVista'. Reasons (evidenced below) included the visual appeal and the increased amount of information provided, which aided participants' understanding of vocal tasks. However, research diary findings suggested that participants' attitudes towards the two types of feedback varied depending on the context in which they were used and across the trial period.

'SingScope'

Engagement

During initial explorations in week one, all participants apart from P2F stated that they found 'SingScope' fun to use. Reasons centred on the immediacy and simplicity of the feedback. This led participants towards playful and creative vocal explorations. P1F summarised: "that one's

['SingScope'] fun! I think because it's simple. You can just do whatever you want and go crazy! I just wanted to make it [the pitch-tracking marker] go up and down". This led her to conclude that she would like to use 'SingScope' during future vocal range explorations. P3F and P4M similarly explored drawing shapes with the pitch tracking line, stating in the focus group that doing so was fun. During week one, P3F, P4M, P5M, and P6M also stated that the clarity and simplicity of the screen made it easier to read, thus aiding their understanding. P3F summarised:

"I enjoyed seeing less information 'cause it's simpler... I enjoy things that look more simple because then, if my brain is tired and not working, I can still look at it and understand".

P3F and P5M also felt that the single pitch line helped guide their vocalisations, showing them "very, very bang on" what they were aiming for (P5M).

Progression

In contrast to the opinions detailed above at the start of the research, as trials progressed, participants started to voice concerns regarding the specificity of having only the single pitch line to focus on. During week four, P2F said: "This one [SingScope] is so in detail, you can see every little movement and it puts me off!". Similarly, P6M said that seeing the pitch line in such close detail felt "a bit intimidating" and P3F found it "distracting" and "harder" to use in the context of exercises. P5M summarised:

"Because this one ['SingScope'] is more responsive, like, it's in such closer detail... it makes me feel like I have to really concentrate if it's that precise and then I feel a bit worried about it. I have to try too hard to make it go straight on the pitch and that feels weird in my voice. But the harmonics one ['VoceVista'] shows you a lot more detail, but more like the overall picture, so I'm trying to get like a more overall shape, which feels better." (RD week 4)

'VoceVista'

Visual Appeal

Throughout the research, participants responded positively to the visual appeal of 'VoceVista', specifically its use of colour to indicate changes of acoustic intensity (McQuade, 2020). During initial explorations in week one, all participants apart from P2F stated that the colours made

'VoceVista' "fun to look at" (P3F). In the focus group discussion, the same participants reflected that the use of colour led to their increased interest in the application, with P6M summarising: "You just pay a lot more attention to the colours... [They] draw you in and make it more interesting".

P3F, P5M, and P6M stated that their increased interest in the colours of the display led them to experiment more with their voices. As P3F said: "I just liked looking at it, to see what was going to happen when I did different things" (FG). During the focus group, participants P1F, P2F, P3F, and P6M discussed that the use of colour also enhanced their understanding of their vocal qualities and the physical coordination required to produce different qualities. For example, P1F said:

"Seeing the brighter colours, or the changes of colour, helped me understand how much muscle or breath I was using to make the sound. And then I knew better how to change or adjust that to make it different".

P3F and P2F also said that the use of colour helped to confirm their perceptions and provided positive reinforcement that they had achieved the goal of the exercises, saying:

"It made it more obvious I suppose when I made a change. Like, if the colour went from blue to orange, I knew I'd made a stronger sound." (P3F, FG)

"I think seeing when there were stronger or brighter colours when I sang higher, that was good. That made me realise that they are strong. That felt pretty good to see that." (P2F, FG)

Amount of Information

During the first vocal exploration session, P2F, P4M, and P5M responded positively to what they perceived to be the increased amount of information that 'VoceVista' displayed, specifically the provision of the treble and bass music staves and piano keyboard, which gave them a stronger sense of where their pitch was, and the fuller display of the complex frequency components of their sound, which provided more information concerning vocal timbre (McCoy, 2019). As the trials progressed, all participants confirmed that having the detailed information was helpful. As P5M reflected in the focus group, 'VoceVista' gave "more options of what you could check, which was more helpful". The increased level of information aided participants' understanding of their

vocal qualities and provided guidance as to what they needed to do to improve, either within the given task or more generally. For example, P1F said:

“I liked all the details. I feel like it made it easier to understand... I understood more about what was going on with my voice and what I needed to do because of all the details”. (FG)

Similarly, during week three of the trials, P2F said: “On [‘VoceVista’], I can definitely tell, like, ‘ok, I need to make this more clear but this more breathy’. I just like that more; it’s more useful.”

For P3F, her preference towards using ‘VoceVista’ increased as she became more familiar with it. During week three she said:

“Because I understand it a bit more now, I actually prefer using that one [VoceVista], ‘cause I can also see the breathiness and stuff in a bit more detail on it, and that’s more useful for me. I thought I’d prefer using the simpler one, because it’s easier to read but now I like having more detail... it helps me work out what I need to do more to improve”.

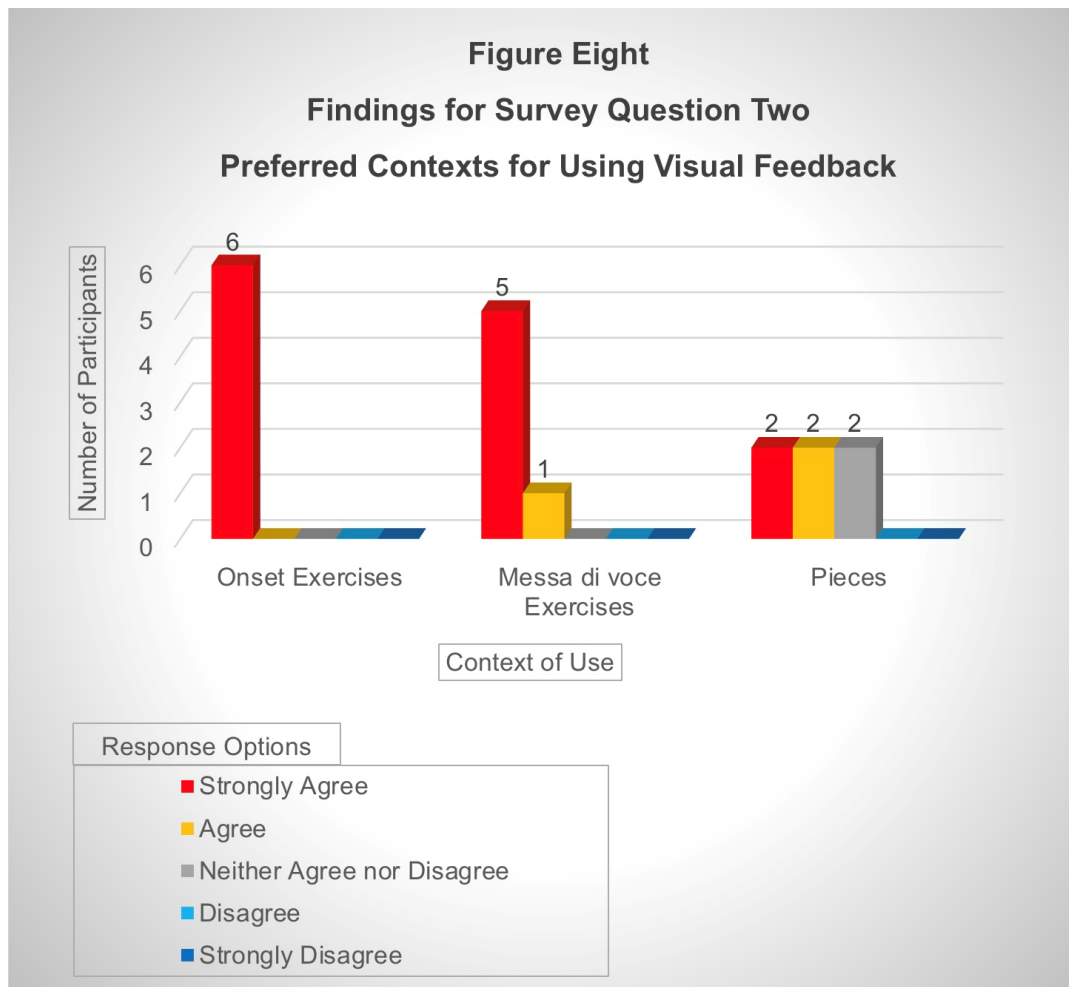
When asked whether the increased amount of information displayed was distracting, all participants replied they did not find it distracting, with P2F saying: “I like how I can see all of it at one time” (RD week 2), and P4M summarising: “you can just choose to focus on what you need to but then you can still see the other bits to keep a check if you want to” (FG).

Research Question Three: Context

‘Do singers’ responses towards VFT change according to the context in which it is used (focussing on use in vocal exercises or repertoire)?’

Quantitative Survey Findings

To address research question three, survey question number two asked participants to indicate how much they agreed or disagreed with statements relating to how helpful they found using the visual feedback within the context of the onset exercises, messa di voce exercises, and within their pieces. Results are displayed in figure eight below.



All participants strongly agreed that they found the visual feedback helpful during the onset exercises. Use within the messa di voce exercises received a similarly positive response, with five participants strongly agreeing and one (P6M) agreeing that it was helpful. Perceptions of helpfulness within the context of pieces were more varied, with two votes each for strongly agree (P1F, P4M), agree (P3F, P5M), and neither agree nor disagree (P2F, P6M).

Qualitative Findings

Exercises

Confirming their survey responses, all participants stated during the focus group that the visual feedback was helpful for working on both types of exercises. Reasons centred on the value of being able to clearly see the vocal qualities (such as breathiness) and musical features (such as pitch stability and loudness) that were being targeted within each exercise. Having this visual

confirmation aided their understanding of the targets of the exercise and of what they needed to do to improve. As P6M said, it “makes it really obvious what you’re aiming to do”. Summarising, P4M said:

“I found it really useful ‘cause I could see what the notes are and how loud they are and how soft or breathy they are, and I think that was useful because, then I could know how to change it or improve it, or if it’s just fine”.

Echoing sentiments from the application discussion, participants noted value in the increased amount of information offered by the ‘VoceVista’ application, which allowed focussed concentration on specific targets within the exercises. Reflecting, P2F said: “in the exercises, you’re focussing in more detail anyway, so, it’s good to look at it then. And the screen helped with that because it was so detailed”.

Repertoire

In contrast to the unanimous perception that the VFT was helpful when working towards vocal exercises, opinions towards using it within pieces varied between participants and depending on the way it was used. P1F voiced the strongest positive response, citing what she perceived to be the increased relevance of using the VFT within her pieces. Explaining her feelings to the focus group, she said: “I think it was much more useful because I could actually see what I needed to do in my piece to improve it”. This led to her increased enjoyment towards using the VFT overall. By week four she said:

“I think that’s very useful, especially for holding all the long whole notes in ‘All Too Well’. So, you can think more about the pitch holding and be more focussed. It’s helpful because you want to know exactly what your voice is doing, and this lets you monitor it and see that you’re doing the right thing. I really enjoy using this now! It’s so helpful!”

During the trials, P5M and P3F voiced similarly positive attitudes for the same reasons as P1F. In week three, P5M said: “I feel like this session was really good. I think that’s because we put it into my music more and I understand more now how it’s useful and what I can do to improve”. By week five, P3F stated:

“I actually think that’s really interesting using it in the music... ‘cause you can actually see where it becomes more useful and figure out where it works to help.

Especially when we used it for the hard onset for the high phrase in ‘Let’s Face the Music’, I really then understood what you wanted me to do, seeing it like that on the screen”.

During the focus group, P3F, P4M, and P5M reflected that the VFT was useful for working in detail on specific elements of a piece, with P3F saying:

“If you notice something in the piece where actually it would be good to look back on, so you can actually see maybe where you’re going wrong, it’s really good because you can pinpoint it and then fix it”.

However, working in this kind of detail produced a negative response from P2F, who said in the focus group: “I didn’t find that useful... I just wanted to sing when we did my pieces, not look at it so closely”. This mirrored her responses during the intrinsic interest section. Although this feeling was not echoed by other participants at this point, it was discussed during questions on how participants might like to use the VFT in the future, which will be outlined in the future use findings section. P2F also stated in the focus group that she found using the feedback “distracting” when she was trying to concentrate on other features such as lyrics, rhythms, and phrasing. P3F and P5M agreed, with P6M adding that he found it “slightly stressful” to shift his focus between musical elements and the screen. This factor led three participants (P2F, P3F, and P6M) to conclude that they would not like to use the feedback when learning a new piece as there would be “too many other things to think about” (P2F FG).

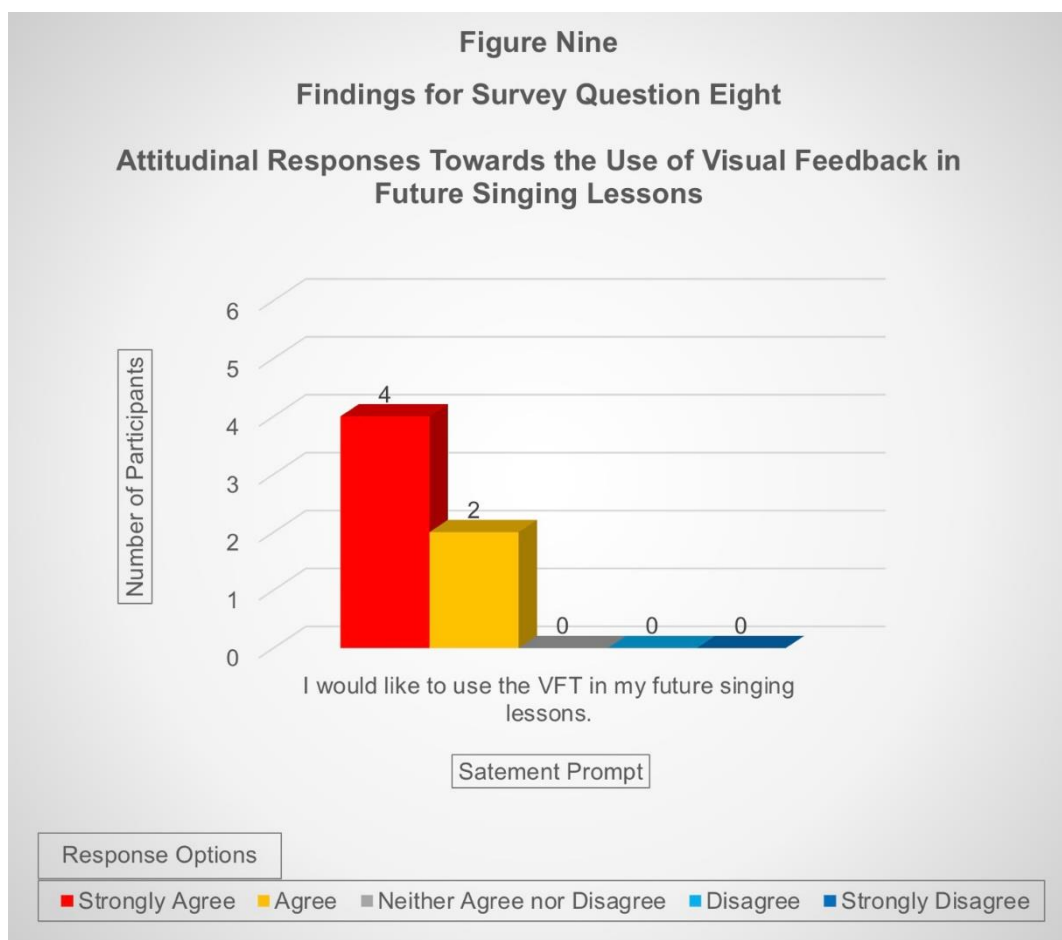
Research Question Four: Future Use

‘Following their experiences, would students like to use VFT in the future?

