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The Effectiveness of Song and Music as Pedagogical Tools in Elementary School Science Lessons: A Systematic Review of Literature

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Abstract

This literature review offers compelling evidence for the significant role music and song can play in cultivating student engagement in elementary school science lessons. With students disengaging from science education, there is concern about the lack of necessary scientific literacy skills required in today's world. To explore whether music and song could be used engage students in science we conducted a thorough search of composite education databases for relevant scholarly articles published 1993-2021. Synthesis of the resulting 26 articles revealed four themes: the common goal of engagement, evidence of learning improvement, broad utility of music and songs as pedagogical tools, and limited long-term studies. While acknowledging the limited evidence presented in these articles, we emphasize that incorporating music and song into science lessons not only enriches the educational environment but also contributes to an arts-infused education known to enhance student performance across a wide range of curriculum domains. We recommend further research with a particular focus on investigating the impact of music and song on science engagement and learning over the long-term in elementary school science classrooms.

Introduction

There is widespread concern that students are not engaged with school science (Goodrum et al., 2001; Tytler, 2008) and science has long been recognized as a compulsory component of school education around the world (Anderson & Li, 2020). However, in many nations, too few students are choosing to continue with post-compulsory science and student engagement with the subject is seen as a key factor in that choice (Palmer et al., 2017; Tytler et al., 2008). School education plays a critical role in preparing students for an uncertain world where jobs are changing, information is complex, and skills relating to science are increasingly important (World Economic Forum, 2020). Too few students choosing science negatively impacts the supply of vital science skills necessary in our modern world.

Participation in science at school is vital to produce the scientifically literate individuals needed to meet projected demands for science, technology, engineering, and mathematics (STEM) skills that are required for our modern society to prosper (Marginson et al., 2013; National Science and Technology Council, 2018). Since the 1990s, fostering school students' interest in the multidisciplinary area of STEM has gained popularity and is now seen as a major driver of national development and wellbeing with governments around the world focusing on enhancing these capabilities (Palmer, 2020; Tytler, 2020).

Similar to engagement with science, engagement with the arts brings benefits to young people's development and higher cognitive functioning across multiple disciplines (Chapman, 2015). Even from a young age, children's solitary music-making such as singing to oneself provides opportunities for self-expression, emotional regulation, and

experimentation with the composition of sound and meaning (Barrett, 2009, 2016). This musical play can be integrated with other creative forms, such as storytelling, to create narrative works that develop multiple skills (Barrett, 2006). The benefits of practicing and studying music can include improved memory, enhanced interpersonal sensitivity, and greater neuroplasticity (Collins, 2014). Each of these attributes is invaluable to the individual, and social cohesion and prosperity to the wider world.

Elementary (primary) school is a critical time during which children can develop lifelong interests (Krapp & Prenzel, 2011). Although young children show particular interest in school science, many become disinterested at the end of elementary education (Tytler et al., 2008). Elementary school teachers play a pivotal role in developing children's engagement with, and interest in science (Fitzgerald et al., 2015). However, evidence suggests that many elementary teachers are uncomfortable teaching science and need help to maintain student interest in the subject (Tytler, 2010). Likewise, there is a significant drop in music study in secondary school (McPherson et al., 2015. Notably, it is students who have prior musical experience that are most likely to continue music study, which suggests that primary school level music experience may be foundational to future interest in studying music (McPherson et al., 2015). As both science and music face a shared challenge, a solution that can benefit both has the potential to have a wide-ranging positive impact.

This review was inspired by emerging research that indicates songs can be effective in engaging secondary school students (Govenor et al., 2013; McFadden, 2012; Smolinski, 2010) and university students (Crowther, 2011) with science. Song lyrics and music can elicit memories and emotion to allow information to be stored and recalled more readily and via multiple memory routes (Calvert & Tart, 1993; Governor et al., 2013). The evidence for the use of science songs is less clear in an elementary school setting, thus prompting this review to determine the current literature in the area.

The aim of this systematic literature review is to provide a synthesis of the state of knowledge in the use of song and music as pedagogical tools in elementary school science. To construct this review, a comprehensive search of all possible relevant peer-reviewed studies available to us through our university was undertaken. Initial searches that were limited to research with elementary aged children revealed few results and so the search was broadened to include literature that could provide insight to the use of song and music in elementary classrooms. We used clearly defined, systematic methods to collate, synthesise, and report the findings of relevant literature to address the research question: *Is there evidence that music and song can be effective pedagogical tools in elementary school science lessons?* After exploring the findings, this review concludes by identifying key research priorities to facilitate theory development in this field.

