Music in the Science Classroom: The impact of content-based songs on learning and engagement

Tom McFadden

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science Communication

Centre of Science Communication, University of Otago, Dunedin, New Zealand

Date: December 2012
Table of Contents

Abstract ........................................................................................................................................ iv
Acknowledgements ...................................................................................................................... v
Author’s Biography ...................................................................................................................... vii
Chapter 1: Overview .................................................................................................................... 1
Chapter 2: Review of the Literature ............................................................................................... 3
  2.1 Introduction ............................................................................................................................ 3
  2.2 Why Integrate Music Into Non-Music Lessons? ................................................................. 3
    Education Theory ....................................................................................................................... 3
    “Brain Sciences” and Multiple Intelligences Theory .............................................................. 4
    Psychological Approaches to Music and Memory ................................................................. 5
    The Integrated Curriculum ...................................................................................................... 6
  2.3 Research into Music-based Teaching in the Classroom ....................................................... 7
    Music as Background ............................................................................................................... 8
    Instrumental as Analogy .......................................................................................................... 8
    Lyrics as Content .................................................................................................................... 9
    Pre-existing Popular Music .................................................................................................... 9
    Original Content-based Songs .............................................................................................. 10
    Parodies ................................................................................................................................ 11
    Focus on Science Songs ....................................................................................................... 11
Chapter 3: Music Video Experiment ........................................................................................... 15
  3.1 Introduction ........................................................................................................................... 15
    Overview of Study .................................................................................................................. 16
    Research Hypotheses ............................................................................................................ 17
  3.2 Methods ................................................................................................................................... 17
    “Fossil Rock Anthem” Music Video ....................................................................................... 17
    “Just-the-facts” Video ........................................................................................................... 18
    Schools and Participants ........................................................................................................ 19
    Stratified Randomization ....................................................................................................... 20
    Data Collection Procedures ................................................................................................... 20
    Measuring Content Acquisition ............................................................................................ 20
    Post-test Measures of Attitude and Motivation ................................................................... 21
    Questionnaire Comments ..................................................................................................... 21
    Follow-up Emails: Measuring Motivation to Learn and Allowing Further Exposure ........ 21
    Statistics ................................................................................................................................. 22
3.3 Results from Post-test (Day 1) ................................................................. 23
    Impact of Videos on Short-Term Content Acquisition .................................... 23
    Perception of Learning .................................................................................. 24
    Attitude Towards Lesson Type ...................................................................... 26
    Adjectives About the Video ......................................................................... 27
    Desire to Share the Video ............................................................................. 29
    Motivation to Learn More ............................................................................ 31
    MUSIC-only Items ....................................................................................... 32

3.4 Results From Follow-up Email (Sent on Day 7) ............................................ 33

3.5 Results from Delayed Post-test (Day 28) .................................................... 34
    Impact of Videos on Content Acquisition Over Time ...................................... 34
    Interaction with Science: Day 1 to Day 28 .................................................. 36

3.6 Discussion .................................................................................................. 40
    Content Acquisition .................................................................................... 40
    Attitude Towards Lesson Type and Desire to Share ...................................... 41
    Motivation to Learn About Science ............................................................. 42

3.7 Limitations of Study .................................................................................. 44
    School Sampling .......................................................................................... 44
    Content Tests ............................................................................................... 44
    Measuring Motivation to Learn More ......................................................... 44
    Issues with Videos During Testing ............................................................... 45
    Presence of Researcher in Room During Testing ......................................... 45
    Follow-up Emails ....................................................................................... 45
    Between-group Leakage ............................................................................... 46

3.8 Conclusions ............................................................................................... 47

Chapter 4: Science Idol 2012 Tour and Competition ........................................ 48

4.1 Background ............................................................................................... 48

4.2 Tour .......................................................................................................... 48

4.3 Competition Planning ............................................................................... 52
    Opening Up the Competition to All of New Zealand ...................................... 52
    Opening Up the Competition to All Ages .................................................... 52
    Incentivizing Submissions ......................................................................... 52

4.4 Online Video Tutorials ............................................................................. 53

4.5 Competition Results and Discussion ......................................................... 55
    Who Participated? ....................................................................................... 56
    Finalists ....................................................................................................... 58
    Grand Prizewinner ..................................................................................... 59
# 4.6 Lessons

- Successes ................................................................. 61
- Uploading Videos ..................................................... 62
- Production Values ..................................................... 62
- Recruitment and School Follow-ups ............................ 63

## Chapter 5: Science Idol 2012 Research .................................. 64

### 5.1 Introduction .......................................................... 64

### 5.2 Research Questions and Challenges ............................ 65
- Challenges to Idealized Research Concept ..................... 66

### 5.3 Methods ............................................................... 67

### 5.4 Results and Discussion ........................................... 68
- Song Writing Experience and Scientific Accuracy (Students Only) .................. 69
- Song Writing Preferences (Students Only) ........................ 71
- Digital Technology ..................................................... 72
- Time Costs ............................................................... 73
- Video Tutorials ......................................................... 74
- Lyrical Recall ............................................................ 75

## Chapter 6: Teacher Comments ........................................... 77

### 6.1 Introduction .......................................................... 77

### 6.2 Methods ............................................................... 77

### 6.3 Results ................................................................. 78
- Reactions to “Fossil Rock Anthem” ................................. 78
- Do Teachers Want to Make Their Own Songs? .................. 80
- Tradeoffs of Song Authorship ....................................... 81

### 6.4 Discussion ............................................................ 82

## Chapter 7: Conclusions .................................................... 85

## References ................................................................. 90

## Appendices ................................................................ 96
- Appendix 3A: California Grade Seven Earth & Life History Standards ............... 96
- Appendix 3B: “Fossil Rock Anthem” Lyrics ............................................... 97
- Appendix 3C: Copyright Request to Manager of LMFAO ............................... 99
- Appendix 3E: Scientific Content Test on Fossils and Earth History .................. 102
- Appendix 3F: Post-test of Attitude & Engagement ...................................... 104
- Appendix 3G: Follow-up Emails ......................................................... 108
- Appendix 3H: Fossil Rock eBook ....................................................... 110
- Appendix 4A: Science Idol Paper Entry Form ......................................... 111
- Appendix 4B: Digital Form with Questionnaire ....................................... 113
- Appendix 4C: Science Idol Judging Criteria .......................................... 116
- Appendix 4D: “Covalent Love” by James Mustapic & Tom McFadden .............. 117
- Appendix 5A: Science Idol Research Questionnaire .................................... 118
- Appendix 6A: Teacher Feedback Questionnaire ....................................... 123
Abstract

As science songs become more popular on the Internet and in classrooms, researchers are exploring whether content-based music can make science lessons more relevant, emotional, and memorable. Interested parties include educators, who believe in the pedagogical power of music, and private education media companies, who are incorporating music into a new wave of educational technologies and services. This thesis investigates the impact of professionally created content-based music videos on intermediate school aged students in New Zealand. A randomized control trial found that the musical lesson was deemed more fun than the control video, and was shared more often outside of the classroom. Students in this music video group had smaller short-term content gains, but these gains persisted after one month, while the larger gains seen by the control group returned to baseline over that same period. This thesis also examines the benefits and costs of student and teacher-generated songs, generated as part of the New Zealand Science Idol 2012 music video competition. Details on the planning, execution, and lessons learned from this competition are included. It is argued that science songs can achieve maximal pedagogical value when produced collaboratively by students and “professionals”, such that they have a local impact on the students involved, while achieving the accuracy and production values needed to be incorporated into classrooms around the world.
Acknowledgements

I would like to start by thanking Fulbright New Zealand. Mele Wendt, Andy Mitchell, and the rest of the Fulbright NZ staff have been friends and advocates throughout my time here. The Fulbright Alumni Association has also been a great source of support – particularly Lynn Tozer and Graham Cochrane. To my fellow Fulbrighters of the past two years: thanks for being inspiring scholars and great friends.

An enormous thanks goes to the staff at the Centre for Science Communication. I chose this program because of the flexibility it offered, and my supervisor, Jean Fleming, gave me the intellectual and creative freedom I was looking for – not to mention very speedy feedback. Steve Ting has been endlessly available and supportive throughout my time in New Zealand. He’s helped on most of my projects, including the video tutorials included in this thesis. Sue Harvey has been a wonderful presence, and I will forever appreciate her insight and understanding. Lloyd Davis, Jenny Rock, and Ross Johnston have all been inspirational in their own way. I’d like to also thank my fellow M. Sci. Comm. students for all their support. Special thanks to Laura Honey and Simon East, for shooting and editing the “Covalent Love” music video.

Producing the “Fossil Rock Anthem” music video required a lot of help. I’d like to thank Wiebke Finkler and Julien Van Mallearts for their early renditions of the song. A huge thank you to my San Francisco collaborators – Luke Taylor for making the instrumental, Nicole Bonsol for singing the chorus, and DJ EarJerker for mixing. Thanks also to Jessica Hinojosa, Jens-Erik Lund Snee, and Jacob Anderson for providing some much needed geological expertise.

Rigorously examining the educational benefits of science rapping was no easy task, and I found nuggets of expertise throughout Otago. Two people really went above and beyond, serving practically as co-supervisors. Steven Sexton at the College of Education gave a much-needed teacher’s perspective throughout. John Williams, from the Division of Commerce, gave rapid and in-depth feedback on survey design, statistical methods, and graphical presentation of data. Thanks also to Angela McLean and Clinton Golding from the Student Learning Centre for early conversations about research methods. Thank you to Keryn Pratt for discussing quantitative techniques. A huge thank you to Higher Education Development Centre staff members Ayelet Cohen, Jenny McDonald, and Swee Kin
Loke for pointing me toward critical (and skeptical) work in educational media. Thank you to Richard White for providing copyright advice.

There are many people who were critical to making Science Idol 2012 the success that it was. Thanks to the U.S. Ambassador to New Zealand David Huebner, and U.S. embassy staff Shauna Mendez, Phil McKenna, and Drew Dumas. Thanks to Joe Klein at KlabLab in San Francisco. An enormous thanks to both the 2010 and 2012 NZISF staffs: Chris Greene, Laura Madden, Merrin Bath, and Sue Clarke. Science Idol was their original idea, and I was so pleased that I could step into such a large role in organizing the 2012 version. I look forward to seeing where the future takes it.

Thanks to Dr. Greg Crowther and Dr. Lodge McCammon for their work in the field of science songs. Without those two, I would have felt like I was the only person in the world studying this stuff. Thanks to Derrick Davis for his help throughout my science rapping career, and Marlon Evans at Hewlett Packard for his guidance and support. Thanks to LMFAO and Universal Music Group for making “Party Rock Anthem” such a catchy song.

Thank you to all the other incredible kiwis I’ve met, particularly Warren Forster and Jane Millichamp for their hospitality and friendship throughout my time here. Although I am now leaving New Zealand, New Zealand will never leave me. Kia ora.
Author’s Biography

Growing up in California, I watched a lot of Bill Nye the Science Guy. Each show ended with a pop song parody covering the scientific theme of that episode. My mom was a primary school teacher and reading coach, who preached the power of phonemic awareness and rhyme in learning. My dad worked as a professor of bilingual education, teaching teachers how to best serve the needs of a diverse student body. While teaching human biology at Stanford University as a course associate, all of these unique influences came together as I began making science raps for my students.

The videos became more and more ambitious, and have since reached a fairly large audience (over one million views so far). Amazingly, I’ve noticed several of these videos cited in the very literature I’m now using for this thesis. Regulatin’ Genes, the first song to get national media attention, has been cited by several articles on science songs (Allgaier, 2012; Crowther, 2012b), and even in an academic paper on hox genes. I’ve gone from making joking songs for my students, to performing live at schools in New Zealand, Mexico, and Japan.

Despite all this hoopla, I’ve tried to retain a healthy skepticism regarding the benefits of science songs. While studying science communication here at Otago, I’ve been more interested in communicating science on its own terms – emphasizing the elegance, messiness, and beauty of science as a body of knowledge and as process of inquiry – not trying to dress it up or “make science cool”. Science is already cool enough on its own. Many science raps (including some of my own) can come off as gimmicky, corny, and unnecessary.

Yet the truth is that I like making science songs. Many students like watching them. They are easy to get down, slightly addictive, and can be distributed widely – the Big Macs of science communication. Hopefully, their side effects are a love of learning rather than obesity.

The goal of this thesis was to try to pit my skepticism against the buzz of excitement emanating from success as a “science rapper”. Do these videos really teach students anything? Does excitement about the music translate into excitement about science? Wouldn’t it be better, from an educational perspective, for students to write their own? How can classroom teachers, the true generators of educational creativity, improve on them? One quote, by educational media skeptic Richard Clark, has stuck with me throughout:
We begin with an enthusiasm for some medium... and search for a sufficient and visible context in which to establish evidence for our solution. Negative evidence is suspect and we are predisposed to believe that it is flawed... Positive evidence is accepted easily because it confirms our expectations and helps to attract research support... If we begin by implicitly and explicitly attempting to validate a belief about the solutions to largely unexamined problems, we are less open to evidence that our intuitions might be very far off the mark. (Clark, 1994)

I hope that I have applied an appropriate level of Clarkian skepticism throughout this thesis. I have certainly enjoyed each step of it, from making new songs, to touring New Zealand, to putting the songs to the test. Given the results of this thesis, I’m sure I will continue to make science songs – even as I strive to share a love of science that is not dependent on pop hooks and synth breaks.
Chapter 1: Overview

Young children tend to love science. From asking questions about the world to engaging in hands-on inquiry, kids see science as fun, sweaty, messy, and awe-inspiring. Yet too many students lose their early love of science around intermediate school, when science becomes an exercise in memorization, jargon, and feeling dumb (Angier, 2007). One way to keep science fun and relevant is to bring student culture, particularly music, into the classroom (Emdin, 2010b). Whether they are written by outside organizations, teachers, or students, songs can aid with memorization, hook kids into a unit, and serve as study tools (Chapter 2). When done well, songs remind students of the joy and adrenaline of scientific pursuit, inspiring further study.

There is a varied literature exploring the benefits of music in education. Reported benefits include improving classroom atmosphere, facilitating learning and remembering of facts, affective engagement, improving student motivation and inquiry, and enhancing student-teacher relationships (see Table 2.1 for a list of reported benefits alongside citations). There is a growing literature focusing specifically on content-based music in the service of science education. Many of these papers have been published within the last few months (Cirigliano, 2012; Crowther, 2012b; Governor, Hall, & Jackson, 2012) and most call for researchers to move beyond the anecdotal tales of benefit into more rigorously organized randomized trials into the use of science songs.

This thesis attempts to push the field of music-based science education forward by a few small steps. Chapter 2 reviews literature from diverse fields, exploring the theoretical justifications for music-based teaching that come out of education and psychology. This chapter also explores practical examples of music-based teaching, with special attention paid to science classes.

Chapter 3 describes a randomized control trial of 84 New Zealand Intermediate school students. This study focused on two questions: 1) can a music video teach scientific content as effectively as a traditional scientific lesson? and, 2) does excitement about the music video at school translate into excitement about the science and further engagement at home?

Chapter 4 details the planning, execution, and outcomes from a student and teacher song writing competition called Science Idol 2012. Thirty participants of all ages from all over New Zealand participated. The chapter explores challenges
and lessons learned during the planning and execution of the promotional tour and competition. It also describes the unique benefits of getting professionals to collaborate with students to produce high quality student-driven music videos that can be used by educators around the globe.

Science Idol 2012 provided access to a unique set of students and teachers, all writing science songs at the same time. This opened an opportunity for research into the costs and benefits of song authorship, the topic of Chapter 5. Very few competition entrants ultimately participated in this research component, but the preliminary data provides a starting point for future research.

Teachers were involved throughout the research described in the previous chapters, and Chapter 6 contains their qualitative feedback on the questions raised by those studies.

Chapter 7 provides a summary and tentative conclusions.
Chapter 2: Review of the Literature

Theory and Practice of Music-based Lessons

2.1 Introduction

In his 2012 review, “Using Science Songs to Enhance Learning”, Crowther describes five ways music-based lessons might impact learning: enhancement of recall, reduction of stress, multi-modal delivery, increased enjoyment, and in-depth exploration of content (2012b). None of these purported benefits are unique to teaching science (see Table 2.1). Consequently, this review examines literature from several fields, citing examples of music-based teaching in the service of several subjects. Section 2.2 focuses on the theoretical and empirical justifications for using music in non-music classrooms, touching on educational theory, neuroscience, and psychology. Section 2.3 explores the anecdotal and experimental data from teachers who have experimented with music in their own classrooms.

2.2 Why Integrate Music Into Non-Music Lessons?

Many teachers and researchers have justified the incorporation of music into their teaching on theoretical grounds. Three bodies of work are of particular relevance: educational theory, “brain science”, and memory research. The use of educational theory in support of such integration, much of which has built on the constructivist theories of John Dewey, seems widely accepted. However, the widespread claims of support from “brain science”, particularly those citing the theory Multiple Intelligences (MI), are divisive. In contrast, the psychology literature does seem to provide some support for the mnemonic benefits of music-based teaching. After a brief review of these three relevant literatures, this section concludes by exploring the debate within education over “integrated curriculum” – the integration of the arts into the teaching of core subjects.