If so, how often and in what context?’

Quantitative Survey Findings

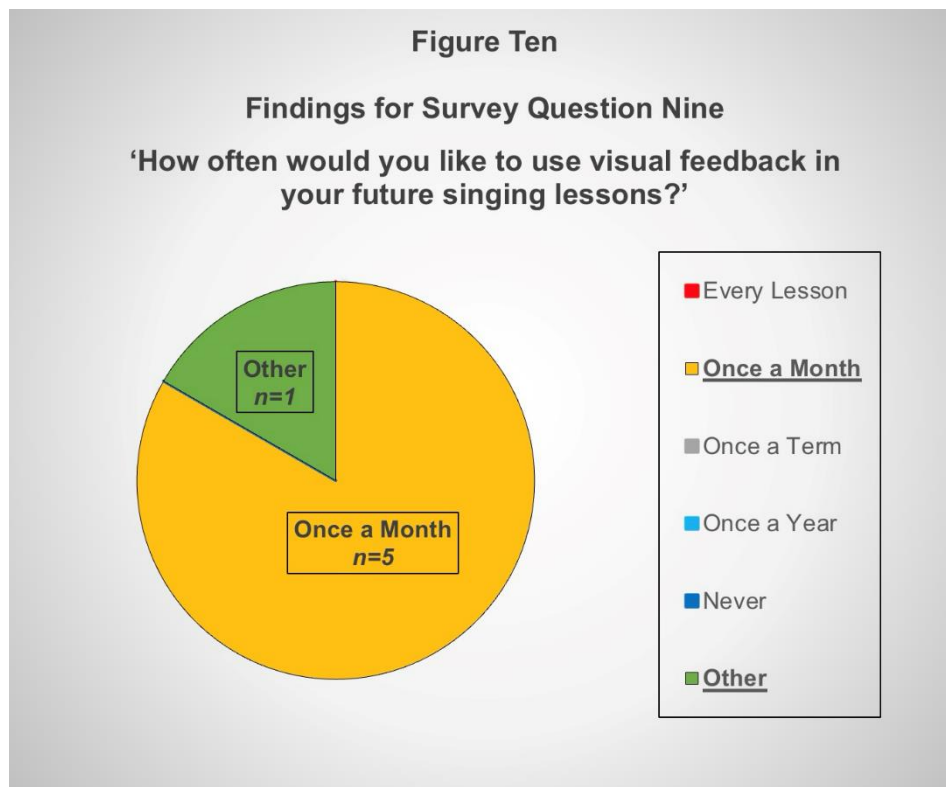
Survey question eight asked participants to indicate how much they agreed with the statement ‘I would like to use the visual feedback in my future singing lessons’. Results are shown in figure nine.



All participants responded positively, with four participants stating they strongly agreed, while P2F and P6M agreed. To obtain further information on participants' opinions towards using the VFT in their future lessons, they were also asked questions relating to the frequency and context in which they might like to use the VFT, which will be reported next.

Frequency

Survey question nine asked participants to indicate how often they would like to use VFT in future singing lessons by selecting a response from the options: every lesson; once a month; once a term; once a year; never; or other. If the 'other' option was selected, participants were asked to provide further details of preferred frequency. Results are displayed in figure ten.

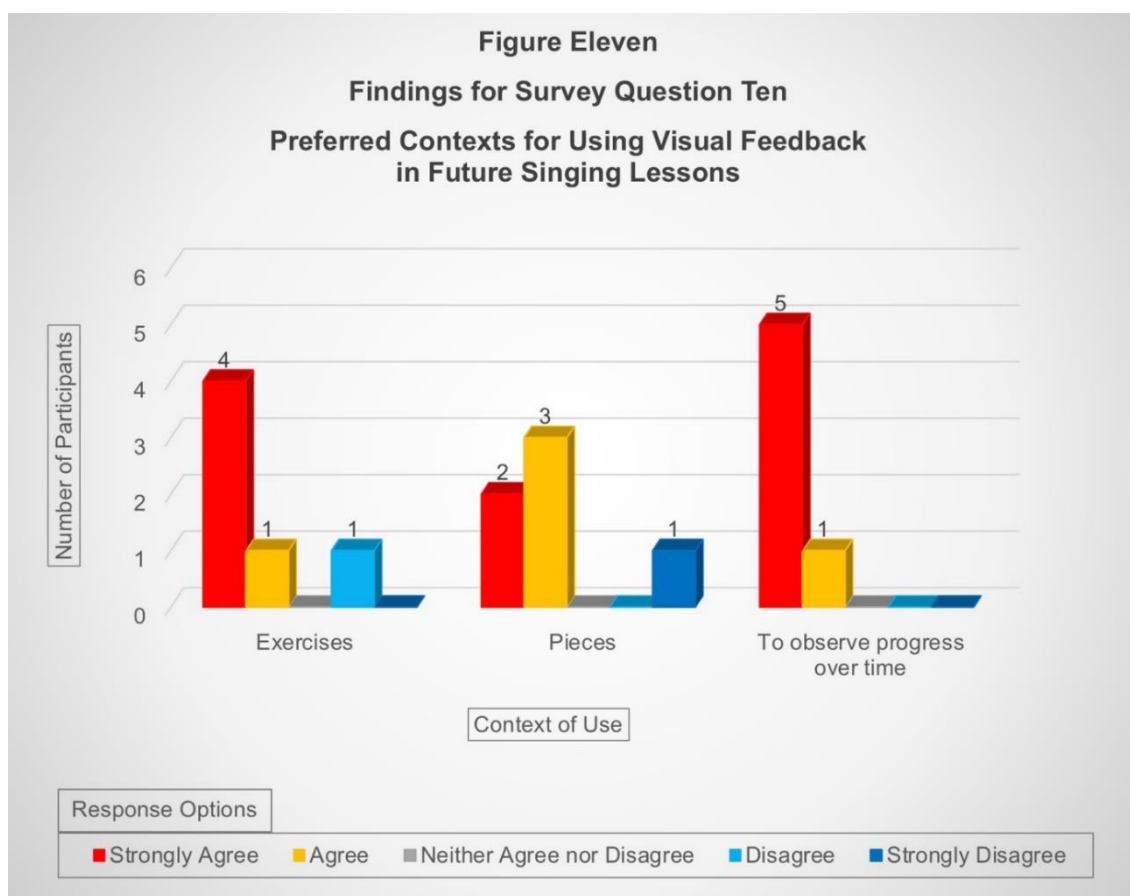


Five of the participants selected the option 'once a month'. One participant (P5M) selected the 'other' option, writing that he would like to use it "every second lesson, so we would have a piece and practice lesson and then a vocal workshop session with the feedback", thus highlighting the importance of valuing individual preferences for personalised learning, which will be considered in the discussion section.

Context

Survey question ten asked participants to indicate how much they agreed or disagreed with statements relating to whether they would like to continue to use VFT within vocal exercises, pieces, or to observe their vocal progress over time. Results are displayed in figure eleven.

The strongest positive response was towards using the VFT to monitor vocal progress over time, with five participants strongly agreeing and one agreeing (P2F). The second strongest positive response was towards using the feedback within vocal exercises, with four participants strongly agreeing, one agreeing (P6M) and one participant (P2F) disagreeing. Although five participants agreed with wanting to use visual feedback within their pieces, only two strongly agreed (P1F and P5M). P2F again indicated a negative response, strongly disagreeing.



Qualitative Findings

Frequency

During the focus group, all participants indicated preferences towards using the VFT monthly, stating that it would be beneficial for identifying specific areas for improvement and then checking progress following a few weeks without the feedback. Summarising, P4M said:

“You could use it to see what you need to work on and then over a few weeks, try to improve on that without the screen. Then you can check how it’s going with the screen a few lessons later and see if you’ve improved”.

Participants agreed that “it could get a bit overused and boring” (P5M, FG) if used more regularly. They also cited conflict with other lesson goals and concerns over balancing lesson time with and without the VFT. While working with the VFT was generally felt to be “really useful for working on specific, detailed things” (P5M, FG), P2F, P3F, and P5M acknowledged that it would be “more helpful if it was [used] less often... so that you can just enjoy singing and working on the bigger picture of a song the rest of the time” (P3F, FG). P4M stated, “you still need time for doing other

things like preparing for concerts and exams” (FG). This feeling was reiterated by P1F, P3F, and P4M, who, in response to open survey question number seven (‘what did you like least about using the VFT?’) all replied that it took time away from working towards other lesson goals.

Context

Concurring with their survey responses, all participants except P2F stated they were keen to use the VFT in the future within vocal exercises to aid their understanding of vocal tasks and to observe progress. All participants apart from P1F confirmed that they were less likely to want to use the feedback within their pieces, citing the same reasons as given in the context findings section, with P5M concurring with P2F’s earlier sentiments, “sometimes you just want to sing, rather than thinking about how you need to improve small things all the time” (P5M FG).

Observing Progress Over Time

Confirming the survey findings, all participants responded positively during the focus group to the idea of using VFT to monitor vocal progress over time. They agreed that the VFT was useful for confirming vocal changes and improvement, with P4M saying: “it’s definitely a really good way to see it... It’s just so clearly showing you things that you might not have noticed before just listening to yourself”. Agreeing, P6M said:

“It makes it really obvious how things are changing, because you can just see it... It felt reassuring to see it there on the screen and it made it make more sense to me. Like, I know how different it feels and I know how it sounds to me, but I don’t know how that comes across out loud or how others hear it”.

Participants all agreed that using the feedback once a term to monitor voice changes and progress would be valuable, with P2F suggesting:

“once at the beginning of the year, once in the middle, and once at the end of the year... because in the beginning, you’re gonna see where your voice is, and then in the middle, you’re gonna see what progress you’re making, and then at the end, you’re gonna be able to see ‘did my voice change?’”.

P5M followed this by saying: “I’ve got a really good idea... we could make a chart on a document, and it would show us over time our voice in a graph in terms of what and where we are”.

Discussion

Intrinsic Value

Technological Interest

Although participants reported positive enjoyment towards working with the VFT overall, qualitative findings provided a more nuanced picture of how their enjoyment and interest progressed across the research process. Five participants reported initial apprehension towards using the VFT. While this was partially attributed to some uncertainty concerning what the technology might show them or what they would be required to do, as similarly noted by the four adult participants in Howard, et al.'s (2007) study, a larger influencing factor was participants' general attitude towards technology. Only one participant, P5M, declared a high level of interest in technology from the outset and instantly moved into extensive vocal play and exploration of the applications. The other five participants reported hesitation due to their negative attitudes towards technology in general. This finding contradicts assumptions held by the teachers within Callaghan, et al. (2004) and Howard, et al.'s (2007) studies and Brunkan's (2009) hypothesis that the inherent motivational value of the technology itself would engage and motivate students, as discussed in the literature review. It is more in line with findings from recent educational research into the integration of technological tools within classrooms. Researchers such as Benvenuti, et al. (2023), Qazi, et al. (2022), and Hietajarvi, et al. (2019) suggest that, although technology is now ubiquitous in adolescents' daily lives, its use will not necessarily enhance students' interest in or enjoyment of educational tasks. My participants' interest and enjoyment towards using the VFT increased with their understanding of what the displays showed them and how the information could be relevant and helpful to aid their progress, mirroring the students' opinions within studies by Callaghan, et al. (2004) and Howard, et al. (2007). This was highlighted in the focus group, with participants stating that by the end of the research, they did not think of the VFT as technology per se, but as an extra source of valuable feedback to help them achieve vocal goals. To adjust one of the quotes from Howard, et al.'s (2007, p.32) study, the VFT kept my participants' interest not '*because*' it involved the use of technology, but '*despite*' it.

Frequency of Use

My participants' decrease in enjoyment and interest towards the end of the research due to the perceived repetitive nature of using the VFT was interesting. This was despite using it in the context of different exercises and pieces. This potentially indicates that, having established its

usefulness, later trials did not offer new information or experiences to engage or motivate participants further. Although the progression of student interest over time has not been addressed in previous qualitative research, this finding could lend insight to quantitative findings. During experimental investigations into the impact of VFT on the pitch-matching skills of 2,021 children aged eight to nine, Paney and Kay (2015) found that those who practised one to five times over the course of two school terms performed best in post-tests. Post-test results decreased as frequency of practice increased. Although Paney and Kay (2015) suggested that decreased results may have been due to increased dependency on the VFT, they also hypothesised that increased use may have resulted in students losing interest in the VFT, potentially adversely influencing outcomes. Rossiter, et al. (1996) came to similar conclusions during six-week investigations into the impact of VFT on the vocal efficiency of two novice adult male singers. While large improvements in performance accuracy were noted during the first two weeks, a general decline and reduced appreciation for the VFT was observed during subsequent use. These findings lend support to vocal pedagogues Holding (2020, 2016), Maxfield (2020, 2019), and Crocco et al.'s (2021, 2019) motor learning-influenced suggestions that decreasing the frequency of VFT use could be vital to maintain singers' engagement and motivation. However, while motor learning research in the field of sports education has confirmed the benefit of this approach (Wulf and Lewthwaite, 2016; Schmidt and Lee, 2019), it has not been researched specifically within voice tuition. My participants' unanimous assertion that using the VFT once a month would be most beneficial for them to observe progress and retain interest, does potentially support this approach. Altering the frequency of my VFT use with students will therefore be an important consideration for future trials within my practice and further cycles of research with a wider range of participants. It also points to the importance of longitudinal research to monitor this variable over time, which will be further discussed below in the future use section.

Types of Display

Pitch-Tracking Display: 'SingScope'

My participants initially responded positively to the pitch-tracking application 'SingScope' due to the clarity of the display and the simplicity of the information provided. This application encouraged the most creative, explorative vocal play at the outset of the research. As Acquilino and Scavone (2022) noted in their review of music applications, the entertaining nature of such interactive displays may have encouraged user motivation. Pedagogues Brunssen and Ballantyne (2018) suggest that using VFT in this free, playful way, shifting students' focus of

attention from the potential awkwardness of making sounds to the visual result (McQuade, 2020), may help adolescents overcome emotional barriers that can often prevent them from exploring their changing voices. Following my finding, I am particularly keen to use pitch-tracking displays to work with adolescent singers on exploring their changing vocal ranges, as suggested by P1F during the first week of trials. Inconsistent range capabilities can be key issues for adolescents during physiological development (Gackle, 2019; Williams and Harrison, 2019). Using pitch-tracking applications to encourage free vocal play and range experimentation may be a useful way to start positively re-establishing vocal motor coordination (Brunssen, 2018). However, as noted by Barnes-Burroughs, et al. (2008), I am aware that adolescents may become uncomfortable or self-conscious using recording and voice analysis tools. Seeing the result of range changes or pitch instabilities on the screen may cause embarrassment during what Sweet (2020a) recognises can be a delicate period when adolescents are forming their singing identities. Therefore, consideration of individual students' attitudes will be vital during future trials.