Methodology

This systematic review of literature has been guided by the principles of the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) Statement (Page, et

al., 2020). This rigorous system ensured the transparent reporting of the review, including its purpose, how it was conducted, how it can be updated, and how it can be replicated. As PRISMA is primarily used for medical research, full use of the methodology was not deemed appropriate. Consequently, we reviewed all items in the 27-item checklist for relevance and omitted those that related to statistical analysis as few studies included the quantitative data required for this type of analysis. We therefore employed the rigour of the PRISMA approach where possible but do not claim that this is a PRISMA review. This review was also guided by the step-by-step process outlined by Fink (2020) and her advice on working with research in the social sciences.

To conduct the literature review, we undertook the following steps:a) Determining inclusion and exclusion criteria

b) Deriving search terms from the project's key concepts and constraints

c) Constructing Boolean search strings from key words

d) Selecting online education focused databases for searching

e) Customising the search string for different databases

f) Systematic recording of the results of searches

g) Screening and selecting relevant literature

h) Thematic analysis

i) Synthesis of findingsThe next section will detail inclusion and exclusion criteria, identification strategy, screening, and selection of results. This is followed by a description of the thematic analysis method.

Inclusion and Exclusion Criteria

Few articles met our initial selection criteria which required the use of music and song as a teaching tool for science in elementary school classrooms. Therefore, to expand our search, we included literature that could provide insights into using music and song in elementary school classrooms.

A study was included when it showed evidence of impacting the following outcomes:

- Increased student interest/motivation in studying science
- Increased teacher interest in using music or song in the classroom when teaching science
- Improved student knowledge about science
- Studies that claimed to achieve these outcomes anecdotally were noted, but they were not considered as strong evidence.

Although this review was focused on elementary science education, we also decided to include literature on use of music and song in secondary science classrooms where the literature referenced elementary science and thus could yield additional insights. This systematic approach allowed us to sort the literature by its form, methods, and results, providing a comprehensive view of the literature and identifying methodological and conceptual gaps.

A study was excluded if it was based on the use of song/music in primary school in science if it was about:

- the teaching *of* music/song exclusively (i.e., with no integration with or connection to science; for example, a music lesson)
- the teaching of *sound* (e.g., sound waves) in science using music (unless this also extended to using music/song as a pedagogical tool)
- the use of music as a cognitive behavioural modification tool (e.g., playing music when students are doing an activity)
- the use of dance as the pedagogical tool (e.g., learning hip hop)

The search was limited to peer reviewed articles and reports published in English. To decide which studies were eligible for synthesis, the methods used in the publication were tabulated in an Excel spreadsheet. The methods used in the selected studies included: sharing of teacher practices, interviews, a structured experiment, focus groups, surveys, observations of classroom activities, or other activities. In studies wherein the methods of the studies were not apparent, they were recorded as "unknown".

Identification Strategy

Search terms. Determining the Boolean search phrase was an iterative process involving the identification of synonyms for key search terms and analysis of the results from each iteration. The overarching Boolean phrase for this review was: (music OR song OR singing OR poem OR poetry) AND (primary OR elementary) AND science AND school. Subsets of this string and additional terms related to music (e.g., riddles, poetry, ethnomusicology) were also used to interrogate the databases until no new articles were found.

Databases. We consulted with university librarians and a faculty education expert to determine the most relevant education databases for this review. The key databases chosen were:

- A+ Education
- Education Database
- Education Research Complete

To ensure that we captured literature that was more broadly published, we chose composite databases that included these key databases. Table 1 shows the list of databases, when they were searched, and the numbers of articles. We were interested in recent publications, and so the original search parameter was from 1990-2020 with our earliest result beginning in 1993. A second search of the literature was done in 2022 to bring the study up to date, after COVID-19 pandemic-related delays disrupted this study in 2021.

- Informit Complete (14 databases): 124 results (26 November 2020; 17 May 2022)
- EBSCOhost Education Research Complete: 660 results (29 November 2020; 17 May 2022)

- Educational Research Information Centre (ERIC) 1727 results (1/12/2020; 17 May 2022)
- A+ Education: 71 results (1 June 2020; 17 May 2022)

We also attempted searching the ProQuest Education Database and Google Scholar, but these searches did not reveal additional relevant articles. In addition, we used citation chaining to locate additional articles and ensure that key articles had not been overlooked. Chaining involved examination of reference lists in relevant articles to find any new key articles that related to the research question. This process resulted in no new articles.