Education Theory

Most proponents of music in the classroom cite the work of American philosopher John Dewey. Some authors favor his educational work, emphasizing that learning should be experiential and that a student’s own culture should be a guiding force in his or her education (Varelas, Becker, Luster, & Wenzel, 2002).
Others emphasize Dewey’s writing on “art as a way of knowing” and of building community (Dewey, 1934; Olson, 2005). Dewey’s work leads to calls for music integration based on student culture, student creation, and community-building. As will be explored in the later chapters, many of these goals can be best achieved when students create the music themselves, rather than simply consuming content-based songs.

“Brain Sciences” and Multiple Intelligences Theory

Though commonplace, the use of neuroscience in education literature can be misguided and detrimental (Purdy & Morrison, 2009). Purdy (2008) argues that, “despite uncertainty within neuroscience itself, teachers are being bombarded with ‘brain-based learning’ packages which contain a significant number of ‘neuromyths’” (p. 197). The literature on music in the classroom is no exception, with some authors using scientific jargon with no apparent grasp of its meaning. One practical guide to using music in the classroom claims, “Music strengthens connections among neurons as it is processed in both hemispheres of the brain, which stimulates cognitive functioning” (Lock, 2006, p. 307). Such claims contain several problems, including an apparent overestimation of the importance of brain lateralization and a befuddled conception of the relationship between cellular, systems, and cognitive neuroscience. As of 2012, cellular neuroscience is probably not the most solid base on which to argue for music in the classroom.

Harold Gardner’s theory of Multiple Intelligences provides another source of tension between educators and scientists. MI theory is regularly used to justify the use of music in the classroom. For example:

From a multiple intelligences perspective, music is the first intelligence that humans develop and could be a strong channel to help readers understand texts as well as create stories. Gardner suggests that the intelligences work in concert providing human beings a repertoire of skills for solving different problems. As a child grows from his or her first experience with sound (i.e., mother's heartbeat), he or she starts associating music and sounds with contexts and actions. (Pane & Salmon, 2011, p. 37)

While many of the educational ideas advocated under MI theory may be very useful, MI theory itself is controversial. Klein (1997) argues that MI is neither empirically plausible nor pedagogically useful. Waterhouse (2006) argues, from a cognitive science perspective, that MI theory lacks adequate empirical support and should not be used to influence educational practice. Until empirical research
into MI theory becomes more robust, it too should not be used as a justification for using music in the classroom.

This is not to say that science provides no insight into this topic. The power of music to enhance verbal memory has been explored by psychologists with empirical rigor.

**Psychological Approaches to Music and Memory**

The question, “Is memory for music special?” has attracted several psychologists intrigued by public claims about of the long-term mnemonic benefits of music (Schulkind, 2009). Based on the results of several experiments, it appears that simply presenting text in musical form does not facilitate word recall any better than exposure to the same text (Racette & Peretz, 2007). However, since not all songs have the same catchiness or emotive qualities, the results of single studies of single songs should not be considered definitive. Studies looking at the impact of popular televised songs have shown results that do support a theory of musical benefits to memory (Calvert & Tart, 1993).

Calvert & Tart’s exploration of the “The Preamble” song, from the television show *School House Rock*, deserves particular attention. Adults who had frequently watched *School House Rock* while growing up recalled 73% of the words in the preamble, while adults who had watched the show infrequently recalled only 17% of the words. In a second study utilizing a randomized experimental design, students exposed to “The Preamble” song out-performed students in the non-music group on short- and long-term recall tests. However, this effect existed only when students watched the song several times, indicating that repetition played a critical role. The authors argue that students can use these songs to “represent, rehearse, and retrieve” verbal content over long periods of time. Some have suggested a “rule of nine” – a chorus must be repeated three times in a song, and a song heard three times, in order to establish the type of internal rehearsal that leads to long-term memory benefits (Governor et al., 2012).

This literature indicates that music does not inherently or automatically enhance memory. However, it appears that music can enhance verbal recall when it leads to increased repetition and emotional arousal. While this is clearly of interest to those studying memory science, what impact does this finding have for educators? Rote memorization of verbal information, whether by music or any other means, is not a high-level goal of education. However, it may explain the
popularity of science songs with medical and nursing students, who are required to memorize huge quantities of information (Cirigliano, 2012). For most other educational missions, increasing students’ capacity for rote memorization is a shaky ground on which to argue for increased use of music in the classroom.

The other benefits of integrating art into the classroom, advocated by educational theorists like John Dewey, are therefore of critical importance in convincing educators of the value of music and science integration. Researchers have explored the impact of music on these higher-level educational goals, which will be explored in Section 2.3. However, it is worth taking a brief detour to explore the debate surrounding “integrated curriculum,” which provides some useful language for discussing different music-based teaching techniques and their goals.

The Integrated Curriculum

Although the idea of using music to teach other subjects is not new (Dewey, 1934; Lindahl, 1948), it remains controversial. Much of the controversy arose in 1990s, during a surge in popularity of “integrated curriculum” (Bresler, 1995). The idea of using music to teach science has been criticized both for marginalizing musical education (Veblen & Elliott, 2000), and for limiting and trivializing science education (Czerniak, Weber, Sandmann, & Ahern, 1999). However, the diversity of integration techniques (see Section 2.3) defies such sweeping condemnations.

Bresler (1995) usefully divided “arts integration” into four basic styles:

- **Subservient integration** (e.g., content-based music like “The Planets Song”) uses the arts to “spice” up other subjects and can be done by teachers with little musical background.
- **Affective integration** (e.g., playing music at breaks) attempts to enhance the emotions and creativity of students.
- **Social integration** (e.g., singing national anthem at school assembly) serves a community-building function.
- **Co-equal integration** (e.g., analyzing the work of composers in a historical context) places the arts and the academic subject on equal footing.

Studies in American schools have shown that social and affective integration are widely used by teachers and are considered to be of value by researchers (Colwell, 2008; Snyder, 2001). However, researchers have argued that “subservient integration”, being superficial and diminishing to the arts, is
overused, while “co-equal integration” is not used enough (Bresler, 1995). This pattern of use in schools is predictable given the difference in time costs for each technique. Using Bresler’s own examples, it is obvious that it will take less time and expertise for a teacher to play “The Planets Song” than it does to teach a well-integrated lesson on musical composition in a historical context. In fact, after a pre-service workshop communicating the benefits of co-equal integration to classroom teachers, the confidence of educators that they could find the time and resources to implement high level co-equal integration during the school year actually decreased (Colwell, 2008). This tradeoff between time and educational benefits will be explored at length in Chapters 5 and 6.

During an era of budget cuts and increased standardized testing in American schools¹ (Humphries, Bidner, & Edwards, 2011), subservient integration remains a practical option. As long as this surface-level incorporation of music into the classroom (which, it should be noted, often incorporates affective and social functions) is not used as an excuse to further cut proper music education, then it may serve as a useful, practical, and effective way to enhance teaching in subjects like science. Clearly, opening class with “The Planets Song” should not be confused for arts education. Nor should a simple, playful song define the limits of how deep the lesson on the solar system will be. However, such content-based songs might be viewed outside of Besler’s context of “integrated curriculum”, and viewed simply in terms of their efficacy at motivating and encouraging student learning for the content being studied (Chapter 3).

Section 2.3 moves beyond these theoretical discussions into the practical world of implementation. Diverse examples are explored, providing anecdotal and experimental arguments for the benefits of using music in the service of non-music education.

2.3 Research into Music-based Teaching in the Classroom

The literature contains a rich diversity of examples of teachers employing music in the service of non-music education. Music is used to teach students of all ages from preschool to university, though it is most often used in primary school.

---

¹ Perhaps the co-equal style of integration, as well as the higher goals of integration proposed by Dewey for community building (1934) and Olson (2005) for music education may be accomplished in less strictly standardized school systems like those in New Zealand. See Paterson (1991) for a New Zealand context. However, as more American states prepare to move toward the national “Common Core” standards, there may be greater room for higher-level arts integration in America as well.
Music has been used in most academic disciplines from sociology to science, though in very different ways. The genre, quality, authorship (professional vs. student-generated), and integration style vary dramatically. This review divides these diverse practical examples into three broad categories: music as background, instrumentals as analogy, and lyrics as content.

Though “music as background” may have some affective benefits, and “instrumental as analogy” may be a good tool for a select group of subjects/lessons, “lyrics as content” appears to be the most dynamic, flexible, and effective tool for teaching most subjects, including science. The final section of this chapter summarizes the studies most relevant to this thesis – those that have measured the learning and motivational impact of content-based songs in the science classroom.

**Music as Background**

Music was often used in classrooms for affective reasons rather than as an explicit teaching tool. Teachers reported that playing music before and after class helped students to relax, signal instructions, and improve student mood (Hailat, Khasawneh, Shargawi, Jawameh, & Al-Shudaifat, 2008; James, 2004). James (2004) was particularly passionate about using music as “padding” during small group discussions to fill in awkward pauses and make students more comfortable.

However, despite teachers and students reporting increased mood and motivation thanks to background music, there was scant evidence that background music improved academic performance (Eady & Wilson, 2004). The supposed “Mozart Effect” (the claim that playing Mozart uniquely improved spatial reasoning) has been largely debunked due to lack of replication and flawed analysis (Waterhouse, 2006).

**Instrumental as Analogy**

Using the instrumental (non-lyrical) portion of a song as an example or analogy for a technical concept was used to teach concepts in math (Shilling, 2002), physics (Hansen, 2005; Mueller, Clair, Kechaidis, Swain, & Macdonald, 2004), and information literacy (Kimball & O’Connor). For example, students listened to and created music in order to explore the physics of sound (Hansen,
While fun and effective across several disciplines, focusing on the auditory features of music is not applicable to all academic disciplines.

**Lyrics as Content**

Focusing on the lyrics of a song in order to introduce or supplement a lesson is the most dynamic and effective way to use music as a teaching tool. Because of the flexibility and diversity of this technique, it is worth subdividing further into pre-existing popular songs, content-based original songs, and content-based parodies.

**Pre-existing Popular Music**

Analyzing lyrics found in popular music is one of the most common methods of harnessing lyrical content to teach. This is particularly true in sociology, unsurprising given the prevalence of popular lyrics that touch on inequality, discrimination, economic influence and other socially relevant topics (Albers & Bach, 2003). Likewise, history classes (Lee, 2007), psychology classes (Leck, 2006), and aging classes (Weinberger, 2008) found many popular songs whose lyrics addressed the content they sought to teach. Most instructors played the popular song in class, using the lyrics as a starting point for discussion or writing. Others had students write analyses of lyrics as a homework assignment. Cooper (2004) has published an extensive bibliography of resources that incorporate popular music into lessons across many subjects.

Jurmu (2005) described a particularly innovative model for incorporating popular music into the physical geography classroom. Though he capitalized on the prevalence of songs written about the plight of specific cultures and degradation of natural resources, his basic model can be used for any subject.² After the teacher modeled the activity, students were encouraged to find popular songs related to class material (either as a central theme or mentioned in passing). If the lyrics were deemed appropriate by the teacher, the student answered a series of questions about the nature, accuracy, and metaphorical value of the lyrics (Jurmu, 2005). This type of activity gets students thinking critically in a context that is relevant to their everyday lives and interests. It also brings songs that student enjoy to the attention of the teacher for use in future lessons.

---

² Leck (2006) similarly used students to find and analyze popular lyrics for a university course on personality psychology.
A primary benefit of using popular music (especially those chosen by the students themselves) is that the songs are more likely to be catchy, emotionally exciting, and familiar to students. If class material becomes associated with songs that students have heard or will hear hundreds of times on the radio or in their personal music collections, they may be more likely to think about those lessons outside of the classroom (a question addressed empirically in Chapter 3).

**Original Content-based Songs**

Original songs and lyrics do not always have the advantage of professional production values, catchiness, or widespread familiarity. However, they can provide a powerful and lasting learning experience if students are given the time and support to write their own songs (Knaresborough, 2009; Sinatra, 2009). Writing their own songs not only allows students to process material they have learned in a new way, but should facilitate increased repetition, engagement, and long-term memory. Student-authored songs also serve affective goals of increasing self-esteem and creativity (Eady & Wilson, 2004). Furthermore, the students who get most excited about such non-traditional assignments are often the students who show the least interest in traditional lessons (author’s personal experience). Original songs written by the teacher serve the goals of humanizing the teacher and improving student-teacher relationship (Albers & Bach, 2003).

The benefits of student and teacher-generated lyrics aside, there are a growing number of original songs written by professionals or curriculum developers. In addition to requiring less preparation and class time, these songs may have better production values and widespread appeal. Several organizations, including Flocabulary (www.flocabulary.com) and Rapademics (www.rapademics.com) have created songs that teach literacy and vocabulary (Beck, 2009). KlabLab (www.klablab.com) has created songs on a number of topics. The popular band “They Might be Giants” (2009) has created an album of original songs and videos explicitly geared toward teaching science. However, many of these programs are geared towards younger students and/or lack the immediate catchiness, familiarity, and appeal of popular songs. Yet popular songs rarely convey content relevant to middle school or secondary science standards. This opens the door not only for more science-oriented originals, but also for science-based parodies.
Parodies

Changing the lyrics to a popular song allows educators to strike a balance between popularity and catchiness (by capitalizing on already popular songs and cadences that students know) and content specificity (lyrics can be tailored to subject matter). Locally produced teacher and student-generated parodies presumably have the same affective and mnemonic benefits mentioned for other song-writing activities. Furthermore, changing the lyrics of an existing song may be easier and more fun for students and teachers than writing a song from scratch. As long as fair-use guidelines are followed, this is a safe and legal option. However, because of fears about the reproduction restrictions of fair-use (Crowther, 2012b), many such parodies are not widely available for use in other classrooms.

Despite legal complications, there are a few examples of educational parodies of professional quality. In the 1990s, the popular children’s science show *Bill Nye the Science Guy* ended each episode with a music video on that week’s theme. Each song was a parody of a popular hit from that era, and most can currently be accessed online at www.youtube.com/nyetunes. However, as time has passed, the familiarity and popularity of the songs parodied has likely decreased among today’s students. In the realm of health education, Beyoncé recently re-released one of her songs with new lyrics about healthy eating and exercise (Jonze, 2011). Whether other popular artists can be convinced to re-record their own songs with messages about science or health remains to be seen. However, content-based parodies by students, teachers, professionals, or the artists themselves provide a promising area for music-based teaching.

Despite this promise, it is important to not rely only on theoretical justifications, teacher instinct, or anecdotal evidence when arguing for music-based teaching. Fortunately there is a growing body of literature and community of scholars interested in measuring the educational impact of content-based songs, specifically in the sciences.

Focus on Science Songs

As mentioned at the beginning of this review, Greg Crowther is one of the primary scholars in this field. He continues to curate a large web depository of science and math songs for use by teachers (2012a). Although he is in the early stages of conducting his own empirical studies, the work he has published so far
focuses on reviewing theoretical benefits and suggesting future research directions (Crowther, 2012b).

Matthew Cirigliano takes another perspective, noting the widespread use of science songs in university medical and nursing classes. Using YouTube analytics, he explored what groups are watching YouTube science music videos, concluding that some videos seem to be used more by those in the 45-55 year old age group rather than those in younger age groups. He interprets this to mean that these videos are more often used by teachers in classrooms and lecture halls rather than by students studying for exams (Cirigliano, 2012). Both Crowther and Cirigliano have called for increased research using randomized control methodology into the actual educational impacts of these songs.

The two studies that have come closest to documenting educational impacts of science songs are a qualitative study done by Donna Governor (2012) and a mixed-methods study done by Lodge McCammon (2008). By interviewing students and teachers who use music in their science classrooms, Governor found that the vast majority of students (59 out of 60) had positive attitudes toward the use of music to teach science. Students reported that the songs got their attention, engaged them with the lesson, and contributed to a deeper learning experience. One of the commonly cited reasons was the novelty of the lessons. Although Governor framed this in a positive light, careful attention must be played to the role of novelty. Students may get excited about an educational music video simply because it is new and different, not because of any unique attribute of music. This could lead to diminished excitement or positivity as students become accustomed to such lessons. The conflating role of novelty is regularly pointed out by educational media skeptics (Clark, 1994), and is one reason why properly controlled studies are critical. It has also been noted that just because students enjoy a lesson does not make it effective, and in certain cases there is negative correlation between student enjoyment and student achievement (Clark, 1982). Although Governor did not measure student achievement, she did interview teachers. Teachers largely thought that musical lessons, when based on the standardized curriculum and followed up with meaningful activities, were very valuable teaching supplements.

McCammon provides a nice compliment to Governor’s work, since he used a control group comparison and a quantitative measure of student achievement.
He worked with an American middle school teacher to create a chemistry song tailored to that teacher's lessons, and then randomly divided the teacher's different classes into two groups: one group that did in-depth activities centered around the chemistry song, and one group that did not engage with the song. He found that student improvement on a chemistry test was comparable between the two groups, but that engagement and motivation were higher in the music group. He writes that, “use of music as a tool for learning can be employed by any teacher to create an exciting and engaging atmosphere where students actively participate and learn to value their classroom experience” (McCammon, 2008).