While initial use of 'SingScope' instigated free vocal play, subsequent use within exercises and repertoire produced a negative participant response. The specificity of the single pitch line made them concerned and uncomfortable as they fixated on trying to achieve what they perceived to be the 'correct' visual result. This aligns with the experiences of two students within Callaghan, et al.'s (2004) study, who found that trying to obtain correct visual feedback made them 'tense' and start to 'force' their voice. While this finding could have been influenced by the type of exercises chosen for this research, it lends further support to the suggestion above that pitch-tracking applications may be more valuable for encouraging free vocal exploration rather than for setting direct technical targets, especially, as Angelakis, et al. (2021) highlight, when considering the vocal health of adolescent singers whose mechanisms may be undergoing change.

Spectrographic Display: 'VoceVista'

Overall, my students voiced significant preferences for the spectrographic application 'VoceVista'. This was mainly due to its visual appeal, specifically its use of colour, and the increased amount of information displayed. Nijs and Leman (2014) noted during trials of the application 'Music Paint' that the use of colour captured the attention of their child participants and led to their enhanced enthusiasm and motivation towards VFT tasks. While my participants acknowledged that the use of colour similarly stimulated their interest in the application, it also enhanced their understanding of vocal concepts. This corroborates the perceptions of one teacher within Welch, et al.'s (2005) study who felt that the use of colour helped solidify his students' understanding of his verbal

descriptions of vocal timbre. As Erickson (2021) hypothesised during her studio-based explorations, the additional visual dimension of colour may make the spectrographic information more accessible and thus help to confirm students' positive actions in greater detail. However, this may produce challenges when working with students with colour vision deficiencies (ColourBlindAwareness.org, 2024) or visual processing disorders (Cicerchia and Freeman, 2024). As suggested by Metatla and Cullen (2018) in their work on creating inclusive technological tools for children with visual impairments, strategies such as adjusting the light and dark contrast of the display, enlarging images, and verbally labelling colour features may prove valuable and would need consideration during future trials with a wider range of participants.

Participants responded positively to the increased amount of information provided by the spectrogram, specifically relating to vocal timbre. Similarly to the students in Callaghan, et al.'s (2004) study, they felt the additional information aided their understanding of the correlation between their physical coordination and the acoustic result. This increased their perception of the value of the application and, therefore, their interest towards using it. They recognised it as a useful tool to help them understand vocal tasks in greater detail and judge more easily how to improve. They also found interacting with the overall picture of the display more useful as it prevented them from fixating on individual elements, as they did with the pitch-tracking display. This finding is in opposition to the perceptions of the teachers within Callaghan, et al. (1999, 2004) and Howard, et al.'s (2007) studies, who assumed that younger, more novice students would prefer the pitch-tracking displays due to their simplicity and accessibility and reserved spectrogram use for advanced adult students. However, it aligns with the students' opinions in those studies and supports Brunkan's (2009) conclusions that spectrograms can be accessible programs for use with children and adolescents. This finding also lends qualitative support to the quantitative experimental findings of Wilson, et al. (2008, 2005), who investigated whether the amount of information provided by VFT had a differential effect on singers of different ability levels. They found that novice and younger singers achieved better results in voice matching tasks when provided with richer contextual feedback. Although my participants' unanimous preference for the 'VoceVista' application may have been influenced by the context in which it was used or my pedagogical delivery during tasks, this finding potentially supports the extended use of this application within my practice. However, careful consideration may be needed when contemplating integration with students with special educational needs such as attention deficit hyperactivity disorders or learning difficulties, who may find the increased amount of information visually distracting (Osborne, et al., 2023) or challenging to interpret (Liang and Li, 2019).

Context

As discussed in the literature review, differences in students' attitudes relative to the specific teaching context in which VFT is used have not been addressed in previous research. My findings regarding variation in participants' responses towards integrating VFT within vocal exercises and repertoire suggest this may be a valuable area for future research to help teachers make better-informed choices regarding VFT application in their practices (Clark, et al., 2020).

Exercises

Within the targeted exercises of this research, the level of visual detail offered by the VFT was perceived to be valuable, providing participants with a clearer understanding of vocal targets. Similarly to the students within Callaghan, et al. (2004) and Howard, et al.'s (2007) research, being able to see the outcome of their vocal attempts provided participants with valuable guidance concerning what they needed to do to improve results. As Nijs and Leman (2014) noted, the VFT stimulated participants' attention towards musical parameters and promoted greater reflection on their actions. As P2F discussed, participants found that the VFT led them to work in a more detailed way, which was viewed as relevant and useful for exercise work, where they were targeting specific technical elements. This opinion did not vary according to the exercise being performed, however, the exercises chosen within this study may have impacted results. For future trials, it would be valuable to extend resources to include a wider range of vocal exercises to verify and expand results.

Repertoire

Opinions towards the use of VFT within pieces varied between participants and according to the way it was being used. This was interesting considering the trial protocol was designed to aid transference of VFT practice from exercises to pieces by targeting the same technical features (onsets and messa di voce). Although four participants acknowledged that the VFT was useful for working in detail on specific technical elements of a piece for the same reasons as given in the exercises, overall, participants were less positive towards using VFT within this context. Reduced positive responses in the future use survey question asking if they would like to use VFT to work on their pieces in the future supported this finding. Participants' decreased interest towards using VFT in their pieces may have been due to the repetitive nature of considering the

same vocal features as the exercises, and potentially lends further insight into why participants' interest generally decreased towards the end of the research, as discussed previously. In future, it may be valuable therefore to consider features specific to the pieces my participants are working towards to keep VFT integration relevant for individual students. Shi's (2021) research into the use of mobile applications in voice training indicated that a key benefit of VFT work is that it can lead to more personalised, student-led learning experiences as students work out more specifically what they need to do to achieve their personal goals from analysing the objective acoustic feedback. Vocal pedagogues Brunssen and Ballantyne (2018) agree, finding in their empirical investigations that using VFT to focus on adolescent singers' individual technical needs can encourage them to explore their voices with more positivity.

Four participants identified challenges when shifting their focus of attention between the musical features of their pieces and the VFT display. This was interesting considering the VFT was only used to target short phrases that they knew from memory and specific technical elements that were used in the exercises. This suggests participants may have been considering potential challenges that they might face with VFT in the future. The assertion by three participants that they would not like to use VFT to work on new repertoire furthers this conclusion. P2F's strong negative response towards using VFT in her pieces due to her desire to "just sing" and not look in such close detail lends support to the perceptions of teachers within Howard, et al.'s (2007) study, who suggested that student acceptance of VFT may vary depending on individual students' goals and interests. Although P2F's feelings were not overtly echoed by other participants, there was overall agreement that it would be important to establish a balance between working in detail with the VFT and having time to work on the "bigger picture of a song" (P3F, FG), especially when working towards performance goals. This aligns with the views of one teacher within Callaghan, et al.'s (2004) study who thought students may be concerned that working with VFT would take time away from repertoire and musicianship learning. This finding strengthens my conclusion that integrating VFT within a monthly cycle may be most beneficial. It also further suggests the importance of valuing individual students' preferences and attitudes. As Meyer, et al. (2021) summarised, once students are introduced to the technology, they should take the lead on how much they would like to use it and in what context. As discussed in the literature review, this may inspire greater feelings of autonomy and, subsequently, improve student motivation and engagement (Shi, 2021).

Future Use

All participants responded positively to the survey question asking if they would like to use VFT in future singing lessons, even P2F, who voiced the most negative feelings overall. Although aforementioned insider researcher considerations may have influenced these answers, participants' willingness to respond negatively to other survey questions indicates the potential reliability of this response. During the focus group, all participants also stated preferences towards using VFT monthly, even P5M, who had displayed the strongest positive responses towards the VFT overall due to his "high level of interest" in technology but suggested that using the VFT more often might become "boring". Combining these findings potentially strengthens my previous conclusion that participants' perception of the usefulness of the VFT was the main motivating factor in their decisions regarding future use, rather than their enjoyment. Having previously discussed findings relating to participants' preferred frequency and context for using VFT, my final discussion section will now concentrate on their unanimously positive response towards using VFT to monitor vocal progress over time.

Monitoring Vocal Progress Over Time

All participants stated that the VFT provided a good platform for observing vocal progress. They felt that seeing vocal features on the screen helped confirm their progress towards singing goals and the vocal changes they were experiencing more generally. As motor learning-influenced vocal pedagogues such as Holding (2020) and Crocco and Meyer (2021) have asserted, allowing students to judge their own progress via external feedback tools such as VFT may lead to increased feelings of autonomy and self-efficacy, which may improve engagement and motivation. My participants' opinions echo those of the adult singers in Howard, et al.'s (2007) study; however, this could be an even more pertinent asset for adolescent singers as they move through periods of vocal change (Baker, et al., 2022b). For P6M, who discussed during the focus group that he was experiencing significant voice changes, the VFT provided useful confirmation of those changes, which in turn reassured him regarding how his sound was coming across to others.

These findings, alongside P5M's final comment regarding the potential use of VFT to help chart voice changes and progress, brought me full circle to my findings from my previous work-based research module BMPF7008 (Watson, 2022a), where I investigated the use of a researcher-

designed voice charting system with eight female adolescent singing students. Participants' average speaking frequency, vocal range, and register transitions were mapped on to pitch charts outlining the four phases of female adolescent voice change as described by voice researchers including Gackle (2019), Dienerowitz, et al. (2021), and Berger, et al. (2018) (see appendix 14, p.112). Participants stated that seeing their vocal attributes alongside recognised voice change features helped confirm their experiences and deepen their overall understanding of voice change. The older participants also reported increased motivation towards exploring their vocal ranges, with the chart providing them with a goal and reassurance of what they might be able to achieve at their stage of development. I concluded that the perceived benefits of the voice charting resource validated the importance of using interactive strategies with adolescent singers that directly relate to their individual experiences. Following the findings from my current research, I am now keen to combine resources from both projects by integrating VFT within voice charting exercises so that students can actively see changes of voice quality, range, and registration. By then mapping these features on to charts outlining the stages of development, it may help singers anticipate and understand vocal progressions, potentially helping to improve confidence and motivation during periods of development.

Longitudinal Research

With my participants concurring that they would like to use VFT termly to monitor vocal progress, it seems vital that research should be extended to enable evaluation across a longer timeframe. As Lã and Fiuza (2022) and Erickson (2021) have noted, longitudinal research is greatly needed in investigations into the use of VFT within vocal tuition to identify the true efficacy of its long-term effect on vocal learning. Gackle (2019) and Baker, et al. (2022b) have also highlighted that there is a significant deficit of longitudinal research investigating adolescent voice development, even though studies moving into this area such as those by Pieper, et al. (2020) and Willis and Kenny (2011) have proved fundamental to our understanding. The long-term commitment required by both researchers and participants make longitudinal studies notably difficult to achieve (Bell and Waters, 2018). However, as voice teachers committed to following students through their school years, we may be perfectly placed to have a significant influence here.

Conclusion

This research was specifically designed to generate practical knowledge which would help me make informed judgements regarding the integration of VFT with adolescents within my future teaching practice. With regard to my intended learning outcomes, the research demonstrated that VFT may provide an engaging, accessible platform for adolescent singers to explore their developing voices. For my participants, this was not related to the inherent motivational value of the technology itself as previously suggested by Brunkan (2009) and Howard, et al. (2007). Rather, my participants' appreciation of the VFT increased as they recognised its potential value for helping them better understand singing tasks, gain a fuller picture of their vocal attributes, and judge more easily how to improve. Following investigation of my students' experiences of working with different types of VFT applications within different contexts, I have arrived at the following conclusions and recommendations for my future practice:

- The immediacy and simplicity of the interface of the pitch-tracking application 'SingScope' inspired fun, creative vocal play. This type of application may therefore be valuable for encouraging adolescent singers to explore new areas of their voices such as range and register changes more freely.
- The spectrogram programme 'VoceVista' proved accessible and engaging for my participants due to its visual appeal, which stimulated interest and helped strengthen understanding of the correlation between their physical coordination and the acoustic result. Participants found the increased amount of information valuable for increasing their understanding of vocal tasks and for monitoring improvement, particularly for working on detailed vocal concepts.
- Participants found the use of VFT within the two vocal exercises more valuable than within repertoire, as it promoted greater reflection on their actions and allowed them to focus more directly on vocal technique.
- Although my participants were responsive to using the VFT to assist with detailed work in their pieces, the importance of balancing this type of concentrated work alongside enjoying work on the "bigger picture of a song" (P3F) and other musical and learning goals was noted. Participants' varied responses to using the VFT within their pieces also highlights the importance of adapting to individual students' interests and preferences.
- Participants were also unanimous that the use of VFT should be integrated within a cycle of work including repertoire and VFT-free vocal exercises, perhaps on a monthly or termly schedule, which would allow them to monitor vocal changes over time as well as work on improvements in the shorter term.

Limitations and Recommendations

The results of this small-scale, practice-based research are limited to its participants, the situated context of my practice, and the procedures employed, thus preventing generalisations to other settings (Denscombe, 2021). However, it is intended that the practical information generated may prove relatable and relevant to other vocal pedagogues working with adolescent singers or wishing to incorporate VFT within their practice (Hammond, 2013; Ivankova, 2015). Building on the benefits of the action research methodology, future cycles should aim to work in collaboration with a wider participant base of students and teachers to verify and expand results, enhance critical evaluation of findings, and provide important peer validity (Clark, et al., 2020; Whitehead and McNiff, 2006). As previously specified, the extension of the research to trial a larger portfolio of exercises across a monthly or termly cycle would necessitate long-term evaluation, thus tying in with the identified need for longitudinal studies both within adolescent voice (Gackle, 2019) and VFT research (Lã and Fiuza, 2022).

Personal Learning Reflections

Trialling VFT applications in a practical setting led to many valuable insights regarding what can work in real-world contexts and significant improvements in my skills at interpreting data from VFT displays. I can now approach expanding resources into other vocal techniques and educational contexts with increased confidence. Analysing the large volume of qualitative data produced by my research methods proved time-consuming within the short period of this research and presented personal challenges when trying to combine a demanding workload with systematic and rigorous research practices, as similarly observed by Denscombe (2021). However, the benefits of working collaboratively with my students and mining their valuable opinions instilled in me the vital importance of this type of research in ensuring that my practices are student-led, relevant, and responsive to their needs and interests, as suggested by Merriam and Tisdell (2016). Finally, as Ballantyne (2018) succinctly wrote, I have learnt “never to underestimate what young people can comprehend when they are given the tools to experience and understand a concept in their own voices” (in Brunssen, 2018, p.126). This research has inspired me to continue to examine how VFT can be used in singing practices to encourage adolescents to explore their developing vocal abilities during periods of change.

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Appendices

Appendix 1: The Exercises

With adolescent voice change being a highly variable, individualistic process (Sataloff, et al., 2017; Sergeant and Welch, 2009) it was important that the exercises chosen encouraged positive vocal exploration of changing voice qualities and musical features rather than setting exact targets.