Screening. The authors worked independently. One author (Booth) sourced and collated publications, identifying their relevance first based on their abstracts; and second, based on their discussion of results. The second author (Palmer) is an expert in education, and independently reviewed these publications and assessed them based on the inclusion/exclusion criteria, study quality, findings, and bias.

The total number of results for each search was recorded, along with the search terms, to aid in refining search terms as the process continued. Upon completing a search, the title, metadata, and abstract (when available) of each result was reviewed to determine its relevance to the inclusion criteria of the project. If deemed relevant, the item's key data were recorded in a spreadsheet. The literature search was deemed complete when searches failed to yield new results. The final number of items catalogued through this process was 310, with some duplicates.

To facilitate analysis of the results within themes, Palmer categorised each article into one of three tiers based on a close reading of the data captured in the spreadsheet:

- Tier 1: the paper directly related to the use of music or songs as a pedagogical tool in elementary science classrooms;
- Tier 2: the source related to the use of music or songs in science teaching but not directly with elementary students; and
- Tier: 3 if the article was related to the use of the arts in in science teaching but not in a school setting.

Selection of Results. Once duplicates had been removed and all sources had been rated into the three tiers, Tier 1 sources and the most relevant articles from the other two categories (as determined by Palmer), were further sorted by categories for analysis (see Table 1). The selection process resulted in 26 articles which were progressed for thematic analysis.

Thematic analysis method

Thematic analysis was conducted on the 26 articles included in this review to identify patterns in the findings to interpret salient aspects of the research topic (Braun & Clarke, 2006). Our methodology was to:

1. Read each paper and note initial ideas to familiarise ourselves with the data.
2. Sort relevant papers into initial themes.
3. Refine the themes by gathering relevant data on each theme.
4. Review and validate the themes.
5. Define and name the themes.
6. Analyse the themes and relate them back to the research question and literature.This analysis resulted in four themes that will be discussed in the next section.

Results

Of the 26 relevant sources in this review, two-thirds focused explicitly on elementary school age participants or equivalent, with journal articles being the most common. The United States was the dominant region represented, and approximately two-thirds of the publications included the sharing of teacher practice or resources used in the classroom. The broad category of 'experiment' was used to describe publications in which there was a 'control' or an attempt to measure the impact of music or songs on participants. Where no pre/post-test indicating the impact of music and song on the teaching of science was given, it was assumed there was none.

Profile of Study Attributes

A frequency analysis of the profile of the articles resulting from this review is presented in Table 1. Note that studies may have multiple foci, methods, and results. Four key themes were identified in the literature:

- Theme 1: The common goal of engagement
- Theme 2: Evidence of learning improvement
- Theme 3: Broad utility of music and songs as pedagogical tools
- Theme 4: Few long-term studies

Table 2 summarises key features of studies included in this review, as well as the clear recommendations we identified that were relevant to this project. We also indicate each study's relevance to the themes observed in the aggregate of all these articles.

Themes Identified

Theme 1: The common goal of engagement. Increasing student engagement with science emerged as a high priority in the literature. A total of 14 studies either demonstrated with evidence or claimed to have achieved the outcome of increasing student engagement with science activities. Methods used included experiments with students, interviews, reviews of the literature, focus groups, and classroom observation. There were six studies which demonstrated an increase in student engagement with evidence, such as student feedback, teacher's own observations, and quantitative results from classroom experiments. Of these six results, all focused

on the study of science. Most of these sources focused on content retention and skill building relevant to the subject, with some particularly focused on the memory-building potential of music and song. Those sources that featured student activities included cohorts from elementary school to university students. There were some studies in which the age or school level of students was not specified.

A further eight results of the search claimed to boost student engagement, but unlike the above six papers, did not provide satisfactory evidence to support this claimed outcome. These items focused on the sharing of teacher's experiences and practice as a method, meaning they featured music and songs in some capacity, and focused on science as an area of learning. Overall, from these 14 sources, fostering student engagement in their science studies using songs and music is an area of interest among scholars.

Theme 2: Evidence of learning improvement. Ten studies demonstrated an increase in students' retention of knowledge or subject content, and all involved the use of songs or music in some capacity. These studies focused on science learning, and used data collection methods including: interviews, focus groups, classroom observations, teacher materials and practices, and, most commonly, experiments and classroom activities with students. Basic science skills, concepts, and vocabulary were the focus of these activities, with the goal of increasing students' retention of classroom content. Additionally, one further source claimed but did not evidence an increase in learning (Mueller et al., 2004), and another study which did focus on science and included an experiment found no difference between the student cohorts and was inconclusive (Hardiman et al., 2019). A third additional study found that there was no improvement of students' achievement (McCammon, 2008).