Both McCammon and Governor provide evidence that musical teaching has educational benefits far beyond rote memorization. They argue that, in addition to affective and social benefits, music can help teach scientific inquiry as a process and way of thinking instead of a set of facts to be memorized. This is important, since facilitating student understanding of scientific inquiry and the construction of scientific knowledge is a critical challenge of modern science education.

In conclusion, the literature provides both theoretical and preliminary empirical support for further incorporation of music-based teaching into science education. The literature also highlights several obvious next steps for this emerging field. It will be important to conduct larger scale randomized control trials that isolate the impact of music from novelty. Researchers should further explore the tradeoffs of song authorship so that teachers can gauge the costs and benefits of devoting class time to student song-writing activities. Furthermore, it will be critical to get teacher perspectives on the diverse that songs can be used for in-depth learning.

The rest of this thesis seeks to chip away at those very questions. Later chapters will focus on the costs and benefits of having students or teachers create their own songs. The next chapter details a randomized control study exploring the educational impact of watching a science music video called “Fossil Rock Anthem”.
Table 2.1 Reported Benefits of Music in the Classroom

Classroom Atmosphere
• Gets students **attention**. (James, 2004)
• Classroom setting becomes more **informal**. (Albers & Bach, 2003)
• Makes students more **relaxed**. (Hailat et al., 2008; Modell, DeMiero, & Rose, 2009)
• Creates a sense of **community** in the classroom. (Modell et al., 2009; Olson, 2005)
• Makes the classroom a **happier** place to be. (Rief & Heimburge, 2006)

Learning & Remembering Facts
• Improves learning by activating **different parts of brain** not involved in language processing. (Peretz & Zatorre, 2004)
• Capitalizes on link between music and **memory**. (Kimball & O’Connor; Ziv, Granot, Hai, Dassa, & Haimov, 2007)
• Improves **recall** of content. (Brosla-Krupke, 2003)
• Improves **literacy** rates. (Pane & Salmon, 2011; Paquette & Rieg, 2008)
• Can play a significant role in raising **state language arts/reading scores**. (Beck, 2009)
• Helps young children develop **vocabulary, attention, and listening skills**. (Browkett & Baillie, 2010)

Affective
• Conveys **emotional dimension**, often missing with traditional classroom techniques of print and formal discourse. (Lewis, 1999; Varelas et al., 2002)
• Increases **understanding and in-depth learning** beyond facts by making material more **personal**. (Brosla-Krupke, 2003)
• **Excites** students; sparks enthusiasm and energy; perks up, rejuvenates, and inspires them. (Rief & Heimburge, 2006)
• Evokes **feelings and emotions**. (Browkett & Baillie, 2010; Sanchez, 2007)

Student Motivation & Inquiry
• Increases **motivation**. (Brosla-Krupke, 2003)
• Increases student **creativity & self-esteem**. (Eady & Wilson, 2004)
• Increases **interest** of both student and teacher. (Bright, 1998)
• Can encourage the learning of **how to use information**, not just memorization of content. (Veblen & Elliott, 2000)
• Makes curriculum more **relevant to student’s lives**. (Emdin, 2010b; Stovall, 2006)
• Helps shift goals from short-term retention of information conveyed by instructors to **applications of information** to solve new problems. (Modell et al., 2009)
• Promotes **wonder** and **creativity**. (Prescott, 2005)

Teacher-Student Relationship
• Allows teacher to establish a **personal style**. (Albers & Bach, 2003)
• **Humanizes** teacher. (Albers & Bach, 2003)
• Provides **common ground** for student and teacher. (Albers & Bach, 2003)
• Encourages teachers and students to use their **imagination**. (Bright, 1998)
Chapter 3: Music Video Experiment

The Impact of a Science Music Video on Content Acquisition and Engagement

3.1 Introduction

Recent literature on music in science education has called for more non-anecdotal research into the impacts of content-based music videos (Crowther, 2012b; Governor et al., 2012; McCammon, 2008). Although such videos can be used for any age group, there is great potential in focusing on intermediate school. This is an age when many students become less interested in science, while their lives become more infused with popular music (Governor et al., 2012).

The study described in this chapter is a randomized control trial of 84 students in two intermediate schools in New Zealand, examining the impact of a science music video on content acquisition and motivation to learn. Students were either shown an animated music video called “Fossil Rock Anthem” or a “just-the-facts” video covering the same material without music or animation. Thanks to the randomized design, between-group differences in learning or engagement could be attributed to the differences in videos, including the music and animation present in “Fossil Rock Anthem.” Conversely, between-group similarities in post-test scores were most likely due to similarities in the two videos, namely that both provided novel experiences exposing students to science in a non-traditional way.

Although both videos covered scientific material appropriate for the age group of the participants, the experimental design did not incorporate the videos into normal class activities. This represents a departure from how such videos would actually be used by a teacher (Governor et al., 2012), whether as an introduction, an activity, part of a homework assignment or a summary of a relevant unit (see Chapter 6). Because videos were not integrated into lessons, this study is more akin to testing the standalone impact of watching a science music video on television (Calvert & Tart, 1993) or YouTube (Allgaier, 2012; Cirigliano, 2012), rather than testing music videos in an educational context.

---

3 Intermediate school consists of year 7 and year 8, the equivalent of 7th and 8th grade (middle school) in the United States. Because this research was conducted in New Zealand, the term intermediate school will be used throughout.
Overview of Study

Eighty-four year seven and year eight students were randomly divided into two groups. One group was shown a music video (MUSIC group) while the other was shown a “just-the-facts video” (FACTS group). On day one, students were pre-tested on science content, shown their assigned video, and post-tested on science content. They were also post-tested on other measures of learning and engagement. On day seven, an email was sent to all students that included a link to their assigned video, and a link to more information. Click rates, which could be monitored thanks to the marketing service MailChimp (www.mailchimp.com), provided a behavioral measure of video engagement and desire to learn more. On day twenty-eight, students took a delayed post-test measuring content retention, interaction with the videos, and interaction with science over the past month. All participants and their parents gave informed consent to participate in this study, which was approved by the Otago University Ethics Committee (reference #12/102).

Table 3.1 Students were randomly divided into two groups (MUSIC and FACTS), and watched one of two science videos. They were given a pre-test and post-test on day 1, a follow-up email on Day 7, and a delayed post-test on day 28. All tests were conducted at school computer labs.

<table>
<thead>
<tr>
<th>Group</th>
<th>Day 1</th>
<th>Day 7</th>
<th>Day 28</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Test</td>
<td>Watch Video</td>
<td>Post-Tests</td>
</tr>
<tr>
<td>Experimental treatment #1</td>
<td>Content</td>
<td>Music video</td>
<td>Content</td>
</tr>
<tr>
<td>MUSIC group</td>
<td></td>
<td>(&quot;Fossil Rock Anthem&quot;)</td>
<td>Motivation to learn</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Desire to share</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Attitude toward lesson and lesson type</td>
</tr>
<tr>
<td>Experimental treatment #2</td>
<td>Content</td>
<td>&quot;Just-the-facts&quot; video</td>
<td>Content</td>
</tr>
<tr>
<td>FACTS group</td>
<td></td>
<td></td>
<td>Motivation to learn</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Desire to share</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Attitude toward lesson and lesson type</td>
</tr>
</tbody>
</table>
Research Hypotheses

1. Both the “Fossil Rock Anthem” music video and the “just-the-facts” video will improve performance on a scientific content test, with the “just-the-facts” video showing greater relative improvement.

2. Students in both groups will report engagement with the lesson and the science covered, with the music video group showing greater relative positivity toward the lesson and a greater relative desire to learn more about the science.

3.2 Methods

“Fossil Rock Anthem” Music Video

The lyrics to the science song being tested were based on the Science Content Standards for California Public Schools Grade 7 Earth and Life History standards (Appendix 3A). The researcher wrote the lyrics to “Fossil Rock Anthem” (Appendix 3B) using the basic lyrical structure of “Party Rock Anthem” by LMFAO, a song chosen for its catchiness and popularity among the target audience. A musician in San Francisco (DJ Lisan) created an instrumental “remake” of the song. A female vocalist in California (Nicole Bolson) sang the chorus, and the researcher performed the male vocals. In order to be in line with the copyright guidelines of Otago University, the researcher wrote to the stakeholders asking for permission to use the basic format of “Party Rock Anthem” for this reworked and reimagined “Fossil Rock Anthem” version (Appendix 3C).

The researcher created an animated music video with two goals in mind: 1) to display and emphasize lyrics; and, 2) to demonstrate scientific concepts via images and animation. For example, during the lyric “each new layer stacking up, with the oldest on the bottom and the newest on top”, the lyrics themselves stack

---

4 Both the music video and just-the-facts video can be seen on the included DVD supplement, or via the following YouTube links. MUSIC: http://youtu.be/ClJ5lwl_wM0, FACTS: http://youtu.be/ydNnAavzwDc.
5 California standards were chosen because New Zealand does not have strict standardization, though New Zealand teachers were consulted to make sure the content would be relevant and age-appropriate.
6 “Party Rock Anthem” was #1 on the New Zealand charts (and 8 other countries) for 11 weeks in 2011. The song won “Favorite Song” at the 2012 Kid’s Choice Awards (http://en.wikipedia.org/wiki/Party_Rock_Anthem).
onto each other in that order (Figure 3.1a). The researcher created the video using Adobe After Effects and Adobe Illustrator.

*Figure 3.1a Screen shot from "Fossil Rock Anthem" music video. Animations in the video were meant to highlight both lyrics and concepts.*

"Just-the-facts" Video

There were several options for what could be used as a comparison group. The literature contained examples of control groups that featured equivalent non-music lessons by teachers (McCammon, 2008), but this was not an option since the current study design did not involve teacher-directed lessons. The control video used in the *Schoolhouse Rock* study on "The Preamble" was a narrated video presenting identical words in a non-musical way (Calvert & Tart, 1993). That technique worked because the lyrics to "The Preamble" song were taken from an external document – the U.S. Constitution. That strategy was deemed inappropriate for "Fossil Rock Anthem", which, like many other content-based songs, featured lyrics that were quite different than traditional prose. Simply reading the lyrics in a non-musical way would have been unnecessarily confusing. Instead, the lyrics were translated into prose covering the same concepts, albeit in slightly more detail.

The narration was delivered aurally and visually, but without music or animation. The video allowed for control of certain variables, including time spent on the lesson, scientific content covered, and the fact that students were getting both audio and visual input (Mayer, 2003). The audio consisted of the researcher’s voice reading the transcript (see Appendix 3D). The visuals were text-only (Figure 3.1b).
Figure 3.1b Screen shot from "just-the-facts" video. The video consisted of text and narration.

Sedimentary rock, where fossils are typically found, form in layers. First, one layer of debris solidifies into rock. Then a new layer deposits and solidifies on top of the older layer. This allows us to tell the relative age of fossils.

A fossil that is found in a lower layer will be older than a fossil found in a layer closer to the surface.

Schools and Participants

Seven schools in Dunedin, New Zealand were contacted, based on recommendations from University of Otago College of Education staff (Lynn Tozer and Steven Sexton). Two schools agreed to participate in the study, referred to in this text as School A and School B.

School A is a decile 7 school while school B is decile 10 school. Both schools are full primary, teaching students from year one to year eight. All year seven (Y7) and year eight (Y8) students were given consent forms to take home. All students who brought back signed consent forms and showed up on the day of the study were included in the research. For a breakdown of participants by school and grade, see Table 3.2.

Table 3.2 All year 7 and year 8 students at participating schools were given consent forms and the option to participate. Both years and both schools were well represented in the group of students who participated.

<table>
<thead>
<tr>
<th>School</th>
<th>Type</th>
<th>Gender</th>
<th>Decile</th>
<th>Full Roll</th>
<th>Y7 Roll</th>
<th>Y7 tested</th>
<th>Y8 Roll</th>
<th>Y8 tested</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>School A</td>
<td>Full-Primary</td>
<td>Co-Ed</td>
<td>7</td>
<td>268</td>
<td>30</td>
<td>25</td>
<td>29</td>
<td>23</td>
<td>48</td>
</tr>
<tr>
<td>School B</td>
<td>Full-Primary</td>
<td>Co-Ed</td>
<td>10</td>
<td>376</td>
<td>35</td>
<td>8</td>
<td>36</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td></td>
<td>33</td>
<td>53</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>86</td>
</tr>
</tbody>
</table>

New Zealand categorizes the economic makeup of families that send children to a given school by decile. Decile 1 represents the tenth of all NZ schools with the lowest average parental income, while decile 10 represents the tenth of all NZ schools with the highest average parental income.
Stratified Randomization

Randomization occurred within each class year and each school so that both MUSIC and FACTS groups would have equal numbers from both schools and both years. The day before the study was initiated for each school, students of each year were randomly placed into one of two groups using an Excel spreadsheet. Each student was assigned a random number on that spreadsheet. The data were sorted in numerical order, with the first half placed into the MUSIC group and the second half placed into the FACTS group.

Data Collection Procedures

All pre-, post-, and delayed post-test questionnaires were created using Google forms. Submitted data were fed directly into a central spreadsheet accessible to the researcher. Videos had been uploaded onto YouTube and embedded into a Google site, which allowed students to watch their assigned video without any of the distracting links and ads that pop up when a video is watched on YouTube itself. This methodology required school computers with an Internet connection fast enough to play a YouTube video (not yet widely available in all New Zealand classrooms). A network of links allowed students to navigate from the pre-test survey to their assigned video to the post-test survey in one sitting.

Each student required their own screen and audio in order to complete their questionnaires and watch their video without distraction. Both schools had sufficient computers and headphones in their computer lab to facilitate this requirement. Each video group was tested separately so that students were not exposed to the alternate group’s video. Teachers were in another room with the students not undergoing testing, while the researcher was in the computer room throughout testing, troubleshooting and answering questions. Participants were asked repeatedly by the researcher and by their classroom teacher not to discuss their video with students in other groups or years until the study was completed.

Measuring Content Acquisition

Although 8th grade science standards are formally assessed in California, 7th grade science standards (which guided the content for the videos) are not. So while many professionally created and well-researched questions were available for 8th grade science standards, almost none were found for the 7th grade science
standards. After several failed attempts to get in contact with 7th grade teachers in California to establish how they test this material, the researcher was left to create a novel eight-item instrument to test these standards (see Appendix 3E).

In addition to the traditional standardized test format, a set of Likert items (Likert, 1932) were used to measure students’ “perception of learning.” These questions were included not only to supplement the multiple-choice content test, but because “perception of learning” itself was a variable of interest.

**Post-test Measures of Attitude and Motivation**

A post-test questionnaire measured reactions to the lesson and motivation to learn more (Appendix 3F). Specifically, Likert-style items were created to measure:

1. Attitude towards the video (*e.g.* was it fun, lame, boring, exciting?)
2. Attitude towards the type of lesson (*e.g.* should this type of lesson be used more often?)
3. Motivation to learn more about the science of fossils and geological history of the earth (*e.g.* do you want to learn more about fossils?)
4. Desire to share the video with friends and family (*e.g.* do you want to share this video with your friends?)

**Questionnaire Comments**

Although the researcher focused on quantitative measures, questions about learning and engagement clearly require a mixed methods approach (McCammon, 2008). The researcher therefore included several optional essay items on the questionnaires that allowed students to give more details and explain their answers.

**Follow-up Emails: Measuring Motivation to Learn and Allowing Further Exposure**

Due to well-established problems with self-report as a measure of behavior (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003) the researcher attempted a novel behavioral measure of “motivation to learn”. On day seven of the study, an email was sent to all participants that included a video link, and a link where they could click if they “wanted to learn more about fossils” (see Appendix 3G). For the music video group, this linked to a PDF about fossils that explains the lyrics of the song.
For the “just-the-facts” group, this linked out to a Wikipedia article on the geological history of Earth.

The primary goal of this email was to move beyond self-report toward a behavioral measure of students’ desire to learn more about the science covered in their videos. The email marketing service MailChimp offers a free service that measures “opens” and “clicks” from an email campaign. This allowed the research to use email click rates on links to measure further interaction with the video and desire to learn more.

This email served the additional purpose of allowing repeated exposure to videos between day 7 and day 28. A commonly held belief is that content-based music may influence longer-term memory because songs get stuck in students’ heads where they are repeated over and over. This may require multiple exposures to a given song (Governor et al., 2012). Consequently, emails included a YouTube link to the assigned video to facilitate further viewings.

The email was sent to students on day seven (rather than day one or two) for the sake of “motivation to learn” measurement. It was thought that, by waiting a few days, the buzz of the recent research experience might die down, allowing a longer-term measure of between group differences in motivation to learn.

**Statistics**

Statistical tests were calculated using StatPlus for mac, an extension of Microsoft Excel.