1 - Exploring Vocal Onsets

Definition:

The term 'vocal onset' is used in singing to describe how the breath and vocal folds coordinate to start a note (Williams, 2019).

Rationale for Use:

Pubertal laryngeal growth can affect the valving action of the vocal folds (Baker, et al., 2022b). Vocal pedagogues working specifically with adolescent singers such as Williams (2019), Brunssen (2018), and Phillips (2014, 2012) recommend using vocal onset exercises to heighten singers' awareness of the different voice qualities that can be achieved through coordinated muscular gestures of glottal adduction, breath pressure and airflow. Working with vocal onsets may help to improve glottal closure (Harris, 2018) and can provide adolescents with opportunities to observe and demonstrate their developing motor coordination (Brunssen, 2018).

Types of Onsets:

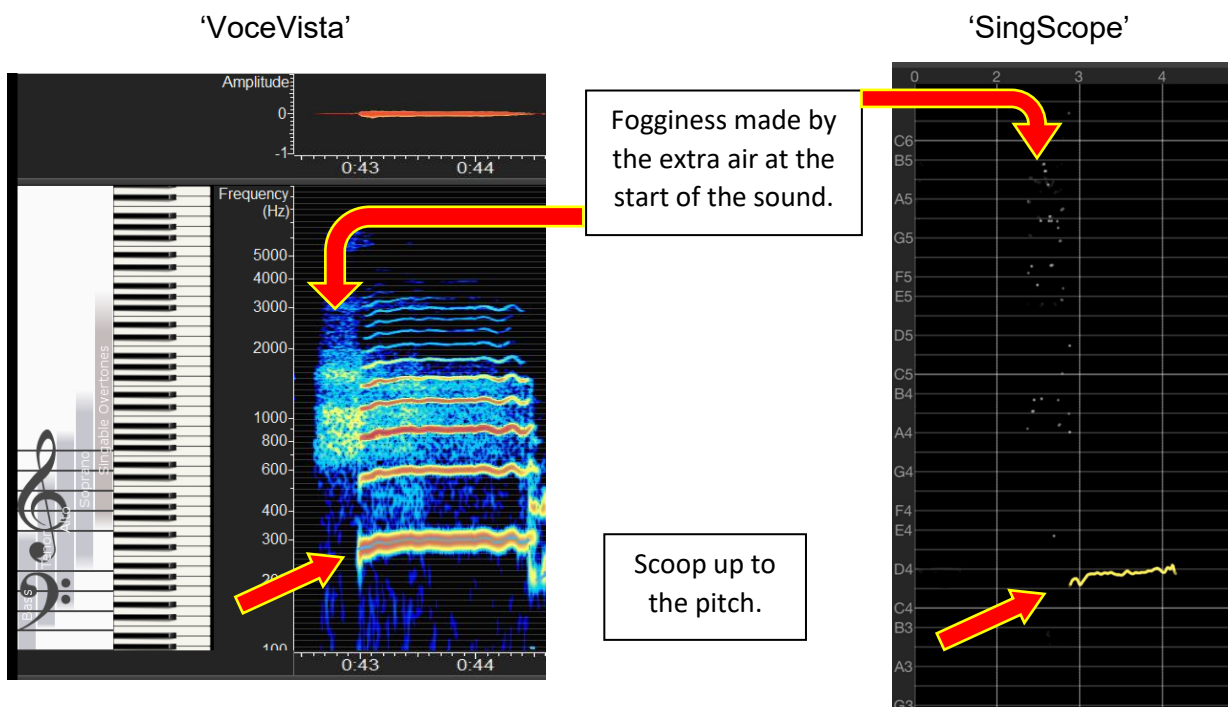
(Adapted from: Chapman, 2017, p. 321; Williams, 2019, p. 104; McCoy, 2019, p. 83)

A) Breathy/Aspirate Onsets

1. Speak the breathy consonant /h/ before the spoken vowel /a/, as in 'Ha'.
2. Speak the breathy consonant /h/ before the sung vowel /a/, noticing that the airflow precedes the phonation.

With the VFT

- There will be a subtle fade in of the sound accompanied by 'fogginess' made by the extra air during the /h/ sound.
- There may also be a scoop up to the pitch.

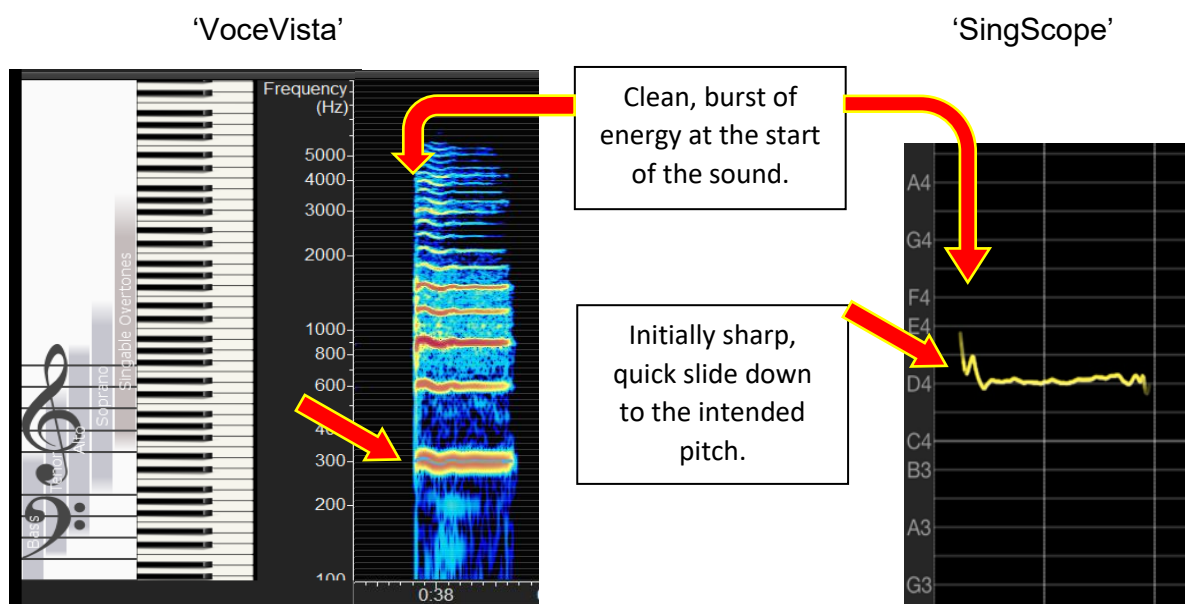


B) Hard/Glottal Onsets

1. Close the vocal folds lightly by preparing to make a tiny cough but stopping short of exploding the air through the glottis. This closure should be effortless. Practice holding this vocal posture for a few seconds, noticing how it feels.
2. Move from this closed action directly into the spoken vowel /a/ or /i/
3. Repeat step 1. But this time move straight into the sung vowel at a medium pitch. You will hear a tiny 'click' at the onset of the glottal sound. Notice that breath is held back prior to this 'click', but that it flows when you phonate the vowel.

With the VFT

- On a spectrogram, glottal onsets will appear as bursts of energy.
- You may notice they are initially sharp, requiring a quick slide down to the intended pitch.

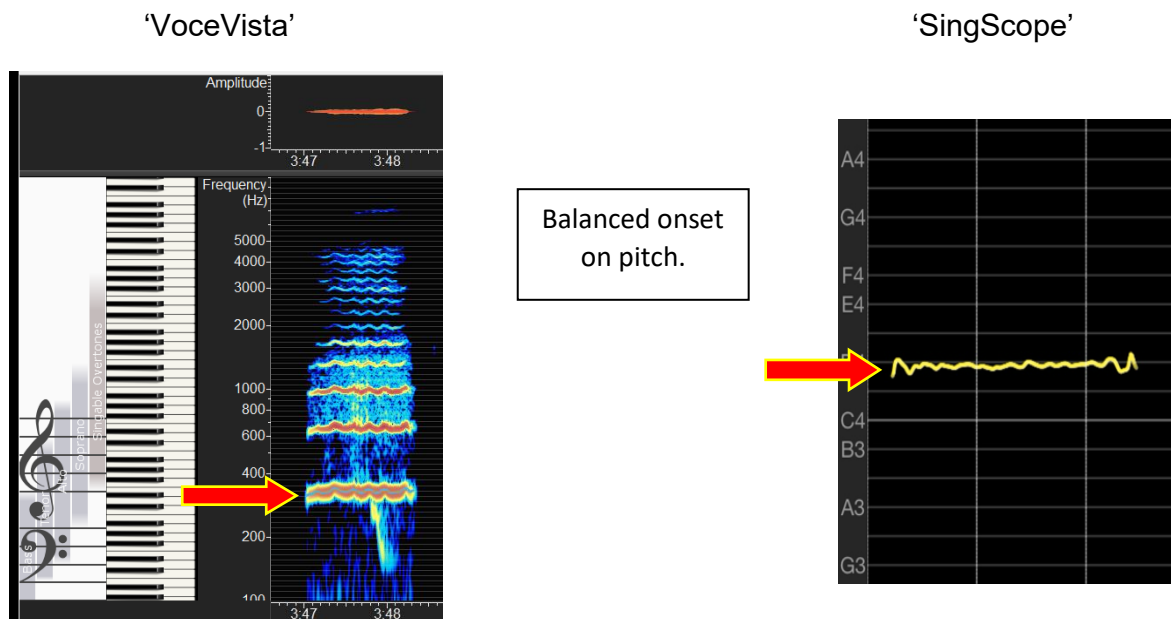


C) Simultaneous/Balanced Onsets

1. Imagine the vowel and the pitch you wish to sing.
2. Start the sound with simultaneous coordination of breath and sound. It can help to achieve this by imitating the cry of a small kitten or the whimper of a puppy. Both these sounds tend to incorporate an efficient onset of breath and voice together.

With the VFT

- On a spectrogram, balanced onsets will appear cleanly, are neither sharp nor flat and allow vibrato to begin immediately.



The Exercises:

1. Repeated Onsets:

- Participants performed the exercise below for each type of vocal onset described above.
- The pitch range chosen was adapted to individual participants, starting at a relatively low pitch in their range and ascending by a semitone for approximately 10 repeats.
- This exercise was repeated for each onset and on each of the three vowels displayed below.



2. *Light Glottal Onsets:*

- Participants sang short vocalisations with light glottal onsets over the interval of a descending major third.
- They started in a comfortable modal voice range and gradually extended upwards, ascending in semitones.



2 - *Exploring Messa di Voce Exercises*

Definition:

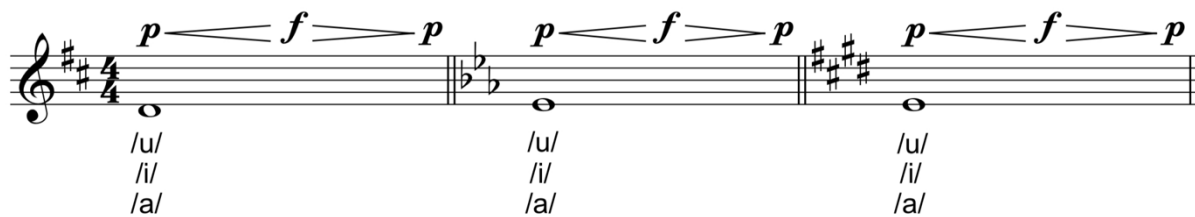
The messa di voce exercise involves a voice onset followed by a crescendo, followed by a diminuendo, then a voice offset while maintaining a single pitch (Titze and Verdolini Abbott, 2012).

Rationale for Use:

Male and female vocal folds increase in length and mass during adolescence due to the influx of pubertal hormones (Sataloff, et al., 2017). Brunssen (2018) states that although this means adolescent vocal folds lose the capacity to respond to high levels of airflow, which younger children use to create loud sounds, they gain the ability to adjust for register, pitch, and dynamics (Titze, 2017). Fuchs, et al. (2009) therefore state that adolescents have a greater capacity for the coordination of the messa di voce as their bodies develop. Titze and Verdolini-Abbott (2012) note that, for sound quality and pitch to remain constant, the messa di voce requires the ultimate control of vocal fold closure and lung pressure changes. The motor skill acquisition of learning to balance these two components (laryngeal muscle activity and lung pressure changes) is vital to the developing singer (Ragan, 2020).

The Exercise:

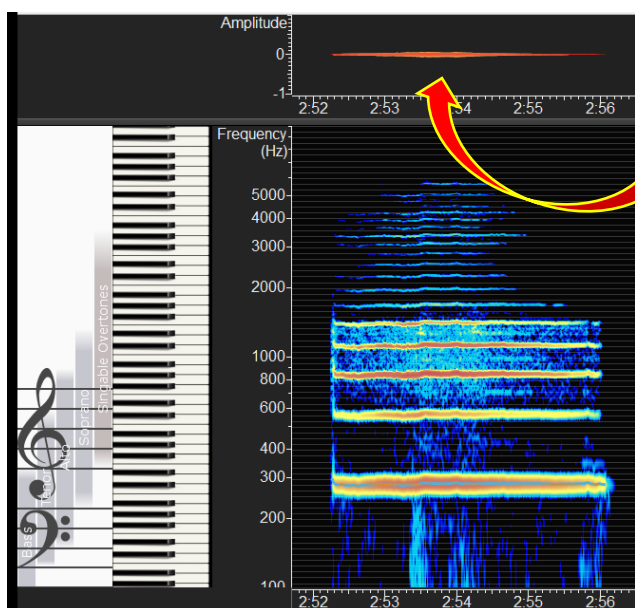
- Participants sang single pitches with a crescendo-diminuendo lasting 5 seconds.
- The pitch range chosen was adapted to individual participants, starting in a comfortable low modal voice range and gradually extending upwards, ascending in semitones for approximately 10 repeats.
- This exercise was repeated for each of the vowels displayed below.



With the VFT

- Visual feedback was used to monitor pitch stability, vocal timbre, and volume.
- With the 'SingScope' application, these features were viewed via the stability of the pitch-tracking line, the intensity of the yellow line, and the amplitude waveform display.
- On the VoceVista display, the features were similarly viewed via the stability of the frequency lines, changes of colour and intensity, and the amplitude waveform display.

'VoceVista'



Amplitude
Waveform
Display

'SingScope'



Appendix 2: List of Applications

Adapted and expanded from Erickson (2021) and Shi (2021).