These results are limited but do indicate the potential of songs and music in science education. Based on these results, it may be that songs and music are well-suited to the study of science, due to the subject's specialised vocabulary, skill sets and processes, and concepts, as music can aid in the recall of such information (Calvert & Tart, 1993; Governor et al., 2013). When taken together with the above discussion on student engagement, it should also be noted that only four of these sources demonstrated with evidence the ability to increase both student engagement in science, *and* students' retention of knowledge and content about science. However, all used songs and music in some capacity. This suggests that there is potential for future research to explore how music and songs can support both engagement with and learning in science.

Theme 3: Broad utility of music and songs as pedagogical tools. Music and song are useful pedagogical tools to use in a range of science classroom activities. The 23 sources contributing to this theme demonstrated that music and song can be used in classroom practice to teach content, and science skills. Within these 23 results, across all subjects of learning, 14 of the sources involved the sharing of teacher practices or materials, 13 involved an experiment, five involved interviews, one involved focus groups, two involved classroom observation, and none involved

surveys. Of the 23 sources, all included a focus on science; a bias which may at least in part be due to the goals of the literature search.

Within the 23sources, 19 of them involved primary school students (or age equivalent) in some capacity, such as the discussion of teacher materials prepared for this age group, or an experiment which involved them.

Theme 4: Few long-term studies. The sources identified in the search of the literature provided a plethora of teacher materials and practices and experiments evaluating whether certain activities increased students' knowledge retention or engagement with science. However, in the sources, limited attention was paid to the potential long-term influence of such initiatives. A rare example of a long-term study included The Song Room's 3-year program (Vaughan et al., 2011), which the researchers found music integration increased students' attendance at school. In addition, a report by the Murdoch Children's Research Institute examined longitudinal data in relation to how students' overall wellbeing affected their involvement in their studies. Similarly, the more general integration of arts programs into school science programs, with the goal of improving long-term memory relating to subject content, had mixed results (Hardiman et al., 2019). Yet, studies which focused on music and memory (Calvert & Tart, 1993; Collins, 2014,; Governor et al., 2013), suggest that this is a promising area for future research. Eleven publications advocated for further research and additional trials of programs, often emphasising the need for studies to be conducted over a longer period of time (Baspinar, 2020; Ben-Horin et al., 2017; Gershon & Oded, 2014; Goldstein et al., 2017; Hardiman et al., 2019; McCammon, 2008; Mueller et al., 2004; Nelson & Norton-Meier, 2009; Ozcan, et al., 2020; Vaughan et al., 2011).

Several sources including literature reviews, reports, and studies separately noted that students' engagement in their school studies starts to decline in late primary school (McCourt, 2016; Tytler et al., 2008), and that this can particularly affect participation in STEM subjects such as science in high school years. However, there are few studies engaging with the specific question of whether music and song-oriented approaches being used in primary school classrooms could impact the uptake of secondary science. Considering the findings described above, such as the researcher/teacher interest in boosting student engagement, teaching methods that explore language and musicality, and the potential for such methods to support students' learning, it is reasonable to conclude that these factors may also affect students' long-term interest in science. Thus, there are fertile grounds for future research in this area.

Discussion

The need for scientifically trained and literate individuals is strong and growing with education systems under pressure to produce students who can fully engage with society. School teachers are tasked with providing the learning experiences that enable students to

engage with science and help them develop the skills necessary to contribute to the advancement of our modern world. Similarly, engagement with the arts brings significant benefits to children's development while fostering an overall richer learning experience (Barrett, 2009; 2016; Collins, 2014). This literature review has revealed that music and song can be effective pedagogical tools in elementary school science lessons. These artforms have strong potential as pedagogical tools for elementary teachers to engage students with science and help them learn scientific concepts and yet this tool is underexplored.

The findings of half of the studies identified either demonstrated or claimed to have increased student engagement in science using music and song. Research by Ainley and Ainley (2011) suggested that students' enjoyment of and interest in science was linked to their choice to engage with science. They noted that this enjoyment came from positive experiences with science and that these past experiences impacted their predictions of future science experiences. The researchers concluded that their analysis of over 400,000 students from 57 countries, that "these results point to the importance of both early experiences with science and the maintenance of a sense of fun and excitement while learning science." (p.11). This is of interest given that studies in this review typically focussed on using these pedagogical tools for content retention and skill building relevant to the subject rather than engagement. Indeed, engagement was a common outcome whilst fewer studies were able to clearly demonstrate an increase in students' retention of knowledge or subject content.