All Likert-items about student opinions (Likert, 1932) offered five categorical options of how strongly a student agreed with a given item (on the post-test, these ranged from “strongly disagree” to “strongly agree”). There is much debate in the literature as to whether to treat such data as ordinal or interval (Clason & Dormody, 1994). In this study, individual Likert-items were treated as ordinal, making a non-parametric test, the χ² test, appropriate. One shortcoming of this test is that it does not imply the directionality of a difference, only that a difference exists. Since the categories ranged from strongly disagree to strongly agree, it was decided that, in instances where there were statistically significant between-group differences, it would be obvious which group agreed or disagreed more strongly with that statement. In other words, distinguishing whether a between-group difference arose because fewer students in one group
disagreed or because more students in that group agreed were considered two sides of the same coin.

Certain clusters of Likert-items tended to measure the same specific construct, such as “desire to learn more about the science covered”. Technically, one must justify the combination of items into a single scale using additional statistical tests. These additional tests have not been performed, and therefore all instances of grouping items together to form a scale should be interpreted with caution.

These scale scores, being interval, were compared using two-tailed t-tests. T-tests were also used to compare content scores and differences in content gain scores. T-tests assume both normality and equality of variance between data sets being compared. The traditional way to test equality of variance is Levene’s test. Unfortunately, StatPlus for Mac does not offer Levene’s test. Instead it offers the F-test for variance, a test which is known for its sensitivity to non-normality. Therefore, in all instances where t-tests were used to compare interval scores, the normality of each data set was confirmed using the Kolmogorov-Smirnov test, and groups were tested for equality of variance using the F-test for variance. In situations where the assumptions of normality or equality of variance were violated, a Mann-Whitney test was used in place of the t-test.

3.3 Results from Post-test (Day 1)

Impact of Videos on Short-Term Content Acquisition

Students in both groups showed improvement on the scientific content test (Figure 3.2). Students in the MUSIC group (n=41) improved from a mean pre-test content score of 67% to a mean post-test content score of 73%, for an average improvement of 6% (t=2.18, p=0.03). Students in the FACTS group (n=43) improved from a mean pre-test content score of 65% to a mean post-test content score of 79% for an average improvement of 14% (t=4.74, p<0.001). The greater relative improvement of the FACTS group compared to the MUSIC group was found to be significant (t=1.92, p=0.5). This result is consistent with the proposed hypothesis that both types of videos improve science content acquisition, but that a straightforward “just-the-facts” video will improve short-term science test performance more than a music video.
Perception of Learning

The increased content score gains of the FACTS group are reflected in student responses to the "perception of learning" items (Figure 3.3).

The vast majority of students in both groups "enjoyed" learning. However, more students in the FACTS group reported learning something new (p=0.001). Although this may reflect video style, the fact that there was more detail included in the FACTS video renders interpretation of this item challenging.

More students in the FACTS group also reported learning something interesting (p=0.04). This may be an artifact of the "learned something new" item, for it is hard to say that you learned something interesting if you did not learn something new.

When given the statement "I understood what was being taught," the results showed a different pattern. Many in the MUSIC group shifted away from the neutral answer, primarily to "agree" with some moving to "disagree." Many in the FACTS group shifted away from "agree" toward "neutral." This difference in reported "understanding" may reflect the increased detail and occasional use of jargon in the FACTS video compared to the simpler repeated messages of the MUSIC video.
The large number of students who were "not sure" how to answer the item about the lesson being "relevant" may reflect students not knowing the definition of the word. The most frequent request the researcher received during the administration of this test was to define the term *relevant* on this item.

The items in this section were added together to form a 25-point "perception of learning" scale (Figure 3.4). The act of adding together Likert items in a single scale typically requires additional statistical tests to confirm that all
items measure the same construct. Such tests were not performed, and therefore this scale measurement must be approached with caution. The FACTS group scored 5% higher on the “perception of learning” scale than the MUSIC group (Mann-Whitney, p=0.03).

**Figure 3.4**

Perception of learning scale. The FACTS group felt like they learned more from their video, mirroring content scores.

Attitude Towards Lesson Type

Attitude toward both lesson types was overwhelmingly positive, with at least 86% in each group agreeing “lessons like the one I just had are better than learning from a textbook” (Figure 3.5). This is consistent with previous literature indicating that students enjoy the novelty of doing something different (Clark, 1994). The lack of between-group differences throughout much of this section indicates that some of the positive attitudes toward content-based music may simply reflect the novelty of the lesson rather than the music itself.

However, there may have been increased strength of agreement on some of these items. For example, those students from the FACTS group who agreed that their video was “better than learning from [a textbook]” were evenly split between “agree” (47%) and “strongly agree” (53%). In contrast, students in the MUSIC group who agreed with this statement typically “strongly agreed” (72%) rather than “agreed” (28%). However, because the overall $\chi^2$ result for this item was not-significant ($\chi^2 =3.06$, df=4, p=0.55), it is unclear whether these apparent differences in strength are meaningful or not.
Students in both groups considered their assigned video to be a valuable way to learn science that should be used more.

Lessons like the one I just had...

![Bar Chart]

Between-group statistics calculated using a $\chi^2$ test, $df=4$

**$= p<0.01$, *$= p<0.5$, +$= p<0.10$

Adjectives About the Video

A series of Likert items asked whether certain adjectives characterized the assigned video lesson (as opposed to previous questions about “type of lesson”). There was a clear difference between groups in response to whether the video was “fun” ($p=0.03$), with 95% in the MUSIC group agreeing with this item compared to 68% in the FACTS group (Figure 3.6). There were also significant differences regarding the pacing of the videos. These items were included because one of the potential pitfalls of content-based music videos is that the lessons move too quickly and incorporate too much audio-visual information. Although most students in both groups did not think either video “moved too fast”, a greater relative proportion of students in the MUSIC group chose “not sure” or “agree” ($p=0.01$). Similar between group differences were found for the statement that the video “was distracting” ($p=0.06$).

Students in both groups overwhelmingly disagreed with statements about the videos being “boring” or “lame.”
Students in the MUSIC group were more likely than students in the FACTS group to agree that their video was "fun", but also more likely to show concern over the video being too fast/distracting. Very few students thought either video was lame or boring.

The video I just watched...

Between-group statistics calculated using a $\chi^2$ test, $df=4$

\[ ** = p<0.01, * = p<0.5, + = p<0.10 \]
Desire to Share the Video

Three items investigated students’ desire to share their assigned video (Figure 3.7). The main difference occurred on the question of whether students would watch the video again at home (p=0.07). The MUSIC group’s increased desire to engage with their video was confirmed behaviorally (next section).

When asked whether the video was something they would tell their friends about, most students in the MUSIC group agreed, while most students in the FACTS group were not sure. Students in both groups were less sure about sharing their videos online.

*Figure 3.7*

Both groups were divided on whether they would interact further with assigned video. Students in the MUSIC group were more likely to report that they would share the video with friends and watch it again at home.

The video I just watched...

<table>
<thead>
<tr>
<th>Item</th>
<th>MUSIC</th>
<th>FACTS</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>...is something I would watch again at home.</td>
<td>10%</td>
<td>7%</td>
<td>0.07+</td>
</tr>
<tr>
<td>...is something I would tell my friends about.</td>
<td>5%</td>
<td>11%</td>
<td>0.19+</td>
</tr>
<tr>
<td>...is something I would share online.</td>
<td>15%</td>
<td>16%</td>
<td>0.67+</td>
</tr>
</tbody>
</table>

Between-group statistics calculated using a $\chi^2$ test, df=4

**$=$ p<0.01, * $=$ p<0.5, + $=$ p<0.10
The three items above measured a similar construct – “desire to share the video outside of the classroom”. Therefore, each item rating was translated into a score between zero and five, and all three items were combined into one scale measurement of “desire to share”. Once again, the required tests needed to thoroughly justify grouping these items together were not done, and this scale must be interpreted with caution. However, the MUSIC group had significantly higher scores (p=0.02) than the FACTS group (Figure 3.8).

Figure 3.8

"Desire to share" scale. The MUSIC group was significantly more likely to want to share their video with others outside of class.
Motivation to Learn More

It is one thing to report that music videos are more “fun” than other videos, with a greater impact on student’s desire to share them. However, a more important question for science teachers is whether this excitement about the music translates into excitement about the science. Several items measured “motivation to learn more about the science” (Figure 3.9), and found that most students, regardless of group, were now more curious about the topics covered.

**Figure 3.9**

| Most students in both groups were excited to learn more about fossils & Earth history after watching their assigned video. |

<table>
<thead>
<tr>
<th>Now that I’ve learned a bit...</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not Sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>MUSIC</td>
<td>2%</td>
<td>24%</td>
<td>49%</td>
<td>24%</td>
<td>24%</td>
</tr>
<tr>
<td>FACTS</td>
<td>20%</td>
<td>48%</td>
<td>30%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>p=0.67</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MUSIC</td>
<td>10%</td>
<td>29%</td>
<td>37%</td>
<td>24%</td>
<td>24%</td>
</tr>
<tr>
<td>FACTS</td>
<td>5%</td>
<td>25%</td>
<td>36%</td>
<td>32%</td>
<td></td>
</tr>
<tr>
<td>p=0.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MUSIC</td>
<td>10%</td>
<td>49%</td>
<td>27%</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>FACTS</td>
<td>7%</td>
<td>36%</td>
<td>41%</td>
<td>16%</td>
<td></td>
</tr>
<tr>
<td>p=0.69</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Between-group statistics calculated using a \( \chi^2 \) test

\[ df=4, \quad ** = p<0.01, \quad * = p<0.5, \quad + = p<0.10 \]
MUSIC-only Items

A series of items asking specifically about the “Fossil Rock Anthem” song were given only to the MUSIC group (Figure 3.10). Almost all (93%) of students were familiar with the song being parodied, “Party Rock Anthem.” There was near unanimous (98%) agreement that the “Fossil Rock Anthem” was catchy, and most (88%) reported that the song was still stuck in their head while filling out the rest of the questionnaire.

Figure 3.10

"Fossil Rock Anthem" is undeniably catchy (98%). Students focused on the meaning of the song’s lyrics while they watched, even as they compared those lyrics to "Party Rock Anthem".

Interestingly, the majority of students (78%) reported paying close attention to the meaning of the lyrics, even while comparing these lyrics to the original “Party Rock Anthem” song. This displays one of the key benefits of parodying a song that students are already familiar with. First of all, the original song is popular because it is catchy, so the science version will benefit from much of that same catchiness. Second of all, students are already familiar with the structure of the original song. It is possible that this familiarity with the structure allows students to pay more attention to the lyrics of the science version, though further investigation is required to explore this hypothesis.
3.4 Results From Follow-up Email (Sent on Day 7)

The day seven follow-up emails were meant to serve two purposes: 1) to provide a behavioral measure of “desire to learn more” by tracking clicks on links; and, 2) to give each student further access to his or her assigned video, allowing further exposure before the day 28 delayed post-test.

Unfortunately, this novel technique did not successfully accomplish either of these tasks. The email addresses reported on consent forms were often parental emails (address name did not match the student’s name), meaning the data gathered may be about parental “opens” and “click rates”. For those who provided a student email, many reported not checking or not remembering their password.

Two links were included in each email: one linking to the assigned video, and one linking to “more information about fossils and the history of Earth.” It was originally conceived that the click rate on the second link would serve as a behavioral measure of desire to learn more about the science. However, there was only one recipient in each group who clicked on this link (data not shown), rendering it a less than useful measure.

To the degree that students did click on links in the email, they clicked to watch the video again. There was a higher number of total “clicks” on the MUSIC group (p=0.15).

To the degree that these data say anything, the MUSIC group’s response to the follow-up email shows increased engagement. More students in the MUSIC group (58%) appear to have opened the email than students in the FACTS group (30%), a difference that was significant (p=0.01). However, MailChimp measures “opens” by including a hidden image in each email. If a recipient opens the email but does not click “display images”, this is not automatically registered as an open. If a recipient does not display images but does click on a link, it is registered as an open. Therefore, it is possible that both groups “opened” at the same rate, but due to the increased “clicks” from the MUSIC group, their open rates were closer to reality while the FACTS open rate was deflated.
3.5 Results from Delayed Post-test (Day 28)

Impact of Videos on Content Acquisition Over Time

Four students were absent for the delayed post-test, leaving the MUSIC group with n=40 and the FACTS group with n=40. The scores of these four students were removed from the pre- and post-test results in order to provide a fair comparison with the delayed post scores. The MUSIC group averaged a score of 73% on the delayed post-test, while the FACTS group averaged 69% (Figure 3.12). The difference between delayed post-test scores for the two groups was not significant (p=0.27).
The content gain from pre-test to delayed post for the MUSIC group averaged +6% while the gain score for the FACTS group was +3%.

The MUSIC group’s overall improvement (pre- to delayed post-) from 67% to 73% approached significance ($t = 1.75, p = 0.09$). The FACTS group’s improvement from 65.4% to 68.7% did not ($t = 0.40, p = 0.69$). Those results are consistent with an interpretation that the MUSIC video group had a slightly greater sustained long-term learning experience. However, the comparison of content gain scores between-groups did not approach significance ($t=0.94, p = 0.35$). To the degree to which this pattern can be considered significant, it is consistent with the idea that the science content gains of the MUSIC group are smaller but sustained, while the content gains of the FACTS group were larger but shorter-lived.
Interaction with Science: Day 1 to Day 28

Participants were asked a series of questions about their behavior between day 1 (the pre- and post-test) and day 28 (the delayed post-test). These Likert items contained the categories “never”, “almost never”, “sometimes”, “often”, and “very often”, as opposed to the post-test measures asking about strength of agreement. It should be noted that the answer “sometimes” reflects some action, rather than the neutral term of “not sure” in the agree-disagree scale used previously.

When given the statement “I’ve found myself thinking about fossils,” there was a significant between-group difference (p=0.02, Figure 3.13). Students in the MUSIC group were most likely to say “never” or “almost never”, while students in the FACTS group were more likely to say “sometimes.” This may reflect a more explicit focus on fossils in the “just-the-facts” video, compared to a greater emphasis on what fossil evidence tells us about the history of the Earth emphasized in “Fossil Rock Anthem.” The MUSIC group reported thinking more often about “the history of life on Earth”, although the between group difference was not highly significant (p=0.20). For the item “I’ve found myself thinking about paleontology (the study of fossils),” there was no between group difference (p=0.75), with both groups primarily choosing “never” or “almost never.”
Students generally did not think much about the science covered in the videos in the ensuing month. Surprisingly, students in the FACTS group were slightly more likely to have thought about fossils.

Over the past month, I've found myself thinking about...

![Bar chart showing the percentage of students in the MUSIC and FACTS groups who thought about different topics over the past month.](chart)

*Between-group statistics calculated using a $\chi^2$ test, $df=4$

** = $p<0.01$, * = $p<0.5$, + = $p<0.10$
The next set of items was meant to measure action rather than thought (Figure 3.14). Most interesting was the question of whether students had discussed relevant science with their family. While 81% of the MUSIC group said never or almost never, only 52% of the FACTS group said never or almost never. This is an item where the demographics of the schools may be quite important. These are high-decile schools with strong academic reputations (ERO, 2010). Therefore, students who were already interested in geology and were taught additional geological acts in the FACTS group might have responded by speaking more about with family members, who tend to be interested and engaged with what students learn at school. For more on this, see discussion.

**Figure 3.14**

Students generally did not pursue more information on science, though students in the FACTS group were more likely to discuss relevant science with their family.

*Over the past month...*

<table>
<thead>
<tr>
<th>Item</th>
<th>MUSIC</th>
<th>FACTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>I talked about fossils or earth sciences with my family.</td>
<td>59%</td>
<td>27%</td>
</tr>
<tr>
<td>p=0.002*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I looked for information about fossils and earth science (for example, from books or the internet).</td>
<td>46%</td>
<td>39%</td>
</tr>
<tr>
<td>p=0.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I talked about fossils or earth sciences with my friends.</td>
<td>61%</td>
<td>41%</td>
</tr>
<tr>
<td>p=0.52</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Between-group statistics calculated using a $\chi^2$ test, df=4*

** = p<0.01,  *= p<0.5,  + = p<0.10
The previous six items were transformed into a numerical scale ("almost never" = 0 and "very often" = 4), and added together to form an "interaction with science" scale with a minimum possible score of zero and a maximum possible score of 24. The same caveats about adding Likert items into a Likert scale hold true for this measurement. The FACTS group scored a mean of 37% on this scale compared to the MUSIC group at 28%, a difference that approached significance (Mann-Whitney, p=0.06).

**Figure 3.15**

The FACTS group was more likely to interact with science between day 1 and day 28, though there was more variation in the MUSIC group.

However, that difference in means must be understood in light of the variance of the groups and the distribution of scores. As can be seen below (Figure 3.16), eleven students in the MUSIC group scored zero on their "interaction with science" scale. This may reflect a substantial subset of any class for whom a science music video will have no pedagogical or motivational value.
3.6 Discussion

Content Acquisition

Despite the increased short-term content acquisition by the FACTS group (Figure 3.2), their gains soon disappeared (Figure 3.12). In contrast, the content score improvements seen by the MUSIC group on day 1 were maintained as of day 28. It should be noted, however, that the MUSIC group’s improvement was small (6%), and that the difference between the MUSIC and FACTS groups on the delayed post content score was not found to be highly significant.