Red Text = Pitch-Tracking Application

Green Text = Spectrogram Application

Highlighted = Applications Chosen for Week One Trials

Bold Text = Two Applications Chosen for the Research (Weeks 2-5)

	Fundamental frequency only (pitch-tracking)	Linear Spectrograph (same distance between units)	Log Spectrograph (distance between units gets smaller)	Db and/or amplitude waveform (WF)	Spectrum and/or FFT	Record/ Playback	Touch Screen	Laptop or iPad	Cost
SingScope	Yes	No	No	Yes	No	Yes	Yes	iPad	Free
Nail the Pitch	Yes	No	No	Yes	No	Yes	Yes	iPad	Free
Voice Analyst	Yes	No	No	Yes	No	Yes	Yes	iPad	£9.99
VocalTuner	Yes	No	No	No	No	No	Yes	iPad	Free
VocalStave	Yes	No	No	No	No	No	Yes	iPad	Free
OnPitch	Yes	No	No	No	No	No	Yes	iPad	Free
Vocal Pitch Monitor	Yes	No	No	No	No	No	No	iPad	£1.99
VoceVista	Yes	Yes	Yes	Yes	Yes	Yes	No	Laptop	£104.00
SpectrumView	No	Yes	No	No	Yes	Yes	Yes	iPad	Free
SpectroPro	No	Yes	Yes	No	Yes	No	No	iPad	£2.49
Sing and See	Yes	Yes	Yes	Yes	Yes	Yes	No	Laptop	£34.50
Live Spectrogram	No	Yes	Yes	No	No	No	No	iPad	£1.79

Appendix 3: School Signed Consent Forms

MA in Professional Practice (Voice Pedagogy) – University of Wales, Trinity St. David
Permission to conduct voice research.

██████████
Director of Music
██████████
Edinburgh
██████████

7th June 2023

Dear ██████████

I am currently undertaking a Master's in Professional Practice (Voice Pedagogy) and am writing to seek permission to conduct research with Fettes College singing students from 3rd form through to 6th form.

My research will investigate the impact of using visual feedback technology with adolescent singers. The research purpose is to expand teaching techniques for working with this age group, aiming to develop the confidence and motivation of adolescent singers and encourage safe exploration of their developing vocal abilities. My research would require students to fill in questionnaires before and after trialling visual feedback applications to gain insights into their levels of confidence and vocal awareness. Students will also be invited to take part in interviews and/or focus groups at the end of the trial period to expand on responses from the questionnaires and I will be maintaining a research diary to record observations and progress during this time.

Research would be undertaken during the autumn term of 2023 and permission and consent would be sought from pupils and their parents/guardians if the School agrees to my proposal. No student would be identified by name at any stage of the research process. Students and their parents will be made aware that participation is voluntary and that they have the right to withdraw from the project at any time. Audio/Visual recordings will be used to record sessions with the feedback, interviews, and/or focus groups. All data collected will be treated confidentially and stored securely in password protected accounts in accordance with the University of Wales Trinity St. David code of ethics.

I would be very grateful if you could sign the section below to confirm your consent if you agree with this proposal. This will then be submitted to the university ethics committee before research commences.

Kind regards,

Lizzie Watson

l.watson@fettes.com

I give permission for Lizzie Watson to conduct the above research project with Fettes College students during the autumn term 2023.

Signed _____
██████████

Dated 8/6/2023

MA in Professional Practice (Voice Pedagogy) – University of Wales, Trinity St. David
Permission to conduct voice research.

██████████
Director of Music

██████████ Preparatory School

██████████
Edinburgh
EH4 1QX

7th June 2023

Dear ██████████

I am currently undertaking a Master's in Professional Practice (Voice Pedagogy) and am writing to seek permission to conduct research with Fettes College Preparatory School singing students from T form through to 2nd Form.

My research will investigate the impact of using visual feedback technology with adolescent singers. The research purpose is to expand teaching techniques for working with this age group, aiming to develop the confidence and motivation of adolescent singers and encourage safe exploration of their developing vocal abilities. My research would require students to fill in questionnaires before and after trialling visual feedback applications to gain insights into their levels of confidence and vocal awareness. Students will also be invited to take part in interviews and/or focus groups at the end of the trial period to expand on responses from the questionnaires and I will be maintaining a research diary to record observations and progress during this time.

Research would be undertaken during the autumn term of 2023 and permission and consent would be sought from pupils and their parents/guardians if the School agrees to my proposal. No student would be identified by name at any stage of the research process. Students and their parents will be made aware that participation is voluntary and that they have the right to withdraw from the project at any time. Audio/Visual recordings will be used to record sessions with the feedback, interviews, and/or focus groups. All data collected will be treated confidentially and stored securely in password protected accounts in accordance with the University of Wales Trinity St. David code of ethics.

I would be very grateful if you could sign the section below to confirm your consent if you agree with this proposal. This will then be submitted to the university ethics committee before research commences.

Kind regards,

Lizzie Watson

l.watson@fettes.com

I give permission for Lizzie Watson to conduct the above research project with Fettes College Preparatory School students during the autumn term 2023.

Signed _____
████████████████████

Dated _____

8 June 2023

Appendix 4: Ethical Approval Form

APPLICATION FOR ETHICAL APPROVAL

In order for research to result in benefit and minimise risk of harm, it must be conducted ethically. A researcher may not be covered by the University's insurance if ethical approval has not been obtained prior to commencement.

The University follows the OECD Frascati manual definition of **research activity**: "creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications". As such this covers activities undertaken by members of staff, postgraduate research students, and both taught postgraduate and undergraduate students working on dissertations/projects.

The individual undertaking the research activity is known as the "principal researcher".

Ethical approval is not required for routine audits, performance reviews, quality assurance studies, testing within normal educational requirements, and literary or artistic criticism.

Please read the notes for guidance before completing ALL sections of the form.

This form must be completed and approved prior to undertaking any research activity. Please see Checklist for details of process for different categories of application.

Delete the Guidance Notes at the end of the form BEFORE submitting your application

SECTION A: About You (Principal Researcher)

1	Full Name:	Elizabeth Watson			
2	Tick all boxes which apply:	Member of staff:	☐	Honorary research fellow:	☐
3	Undergraduate Student	☐	Taught Postgraduate Student	☒	Postgraduate Research Student
4	Institute/Academic Discipline/Centre:	WAPPAR			
5	Campus:	Carmarthen			
6	E-mail address:	Student email: 2029079@student.uwtsd.ac.uk Personal email: ealc@hotmail.co.uk			
7	Contact Telephone Number:	07900 623330			
For students:					
8	Student Number:	2029079			
9	Programme of Study:	MA in Professional Practice (Voice Pedagogy)			
10	Director of Studies/Supervisor:	Julie Crossman/ Debbie Winter			

SECTION B: Approval for Research Activity

1	Has the research activity received approval in principle? (please check the Guidance Notes as to the appropriate approval process for different levels of research by different categories of individual)	YES	☒	NO	☐
		<i>Date</i>			
2	If Yes, please indicate source of approval (and date where known):	Research Degrees Committee	☐		
3	Approval in principle must be obtained from the relevant source prior to seeking ethical approval	Institute Research Committee	☐		
4		Other (write in) WAPPAR Ethics Board Representative	☒		

SECTION C: Internal and External Ethical Guidance Materials

Please list the core ethical guidance documents that have been referred to during the completion of this form (including any discipline-specific codes of research ethics, and also any specific ethical guidance relating to the proposed methodology). Please tick to confirm that your research proposal adheres to these codes and guidelines.	
1	UWTSD Research Ethics & Integrity Code of Practice ☒
2	UWTSD Research Data Management Policy ☒
3	Fettes College Codes of Conduct, Safeguarding, and Child Protection Policies (https://www.fettes.com/about-us/policies) ☒

SECTION D: External Collaborative Research Activity

1	Does the research activity involve collaborators outside of the University?	YES	☐	NO	☒	
2	If Yes, please provide the name of the external organisation and name and contact details for the main contact person and confirmation this person has consented to their personal data being shared as part of this collaboration.					
3	Institution					
4	Contact person name					
5	Contact person e-mail address					
6	Has this individual consented to sharing their details on this form?	YES	☐	NO	☐	
7	Are you in receipt of a KESS scholarship?	YES	☐	NO	☐	
8	Is your research externally funded?	YES	☐	NO	☐	
9	Are you specifically employed to undertake this research in either a paid or voluntary capacity?	Voluntary	YES	☐	NO	☐
10		Employed	YES	☐	NO	☐
11	Is the research being undertaken within an existing UWTSD Athrofa Professional Learning Partnership (APLP)?	If YES then the permission question below does not need to be answered.	YES	☐	NO	☐
12	Permission to undertake the research has been provided by the partner organisation	(If YES attach copy) If NO the application cannot continue	YES	☐	NO	☐

Where research activity is carried out in collaboration with an external organisation

13	Does this organisation have its own ethics approval system?	YES	☐	NO	☐
14	If Yes, please attach a copy of any final approval (or interim approval) from the organisation				

SECTION E: Details of Research Activity

1	Indicative title:	Exploring the Impact of Visual Feedback on Adolescent Singers: An Investigative Study		
2	Proposed start date:	10 th July 2023	Proposed end date:	1 st March 2023
3	Introduction to the Research (maximum 300 words) Ensure that you write for a <u>Non-Specialist Audience</u> when outlining your response to the three points below: • Purpose of Research Activity • Proposed Research Question • Aims of Research Activity • Objectives of Research Activity Demonstrate, briefly, how Existing Research has informed the proposed activity and explain • What the research activity will add to the body of knowledge • How it addresses an area of importance.			
4	Purpose of Research Activity Adolescents experience changes in vocal range, stability, and timbre due to rapid growth of laryngeal structures stimulated by hormonal changes. These changes can result in negative emotions, which can lead to decreased confidence, self-deprecation, struggles pertaining to singer identity development, and decreased participation in singing activities. The purpose of this research is to examine whether the use of visual feedback technology during singing tuition could help engage and motivate adolescent singers, build confidence in their changing vocal abilities, and enhance the teacher-student relationship. (this box should expand as you type)			
5	Research Question Can the use of visual feedback within singing tuition improve adolescent singers' motivation and confidence and encourage them to continue exploring their developing vocal abilities during periods of change? (this box should expand as you type)			
6	Aims of Research Activity - Increase my understanding of adolescent voice maturation. - Add new techniques to my toolkit as a singing teacher for increasing the confidence, understanding, and knowledge of my adolescent students. - Increase my own proficiency in using visual feedback technology including spectrographic and pitch-tracking applications. - Enhance awareness of the challenges associated with adolescent voice change more widely among colleagues, parents/guardians, and students. - Determine how visual feedback may benefit student learning, confidence, and vocal progress.			

	- Draw conclusions and make recommendations for effective teaching approaches for adolescent singers, which could then be trialled more widely with other teachers in the future. (this box should expand as you type)
7	Objectives of Research Activity - Develop a protocol integrating visual feedback within a series of exercises and techniques designed for adolescent singing tuition. - Identify the issues that voice teachers should consider when applying visual feedback within their practice with adolescent singers. - Ascertain whether the integration of visual feedback improves the confidence and motivation of adolescent singers. (this box should expand as you type)
8	Proposed methods (maximum 600 words) Provide a brief summary of all the methods that may be used in the research activity, making it clear what specific techniques may be used. If methods other than those listed in this section are deemed appropriate later, additional ethical approval for those methods will be needed.
9	This research will use a mixed methods methodology. The research will primarily focus on the subjective experiences and opinions of adolescent singers towards the use of visual feedback within vocal tuition. I aim to conduct a hermeneutical analysis of text-based qualitative data from semi-structured interviews, focus groups, observations, journals, and field notes to identify and interpret common themes within participant responses and my own reflections. Quantitative data will also be collected via questionnaires and acoustic recordings and analysis to establish and compare trends. Methods 1. <u>Literature Review</u>: I will conduct a desktop review to examine current research investigating the use of visual feedback within adolescent singing tuition. 2. <u>Questionnaires</u>: Semi-structured questionnaires will be used to assess participants' attitudes towards their vocal abilities and towards the use of technology within singing lessons before and after trials of visual feedback over a period of six weeks. The questionnaires will contain a series of closed and open questions (approximately 15-20 questions to prevent participants becoming disengaged) to make it simpler for participants to fill in and for comparative analysis. a. Quantitative data collection tools including Likert, self-efficacy, and motivation scales will be used pre- and post-trials to assess levels of participant confidence, motivation, and understanding. b. Open questions will be used to enable participants to expand on responses. 3. <u>Qualitative Semi-Structured Interviews and Focus Groups</u>: Open ended questions will be used to obtain detailed qualitative information expanding on the responses given in the questionnaires. In focus groups, the number of participants will be limited to approximately five to enable in-depth discussions while ensuring equal participation. Focus groups may enable participants to explore issues using their own vocabulary and encourage honesty. However, group interactions compromise confidentiality and I would have to guard against placing minors in situations where they may feel uncomfortable or unacceptable self-disclosures may occur. Interviews and/or focus groups will be audio- and video-recorded and transcribed. 4. <u>Recordings and Observations</u>: Sessions trialling visual feedback will be audio and video recorded to document progress over the six weeks. I will seek written permission from students/parents/guardians and the School to conduct the recordings. 5. <u>Recorded samples of participants' acoustic output</u> using spectrographic and pitch-tracking applications will be analysed to assess the efficacy and efficiency of using visual feedback

	during singing techniques over a period of 6 weeks. Recordings will be stored in password protected cloud storage and deleted at the end of the study. 6. <u>Research Diary</u>: I will maintain a research journal recording field notes, thoughts, and reflections after each trial session. This will be used to accurately record observations, progress, and incidents during sessions. This will help to triangulate data to assess whether my observations correlate with participants' experiences and highlight potential anomalies. The journal will anonymise students to avoid identification and guard their privacy. A preliminary permission letter will clearly state the purpose of the diary to the School, participants, and parents/guardians. As an insider-researcher I will need to guard closely against bias, a vested interest in results, the power relationship I have as a teacher, and difficulties remaining objective. I must be aware of the response effect, ensuring students are not led to responses that they believe to be correct or desired, whether by social cues or awareness of being involved in research. The benefits of drawing from previous teaching relationships should help elicit more truthful and valuable data. (this box should expand as you type)

10	Location of research activity Identify all locations where research activity will take place.	
11	This research will take place in two locations: Fettes College in Edinburgh, where I am a self-employed singing teacher, and within my private teaching practice, which I conduct from my home. <i>(this box should expand as you type)</i>	
12	Research activity outside of the UK If research activity will take place overseas, you are responsible for ensuring that local ethical considerations are complied with and that the relevant permissions are sought. Specify any local guidelines (e.g. from local professional associations/learned societies/universities) that exist and whether these involve any ethical stipulations beyond those usual in the UK (provide details of any licenses or permissions required). Also specify whether there are any specific ethical issues raised by the local context in which the research activity is taking place, for example, particular cultural and/or legal sensitivities or vulnerabilities of participants.	
13	N/A <i>(this box should expand as you type)</i>	

14	Use of documentation not in the public domain: Are any documents NOT publicly available?	NO	☒
		YES	☐
15	If Yes, please provide details here of how you will gain access to specific documentation that is not in the public domain and that this is in accordance with prevailing data protection law of the country in question and England and Wales. <i>(this box should expand as you type)</i>		

SECTION F: Scope of Research Activity

1	Will the research activity include:	YES	NO
2	Use of a questionnaire or similar research instrument?	☒	☐
3	Use of interviews?	☒	☐
4	Use of diaries?	☒	☐
5	Participant observation with their knowledge?	☒	☐
6	Participant observation without their knowledge?	☐	☒
7	Use of video or audio recording?	☒	☐
8	Access to personal or confidential information without the participants' specific consent?	☐	☒
9	Administration of any questions, test stimuli, presentation that may be experienced as physically, mentally or emotionally harmful / offensive?	☐	☒
10	Performance of any acts which may cause embarrassment or affect self-esteem?	☒	☐
11	Investigation of participants involved in illegal activities?	☐	☒
12	Use of procedures that involve deception?	☐	☒
13	Administration of any substance, agent, or placebo?	☐	☒
14	Working with live vertebrate animals?	☐	☒

15	Other primary data collection methods, please explain in this box For example, 'focus groups'. Please indicate the type of data collection method(s) in this box and tick the accompany box.		
16	Details of any other primary data collection method: Focus Groups. (this box should expand as you type)	☒	☐

If NO to every question, then the research activity is (ethically) low risk and **may** be exempt from **some** of the following sections (please refer to Guidance Notes).