The small number and short-term focus of the studies found in this literature review means that generalised statements cannot be made regarding the utility of song and music as pedagogical tools to affect long term change in students' science knowledge or their disposition towards science. The lack of a longitudinal studies means the retention of science knowledge or the development of a positive attitude towards science beyond the duration of the activity or study cannot be verified. Given that findings of the studies suggest interest in science starts to decline towards the end of elementary school (McCourt, 2016; Tytler et al., 2008), further research into whether interventions involving music and song can reverse or halt this trend could be promising.

It should be noted that this review was limited by the databases used and much of the literature found in initial searches was focused on the teaching of song and music rather than teaching other subjects *with* song and music as a tool. An internet search revealed that there are numerous resources and non-academic articles available that imply the value of these pedagogical tools for teachers. This search was complicated by many teacher resources which had not been evaluated as pedagogical tools in a rigorous manner. It appears that these tools are popular and in demand but there is a need for further research to determine their full value and how they can best be used to improve students' learning and engagement with science.

Given the focus on the sharing of teacher practices and materials in music and songs, and the comparable dearth of sources with methods that directly include students themselves, such as interviews, focus groups, and classroom observations, there is a need

for more research that directly involves students in the context of the impact of music and songs on learning. Only students can truly provide insight into how music and songs influence their engagement with and knowledge of a subject, and so their input is vital in future studies.

Conclusion

The results of this literature review were ultimately reduced to a set of 26 papers that came from a broad and 'creative' set of searches to identify appropriate studies. The breadth of our searches leads us to believe there is great interest and potential in integrating song and music into elementary school science. However, although there is much anecdotal evidence, there is limited empirical evidence to support the application of music for the purpose of increasing student engagement in science. This represents a tantalising area or future research, and a promising foundation is laid in this literature review.

Within the studies, teachers consistently reported that they found songs and music useful pedagogical tools although there was little data collected from students to explore their views. We suggest that future studies to explore student responses to using music and song in science classrooms, how these tools are being used in classrooms, would be valuable. Further, longitudinal studies to determine if these pedagogical tools affect lasting change in students' learning outcomes.

This review offers compelling evidence for the significant role music and song can play in cultivating student engagement in science. It not only underscores the importance of fostering collaboration between different subject areas but also emphasises the creation of authentic and engaging learning experiences. This collaborative approach directly addresses a longstanding concern, the potential overemphasis on science and mathematics in schools, coupled with our increasing reliance on technology, which has, at times, failed to nourish our creative imaginations (Seidel, 1999).

Incorporating the arts into science lessons not only enriches the educational environment but also contributes to an arts-infused education known to enhance student performance across a wide range of curriculum domains (Burton et al., 1999). Renowned neuroscientist and musician Daniel Levitin (2021) argues that the use of song has been a fundamental pedagogical tool since pre-literate times and that music is a superior preservation system for children's learning knowledge than speech alone. We suggest that engagement, rather than simply knowledge, should be considered as a critical outcome of using music and song in elementary science classrooms and recommend further exploration into the use of music and song in science classrooms. We believe this review provides convincing evidence to support the value of the arts to enhance learning in science and will inspire elementary teachers to explore using music and song to engage their students in learning.

Table 1

Profile of attributes from 26 selected articles

Criterion	Analysis (number of studies)
Year of publication	Date (#) 1993-2021
Location	Country (#) Australia (3), United States of America (USA, 16), Canada (1), Middle East (1), Indonesia (1), Turkey (1), New Zealand (1), Norway (1)
Document type	Type (#) Journal Articles (23), Reports (1), PhD Thesis (2)
Focus	Music/Song (25) Elementary school age (19) Not Elementary school (7)
Methods	Sharing teacher practice/materials (15), Interview (7), Experiment (15), Focus Group (1), Survey (0), Observation (2)
Results (with evidence)	Increased student engagement in study (6), Increased teacher interest in using music/arts in classrooms (3), Increased student knowledge (10)

Table 2

Table of detailed article attributes

Citat-ion	Study location	Study Methodology	Key findings	Recommend-ations	Contribution to themes
Adams et al., 2014	USA	Sharing teacher practice materials, interview	Guided inquiry can aid in the integration of science with music and better engage students	None	2, 3
Anderson, 1993	USA	Sharing teacher practice materials	Using rap music in the classroom where appropriate can be a way to engage and recognise youth and youth cultures	Teachers should use rap music occasionally to motivate and instruct students	3