Insofar as there may be a trend within these data concerning content acquisition, results suggest larger but temporary short-term gains for the FACTS group, compared to smaller but sustained gains for the MUSIC group. This suggests there may be pedagogical value to music video lessons on their own and that some of the catchiness (Figure 3.10) of the music may translate into longer-term content acquisition. This is particularly interesting in light of experiments in a related field, video games in education. A recent study of a teacher-created genetics video game found that there were no learning differences between the video game group and the control group, but that the video game group was more engaged in the lesson (Annetta, Minogue, Holmes, & Cheng, 2009). This same
pattern of increased engagement and comparable learning outcomes was also seen in a control trial of music-based teaching (McCammon, 2008). Unlike the present study, neither of those studies did medium or long-term follow-ups, something to be noted when conducting future research in both music and video game education. If larger sustained long-term learning outcomes from musical lessons could be replicated in a larger, more diverse group of students, it could provide strong evidence of the pedagogical advantages of content-based music.

**Attitude Towards Lesson Type and Desire to Share**

Students respond favorably to novelty, which is critical to remember when interpreting educational media studies (Clark, 1994). As both the MUSIC and FACTS videos represented a departure from normal classroom activities, it was not surprising to see that both lesson types were considered “better than a normal textbook” (Figure 3.5). The lack of between-group differences on this item confirmed the importance of well-controlled experiments, and provided a warning not to jump to the conclusion that positive reviews of a new lesson were due to the specific attributes of that lesson.

However, data from this study do demonstrate the unique pros and cons of music video lessons. The data confirmed the researcher’s hypothesis that some content-based music videos may be considered too fast or too distracting by a subset of students (Figure 3.6). This doesn’t necessarily mean that videos should be slower or less complex (although getting the right balance is important). This does mean that there should be opportunities to watch a music video multiple times and to engage with its content on a much deeper level. Incorporating deeper follow-up activities and lessons into this type of research model would be a logical next step (McCammon, 2012).

Beyond pacing, another significant result was that the music video was perceived as being more fun (Figure 3.6). As the MUSIC group rated this item significantly higher than the FACTS group, this “fun factor” cannot be explained only as a product of novelty, and can reasonably be attributed to the incorporation of pop music or animation into the lesson. Qualitative comments by the students confirm that both music and animation played a role. Making science lessons “fun” is a key goal for maintaining scientific interest at this age and does not necessarily require the use of music. Hands-on activities and inspiring lessons can do the same things for many students (Gibson & Chase, 2002). However, if lessons
can be made more fun for a larger subset of students simply by watching a three-minute video, then content-based videos may indeed be of value.

The increased “fun factor” may have influenced the MUSIC group’s increased “desire to share” the video outside of class (Figures 3.7 and 3.8). Whether sharing with family, friends, or online, students in the MUSIC group were more likely to report a desire to interact with the video outside of the classroom. Increasing voluntary student interaction with science themed videos outside of class or homework would certainly be a valuable outcome. But does this translate into further interaction with scientific material itself?

**Motivation to Learn About Science**

There were three general ways that motivation to learn about science was measured: post-test, email click rate, and delayed post-test. There was no difference on immediate post-test questions about desire to learn more about fossils or the history of Earth (Figure 3.9). Both groups reported increased interest in these subjects and a desire to seek out more information.

The “I want to learn more” link on the follow-up email turned out to be an inadequate behavioral measure, as only one student in each group clicked on it. Email is simply not a commonly used tool by this age group. Students responded anatomically that they “never check their email”, often forget their passwords, or used a parental email that did not get passed along to them. Therefore, the low overall click rate is much more likely due to intermediate students’ relationship with email rather than their lack of motivation to learn. This should not discourage researchers from attempting to utilize students’ increasing use of technology in order to gain behavioral measures that supplement self-report measures.

The delayed-post items, where students reported on whether or not they engaged with the science over the past month, were of interest. In general, there was a trend toward increased scientific interaction reported by the FACTS group compared to the MUSIC group. The FACTS group reported thinking more often about fossils, though not about the history of life on Earth (Figure 3.13). There was no statistically significant difference on items asking about whether students thought about paleontology (most didn’t), whether students sought out additional information on the science (most didn’t) or whether students discussed the
science with their friends (most didn’t, Figures 3.13 and 3.14). The FACTS group was, however, more likely to discuss the science with their family (Figure 3.14).

It is important to interpret these results in light of the demographics of the participants in the study. These students go to high-performing, high-decile schools that are known for having a high level of parental involvement (ERO, 2010). Many genuinely enjoyed the science presented in the FACTS video because it taught them more about a subject they were already curious about. For example, one student in the FACTS group wrote,

Great video, I’m interested in geological movement in the earth. My English report was about continental drift and Alfred Wegener’s theory behind the geological forms of the earth 300 million years ago.

Students being pre-aroused on the scientific subject matter could have helped to explain why a video clearly presenting scientific information may have lead to more family discussions about the science.

Another important factor to remember is variation within students. It was not expected that all students would have the same reaction to either video type. The fact that so many more students in the MUSIC group scored 0% on the delayed post “interaction with science” scale (Figure 3.16) is a good reminder that content-based music videos will not translate into scientific engagement for a significant subset of students.

However, if content-based music videos can be incorporated into classroom lessons, then many of their advantages can be combined with the advantages of traditional classroom teaching. A three-minute science music video can make an introductory lesson more fun, and motivate students to voluntarily participate in a science-themed activity outside of their schoolwork. This may even arouse and motivate a subset of students who are not as excited about traditional recitations of the material. Any classroom incorporation of a music video lesson could easily combine the learning advantages of both video types by blending music with more information and activities. The “facts” would be clearly presented by the teacher or via reading assignments, potentially leading to greater short-term increases. The question is whether the incorporation of that musical lesson as a hook, a review, or an activity in its own right, is worth the time and resources. Based on the results of this study and others (Governor et al., 2012; McCammon, 2008) it can be argued that using a music video in one of these ways
would be worth the short time cost, due to its impact on motivation and engagement alongside potential benefits in medium-term content retention.

3.7 Limitations of Study

School Sampling

Schools were not randomly selected. The two schools that participated are not demographically representative of either New Zealand or Dunedin. In fact, these are schools that often cooperate with the University of Otago in research projects. This school sampling bias must be considered in the interpretation of student’s response to both videos (see previous discussion about beneficial impact of FACTS video).

Content Tests

Content acquisition was quantified by comparing pre-test, post-test, and delayed post-test scores. Although this content test captured a lot of variation in students’ knowledge (Figure 3.17), it did not leave much room for improvement. Thirty percent of students scored either 7/8 or 8/8 on the pre-test, leaving little room to measure improvement in scores.

Figure 3.17

Pre-test content score distribution on an 8 item content test. There is considerable variation, but little room for improvement for those at the top.

Measuring Motivation to Learn More

It was decided that many engagement measures were more appropriate as a post-test only measure rather than a pre-post comparison. This was obvious for the type of questions that asked participants to discuss things specific to a video that they would not have watched as of the pre-test. However, it would have been
more sound to measure “motivation to learn about the science”, on both the pre- and post-tests on day 1. If this is done in the future, it is worth considering an additional control group to measure pre-test effects.

**Issues with Videos During Testing**

School B had blocked YouTube on student computers, forcing the researcher to download copies of the video onto the hard drives of each computer and adjust the instructions accordingly. School A had an Internet connection that was unreliable. Many videos paused repeatedly, which was frustrating for students (but happened with equal frequency across groups). It should be noted for future research that every school will have a different computer set up, requiring substantial communication, preparation, and piloting, with tailoring and troubleshooting methods for each school.

**Presence of Researcher in Room During Testing**

Both videos contained audio of the researcher's voice: the FACTS video in the narration and the MUSIC video in the vocals. However, the role of the researcher in creating the FACTS video seemed to be more obvious to students. It is therefore possible that the presence of the researcher in the room during testing lead members of the FACTS group to be more positive about their attitude toward that lesson type, simply because it was more obvious that the person whose work they were judging was in the same room as them.

**Follow-up Emails**

The use of the follow-up emails in this type of research paradigm was promising, but problematic. As technology works its way into people’s lives in the classroom at home, there will be more and better opportunities for researches to get much more valid data on student behavior outside of the classroom. This email click-tracking scheme was an attempt to do just that. However, email itself is a problematic way to interact with 11 and 12 year olds, as discussed earlier. In the context of this study, this lead to two problems – one minor and one major.

1. Minor: an unsatisfactory measure of student interaction with video and desire to learn more, leaving the researcher to rely on self-report data.
2. Major: because the email was also the mechanism of allowing students to get repeated exposure to their video, the lack of opens (alongside spotty Internet connections in many homes) diminished the impact of a three-
week exposure to the video. In light of this lack of continued exposure, the delayed-post results are all the more surprising.

In retrospect, waiting seven days to send the follow-up email may have been a mistake. Expecting interest in the video to carry over seven days later may have been unrealistic given how music videos are actually used in the classroom—a short-term hook into a lesson. Furthermore, since the email also included a link to the video, delaying email delivery lead to fewer students paying attention to that link, fewer students exposing themselves to the song, and a consequentially different impact on delayed post scores a month later.

The “more information” link was also problematic. The researcher had created a PDF (see Appendix 3H) to specifically accompany the “Fossil Rock Anthem” music video to allow interested students to delve deeper into the material. Yet the researcher did not create an equivalent PDF for the control group. Instead, a link to a Wikipedia article on the geological history of Earth was included. Luckily for this study, so few students’ clicked on this link that it did not impact on the results. However, this should be recognized as a mistake to be rectified in future research.

**Between-group Leakage**

There was potential for leakage throughout this study, despite repeated instructions from the researcher to avoid discussion. The use of the follow-up email to send out video links made leakage much easier as students could simply forward the email or the link to their friends. However, due to the low open rate of the emails, this did not appear to be a problem. However, verbal leakage—students telling each other about their videos directly after day 1 testing—may have occurred. Other studies have addressed this problem by having students sign a pledge not to discuss their lesson with other students (McCammon, 2012).

Fortunately, the structuring of the immediate pre-post data collection made leakage on this preliminary measurement almost impossible. Students simply did not have the opportunity to tell each other about the videos they watched.
3.8 Conclusions

In conclusion, this study provides support for further integration of short music-based videos into science education. Though given the variability in student responses to the video, a key question for future research will be which students benefit most from music-based lessons. Are these videos more likely to engage students with specific musical interests, low or high engagement with science class, or from certain demographic groups? It was interesting that the music video had a positive learning and motivation impact, even though it was not incorporated into the unit being taught in school. Further research should examine whether such videos can have increased impact when they are incorporated into classroom activities. Examples of activities to engage students with pre-made science songs are plentiful in the literature (Governor et al., 2012) and will be explored further in Chapter 6.

Having students create their own science songs is another clear way to use music in the service of science education. The next chapter explores Science Idol 2012, a New Zealand wide science song writing competition for students.
Chapter 4: Science Idol 2012 Tour and Competition

4.1 Background

In June 2010, I was a keynote speaker at the New Zealand International Science Festival (NZISF). I performed live at fifteen Otago schools and lead workshops for twenty children from ages eight to fourteen. Workshop participants were given four hour-long lessons on how to create their own science songs. They performed live at the end of NZISF 2010 in a competition to become New Zealand’s first “Science Idol”. A year later, the NZISF director, Chris Greene, asked me to take a larger role in planning and executing “Science Idol 2012.” We decided that the 2012 competition and school tour would be opened up to all of New Zealand.

The planning, execution, and outputs of Science Idol 2012 became a large part of the “creative component” for this thesis. Recruiting a large group of students to create their own songs also provided an opportunity to explore the tradeoffs of science song authorship. What were the costs and benefits of having students write and produce their own science songs (Chapter 5) versus passively consuming a pre-made science music video (Chapter 3)?

This chapter details the planning, execution, outputs, and lessons from the Science Idol 2012 tour and competition. This includes basic demographic data from an entry form questionnaire filled out by all participants, and YouTube analytic data on video tutorials and winning videos. Chapter 5 will explore the results of a follow-up research questionnaire, which was completed by a small number of participants after the competition had closed.

4.2 Tour

During the 2012 tour I visited 19 schools in four New Zealand cities - Auckland, Wellington, Christchurch, and Dunedin. Schools ranged across all deciles and age groups (Figure 4.1 and Table 4.1). At each school I performed a 45-minute multimedia performance integrating live performances of songs,

---

8 The pronoun “I” will be used throughout this chapter to refer to the researcher, Tom McFadden. The pronoun “we” will be used to refer to Tom McFadden and the NZISF staff.
9 A well-edited summary produced by Our Changing World (Radio NZ) is included in the attached DVD. It is also available here: http://podcast.radionz.co.nz/ocw/ocw-20120531-2106-science_rapping-048.mp3.
personal anecdotes, science lessons, and audience participation. The song choice and tone varied for different ages, but in all cases the aims of the performance were as follows.

1. To instill a contagious enthusiasm for science in the classroom and remind students that science is a way of thinking, not just a body of facts.
2. To promote creativity and the blurring of educational boundaries. My blend of hip hop and science was provided as an example of what one can do when diverse passions are combined.
3. To inspire students to explore their own passions – in any area of their lives, including science, school, and art.
4. To encourage students to participate in Science Idol 2012 by creating their own science song and music video.

We were able to fund the tour thanks to a generous grant from the U.S. embassy in New Zealand, who not only paid for airfare and lodging, but provided logistical support by liaising with schools outside of Dunedin. The NZISF staff provided logistical support in Christchurch and Dunedin. The NZISF public relations staff set up several media events, which further served to promote the competition.
Figure 4.1a-d Science Idol 2012 School Tour Stats

a. Schools visited by decile

b. School shows by age

c. School shows by region

d. School shows by size
<table>
<thead>
<tr>
<th>City</th>
<th>Location</th>
<th>School Ages</th>
<th>Gender</th>
<th>School Roll</th>
<th>Type</th>
<th>Decile</th>
<th>Ages @ Show</th>
<th>Approx #s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auckland</td>
<td>Churchill Park School</td>
<td>Full Primary</td>
<td>Co-Ed</td>
<td>449</td>
<td>State</td>
<td>10</td>
<td>Y7-Y8</td>
<td>80</td>
</tr>
<tr>
<td>Auckland</td>
<td>Orakei School</td>
<td>Full Primary</td>
<td>Co-Ed</td>
<td>136</td>
<td>State</td>
<td>3</td>
<td>Y5-Y8</td>
<td>60</td>
</tr>
<tr>
<td>Auckland</td>
<td>Blockhouse Bay Intermed.</td>
<td>Intermediate</td>
<td>Co-Ed</td>
<td>836</td>
<td>State</td>
<td>6</td>
<td>Y7-Y8</td>
<td>836</td>
</tr>
<tr>
<td>Auckland</td>
<td>Diocesan School for Girls</td>
<td>Composite (1-15)</td>
<td>Girls</td>
<td>1430</td>
<td>Private</td>
<td>10</td>
<td>Y7-Y8</td>
<td>100</td>
</tr>
<tr>
<td>Auckland</td>
<td>Sir Edmund Hillary Collegiate</td>
<td>Secondary</td>
<td>Co-Ed</td>
<td>563</td>
<td>State</td>
<td>1</td>
<td>Y9, one class</td>
<td>20</td>
</tr>
<tr>
<td>Wellington</td>
<td>St. Brendan’s School</td>
<td>Full Primary</td>
<td>Co-Ed</td>
<td>261</td>
<td>State Int.</td>
<td>8</td>
<td>Y7-Y8</td>
<td>70</td>
</tr>
<tr>
<td>Wellington</td>
<td>Linden School</td>
<td>Contributing</td>
<td>Co-Ed</td>
<td>120</td>
<td>State Not Int</td>
<td>4</td>
<td>Y1-Y5</td>
<td>120</td>
</tr>
<tr>
<td>Wellington</td>
<td>Koraunui School</td>
<td>Contributing</td>
<td>Co-Ed</td>
<td>319</td>
<td>State Not Int</td>
<td>4</td>
<td>Y1-Y8</td>
<td>240</td>
</tr>
<tr>
<td>Wellington</td>
<td>Cardinal McKeefry</td>
<td>Full Primary</td>
<td>Co-Ed</td>
<td>102</td>
<td>State Int</td>
<td>10</td>
<td>Y7-Y8</td>
<td>60</td>
</tr>
<tr>
<td>Wellington</td>
<td>Wellington Girls</td>
<td>Secondary (9-15)</td>
<td>Girls</td>
<td>1272</td>
<td>State Not Int</td>
<td>10</td>
<td>Y9 &amp; Y13</td>
<td>40</td>
</tr>
<tr>
<td>Christchurch</td>
<td>Cashmere high</td>
<td>Secondary (9-15)</td>
<td>Co-Ed</td>
<td>1716</td>
<td>State Not Int</td>
<td>8</td>
<td>Y9-Y13</td>
<td>200</td>
</tr>
<tr>
<td>Christchurch</td>
<td>Discovery One School</td>
<td>Full Primary</td>
<td>Co-Ed</td>
<td>146</td>
<td>State Not Int</td>
<td>6</td>
<td>Y1-Y5</td>
<td>120</td>
</tr>
<tr>
<td>Christchurch</td>
<td>Aranui</td>
<td>Secondary (9-15)</td>
<td>Co-Ed</td>
<td>577</td>
<td>State Not Int</td>
<td>2</td>
<td>Y9-Y13</td>
<td>250</td>
</tr>
<tr>
<td>Christchurch</td>
<td>Selwyn House</td>
<td>Full Primary</td>
<td>Girls</td>
<td>243</td>
<td>Private</td>
<td>10</td>
<td>Y7-Y8</td>
<td>50</td>
</tr>
<tr>
<td>Christchurch</td>
<td>Catholic Cathedral College</td>
<td>Secondary (7-15)</td>
<td>Co-Ed</td>
<td>332</td>
<td>State: Int</td>
<td>3</td>
<td>Y9-Y10</td>
<td>100</td>
</tr>
<tr>
<td>Dunedin</td>
<td>Dunedin North Intermediate</td>
<td>Intermediate</td>
<td>Co-Ed</td>
<td>203</td>
<td>State: Not Int</td>
<td>6</td>
<td>Y7-Y8</td>
<td>200</td>
</tr>
<tr>
<td>Dunedin</td>
<td>Tahuna</td>
<td>Intermediate</td>
<td>Co-Ed</td>
<td>497</td>
<td>State: Not Int</td>
<td>8</td>
<td>Y7-Y8</td>
<td>200</td>
</tr>
<tr>
<td>Dunedin</td>
<td>Balmacewen</td>
<td>Intermediate</td>
<td>Co-Ed</td>
<td>503</td>
<td>State: Not Int</td>
<td>9</td>
<td>Y7-Y8</td>
<td>300</td>
</tr>
<tr>
<td>Dunedin</td>
<td>St. Clair School</td>
<td>Contributing</td>
<td>Co-Ed</td>
<td>369</td>
<td>State: Not Int</td>
<td>6</td>
<td>Y1-Y5</td>
<td>50</td>
</tr>
</tbody>
</table>

| 19 Schools Visited | Students Total | 3096 |
4.3 Competition Planning

Opening Up the Competition to All of New Zealand

The first NZISF Science Idol competition in 2010 was local, live, and limited. I conducted workshops to coach students through the songwriting process in person, which limited how many students could participate. The workshops culminated with live student performances. This format lead to a fun and successful event at NZISF 2010, though the performances, being live, could not be easily shared with a wider audience.