If YES to any question, then no research activity should be undertaken until full ethical approval has been obtained.

SECTION G: Intended Participants

1	Who are the intended participants:	YES	NO
2	Students or staff at the University?	☐	☒
3	Adults (over the age of 18 and competent to give consent)?	☐	☒
4	Vulnerable adults?	☐	☒
5	Children and Young People under the age of 18? (Consent from Parent, Carer or Guardian will be required)	☒	☐
6	Prisoners?	☐	☒
7	Young offenders?	☐	☒
8	Those who could be considered to have a particularly dependent relationship with the investigator or a gatekeeper?	☐	☒
9	People engaged in illegal activities?	☐	☒
10	Others (please identify specifically any group who may be unable to give consent) please indicate here and tick the appropriate box.	☐	☒
11	Other – please indicate here: (this box should expand as you type)		

12	Participant numbers and source Provide an estimate of the expected number of participants. How will you identify participants and how will they be recruited?	
13	How many participants are expected?	I will aim to recruit a convenience sample of approximately 15-20 participants. (this box should expand as you type)
14	Who will the participants be?	The participants will be adolescent singing students from Fettes College and my private teaching practice between the ages of 10-18 years. (this box should expand as you type)
15	How will you identify the participants?	Adolescent students currently undertaking singing lessons and/or involved in school choirs or group singing activities will be asked if they would like to participate in this research. Parent/guardian consent will be obtained via written letter and email. Permission has been sought from Fettes College for research to take place. (this box should expand as you type)

16	Information for participants:	YES	NO	N/A
17	Will you describe the main research procedures to participants in advance, so that they are informed about what to expect?	☒	☐	☐
18	Will you tell participants that their participation is voluntary?	☒	☐	☐
19	Will you obtain written consent for participation?	☒	☐	☐
20	Will you explain to participants that refusal to participate in the research will not affect their treatment or education (if relevant)?	☒	☐	☐
21	If the research is observational, will you ask participants for their consent to being observed?	☒	☐	☐
22	Will you tell participants that they may withdraw from the research at any time and for any reason?	☒	☐	☐
23	With questionnaires, will you give participants the option of omitting questions they do not want to answer?	☒	☐	☐
24	Will you tell participants that their data will be treated with full confidentiality and that, if published, it will not be identifiable as theirs?	☒	☐	☐
25	Will you debrief participants at the end of their participation, in a way appropriate to the type of research undertaken?	☒	☐	☐
26	If NO to any of above questions, please give an explanation			
27	(this box should expand as you type)			

28	Information for participants:	YES	NO	N/A
29	Will participants be paid?	☐	☒	☐
30	Is specialist electrical or other equipment to be used with participants?	☒	☐	☐
31	Are there any financial or other interests to the investigator or University arising from this study?	☐	☒	☐
32	Will the research activity involve deliberately misleading participants in any way, or the partial or full concealment of the specific study aims?	☐	☒	☐
33	If YES to any question, please provide full details			
34	I will be using audio/visual recording on an ipad to record interviews, focus groups, and sessions using visual feedback. Visual feedback applications will be used during session trials. These will include spectrographic applications including VoceVista and Sing&See for PC, SpectrumView and Spectrogram Pro for iOS, which show the acoustic energy components and frequency distribution of a voice signal. Pitch-tracking applications including Singscope, Voice Analyst, VocalStave, VocalTuner, Nail the Pitch, Ella Sight Singing, and Errol Singer's Studio may also be used in trials. (this box should expand as you type)			

SECTION H: Anticipated Risks

1	Outline any anticipated risks that may adversely affect any of the participants, the researchers and/or the University, and the steps that will be taken to address them. If you have completed a full risk assessment (for example as required by a laboratory, or external research collaborator) you may append that to this form.		
2	Full risk assessment completed and appended?	Yes ☐	No ☒
3	Risks to participants		

	For example: emotional distress, financial disclosure, physical harm, transfer of personal data, sensitive organisational information	
4	Risk to Participant: Voices are very personal attributes. As such, investigations exploring the capabilities of students' singing voices could cause emotional distress or discomfort, especially during periods of adolescent vocal change. Making audio or video recordings of trial sessions and interviews or focus groups may also cause embarrassment or discomfort. Some students may feel that the approach is not beneficial to them. I will be recording the sessions, interviews, and focus groups and transcribing the data so there are risks relating to the disclosure of personal data. Noting detailed responses in my research diary could result in participants seeing my views and observations and reacting negatively, which could affect teacher/student rapport. <i>(this box should expand as you type)</i>	<i>How will you mitigate the Risk to Participant</i> Students will be made aware that they can withdraw from the research at any point if they feel uncomfortable. Participant information sheets will provide links to mental health and well-being services and pastoral staff, parents/guardians will be made aware that the research is taking place and the potential emotional risks. The objectives will be outlined clearly to ensure participants understand that this research is being undertaken to assess positive and negative feelings about the resources and that all opinions are valid and important. A code will be used for all participants and data will be stored on my password and facial recognition secured computer, of which only I have access. I intend to write sensitively so that students can read and check comments without being adversely affected. The journal will be typed and stored in password protected cloud storage. <i>(this box should expand as you type)</i>
5	If research activity may include sensitive, embarrassing or upsetting topics (e.g. sexual activity, drug use) or issues likely to disclose information requiring further action (e.g. criminal activity), give details of the procedures to deal with these issues, including any support/advice (e.g. helpline numbers) to be offered to participants. Note that where applicable, consent procedures should make it clear that if something potentially or actually illegal is discovered in the course of a project, it may need to be disclosed to the proper authorities Exploring vocal changes may necessitate discussing physical adolescent changes, which may make students/parents/guardians uncomfortable or unhappy to participate. I have investigated the current School protocols that are in place for discussing adolescent physical, emotional, and social changes and have discussed with the head of PSE provision how I can tie in with the sessions provided to students to mitigate any issues that may arise. Preliminary letters to students/parents/guardians will outline the purpose of the research and the potential raising of these areas. It will be made explicit that participation is voluntary and that participants can withdraw at any time if they feel uncomfortable. Participants will have the option of omitting questions they do not wish to answer within questionnaires, interviews, or focus groups. <i>(this box should expand as you type)</i>	
6	Risks to investigator For example: personal safety, physical harm, emotional distress, risk of accusation of harm/impropriety, conflict of interest	
	Risk to Investigator: - One-to-one teachers must always be aware of possible misunderstandings between pupils relating to occurrences in the classroom, which could affect them on a professional or personal level.	<i>How will you mitigate the Risk to Investigator:</i> - Lessons and contact with participants will occur in rooms which have open access and windows so that activity can be monitored externally within a larger music department. Parents of private pupils will be offered to observe lessons or wait in an adjoining room.

	- As an insider researcher, my working relationship with participants or those who choose not to participate may be affected post-study. - Balancing the needs of my research project alongside my regular teaching priorities with each student may be challenging for time management and organisation. <i>(this box should expand as you type)</i>	Students will be placed near the door for ease of access/exit and to prevent close contact with the principal researcher. Lesson times will be inputted into the School lesson booking system and participants' tutors will be made aware of the times. - Students will be assured that participation is voluntary and their choice to participate or not will in no way affect the teacher/student relationship. Participants will also be made aware that they can withdraw at any time. It will be outlined that all feedback will be valued, and my email will be given to parents/guardians if they wish for verbal feedback or to discuss further post-study. - Participants and parents/guardians/Fettes college will be assured that the research should add value to their lessons but will be structured to not take away time from their current singing goals. Lessons will be planned carefully to ensure time management is well-balanced for both myself and my participants. <i>(this box should expand as you type)</i>		
7	University/institutional risks For example: adverse publicity, financial loss, data protection			
	Risk to University: The risk to the university would be data protection. <i>(this box should expand as you type)</i>	How will you mitigate the Risk to University: Data will be coded to ensure anonymity and securely stored on my computer, which is password and facial recognition protected and only accessed by myself. All data will be destroyed at the end of the project. <i>(this box should expand as you type)</i>		
8	Disclosure and Barring Service			
9	If the research activity involves children or vulnerable adults, a Disclosure and Barring Service (DBS) certificate must be obtained before any contact with such participants.	YES	NO	N/A
10	Does your research require you to hold a current DBS Certificate?	☒	☐	☐

SECTION I: Feedback, Consent and Confidentiality

1	Feedback What de-briefing and feedback will be provided to participants, how will this be done and when?
	Within my introductory email and letter, it will be explained that verbal feedback on outcomes will be provided on request. My Fettes College email address will also be provided to parents/guardians, staff, and pupils if they wish to contact me for further details or to see the final report. <i>(this box should expand as you type)</i>
2	Informed consent Describe the arrangements to inform potential participants, before providing consent, of what is involved in participating. Describe the arrangements for participants to provide full consent before

	data collection begins. If gaining consent in this way is inappropriate, explain how consent will be obtained and recorded in accordance with prevailing data protection legislation.
	- The purpose of the research will be explained to participants and parents/guardians in an introductory email/letter so that they are well informed of the time involvement, what information I am seeking and its purpose, and what their role will be. - Parents/guardians will be sent a permission letter seeking signed consent explaining the nature of the study and how it will be conducted. Additional verbal consent will be sought from participants. It will be indicated clearly that participation is voluntary. - Participants and parents/guardians will then be asked to sign an appropriate consent form before research commences and before undertaking questionnaires. Participation in interviews will be voluntary and informed consent would also be obtained from participants' parents/guardians before interviews commence. - Permission for research to take place has been sought from Fettes College directors of music of both senior and preparatory schools. (this box should expand as you type)
3	Confidentiality / Anonymity Set out how anonymity of participants and confidentiality will be ensured in any outputs. If anonymity is not being offered, explain why this is the case.
	- All data will be disposed of when the study is complete. - The names of students and my School institution will not be recorded in my report to ensure confidentiality and anonymity. - Codes (student A, B, C, etc) will be used to identify participants, the key to which will be stored in password protected cloud storage, which will not be shared. - Names of participants or my School will not be included in any publications without explicit permission. (this box should expand as you type)

SECTION J: Data Protection and Storage

In completing this section refer to the University's Research Data Management Policy and the extensive resources on the University's Research Data Management web pages (<http://uwtsd.ac.uk/library/research-data-management/>).

1	Does the research activity involve personal data (as defined by the General Data Protection Regulation 2016 "GDPR" and the Data Protection Act 2018 "DPA")?	YES	NO
	<i>"Personal data" means any information relating to an identified or identifiable natural person ("data subject"). An identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person.</i>	☒	☐
2	If YES, provide a description of the data and explain why this data needs to be collected:		
	- Personal data that will be collected includes names, addresses and email addresses for sending out information concerning the study to participants and parents/guardians, and signed consent forms. - Audio/visual recordings will be made and transcribed. - Students will be allocated a code for anonymity. A list of names and the corresponding code will be stored in a password protected document and password protected cloud storage, which will not be shared. (this box should expand as you type)		
3	Does it involve special category data (as defined by the GDPR)?	YES	NO
	<i>"Special category data" means sensitive personal data consisting of information as to the data subjects' –</i>		

	(a) racial or ethnic origin, (b) political opinions, (c) religious beliefs or other beliefs of a similar nature, (d) membership of a trade union (within the meaning of the Trade Union and Labour Relations (Consolidation) Act 1992), (e) physical or mental health or condition, (f) sexual life, (g) genetics, (h) biometric data (as used for ID purposes).	☐	☒
4	If YES, provide a description of the special category data and explain why this data needs to be collected: N/A <i>(this box should expand as you type)</i>		
5	Will the research activity involve storing personal data and/or special category data on one of the following:	YES	NO
6	Manual files (i.e. in paper form)?	☐	☒
7	University computers?	☐	☒
8	Private company computers?	☐	☒
9	Home or other personal computers?	☒	☐
10	Laptop computers/ CDs/ Portable disk-drives/ memory sticks?	☒	☐
11	"Cloud" storage or websites?	☒	☐
12	Other – specify:	☐	☒
13	For all stored data, explain the measures in place to ensure the security of the data collected, data confidentiality, including details of password protection, encryption, anonymisation and pseudonymisation: - All data will be encrypted and kept in password protected, two factor authenticated cloud storage on my School's Office 365 system which will not be shared. Access to this through my personal computer is also protected by facial recognition and passcodes. - Audio/visual data will be transcribed and shown to participants to check accuracy of reporting. - Any USB sticks used to store or transfer data will be password protected. - All participants will be given a unique identifier to ensure confidentiality and this list will be kept securely in the password protected folder. - This study will use parent/guardian email and address information collected through a secure isams School account, which is password protected and secured through two factor authentication in accordance with school policy. - Participant's names will be anonymised to protect identity and ensure confidentiality. <i>(this box should expand as you type)</i>		
14	All Data Storage		
15	Will the research activity involve any of the following activities:	YES	NO
16	Electronic transfer of data in any form?	☒	☐
17	Sharing of data with others at the University?	☒	☐
18	Sharing of data with other organisations?	☐	☒
19	Export of data outside the European Union or importing of data from outside the UK?	☐	☒
20	Use of personal addresses, postcodes, faxes, emails, or telephone numbers?	☒	☐

21	Publication of data that might allow identification of individuals?	☐	☒
22	Use of data management system?	☐	☒
23	Data archiving?	☐	☒
24	If YES to any question, please provide full details, explaining how this will be conducted in accordance with the GDPR and DPA (and/or any international equivalent):		
	- All data will be encrypted and kept in password protected, two factor authenticated cloud storage on my School's Office 365 system which will not be shared. Access to this through my personal computer is also protected by facial recognition and passwords. - Any USB sticks used to store or transfer data will be password protected. - All data transfers will be encrypted and password protected. - All participants will be given a unique identifier to ensure confidentiality and this list will be kept securely in the password protected folder. The data will be stored until the completion of the project and then deleted. - In accordance with the DPA2018, participants will have the right to ask to see what data is held relating to them, and this data will be deleted immediately if the participant requests this, in which case the data will not be used in the project. - This study will use parent/guardian email and address information collected through a secure isams School account, which is password protected and secured through two factor authentication in accordance with school policy. - Participant's names will be anonymised to protect identity and ensure confidentiality. <i>(this box should expand as you type)</i>		
25	List all who will have access to the data generated by the research activity:		
	The principal researcher only. Due to my role as a self-employed teacher, there is no conflict with any other agency or organisation. <i>(this box should expand as you type)</i>		
26	List who will have control of, and act as custodian(s) for, data generated by the research activity:		
	The principal researcher only. <i>(this box should expand as you type)</i>		
27	Give details of data storage arrangements, including security measures in place to protect the data, where data will be stored, how long for, and in what form. Will data be archived – if so how and if not why not.		
	- All data will be encrypted and kept in password protected, two factor authenticated cloud storage on my School's Office 365 system which will not be shared. Access to this through my personal computer is also protected by facial recognition and passwords. - Any USB sticks used to store or transfer data will be password protected and will be reformatted at the end of the project to destroy the data. The data will be stored until the completion of the project and then deleted. - Data will be anonymous and used only for the research purposes outlined. All data will be erased/ destroyed once analyses are complete. <i>(this box should expand as you type)</i>		
28	Please indicate if your data will be stored in the UWTSD Research Data Repository (see https://researchdata.uwtsd.ac.uk/). If so please explain. <i>(Most relevant to academic staff)</i>		
	N/A <i>(this box should expand as you type)</i>		
29	Confirm that you have read the UWTSD guidance on data management (see https://www.uwtsd.ac.uk/library/research-data-management/)	YES NO	☒ ☐