Citat-ion	Study location	Study Methodology	Key findings	Recommend-ations	Contribution to themes
Baspinar, 2020	Middle East	Literature Review	Music can be used as a means for engagement	Further research	3
Ben-Horin et al., 2017	Norway	Interview	Teachers believed music made students more engaged with science and remember more	Program should be trialled more broadly	3
Cali, 1999	Australia	Sharing teacher/practice materials	Making their own instruments and then Learning to perform improved student interest in learning	None	3
Fones, 2000	USA	Sharing teacher practice materials	Students enjoy singing science songs and remember science content better	None	1, 3
Fortner, 1997	USA	Sharing teacher practice materials	Songs can be useful for teaching science content	Arts methods should be introduced into science	3
Gershon & Oded, 2014	USA	Sharing teacher practice materials, experiment	Students used song writing to learn science inquiry processes	Further research	1, 3
Goldstein et al., 2017	USA	Literature review	Student engagement was increased	Further research	3
Hardiman et	USA	Experiment	Arts-integrated education was effective in	Further research	4

Citat-ion	Study location	Study Methodology	Key findings	Recommend-ations	Contribution to themes
al., 2019			learning science		
Harper et al., 2019	Australia	Sharing teacher practice materials, experiment	University students and primary students benefitted from music in science class.	None	1, 2, 3, 4
Hoffmann, 2013	USA	Sharing teacher practice materials, experiment	Teaching science content through catchy songs improves students' recall	Songs are a useful tool for teachers	1, 2, 3
McCammon, 2008	USA	Experiment	Science songs improved student motivation and teacher passion for teaching chemistry	Future studies should be longer than two weeks, and more creative assessment tasks needed	1, 3
McCourt & Kelley, 2016	USA	Sharing teacher practice materials	Building instruments and writing and performing a song improved student understandings of sound	Valuable strategy	4
McLaughlin, et al., 1999.	USA	Sharing teacher practice materials	Students can learn about photosynthesis through a song and drawing activity	None	1, 3
Waters & Straits, 2008	USA	Sharing teacher practice materials	Students can learn about rocks by writing lyrics to rock songs	None	1, 3

Citat-ion	Study location	Study Methodology	Key findings	Recommend-ations	Contribution to themes
Mueller, et al., 2004.	Canada	Sharing teacher practice materials, experiment	Playing instruments helped students learn and recall science concepts relating to sound.	Future versions should include time for teacher reflection. Model could be expanded to mathematics and language	1, 2, 3
Mulyeni, et al., 2019	Indonesia	Experiment, observation	Songs helped students learn basic science skills.	This inquiry-based learning approach could be used with students in other grades	1, 2, 3
Nelson & Norton-Meier, 2009	USA	Sharing teacher practice materials, experiment	Students collaborated with a professional musician to write and record a science song, and this improved recall and enjoyment	Further research	1, 2, 3
Ozcan, et al., 2020.	Turkey	Experiment	Handwashing song about handwashing produced statistically significant increase in knowledge about correct handwashing processes	Further research over longer timeframe	2, 3

Citat-ion	Study location	Study Methodology	Key findings	Recommend-ations	Contribution to themes
Round & McPhail, 2019.	New Zealand	Interview, experiment, observation	Students' listening to music and recording their feelings improved language skills and engagement	The method be adapted by other non-specialist teachers	3
Smolinski, 2011	USA	Sharing teacher practice materials, interview, experiment	Hearing and writing science songs can increase student engagement	Music should be used in science classes to motivate students	1, 3
Smolinski, 2010	USA	Interview, experiment, focus group	Statistically significant improvements in students' learning science with song	More access to resources and training to implement music and song in science and student feedback should be sought	1, 2, 3
Vaughan, et al., 2011	Australia	Experiment	Song program improved students' grades in several subjects, attendance, and wellbeing	Further research	1, 2, 4
Williams, et al., 2013	USA	Sharing teacher practice materials, experiment	A music and rap activity improved student enjoyment and learning	None	1, 2, 3
Yoon & Kim, 2017	United States	Experiment	The science-based songs developed and taught by	Activity expanded	3

Citat-ion	Study location	Study Methodology	Key findings	Recommend-ations	Contribution to themes
			student teachers improved their knowledge and enjoyment of teaching science and that of their students		

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