We decided that a large New Zealand-wide audience could be reached in 2012 if, instead of in-person workshops, I created a set of online video tutorials to walk students through the process of making their own science music video. By making participant submissions digital (a short, “one take” video) rather than live, people from any part of the country could participate and share their work.

Opening Up the Competition to All Ages

Since many teachers and university students have the skills and interest to create science songs, we decided to open up the competition to older participants as well. The digital nature of the tutorials and submissions removed any need to limit participant numbers. In order to make the competition fair, we divided the field into three age categories: 1) Ages 8-14, 2) Ages 15-21, and 3) Ages: 22+ (see entry forms in see Appendix 4A).

Incentivizing Submissions

Although science song creation is fun, it takes substantial effort. We hoped to incentivize participation by offering prizes for winners. I reached out to San Francisco music education startup KlabLab (which has been running workshops and competitions at schools in California) to sponsor iPads for each of the age group winners. We devised a grand prize where the top entry would get to rework his or her song with me, and would professionally record their vocals at the Otago University Music Department’s Albany Street studio. This grand prizewinner was to be selected from the three age group winners.
4.4 Online Video Tutorials

I have run science song-writing workshops for students and teachers of many ages. While there are a few “tips and tricks” that help when creating an audio-visual output, an important part of the learning experience is simply learning by doing. The instructions and tutorials were therefore meant to give all the information necessary to make a solid product, without limiting creativity. The tutorials were created specifically with Science Idol 2012 in mind, with the goal that they could be used in the future by any teacher or student hoping to get advice on song-writing or audio-visual production. Video tutorials were uploaded on the 29th of April 2012. Science Idol submissions were due on the 18th of June 2012.

Table 4.2 View Counts for Science Idol Video Tutorials, since posting them on the 29th of April 2012 (Source: YouTube Analytics)

<table>
<thead>
<tr>
<th>Video Topic</th>
<th>NZ Views as of 18-June-2012</th>
<th>Worldwide views as of 18-June-2012</th>
<th>NZ Views as of 8-Oct-2012</th>
<th>Worldwide views as of 8-Oct-2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction</td>
<td>484</td>
<td>746</td>
<td>604</td>
<td>1037</td>
</tr>
<tr>
<td>2. Brainstorming</td>
<td>71</td>
<td>157</td>
<td>100</td>
<td>239</td>
</tr>
<tr>
<td>3. Lyrics</td>
<td>56</td>
<td>150</td>
<td>76</td>
<td>215</td>
</tr>
<tr>
<td>4. Audio</td>
<td>48</td>
<td>108</td>
<td>67</td>
<td>163</td>
</tr>
<tr>
<td>5. Video</td>
<td>55</td>
<td>134</td>
<td>73</td>
<td>202</td>
</tr>
<tr>
<td>Totals</td>
<td>714</td>
<td>1295</td>
<td>920</td>
<td>1856</td>
</tr>
</tbody>
</table>

The lowest view count in New Zealand through the 18th of June (48) provides a rough estimate of how many kiwis might have used the tutorials in the context of Science Idol 2012 (Table 4.2). Although there were not 48 submissions (there were 27), most Science Idol entrants who filled out the “Research Questionnaire” (see chapter 5) reported watching all five tutorial videos.

Worldwide post-competition view counts indicate that the video tutorials are serving their secondary purpose – inspiring and facilitating creative audio-visual production by students and teachers outside of the context of Science Idol.

But who were the New Zealanders who used these tutorials during the competition? Demographic information was available only for “Video #1: Introduction.” Presumably, this information is representative of the other four video tutorials. These data (Figure 4.2) confirm that the videos hit the target demographic of young people, with 33.2 % of views coming from ages 13 to 17 and 13.7% coming from ages 18 – 24. There was a skewed gender ratio, with
63.8% female and 36.2% male (41% of which were 45-54 and therefore more likely to be parents or teachers). This skewed gender ratio may reflect: 1. patterns of female scholastic participation and performance in school 2. patterns of participation in the New Zealand International Science Festival 3. patterns of interest in science song writing competitions, or 4. a statistical fluke.

*Figure 4.2 Science Idol Introduction Video Demographics, 29 April 2012 to 18 June 2012 (Source: YouTube Analytics)*

Figure 4.3 shows the websites where people tended to watch the video tutorials. During the run up to Science Idol 2012, most people viewed the video tutorials via the embedded link on the NZISF website (scifest.org.nz). This is where we wanted participants to get the information, given that the website also included important logistical details and instructions for the competition. Although this indicates that most awareness of and about the competition was facilitated by the NZISF website, the results of the “Entry form questionnaire” (next section) indicate that most participation in the competition was driven by live performances at schools during the Science Idol 2012 school tour.
4.5 Competition Results and Discussion

Participants submitted their entries by uploading their music video to YouTube or Vimeo, then filling out an “Entry form questionnaire” (Appendix 4B) powered by Google forms. In addition to soliciting demographic data and the url of their video submission, this form required parental consent for entrants under the age of 18. Although there were 27 entries, five of the participants mailed in their submissions and did not fill out this form. These data represent the remaining 22 entrants.
**Who Participated?**

*Geographic Region*

The geographical location of competition entrants is shown in Figure 4.4. Given the fact that Auckland, Christchurch, and Wellington all had the same number of school shows (Figure 4.1), Auckland’s lack of representation in the contest was somewhat surprising. It was not surprising that almost half of participants were from Dunedin, given my higher profile at local schools (due to widespread coverage in the *Otago Daily Times* and my outreach work at Dunedin schools). It is a testament to the hard work of the tour staff and the publicity campaign that there was over 50% participation from outside of Dunedin. This represents an important step toward increasing the profile of NZISF outside of the city in which it is held.

However, I believe that participation rates could have been even higher had there been better communication with schools and teachers before and after school tour performances (see discussion).

**Figure 4.4 Most Science Idol participants came from Dunedin, followed by Christchurch and Wellington.**

<table>
<thead>
<tr>
<th>Location</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dunedin</td>
<td>10</td>
</tr>
<tr>
<td>Christchurch</td>
<td>4</td>
</tr>
<tr>
<td>Wellington</td>
<td>4</td>
</tr>
<tr>
<td>Waiuku (North Island)</td>
<td>1</td>
</tr>
<tr>
<td>Kaikoura</td>
<td>1</td>
</tr>
<tr>
<td>Nelson</td>
<td>1</td>
</tr>
<tr>
<td>Oamaru</td>
<td>1</td>
</tr>
</tbody>
</table>

**Recruitment**

Most participants heard about the competition through the Science Idol 2012 school tour. The rest found out through media events organized by the NZISF publicist, word of mouth, or general NZISF promotions.
Figure 4.5 Most Science Idol 2012 participants found out about the competition via the school tour performances.

How did they hear about competition?

- Science Festival / Word of Mouth: 5
- Tom performing at school: 12
- Erin Simpson Show: 2
- National Radio: 1
- Stuff.co.nz: 1

Age Group

Participants came primarily from the youngest age group, ages 8-14. This makes sense, as intermediate school was the NZISF’s target age group in terms of school shows and publicity.

Figure 4.6 The majority of Science Idol participants were in the youngest age group (ages 8-14).

Science Idol Participation by Age Group

- Ages 8-14: 7
- Ages 15-21: 12
- Ages 22 and above: 3

It is worth pausing to investigate the ratio of young students (age 8-14) to senior students (age 15-21) (Figure 4.6). After the 2010 festival, the NZISF director and I agreed that intermediate school students responded more favorably to live performances than secondary students. So in 2012, the tour focused on
visiting younger students (Figure 4.1b). This begs the question: was the relative popularity of the 2012 competition among younger students a result of their increased interest in such competitions, or simply an artifact of the biased tour schedule?

Upon first glance, the Science Idol participation data seem to indicate the youth-skewed age ratio (80% to 20%) could be based on the tour’s bias toward intermediate schools (76% to 24%). However, the data on how participants found out about the competition tell a different story (Table 4.3). Seventy-five percent of younger participants found out about the competition from the tour, while none of older participants had been at a tour show. This means that none of the 610 secondary school students who witnessed the Science Idol tour decided to participate in the competition. These students may simply have been busier with their studies or they might have thought that competition was more suitable for younger students. Either way, it appears that intermediate-aged students were more receptive than older students to my calls for participation at live shows.

**Table 4.3** Most 8-14 year old participants found out via the school tour, while most older participants found out via other means.

<table>
<thead>
<tr>
<th></th>
<th>Students at School Shows during Tour</th>
<th>Science Idol Participants</th>
<th>Science Idol Participants: How they found out</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td># Students @ shows</td>
<td># Participants</td>
<td>Tour</td>
</tr>
<tr>
<td>Ages 8 to 14</td>
<td>Age Ratio 76%</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>Ages 15 to 21</td>
<td>Age Ratio 24%</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>15</td>
<td>9</td>
</tr>
</tbody>
</table>

**Finalists**

An NZISF staff member and I judged all entries, based on three criteria: scientific content, lyrical ingenuity, and performance. A full description of judging criteria can be seen in Appendix 4C.

We decided that there should be a minimum of three finalists in each age group, with room for more finalists if entries passed a quality threshold. In the end there were three finalists in each of the two younger age groups and five finalists
in the oldest age group. From those finalists we selected one category winner from each age group. From those category winners we selected one grand prizewinner.

**Grand Prizewinner**

The grand prizewinner was James Mustapic, a high school student from Dunedin, NZ. His song, “Covalent Love”, parodied a song called “Boyfriend” by Justin Beiber. James’s lyrics maintained Beiber’s themes of love and courtship in order to describe the differences in how electrons are shared between atoms in ionic and covalent bonds.

I consulted with local high school chemistry teachers and Otago University academic staff to fact-check the song and we expanded its message by fine-tuning the chorus and adding another verse. The final lyrics to “Covalent Love” can be seen in Appendix 4D. I then coached James on vocal recording and prepared him to record the final version of his song in the state-of-the-art Otago University Music Department Albany Street studio. Two fellow M. Sci. Comm. Students (Laura Honey and Simon East) shot and edited a behind-the-scenes video of James in the studio. The video was posted on YouTube on 6 July 2012.

As of the 6th of October 2012, the studio version of “Covalent Love” had received 4,491 views around the world. About 1/4 of those views have been in New Zealand. “Covalent Love” has been particularly popular with 13-17 year old girls, which is unsurprising given the fan base of Justin Beiber (Figure 4.7).
In addition to an impressive worldwide view count, I have been surprised at the positive YouTube reaction given the site’s reputation for vitriolic hatred, particularly of anything Beiber-related. The like-to-dislike ratio is of particular note. Of all people who bothered clicking “like” or “dislike,” 99.07% have liked “Covalent Love” (107 likes to 1 dislike). In contrast, only 66.9% of have liked “Boyfriend” (810,908 likes to 401,805 dislikes (green/red bars in Figure 4.8)). This difference was significant ($\chi^2 = 50.56, p<0.001$), though it likely reflects a difference in audiences rather than differences in the video itself. “Covalent Love” presumably has attracted a small subset of science-friendly people, while the Beiber video attracts a general swath of teenagers who enjoy loving and hating Beiber with equal passion. It would be interesting to see a controlled comparison of reactions to the video within the same audience.
This final version of “Covalent Love” represents a positive model of what content-based science songs can achieve. It is student-conceived and largely student-written, providing a powerful experience for the student who created it. The content has been thoroughly vetted by educators and scientists. By recording at a state-of-the-art facility, the musical production values are at a professional level. By parodying an incredibly popular song (159 million hits on YouTube as of 7th of October), the song will automatically be catchy. And when people hear the Beiber-version of the song, people may be likely to start thinking about covalent bonding.

There is, however, room for pedagogical improvement in the visuals. While the current visuals (James performing in the studio) are entertaining and professional, they add little to the educational value of the video. However, this may provide an opportunity for teachers and students around the world to create their own visuals. Students creating their own videos for pre-made science songs has been proposed as one of best ways to incorporate content-based music into classroom activities (McCammon, 2012).

4.6 Lessons

Successes

I am proud of what we were able to accomplish in the first year trying to bring Science Idol to all of New Zealand. I am pleased that we were able to partner with organizations that could provide such excellent prizes and could sponsor
such a far-reaching tour. I am pleased that we made submissions digital, which left all participants with a record of their work that they could easily share with friends and family. Finally, I am pleased that there is a legacy in that the instructional videos are now available online, encouraging and facilitating further creative endeavors around the world.

I am impressed with the impact of media appearances as well. My appearance on The Erin Simpson show was able to recruit two extra participants with many intermediate students at subsequent shows reporting that they saw me on the show when it aired. The winner of oldest age group, based in Nelson, found out about the competition thanks to a National Radio interview I did in Wellington. The success of these media opportunities and the participation they inspired are a testament to the hard work of NZISF publicist Merrin Bath.

**Uploading Videos**

We originally decided that it did not matter whether participants used YouTube or Vimeo to upload their submissions online. We wanted submissions to be open to the public, but wanted to be able to download a version to be edited for a highlight reel. As it turned out, Vimeo makes downloading someone else’s video very easy, while this is next to impossible on YouTube. Future competitions would be wise to stick to Vimeo.

**Production Values**

The results of this competition highlight the importance of production values if content-based science songs are to reach a wide audience. When one compares the popularity of the two version of “Covalent Love” (James’s original submission and the final studio version), the differences are subtle but powerful. The words and performance are essentially the same, but the audio recording quality in the final version is much more professional. Instead of showing a black screen with words, the final version has a well-produced video showing James performing. The final studio version has three times as many hits, despite the fact that the original submission got far more media attention as the grand prize winning submission. These production values did not come cheap (several hours in a world class audio studio sponsored by NZISF), but I believe they are important if one’s goal is to move from local to global viewership.
Recruitment and School Follow-ups

Given that I performed in front of over 3,000 students during the tour, I am disappointed with how few students or teachers from those schools wound up participating. In my opinion, the key to improving participation is to find an adult at each school, whether teacher or principal, who is excited about the competition and wants to take local ownership. Many students told me that they had “planned on participating,” but they never got around to it. If we had been better at following up with teachers, and teachers followed up with those students, we might have seen more entries.

Fortunately, there were several examples of teachers who did take ownership of this competition in their classrooms. They were able to get entire classes involved in the production of their teacher video and they encouraged students to participate themselves. These same teachers and students were also most often the very participants most willing to fill out the Science Idol 2012 “research questionnaire”, the subject of Chapter 5.
Chapter 5: Science Idol 2012 Research

5.1 Introduction

There are diverse methods to bring music into science education (see Chapter 2). Some of the most popular strategies involve content-based songs (Crowther, 2012b). Yet the educational benefits and costs depend on who writes the songs. There is not much data available comparing the tradeoffs associated with authorship. Are science songs most pedagogically valuable when written by students, teachers, or professionals? What are the auxiliary benefits of each, such as digital skill acquisition or enhanced student-teacher rapport? What are the time and financial costs?