30	Confirm that you are aware that you need to keep all data until after your research has completed or the end of your funding	YES	☒
		NO	☐

SECTION K: Declaration

31	The information which I have provided is correct and complete to the best of my knowledge. I have attempted to identify any risks and issues related to the research activity and acknowledge my obligations and the rights of the participants. In submitting this application I hereby confirm that I undertake to ensure that the above named research activity will meet the University's Research Ethics and Integrity Code of Practice which is published on the website: https://www.uwtsd.ac.uk/research/research-ethics/		
	Signature of applicant:	<i>E. Watson</i>	Date: 07/06/2023

For STUDENT Submissions:

32	Director of Studies/Supervisor:	Laura James	Date: 3.7.23
33	Signature:	<i>Laura James</i>	

For STAFF Submissions:

34	Academic Director/ Assistant Dean:		Date:
35	Signature:		

Checklist: Please complete the checklist below to ensure that you have completed the form according to the guidelines and attached any required documentation:

☒	I have read the guidance notes supplied before completing the form.
☒	I have completed ALL RELEVANT sections of the form in full.
☒	I confirm that the research activity has received approval in principle
☒	I have attached a copy of final/interim approval from external organisation (where appropriate)
☐	I have attached a full risk assessment (and have NOT completed Section H of this form) (where appropriate) ONLY TICK IF YOU HAVE ATTACHED A FULL RISK ASSESSMENT
☒	I understand that it is my responsibility to ensure that the above-named research activity will meet the University's Research Ethics and Integrity Code of Practice.
☒	I understand that before commencing data collection all documents aimed at respondents (including information sheets, consent forms, questionnaires, interview schedules etc.) must be confirmed by the DoS/Supervisor, module tutor or Academic Director.
☒	I have deleted the guidance notes before submitting the PG2 for consideration

RESEARCH STUDENTS AND STAFF ONLY

All communications relating to this application during its processing must be in writing and emailed to pgresearch@uwtsd.ac.uk, with the title 'Ethical Approval' followed by your name.

Appendix 5: Parent Information Sheet

Research Information Sheet

Technology in the Singing Studio:

A Pilot Action Research Study Investigating Adolescent Singers' Experiences of Using Real-Time Visual Feedback Within Singing Tuition.

Researcher: Elizabeth Watson

I would like to invite your child to take part in my current research investigating adolescent singers' experiences of using real-time visual feedback applications within singing tuition. This research is being undertaken as part of my Master's degree in professional practice (vocal pedagogy) through the University of Wales Trinity St. David and the Voice Study Centre.

All my current singing students in the second form will be invited to participate.

This research is voluntary; joining the study is entirely up to you and your child. Decisions concerning participation will in no way affect your child's current singing tuition.

About the Research

Rapid advancements in mobile technology have revolutionised many areas of our lives. Despite significant advances in applications designed to provide singers with accurate, objective real-time visual feedback of their vocal output to improve technique and performance, such technology is not commonly used in singing lessons. The purpose of this study is to work collaboratively with participating students to ascertain whether the integration of real-time visual feedback within singing lessons may be beneficial to them.

The research will consist of:

- A trialling stage: Real-time visual feedback will be integrated within five of your child's normal timetabled singing lessons during September and October, running alongside their current tuition.
- A questionnaire: Participants will then be asked to complete an online questionnaire at home over the October half term holiday. The questionnaire will consist of questions relating to their experiences and views towards using real-time visual feedback during the trial period.
- A group discussion: Participants will then be invited to participate in a group discussion with other participants from their year group to expand on questionnaire responses. This will happen in addition to their normal timetabled lessons. Tutors will be contacted to ensure we find a mutually convenient time outside of students' academic and other co-curricular priorities.

During the trialling stages, sessions will be audio/video recorded, with observations and student responses documented in a research journal.

The group discussion will be audio and video recorded to enable transcription for data analysis. The recordings will only be viewed by me. They will be stored securely in two-step verification password protected accounts and will be deleted following project completion in July 2024.

Benefits and Risks

This research is being undertaken to ascertain whether the use of real-time visual feedback may be beneficial to adolescent singers. All opinions, positive and negative, will be welcomed without consequences. While it is hoped that the research process will be a positive and interesting experience for participants, analysing vocal performances using visual feedback and discussing opinions in a recorded group session could cause participants to become self-conscious or embarrassed. Due to the voluntary nature of this research, participants may withdraw from the process or omit questions at any point if they feel uncomfortable. Pastoral staff at School will be made aware of the research and participants will be referred to them if there are any concerns regarding their wellbeing during the project. Please also see the School mental health and wellbeing support pages if you have any concerns at home: [https://www. \[REDACTED\] /about-us/policies](https://www. [REDACTED] /about-us/policies).

You may also find the following website useful for links to helplines:

<https://www.healthyyoungmindsinherts.org.uk/publications/2020/apr/signposting-guide-youngpeople>

Confidentiality

Your child's identity will remain anonymous during reports on the results of this research. Code names will be used throughout the report and any details of responses which may reveal their identity or the identity of people they speak about will be disguised. All data collected will be treated confidentially and stored securely in password protected accounts in accordance with the University of Wales Trinity St. David code of ethics.

Review

This study has been reviewed and given favourable opinion by the University of Wales Trinity St. David Research Ethics Committee and permission to conduct the study has been granted by the Directors of Music of the Preparatory and Senior schools.

Feedback on outcomes of the study will be provided on request following completion of the study in March 2024.

Contact

If you or your child have any questions about participating in this study, please contact me via email at l.watson@fettes.com or by phone on 07900 623330.

Please feel free to talk to others about this research.

If you are happy for your child to participate and your child is willing to do so, please complete the attached consent form by typing your and your child's names as a digital signature and email back to me by the 4th September 2023.

Many thanks in advance for your time and responses,
Lizzie Watson

Appendix 6: Participant Information Sheet

Technology in Singing Lessons - Research!

What is the research about?

I am currently researching the use of technology in singing lessons.
I am really interested to know your thoughts on using iPad and computer applications that display your voice in real-time while you are singing.
To do this, I'd like to invite you to be part of my research!

What will I be asked to do?

STEP 1: Try things out!

First, we'll try out some applications for a short time during five of your usual singing lessons. We'll use them during some vocal exercises and within parts of your songs.

STEP 2: Answer a questionnaire.

Then I'll ask you to fill out a questionnaire about your thoughts on using the applications in your lessons; what was good and what was not good!

STEP 3: Take part in a group discussion.

We'll then discuss with other singing students from your year group what you all thought about using the technology.

Are there any benefits or risks to taking part?

You may find taking part in the research beneficial for your singing, but the most important thing is that you honestly tell me what you think is good or bad about using the technology.
Looking at your vocal sound on a screen may be a little daunting. If you feel at all uncomfortable during any stage of the research or answering any questions, you can choose not to answer or you can stop the research at any time.

Do I have to take part?

It's completely up to you to choose if you would like to take part and it's OK to say no!
You do not have to explain why you do not wish to take part and it will not affect your regular singing lessons in any way.
Think about it at home and talk to your parents and other students before you decide.

What happens when the research finishes?

The results of the study will be written up so that people can read about it, but any information about you will be kept private and confidential.

Come and find me in School or email me at any time if you have any questions!

Mrs Watson: l.watson@fettes.com

Appendix 7: Parental Consent Form

Below is an example consent form.

Signed consent forms for each participant (with identifying information redacted) can be found at the following links:

[P1F - Signed Parental Consent Form August 2023.pdf](#)

[P2F - Signed Parental Consent Form August 2023.pdf](#)

[P3F - Signed Parental Consent Form August 2023.pdf](#)

[P4M - Signed Parental Consent Form August 2023.pdf](#)

[P5M - Signed Parental Consent Form August 2023.pdf](#)

[P6M - Signed Parental Consent Form August 2023.pdf](#)

Consent Form

Technology in the Singing Studio:
A Pilot Action Research Study Investigating Adolescent Singers' Experiences of Using Real-Time Visual Feedback Within Singing Tuition.

- I _____ voluntarily agree for my child to participate in the above titled research.
- I confirm that I have had the purpose and nature of the study explained to me in writing. I have had the opportunity to consider the information and ask questions about the study.
- I understand that my child's participation is voluntary and that they are free to withdraw or omit questions at any time without consequences.
- I understand that participation involves trials of visual feedback during five of my child's regular singing lessons, completion of one questionnaire, and participation in a group discussion.
- I agree to my child being audio and video recorded during the sessions and group discussion. The recording will only be viewed by the researcher and will be deleted after project completion in July 2024.
- I understand that I can withdraw permission to use data from my child's questionnaires and/or group discussion within two weeks after completion, in which case the material will be deleted.
- I understand that all information my child provides will be treated confidentially and stored securely.
- I understand that my child may not benefit directly from participating in this research.
- I understand that in any report on the results of this research, my child's identity will remain anonymous.
- I understand that disguised extracts from my child's responses may be quoted in a written report, project presentation, and possible future published papers or conferences.
- I understand that if I inform the researcher that my child or someone else is at risk of harm, they may have to report this to the relevant authorities. They will discuss this with me first but may be required to report with or without my permission.
- I understand that signed consent forms, documented responses, and recordings will be retained on a password protected laptop until July 2024.
- I understand that a transcript of my child's responses in which all identifying information has been removed will be retained for two years, until July 2026.
- I understand that under the freedom of information legislation I am entitled to access the information my child has provided at any time while it is in storage as specified above.
- I understand that I am free to contact any of the people involved in the research to seek further clarification and information.

Child's Name: _____

Parent/Guardian Name: _____

Signature: _____ Date: _____

Researcher:

Elizabeth Watson
BA (Hons), cert SLT.
l.watson@fettes.com
07900 623330

Signature: _____ Date: _____

When completed: 1 for participant/parent/guardian; 1 for researcher site file

Appendix 8: Research Diary and Coding

The research diary is compiled in six documents, with an individual document for each participant.

Please follow the links below to view each document:

[P1F Research Diary.pdf](#)

[P2F Research Diary.pdf](#)

[P3F Research Diary.pdf](#)

[P4M Research Diary.pdf](#)

[P5M Research Diary.pdf](#)

[P6M Research Diary.pdf](#)

Appendix 9: Attitudinal Survey

Working with Visual Feedback Technology in Singing Lessons

Thank you so much for helping me trial visual feedback applications during your singing lessons over the last five weeks!

This questionnaire will now ask you about your feelings and views towards using the visual feedback technology in your lessons.

The questionnaire is split into two short sections:

The first section asks you about your experiences while using the visual feedback technology.

The second section asks you about your feelings towards using the visual feedback technology in the future.

* Required

SECTION ONE:

Your opinions and feelings towards using the visual feedback technology in your singing lessons.

1

Below is a list of responses that singers have had towards using visual feedback technology in singing lessons.

Some singers agree with these statements, and others do not.

Please indicate what you think by selecting how much you agree or disagree with the statements: *

	Strongly Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree
I enjoyed working with the visual feedback.	☐	☐	☐	☐	☐
I understood what the visual feedback was showing me about my singing.	☐	☐	☐	☐	☐
Using the visual feedback took up too much of the lesson time.	☐	☐	☐	☐	☐
I felt I did well in the visual feedback exercises.	☐	☐	☐	☐	☐
It was interesting to look at my sound using the visual feedback.	☐	☐	☐	☐	☐
I found it distracting to watch the visual feedback while I was singing.	☐	☐	☐	☐	☐

3 of 10

I felt confident during the visual feedback exercises.

☐☐☐☐☐

Watching the visual feedback helped me to focus on my singing during the exercises.

☐☐☐☐☐

I felt anxious about making mistakes during the visual feedback exercises.

☐☐☐☐☐

I found it useful to look back at the visual feedback after I had sung the exercise.

☐☐☐☐☐

I felt that time flew by when I was using the visual feedback.

☐☐☐☐☐

I found working with the visual feedback boring.

☐☐☐☐☐

I felt my singing improved while using the visual feedback.

☐☐☐☐☐

I learnt something new about my voice while using the visual

☐☐☐☐☐

2

Some singers find using visual feedback helpful for improving their singing skills, and others do not.

Please indicate how helpful you found the visual feedback by selecting how much you agree or disagree with the following statements:

I found it helpful to use the visual feedback during...

*

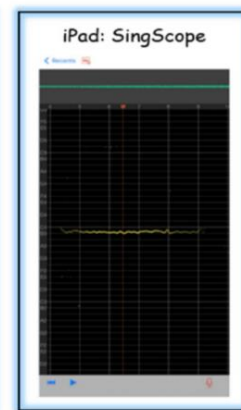
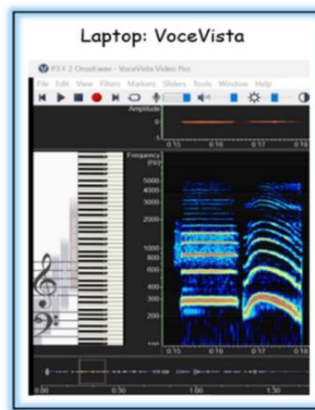
	Strongly Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree
... the onset exercises. <i>(the way you start a note: breathy, hard, or smooth)</i>	☐	☐	☐	☐	☐
... the loud and soft exercises. <i>(getting louder and softer on one note)</i>	☐	☐	☐	☐	☐
... my pieces.	☐	☐	☐	☐	☐

3

Over the last five weeks, we used the laptop application 'VoceVista' and the iPad application 'SingScope'.

Overall, which application do you think was the...

*



	Laptop: VoceVista	iPad: SingScope
... easiest to use?	☐	☐
... simplest to understand?	☐	☐
... most enjoyable to use?	☐	☐
... most helpful for working on onsets?	☐	☐
... most helpful for working on louds and softs?	☐	☐
... most helpful when working on your pieces?	☐	☐
<u>Overall, which did you like using the most?</u>	☐	☐

4

Think about a time over the last five lessons when you felt you performed a vocal exercise well.

How did seeing the result of that exercise on the screen make you feel? *

5

Now think about a time when you found an exercise challenging to sing.