McCammon (2012) speaks eloquently on this topic, based upon his own research and teaching experience. It does not make much sense, McCammon argues, for a mathematics teacher to devote hours of class time to song writing. After all, it is mathematics class – not song-writing class. Since so few students are a natural lyricists or musicians, imposed song-writing activities will be time-consuming at best, and frustrating and ineffective at worst. Without proper supervision, final student products may be factually incorrect, leading to long-term memorization of incorrect information (McCammon, 2012). The final product, though watched repeatedly by that student and his or her friends, will rarely be of high enough quality to catch on with other teachers or students.

Despite those caveats, there are clearly some students for whom song writing will be a fun and valuable way to engage with scientific material (Chapter 4). What’s more, the song-writing experience may have educational benefits beyond the scope of the scientific content being translated into music.

This chapter will explore these questions in the context of a New Zealand science music video competition, Science Idol 2012. The data, although very limited, may be of interest to three audiences: 1) organizers of educational song competitions, 2) classroom teachers who incorporate content-based songs into their teaching, and 3) researchers investigating content-based music.
5.2 Research Questions and Challenges

The Science Idol competition, by its very nature, attracted students and teachers who were interested in devoting time and effort to song and video production. By focusing on such a self-selecting sample, this study could not explore the tradeoffs of science song authorship for a typical population. It may provide a starting point, however, for future research that can look at a more diverse sample.

There were four primary research questions.

1. **Time**: how much time did participants devote to studying science compared to audio-visual production?
2. **Digital skills**: did the experience lead to development of digital media skills?
3. **Science**: was the song-writing experience also a science learning experience?
4. **Lyrical recall**: were students better at recalling the lyrics to their own song compared to recall of lyrics of a professionally produced science song?

The specific questions used in the research questionnaire can be seen in Appendix 5A.

The first three research questions were to be addressed via a simple self-report questionnaire, and the fourth via a more unusual methodology. I expected to find the following.

1. **Time**: science music video creation would require many hours of work, most of which would be dedicated to audio-visual production rather than studying the scientific topic.
2. **Digital skills**: most Science Idol 2012 participants would be inspired to acquire new digital skills such as audio or video editing.
3. **Science**: student-written songs would be less scientifically accurate than teacher-produced or professionally produced song, but would still provide a valuable learning experience for participants.
4. **Lyrical recall**: due to the intensity and repetition of the creative process, students would remember the lyrics to their own song much better than they would remember the lyrics to a science song they did not write ("Fossil Rock Anthem").
Challenges to Idealized Research Concept

**Recruitment and Timing**

It was originally conceived that all Science Idol participants would fill out a research questionnaire upon submission, ensuring maximal participation in the research component. However, the NZISF team advised against making the entry process too time-consuming, for fear of limiting entries. Additionally, since submissions were coming in from all over New Zealand, it would have proved challenging to get parental and student ethical research consent forms signed prior to submission (a digital parental consent option was used for the entries themselves).

Ultimately, only a short “Entry Form Questionnaire” was filled out by entrants (results in Chapter 4). In addition to asking about basic demographic information, the form included one item asking, “Would you like to participate in further research?” Ten entrants agreed to the follow-up research. Of those ten, eight returned their consent forms and filled out the “Research Questionnaire.”

Given the small sample size (n=8) and the self-selected nature of the respondents, the data from the research questionnaire must be interpreted with caution.

**Lyrical Recall**

One of the few studies exploring the long-term educational value of content-based music used a straightforward measure of lyrical recall to measure educational outcomes (Calvert & Tart, 1993). Their simple method of calculating the percentage of lyrics recalled provided a useful measure of lyrical memory, and a potential way to compare the lyrical recall effects of song authorship for a given individual.

In the original conception of the research, entrants would be asked to write as many lyrics as they could remember upon submission, providing a baseline “own lyrics score”. They would then watch “Fossil Rock Anthem” twice and be asked to write as many of the lyrics from that song as they could, providing a baseline “Fossil Rock lyrics score”. These two scores were meant to serve as baseline scores for follow-up measurements comparing lyrical recall based on song authorship.
After filling out the initial research questionnaire, participants would be given a link to “Fossil Rock Anthem” to watch as much as they wanted over the next month. At the end of that month, a follow-up questionnaire would again ask students to recall lyrics from each song. A similar follow-up could be done years later. This would allow us to compare within-subjects over time, helping to control for individual variation in memory. Although this methodology is rife with uncontrolled extraneous variables beyond song authorship (repetition, song content, song style, song length, etc.), it seemed to be the best way to approach the question with the available cohort.

Unfortunately, it took many weeks of reminders to get consent forms and questionnaire responses back from research participants. These delays hampered opportunities to explore longer-term lyrical recall. Instead, baseline scores for “own lyrics” and “Fossil Rock lyrics” trickled in for each participant over the course of weeks. A simple comparison of lyrical recall between “own song” and “Fossil Rock Anthem” has been included, though it allows no solid conclusions to be drawn about the power of song authorship.

5.3 Methods

Consent forms were sent to all participants in Science Idol 2012 who agreed to participate in follow-up research (11 out of 27). Online research questionnaires (powered by Google forms, similar to methods used in Chapter 3) were emailed to participants upon receipt of consent forms. Research questionnaires were filled out between two weeks and two months after Science Idol 2012 entries were submitted. This variation depended on how long it took to get consent forms and to get survey response. Eight Science Idol 2012 participants ultimately completed the research questionnaire.

Because both students (n=5) and teachers (n=3) participated, two slightly different questionnaires were administered for each group. However, both questionnaires covered the following.

1. Time spent on each step.
2. Use of digital technology.
3. Song writing experience.
4. Lyrical recall of own song (weeks after submission) and of “Fossil Rock Anthem” (immediately after seeing it for the first time).
5. Interaction with the Science Idol video tutorials.

Most questions used Likert-style items similar to those described in Chapter 3. Each section of the questionnaire had a textbox allowing participants to comment on their answers. For complete list of questions, see Appendix 5A.

Lyrical recall was measured by asking participants to recall all lyrics to their song. Participants were explicitly asked not to go back and look at their video or materials, though this could not be monitored. All participants had submitted a full copy of their lyrics upon submission, allowing for a calculation of the percentage of "own song lyrics" recalled.

After writing lyrics to their own song from memory, participants were instructed to watch the “Fossil Rock Anthem” music video two times. Immediately after, they were asked to recall as many lyrics from the song as they could. By comparing their recall to the original lyrics of “Fossil Rock Anthem, lyrical memory was calculated as a percentage score.

All data were collected in accordance with processes approved by the Otago University Ethics Committee (reference #12/102).

5.4 Results and Discussion

All participants (n=8) enjoyed the song-writing experience. Ten percent looked forward to making science songs in the future, though only 50% were sure that would do so in the absence of another competition. The fact that 13% would not make another song unless there was a competition, and 38% were unsure, supports the idea that an incentivized competition may have been an important motivating factor for some students to create content-based songs.
One teacher was particularly enthusiastic about writing science songs, something she had experimented with prior to the competition.

I was stuck for ideas for my next lesson so went to play my guitar for a break and all of a sudden lyrics started popping into my head. I’ve since gone on to create a number of songs and had amazing success in the classroom. I had students quoting the song in their practice exams and even when I returned to the same school almost a year later, my students walked into class and immediately started humming the song. Song writing is something that I will definitely continue to do.

**Song Writing Experience and Scientific Accuracy (Students Only)**

Four out of five students reported that they “learned a lot” about their scientific topic. Obviously, a more controlled methodology (with assigned topics and featuring content tests similar to Chapter 3) would be needed to investigate this question more carefully.
When asked to comment generally on the song writing experience, one student wrote:

Writing a rap about science was an interesting way to show scientific ideas and is sometimes a better way of communicating with a certain type of audience. People are more interested in music than learning, so disguising it in rap is a good idea.

Another student pointed out that she was not engaged with the scientific material until her teacher (who also submitted an entry to the competition) challenged the class.

Before writing the song I was confused on how the water cycle worked, since I hadn't been paying much attention. Then [our teacher] started writing a song and said that his was "tight" and he would beat us. So [I] decided to write a song. While writing the song, I learned a lot about the water cycle.

Three out of five students expressed concern about the scientific accuracy of their lyrics. However, it is not clear whether this nervousness reflects the fact that “accuracy” was going to be judged, or whether they did not have a firm grasp on their scientific topic. This renders this item difficult to interpret. It is also possible that those expressing confidence in the accuracy of their songs might be overly confident – a dangerous outcome that would lead to memorizing inaccurate information. The inclusion of “scientific accuracy” as a judging criterion in the competition may have helped with these issues. Accuracy is an important element
of the science song writing experience for educators or competition organizers to keep in mind.

**Song Writing Preferences (Students Only)**

Another set of questions asked students about their preferences on science song writing. Most students wanted to be able to choose their own scientific topic. There was a mix of opinions regarding whether students wanted to work on their songs during class time or at home. Students were divided about working in groups.

**Figure 5.3**

Students (n=5) prefer to choose their own topic, and are split over working on songs in class and working in groups.

These results support the decision to allow flexibility in the Science Idol 2012 competition in terms of genre, group size and topic choice (Chapter 4). If these data reflect wider student preferences, this information may be of value for other science song competitions.

However, classroom-based science song activities clearly cannot allow the same degree of flexibility in topic choice. Given how most teachers use song-writing assignments (Chapter 2), they are most valuable when they build on the relevant topic being covered in class. Furthermore, despite student preferences, it appears that students still enjoyed topics even when assigned. As one student wrote:
Our teacher assigned our class to make a song about the water cycle, that’s the only reason I was on that topic. Writing the song: I went home and wrote it, then came to school and my friends wanted to help me sing it.

Digital Technology

The New Zealand Ministry of Education has cited e-learning and digital skill acquisition as key areas to focus on when in improving education in the twenty-first century (Wright, 2010). One series of questions on the Science Idol questionnaire asked students and teachers about their use of digital technology during the competition. Three out of eight participants reported learning a new digital skill for the competition. Four out of eight felt inspired to pick up new skills in the future. This supports the notion that competitions like Science Idol 2012 not only provided an educational experience in science and music, but also digital technology. It also indicates that many “digital natives” (Prensky, 2007) are already competent with the digital technology needed for such an activity. It is interesting to note the variation in responses.

Figure 5.4

Participants (n=8) had diverse experiences with digital technology.

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not Sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I had to learn new digital skills (like audio or video editing) in order to create my Science Idol 2012 submission.</td>
<td>25%</td>
<td>38%</td>
<td>0%</td>
<td>25%</td>
<td>13%</td>
</tr>
<tr>
<td>I have been inspired by this activity to improve my digital skills.</td>
<td>13%</td>
<td>13%</td>
<td>25%</td>
<td>25%</td>
<td>25%</td>
</tr>
<tr>
<td>I wish I had had access to more digital technology.</td>
<td>13%</td>
<td>13%</td>
<td>25%</td>
<td>25%</td>
<td>25%</td>
</tr>
<tr>
<td>My family or friends were able to supply me with the digital tools I needed.</td>
<td>13%</td>
<td>38%</td>
<td>0%</td>
<td>25%</td>
<td>25%</td>
</tr>
<tr>
<td>My school was able to supply me with the digital tools I needed (i.e. computers, cameras).</td>
<td>38%</td>
<td>13%</td>
<td>13%</td>
<td>13%</td>
<td>25%</td>
</tr>
</tbody>
</table>

For many students, digital technology is such an intrinsic part of their lives that there was nothing novel about the experience of creating a YouTube music video. One student wrote, “I just made it up on the family laptop with no help whatsoever! :).” Another student was easily able to use the technology at school:
At my school every student needs their own laptop so it was easy. I am very good at using my computer so it wasn’t needed and we did not do much editing.

Other students had access to resources from their family.

Nobody in our family is that great with filming so we filmed it on an iPhone camera which was different and created different challenges with producing the rap.

The fact that all participants were able to get gear from friends, family, or school, supports the idea that technological barriers were not overly high for this competition. Though of course, only the people who could get access to this technology ended up participating in the competition. Future studies would do well to examine a sample of students before they choose whether or not to participate in a science song competition, allowing the researcher to find out what proportion choose not to participate for reasons of access to technology.

Yet the competition only required a camera and an Internet connection. These are becoming ubiquitous in the lives of most students in New Zealand and the United States. The rules of the competition allowed for a “one-take” video of a live performance without any audio/video editing. The structure of the competition therefore lowered barriers to entry as much as possible, while encouraging the acquisition of new digital skill development.

**Time Costs**

Participants were asked to report on how much time they spent on the five stages of the process: reviewing the science, writing lyrics, producing audio, producing video, and uploading their submission.

Participants typically spent less than an hour reviewing the science, though one spent 5-10 hours on this task. Most reported spending between 1-5 hours writing lyrics, while the other three spent less than an hour. Most spent 1-5 hours producing their audio, with one spending less than an hour and one spending over 10 hours. Most spent 1-5 hours producing their video, with the other three spending less than an hour. For most, uploading their video also took less than an hour.
Overall, a full submission required about 6-10 hours of work, with most of that time spent on audio-visual production rather than “studying science.” While that may sound like a lot of time, most of the participants were surprised by how little time it took to create their final product. A typical response was that, “This project was quite quick to create when you look at the final outcome, so I do not think it was a waste of time.” This supports the idea that the format of this competition did not require a prohibitive amount of time. Once again, to truly address this question, one would need a prospective longitudinal study.

**Video Tutorials**

Five out eight (63%) participants watched all five video tutorials in the run up to the competition. They reported that the most valuable video tutorials were the one introducing the competition (which presented the rules) and the tutorials on audio and video production. These same videos were more often cited as being of potential value in the future. For more on how these video tutorials have been used since the competition, see Chapter 4.

**Table 5.2 Video Tutorials**  
(for each video, participants could mark multiple answers)

<table>
<thead>
<tr>
<th>Interaction with Science Idol Video Tutorials (n=8)</th>
<th>Watched video at least once</th>
<th>Used video info during competition</th>
<th>May use in the future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video 1 Introduction</td>
<td>7</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Video 2 Brainstorming</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Video 3 Lyrics</td>
<td>5</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Video 4 Audio</td>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Video 5 Video</td>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
Lyrical Recall

When asked to recall the lyrics of their own Science Idol songs, participants wrote, on average, 63% of their original lyrics. Three out of eight were able to recall between 95%-100% of lyrics. Three out of eight recalled between 40% and 80%, while two recalled between 10% and 30%. When asked to recall the lyrics of “Fossil Rock Anthem” immediately after watching it twice, participants were able to recall, on average, 18% of the total song.

Figure 5.5

Unfortunately, this result tells us very little about the role of song authorship on lyrical recall. There are many other variables that differ between the two experiences, such that it is irresponsible to overly interpret these differences, however large. One obvious confounding factor is repetition. Participants would have heard their own song dozens of times in the process of writing, recording, and editing their submission. In contrast, they only heard Fossil Rock Anthem twice. That being said, that same repetition may be the key to anecdotal reports of long-term musical memory for student-authored songs (Crowther, 2012a).

Insofar as repetition has a decisive influence on lyrical recall, certain activities that lead to repeated listenings of professionally generated songs (McCammon, 2012) may lead to comparable long-term recall in non-student-generated songs. For example, McCammon (2012) gives students a pre-made song and asks them to come up with body movements to represent the lyrics. The students record these “kinesthetic lectures” on video. In the process of editing the video and watching themselves in the final product, they end up listening to the song dozens of times.

This type of educator innovation is one of the most exciting things about the world of blending arts and science education. Since teachers know what the
realities of education are on the ground, teachers’ voices will be critical in determining the correct way to move forward with content-based songs. These educator voices are the subject of Chapter 6.
Chapter 6: Teacher Comments

6.1 Introduction

“The teachers' particular preconceptions are crucial to the course of innovation and change... Even though many products are adopted by the most farsighted, enlightened school administrations, they are doomed if classroom teachers don’t perceive them as meaningful within the current classroom environment.” (Knupfer, 1988)

As Knupfer (1988) states, the perspective of teachers is critical in the development of any educational tool. Therefore, two samples of teachers were given the opportunity to give their thoughts on the content-based music discussed in this thesis. The first group consisted of the three teachers who filled out the Science Idol research questionnaire (Chapter 5). This included one primary teacher, one intermediate teacher, and one high school teacher. The second group consisted of the seven teachers whose students participated in the “Fossil Rock Anthem” music video experiment (Chapter 3). All teachers in this second group taught at intermediate schools.

These teachers were chosen to participate due to their previous involvement in other components of this thesis. Therefore, their views are not representative of all New Zealand teachers. In particular, teachers who entered the Science Idol competition are predisposed to favor using music to teach science. Nonetheless, the opinions of both sets of teachers provide an important perspective on the primary questions of this thesis: what are the costs and benefits of content-based songs, whether made by outside professionals, students, or teachers?