How did seeing the result of that exercise on the screen make you feel? *

6

What did you like BEST about using the visual feedback technology? *

7

What did you like LEAST about using the visual feedback technology? *

SECTION TWO:

Your feelings towards using the visual feedback technology in the future.

8

Please indicate your feelings towards using visual feedback technology in your future singing lessons by selecting how much you agree or disagree with the following statement: *

I would like to use the visual feedback in my future singing lessons.

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

☐☐☐☐☐

9

How often do you think you would like to use the visual feedback in your future singing lessons? *

- ☐ Every Lesson
- ☐ Once a Month
- ☐ Once a Term
- ☐ Once a Year
- ☐ Never
- ☐ Other

Please indicate your feelings towards using visual feedback technology in the future by selecting how much you agree or disagree with the following statements:

In my future singing lessons, I would like to use the visual feedback... *

	Strongly Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree
... within my vocal exercises.	☐	☐	☐	☐	☐
... within my pieces.	☐	☐	☐	☐	☐
... to observe my singing progress over time.	☐	☐	☐	☐	☐

Appendix 10: Open Question Survey Responses and Coding

CODING - Magnitude - o Positive / Negative / Neutral - o Intensity – Strong/Moderate/No opinion - o Often/somewhat/not at all - Descriptive – Topic code - In Vivo – “own language” - Emotion – feelings experienced/recalled/inferred by researcher – combination in vivo and emotional state. - Value – value, attitude (way we think/feel about self/person/thing), belief.			
Question Four: Think about a time over the last five lessons when you felt you performed a vocal exercise well. How did seeing the result of that exercise on the screen make you feel?			
Participant	Participant Written Response	In Vivo Coding	Descriptive Thematic / Topic Code
P1F	I really enjoyed doing the onsets and it was very helpful to have all the specific information on the screen.	“enjoyed doing onsets” “very helpful” “specific information”	- Enjoyment – positive emotion - Helpful – Specific information
P2F	When I was trying to make it as smooth as possible and I got it almost perfect I was very proud also because I beat Mrs Watson. 😊	“I got it almost perfect” “very PROUD” “beat Mrs Watson”	- Task Achievement – ability to <u>see result</u> – self judgement. - Self efficacy - Proud – positive emotion - Competition – goal/turned into game
P3F	Seeing the results on the screen made me happy especially because I managed to do it after some attempts.	“seeing the results” “happy” “managed to do it”	- Task Achievement – ability to <u>see result</u> – self judgement - Self-efficacy . - Happy – positive emotion
P4M	I didn't feel much but it was cool to notice how breathy or how loud / quiet the notes were!	“didn't feel much” “cool” “notice how breathy/loud/quiet”	- Enhanced awareness of voice characteristics – “notice” Cool - o interesting? - Useful characteristics? - o aid understanding? - ability to SEE the result.

P5M	Happy and proud.	"happy" / "proud"	- Proud of achievement. - Happy - positive emotion
P6M	Quite happy because I can see how much my voice has changed.	"Quite happy" "See how much my voice has changed"	- Enhanced awareness of voice. - See development. - Happy – positive emotion. - o Enhance <i>understanding</i>? - o Confirmatory?
Question Five: Now think about a time when you found an exercise challenging to sing. How did seeing the result of that exercise on the screen make you feel?			
P1F	When we were doing louds and softs it helped me improve by seeing how much breath and muscle I was using.	"helped me improve" "seeing how much"	- Helped to improve – result based. - Achievement – ability to see result - Enhance awareness of voice – seeing physiological function - Improve understanding.
P2F	Trying to make it not very breathy. I found it very difficult to make it crystal clear.	"found it very difficult"	- Target = not achieved = no emotion stated. - "very difficult" to achieve something on the screen that might not happen. <i>Reflection</i> - o Did the use of the feedback make this goal more challenging than it would be with teacher feedback? - o The objective nature making it harder because trying to achieve a 'perfect' result. - o Whereas with teacher feedback alone, you can alter the perception. - o TOO specific? - o Important to state the natural diversity in voice, setting appropriate/realistic targets.
P3F	Seeing the results on the screen made me want to retry it until I got better.	"seeing the results" "made me want to retry" "until I got better"	- Motivation - Target = seeing the result - Seeking improvement. - Determination.
P4M	It felt challenging of course but it wasn't so hard once I'd done it a few times!	"challenging" "wasn't so hard" after repeats.	- Improvement after repeats = improved understanding leading to improved result? - motivation to redo. - Perseverance? - o Could he see that it was getting easier to achieve? - Challenging but not negative comment.

P5M	A bit disappointed as it felt like I had done it right but the screen said I didn't.	"bit disappointed" "felt like I had done it right" "screen said I didn't"	-Difference between intrinsic perception - "felt" achieved - and objective result. -Aid understanding? Aid vocal awareness long-term? <i>Reflection</i> - Objective reality – disappointment? - Not able as teacher to direct the response (control over the response) as they can see the reality.
P6M	Good.		Positive response – improved positivity towards singing goals? <i>Reflection</i> - Short response – lack of understanding of question? - Issue with open question – not prompting full response. - To follow up in FG.
Question Six: What did you like BEST about using the visual feedback technology?			
P1F	It helped to see what's actually going on with your vocals and helps to show what you can improve on.	"helped" "see what's actually going on" "show what you can improve"	- Enhanced vocal awareness - Goal = improvement – Value.
P2F	The wobbly lines made me realise how smooth it has to be!	"made me realise"	-Enhanced vocal awareness -Goal setting/Task clarification.
P3F	I liked how clear it was.	"I like" "clear"	-Clarity of the screen – aiding understanding? -Simple to understand goals/targets?
P4M	THE SINGING TAILS!		-Goal achievement. - Pleased with outcome or just enjoyed the visual? - Knew tails meant he had done the exercise well = achievement.
P5M	Singing through a straw!		Novel task – enjoyment.
P6M	The amount of apps that are there for you to use	"amount of apps"	-Variety of technology. <i>Reflection</i> - Novelty – spark interest? - Accessibility?

Question Seven: What did you like LEAST about using the visual feedback technology?			
P1F	That it took some time off my lessons.		- Took up lesson time
P2F	When I was under/over pitch and I only got it on the 3/4 try!	"only got it on the 3/4 try"	- Goal/target – challenging to achieve.
P3F	It took up a bit of time in the lesson.		- Took up lesson time.
P4M	probably the fact that i didn't get a full lesson time on my German song!		- Took up lesson time.
P5M	When we were doing the really challenging onsets as it made me feel a bit demoralised as I thought it sounded great.	"demoralised" "I thought it sounded great"	-Difference between intrinsic perception and objective result. <i>Reflection</i> ○ Objective reality – demoralised? ○ Not able as teacher to direct the response (control over the response) as they can see the reality. ○ Will this aid his understanding/vocal awareness longer term or is it negative experience?
P6M	Struggling with it.	"struggling"	<i>Reflection</i> ○ Short response – Issue with open question – not prompting full response. ○ Struggling with what? ○ Goal achievement? ○ Challenging exercise? ○ Tech itself? ○ Understanding? - TO ASK IN FG
Question Eight: How often would you like to use the visual feedback in the future.			
	○ Option response: OTHER		
P5M	Every second lesson so we would have a piece and practice lesson then a vocal workshop lesson.		

Appendix 11: Focus Group Transcription and Coding.

Please follow the link below to take you to the focus group transcript and coding:

[Appendix 11 - FOCUS GROUP transcription - CODING.pdf](#)

Appendix 12: Research Diary and Focus Group Thematic Data Analysis Tables

Please follow the link below to take you to the research diary and focus group thematic data analysis tables:

[Appendix 12 - Research Diary and Focus Group Thematic Analysis.xlsx](#)

Appendix 13: Compiled Survey Responses: Quantitative Data

Response Options

5: Strongly Agree	4: Agree	3: Neither Agree nor Disagree	2: Disagree	1: Strongly Disagree
--	---------------------------	--	------------------------------	---

Question no.	Statement/Question	Participants					
		P1F	P2F	P3F	P4M	P5M	P6M
SECTION ONE							
Q1	a) I enjoyed working with the VFT.	5	4	5	5	5	5
	b) I understood what the VFT was showing me.	5	5	5	5	5	4
	c) Using the VFT took up too much of the lesson time. (N)	4	5	3	3	3	3
	d) I felt I did well in the VFT exercises.	5	4	4	4	5	4
	e) It was interesting to look at my sound using the VFT.	5	5	5	5	5	5
	f) I found it distracting to watch the VFT while I was singing. (N)	2	2	4	2	3	2
	g) I felt confident during the VFT exercises.	4	4	4	4	5	3
	h) Watching the VFT helped me to focus on my singing.	5	2	4	3	5	4
	i) I felt anxious about making mistakes when using the VFT. (N)	1	2	3	1	4	3
	j) I found it useful to look back at the VFT after I had sung.	5	4	5	5	5	4
	k) I felt that time flew by when I was using the VFT.	5	1	5	3	5	5
	l) I found working with the VFT boring. (N)	2	5	1	1	2	2
	m) I felt my singing improved while using the VFT.	5	5	5	3	5	4
	n) I learnt something new about my voice while using the VFT.	5	5	5	5	5	5
	(N) = negative statement prompt						
Q2	I found it helpful to use the VFT during...						
	... the onset exercises	5	5	5	5	5	5

	... the messa di voce exercises	5	5	5	5	5	4
	... my pieces	5	3	4	5	4	3

Q3	Which application was the...						
VoceVista	... easiest to use?	SS	VV	SS	VV	VV	SS
SingScope	... simplest to understand?	SS	SS	SS	SS	SS	SS
	... most enjoyable to use?	SS	VV	VV	VV	VV	VV
	... most helpful for working on onset exercises?	VV	VV	VV	VV	VV	VV
	... most helpful for working on messa di voce exercises?	VV	VV	VV	VV	VV	VV
	... most useful for working on your pieces?	VV	VV	VV	VV	VV	VV
	Overall, which did you like using the most?	SS	VV	VV	VV	VV	VV

SECTION TWO

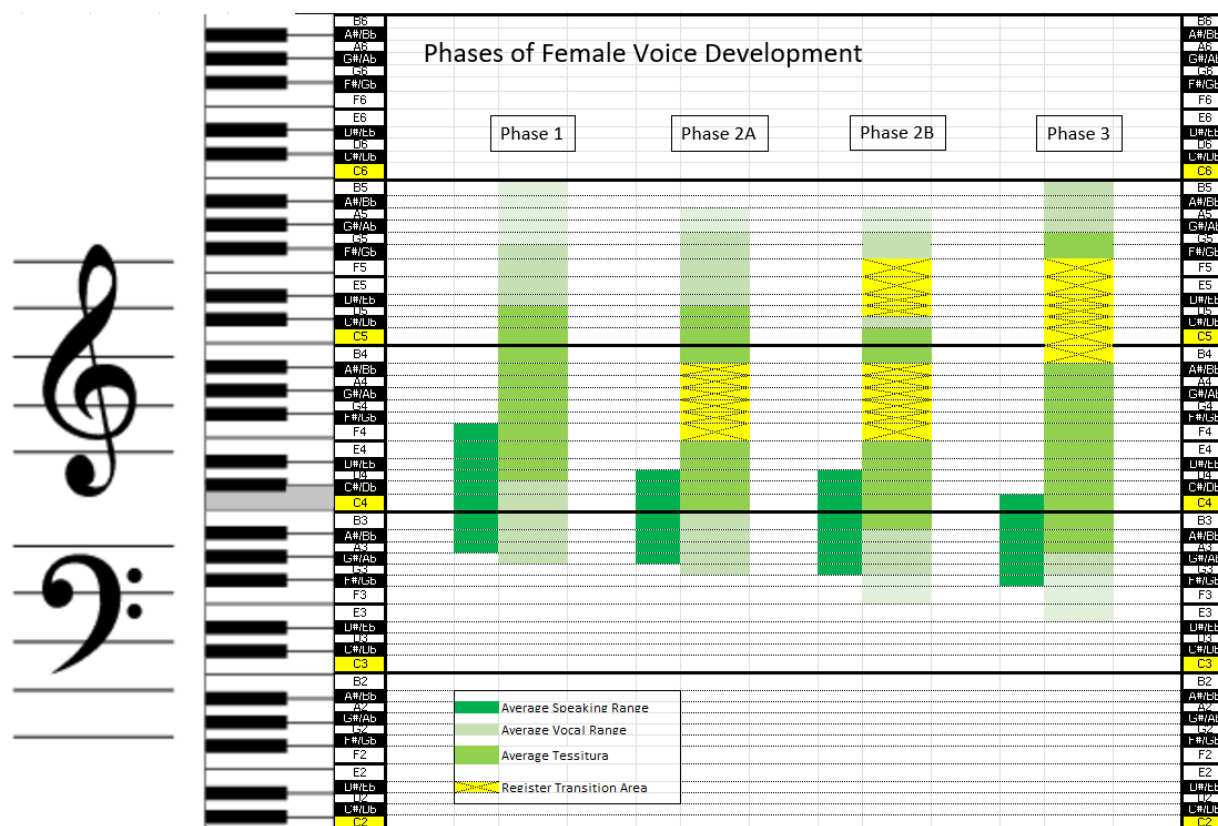
Q8	I would like to use the VFT in my future singing lessons.	5	4	5	5	5	4
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Q9	How often would you like to use VFT in your future singing lessons?	Once a Month	Once a Month	Once a Month	Once a Month	Other	Once a Month
Every Lesson							
Once a Month							
Once a Term							
Once a Year							
Never							
Other							

Q10	In my future singing lessons, I would like to use the VFT...						
	... within my vocal exercises.	5	2	5	5	5	4
	... within my pieces.	5	1	4	4	5	4
	... to observe my singing progress over time.	5	4	5	5	5	5
	... within my individual practice.	3	2	4	3	5	3

Appendix 14: Voice Charting Resources

Female Adolescent Voice Chart



Voice Charting Exercises (adapted from Gackle, 2011)

Average Speaking Pitch

- Ask the singer to slowly count backwards from 10 with a continuous, projected tone (approximately 92 BPM).
- Match the average pitch heard on the keyboard (or use voice analyst software to identify the pitch).

Vocal Range

- Starting five tones above the average speaking pitch, ask the singer to vocalise a descending five-note scale on an /a/ vowel (sol, fa, mi, re, do), moving steadily down the range in semitones with each repeat and listening for continued ease of production.
- Notice when the timbre changes or strain comes into the tone.
- Note the lowest singing pitch as the "lowest terminal pitch".
- Return to the starting pitch and repeat the process, moving upwards in semitones to the highest produced singing pitch.
- Notate this as the "upper terminal pitch"

Tessitura (comfortable singing range)

- Using an /u/ vowel, have the singer crescendo on specific notes within the range (starting in the middle of the vocal range), listening for colour, ease of production, clarity, volume, etc.
- The tessitura will be where the most clear, unforced, comfortably produced, resonant sound is created.
- Ask the singer to sing a familiar song such as Happy Birthday in various keys (F, A, D majors)
- Note the span of notes where the greatest ease of production, clarity and volume occurs.

Register Transitions

- Ask the singer to sing an ascending major scale starting on A3 or Ab3.
- Listen carefully for changes in timbre around the interval F4 – A4