6.2 Methods

A qualitative approach using a constructivist framework is an established and valuable tool for exploring teacher opinions on using music in the science classroom (Governor et al., 2012). All data for this study were gathered via online teacher questionnaires, making it impossible to study teacher's behavior in their natural setting. Although in-person interviews or focus groups may have made for a richer data set, the geographical diversity of the participating teachers made an online questionnaire the most feasible way to gather qualitative data. Teachers
were not selected randomly. One group was selected based upon their participation in Science Idol 2012, and another group was selected because their students had participated in the music video experiment discussed in Chapter 3. All teachers were therefore aware of basic ways that music could be incorporated into the science classroom. Once these teachers were selected, all were given information forms and consent forms in line with the procedures approved by the Otago University Ethics Committee (reference #12/102).

Teachers gave their feedback via online questionnaires powered by Google forms (see Appendix 6A). Questions were designed to address fundamental questions about science song authorship, but consisted primarily of open-ended “essay” items that allowed teachers to write open-ended answers. A link to the video “Fossil Rock Anthem” was included in the questionnaire, giving teachers the opportunity to comment directly on the science music video most closely studied in this thesis. Teachers were asked to watch the video twice. They were then asked to give their comments on whether and how they might use this type of video in the classroom. Teachers had the opportunity to compare the tradeoffs of using a premade song such as “Fossil Rock Anthem” versus creating their own songs or having their students write songs. In addition to open-ended questions, a number of multiple-choice questions were included.

Due to the limited number of questions and the small number of participants, formal qualitative approaches such as coding or cross-case analysis were not used during the interpretation of the data. For each question, the researcher analyzed all teacher responses, and common themes and divergent answers were identified and reported. Due to the highly self-selecting nature of participants, common themes should not be considered representative of any larger population of teachers outside of those included in the study.

6.3 Results

Reactions to “Fossil Rock Anthem”

All teachers (n=10) responded favorably to “Fossil Rock Anthem”, with 100% reporting that they would use such a video in their class. Several teachers commented on the use of imagery and visual lyrics to help convey concepts. One teacher reported the following.
Great video. Fantastic way of conveying key information about fossils/geology; enticing students to want to learn more; making the information memorable. The highlighting of the lyrics helps engage the audience to follow each word. The images reinforce the message really well and I really like how both images and words are used in motion to reinforce each respective bit of information... And the choice of song is obviously a current hit with youth so that's a real attention grabber as well. Use of humour makes it all the more enjoyable – e.g. everyday I'm shovelin'. You know the kids are gonna laugh at this point. And this kind of video can encourage students to make their own songs.

Teachers had many ideas about how such a video could be incorporated into the classroom. Seventy-one percent of non-Science Idol teachers (n=7) thought the video could be used as an introduction to a unit. The same percentage also thought the video would be an engaging way to "hook kids in" to a unit. Many (57%) also thought the video would be useful as a summary at the end of the unit. Not surprisingly, the sole primary teacher was the only one to suggest that that the video could be used as a "dance session at the start of class." When given the open-ended opportunity to report on other ways of incorporating such a video, one teacher reported the following diverse set of ideas.

Perhaps at the start of the unit you can ask students to collectively write down all the things they know about fossils/geology. Then watch the video and get them to identify things they already know, and potentially what was new information... You could use the video after certain bits of information have been covered in class. A) as a reinforcement tool, and B) ask the students to identify where in the song it talks about what they have just learned. Also, it could be used at the end of the topic as a summary tool. You could print out the lyrics, but blank out some of the words for the students to fill in. You could play it once or twice then ask them questions about what features in the video. You could split the class in groups and have them perform different sections of the song (even mute it and have them sing along). You could use it as an example of a song and have your students now write their own songs (especially good if your topic branches further than the scope of the original song).

A common theme reported by teachers was the engagement value of "Fossil Rock Anthem". One commented on across-the-board engagement saying, "Something like this would truly have the students engaged." Another mentioned that the song could engage students who are typically switched off. Another said that the music value would be more engaging than "traditional" methods.

Teachers were also asked how the "Fossil Rock Anthem" music video could best be improved. They finished the statement, "Music Videos like "Fossil Rock Anthem" would be more effective at teaching scientific content if..." Themes that emerged from teacher answers included a focus on relevance to what is taught in schools and making sure songs were age-appropriate. As one teacher commented, "The inventors could know what the demand was for their vid... find out what kids
'have to know' then tailor it to suit.” This is clearly an easier task in highly standardized systems like the American system, though some scientific concepts are so commonly taught that it would not be difficult for science song makers to craft content appropriate for New Zealand classrooms with the help of New Zealand teachers.

Interestingly, only one teacher out of seven thought that “Fossil Rock Anthem” would be valuable as a take-home activity for students. This may be of relevance to the interpretation of the results in Chapter 3. The “follow-up” activity for students merely gave them the option of watching the video and reading follow-up information at home, so students were not getting maximal educational value out of the video. As one teacher put it, “I would not send it as a take-home activity as not all children in my class have access outside of school to the Internet.”

This teacher feedback provides an important reminder that music videos will only be valuable to the degree that they are incorporated into classroom teaching. As was documented in Chapter 3, the mere existence of science music videos as an optional entertainment activity meant to compete with the rest of student entertainment options will not necessarily have powerful educational impacts.

**Do Teachers Want to Make Their Own Songs?**

The seven teachers who did not submit to Science Idol were asked whether they would ever make their own science songs. The majority (71%) said they would not (Figure 6.1).

*Figure 6.1*

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Percentage</strong></td>
<td>29%</td>
<td>71%</td>
</tr>
</tbody>
</table>

Those who said “No” cited two factors: a lack of musical knowledge and a lack of time. A common theme that emerged was a reported “lack of musicality”
among respondents, or an “inability to sing.” Even more important were the time constraints on teacher schedules and class time.

One teacher who said that she would be happy to make her own song, made a critical point regarding experience-based science education, pointing out the need for a rational connection between content and music.

[I would make a song], provided the content lent itself naturally to music. The main thing with science, for me, is that the kids learn concepts through experiments, observations and experiences. Audio-visual resources are great now e.g You tube etc. but for learning to take place I believe experience is best when possible.

The question of whether certain science topics lend themselves to a musical treatment is an interesting one that will be addressed further in the discussion. The importance of experiential teaching will also be addressed.

**Tradeoffs of Song Authorship**

All teachers were asked about their thoughts regarding the tradeoffs of song authorship. All were asked to respond to the following question: “Insofar as science songs are incorporated into the classroom, do you think they should be written by teachers, students, or outside organizations? Please explain your answer.” Most argued that student-produced songs were *theoretically* best. The benefits to having students write their own songs included “reinforcement of ideas,” “having fun with their knowledge,” and “increased memory and ownership of ideas.”

However, most teachers were skeptical that there was enough time to devote to such projects. One teacher pointed out that much of the time needed for such an activity would be devoted to arts curriculum rather than science, saying, “[Students] would of course need significant guidance to begin with as the lyrics, the song structure, the music choice, the rhythm and the ‘poetry’ involved fall under the literature/arts banner as opposed to the science banner.” Timing was a particular issue for teachers who taught secondary aged students.

Not surprisingly, the teachers who participated in Science Idol were more positive regarding the benefits of teacher-generated songs. One reported the following story about writing songs in her own classroom.

The students react well to their teacher getting so involved in their learning. They love to see a teacher has posted themselves on YouTube. And in my case, I love to get my guitar out in class, which has the added bonus of boosting teacher-student relationships (which is most important for learning in the classroom) as they get to see one of your hobbies.
Another teacher pointed out that having teachers generate songs solves the problem of accuracy (faced by student-generated songs) and the problem of relevance (faced by professionally generated songs).

Most teachers liked the idea of outside professionals creating science music videos, as this certainly had the lowest time costs. There was understandable concern, however, about these songs being properly tailored to their own lessons. One teacher pointed out that such songs “generally are higher quality videos so more visually appealing for the students,” but that, “one downfall can be that the song is pitched at a level above or below what you are teaching.” Some of the less musically inclined teachers thought that videos created by outside organizations would be particularly useful because they required no musical knowledge on the part of the teacher. The trade-offs associated with science song authorship are summarized in Table 7.1 as part of the conclusions drawn in Chapter 7.

6.4 Discussion

Teachers responded very favorably to “Fossil Rock Anthem”, though some were unsure whether the song was geared at the right academic level for their intermediate students. It would be interesting to get the feedback of teachers in California given the fact that the song was written specifically to address California’s 7th grade state standards. Now that the song has been made public on YouTube, it is interesting to note that, although the video is being used by teachers from primary schools to university, it is more popular among university classes than primary ones, indicating that the content of the song may in fact be best suited to older students. Teachers confirmed that small time costs and professional quality were clear benefits of outside-produced science songs. On the whole, these findings are consistent with Governor’s qualitative study reporting positive attitudes that American teachers felt toward using science songs in the classroom (2012).

Teachers who did not participate in Science Idol were generally not very excited about creating their own songs. This lack of desire or time to create their own songs may be the norm among a typical population of teachers. While teachers thought that student-generated songs would be pedagogically valuable, there was agreement that there was not always enough class time for student-generated song activities.
One teacher said that she would make songs only if a given scientific topic lent itself to music. This raises a fundamental question for this thesis. Are the benefits of content-based songs content-specific, or are there generalizable benefits of using music to teach non-music content? The evidence from this thesis supports an answer of: “Yes, for a subset of students.” As mentioned in the literature review, there are a few scientific topics in physics such as acoustics that are particularly appropriate for music-based lessons, using the music itself as a way to explore the physics of sound. However, because lyrics can cover any topic in any academic discipline, there is not necessarily going to be a unique relationship between a scientific lesson and a musical genre. What matters more is that the musical genre fits into the students’ own culture, providing them with a familiarity and a connection to their everyday life that allows them to immediately engage with the lesson (Chapter 3).

Another teacher pointed out that music could be superfluous in light of the obvious benefits of experiential teaching in the science classroom. If music is incorporated into science education, it must not come at the expense of inquiry-based best practices. This teacher pointed out that the best way to teach science remains hands-on inquiry-based activities (Gibson & Chase, 2002). Content-based songs should certainly not replace such activities. Songs can, however, supplement lessons and activities, serving to engage certain students who may not be engaged otherwise. As pointed out by Governor (2012) and McCammon (2008), science songs can offer educational benefits beyond rote memorization, and contribute to an inquiry-based, experiential approach.

As many of the teachers pointed out, there is not enough time in most high school classes to allow students six hours of class time for song creation. However, there may be time for a three-minute video that hooks students in, and remains stuck in their head as they do the main activity of the day. Creating time for student-generated songs may only be likely if teachers from different disciplines are willing to collaborate across classes, or if song-writing activities are incorporated into extracurricular activities such as after school clubs.

The teacher comments throughout this chapter build on the theme of educational diversity and flexibility that have permeated previous chapters. Different teachers will chose to use different songs. They will assign different activities based on the needs of their students. They may allow a subset of
musically oriented students to create a song in lieu of another assignment or encourage an entire class to practice song writing as an integrated lesson in both the arts and science. Teachers will not be surprised by the findings of Chapter 3 – that different students respond to songs like “Fossil Rock Anthem” in different ways. Skilled teachers will be able to use such content-based music videos alongside traditional scientific lessons and inquiry-based activities in order to best serve all students. These themes will be explored further in the concluding chapter, Chapter 7.
Chapter 7: Conclusions

The academic study of music-based science education is a growing field (Chapter 2). Many papers have called for larger-scale randomized trials that can help clarify the benefits of content-based music. Given the diversity of ways that music can be incorporated into the science classroom, there are many questions that require more research, including identifying what types of students respond best to musical lessons and whether using class time to teach students song-writing techniques is worth the cost. This thesis has attempted to make progress on a number of questions in the field, particularly the motivational and learning impacts of watching a professionally produced science song, and the tradeoffs of science song authorship.

Chapter 3 featured a randomized trial of 84 New Zealand intermediate students exploring the impact of the educational music video “Fossil Rock Anthem.” Watching that video had many positive impacts on students, ranging from instilling a greater curiosity about the science itself to teaching students facts about fossils and Earth history. However, the other experimental group, which watched a “just-the-facts” video of similar length and content, experienced many of these same benefits. Although the MUSIC group was more likely to watch their video again at home and share the video with their friends and family, the FACTS group was more likely to think about the science covered and discuss it with their family. The music video was perceived to be more “fun”, but also moved too fast according to a minority of students. In terms of content acquisition, the data suggest that the musical lesson had a smaller but sustained impact on scientific knowledge, compared to a larger but short-lived boost in knowledge for the control group. It is important to remember that the experimental design created a somewhat artificial learning environment. In reality, the benefits of both the MUSIC and FACTS group would easily be integrated together while the teacher was covering a unit on fossils and Earth history. Future research would do well to include follow-up activities that integrate a music video’s lyrics and content into other classroom activities, and see whether such activities increase learning and engagement outcomes from content-based music videos.

Chapter 4 described the planning and execution of a science song writing competition called Science Idol 2012, part of the New Zealand International Science Festival (NZISF). This competition may provide a model for other
teachers, festivals, and organizations interested in harnessing the power of music to increase engagement with science. The final outcomes of the competition, particularly the grand prize winning “Covalent Love,” will be valuable resources to science teachers around the world. The digital nature of the competition makes it an easily replicable event. It turned out that the most effective way to recruit primary and intermediate student participation was physically visiting schools and getting a teacher or principal on board with the local support of the event, although this was not effective for secondary students. Getting prizes sponsored by partner organizations was also an important part of recruitment. Although younger (intermediate age) students seemed more engaged with the competition than older (high school age) students, there was a substantial interest by university students and science teachers. The videos made by these older entrants were typically of higher production values and educational value. Future competitions should offer categories for older students and teachers.

Chapter 5 described the results of a short research questionnaire that followed up with some of the Science Idol 2012 participants. Given the logistical hurdles of follow-up emails, additional student and parental consent forms, and multiple follow-up questionnaires, few people wound up participating in the research component. The data set was small, but a few preliminary conclusions can be drawn. Students have diverse science song-writing preferences. Whether it is working by one’s self or in a group, working in class or at home, creating a parody or an original, having an topic assigned or chosen, student preferences vary. Although teacher-imposed structure is a critical part of incorporating science song writing activities into class, teachers may want to explore where student preferences lie and consider flexible assignments. Participants spent about six to ten hours on their Science Idol entries, most of which was spent producing audio and video rather than studying science. Participants generally thought this was a short amount of time given that they were able to create such a fun and useful final product. Students were often nervous about the scientific accuracy of their songs, which may lend evidence to McCammon’s critique of student-generated songwriting activities as leading to longer-term memorization of inaccurate information.

Chapter 6 summarizes the views of a small sample of teachers on music in the science classroom. These views were solicited throughout the research
conducted for the other chapters. Teachers were strongly in favor of student-generated songs, but acknowledged that there was rarely time to allow for such an activity. Teachers were open to songs produced by outside organizations, as long as they were tailored to the subject matter and age group. Only a small subset of musically inclined teachers was open to the idea of writing their own songs. However, all of the teachers had ideas on different activities that could incorporate and build on content-based music. These follow-up activities are most likely critical to getting the full learning value out of science songs.

Given the costs and benefits of having different groups create science songs (Table 7.1), there is great potential for projects that harness the benefits of all three categories by having outside organizations team up with classrooms to create science songs. If a classroom is capable of devoting time to an integrated science and music based activity, and if production costs can be secured via grants, non-profits, schools, or private education companies, then a given classroom can end up producing a final product that can be used by other classrooms around the world. Since students and teachers will drive content selection, the content will be perfectly tailored to that age group. The students who participate will have a powerful learning experience in science, communication, and musical production. The inclusion of teachers throughout requires no musical talent on the part of the teachers, but will facilitate the creation of songs that are accurate and pedagogically useful. By teaming up with multimedia professionals, the musical quality and video quality will be high enough that teachers and students from other classrooms will be as likely to be entertained by the final product as the students themselves. This final product can be remixed by students from other classrooms, or used as a basis for their own music videos. A student video competition using the song “Covalent Love” (Chapter 4) could provide an interesting test of whether a well-produced science song could grab the attention and inspire other students around the world.

Like most research, this thesis has not settled the primary research questions set out at the beginning of the research experience. It has chipped away at those questions, and opened up several new research avenues. It would be valuable to replicate the experiment laid out in Chapter 3 with a larger and more diverse population of students, and to study the impacts of a follow-up engagement activity on learning and motivation. Future science song writing
competitions would be wise to maintain a flexible and low-barrier format, but to plan on including a small research component that allows them to learn more about the costs and benefits of the song-writing experience, particularly regarding scientific learning and accuracy. Teachers should continue to have a large role in the planning and execution of any research into music-based education, and to share their unique ideas for how to incorporate science-based songs into their lessons. There may be great opportunities for classrooms to team up with science song professionals to create products that can be used and remixed by other classrooms around the world. As education continues to adapt to a changing technological landscape and educators experiment with increased individualization and adaptability of the student learning experience, researchers and educators will do well to keep in mind the strength of music as a teaching tool.
**Table 7.1 Pros and cons of science song authorship**

<table>
<thead>
<tr>
<th>Song Authorship</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student-written</strong></td>
<td>• Longer-term memory impact (consistent with data from Chapter 5)</td>
<td>• If not accurate, students will commit mistakes to long-term memory (McCammon, 2012)</td>
</tr>
<tr>
<td></td>
<td>• Allows for deep engagement with scientific material (Chapter 5)</td>
<td>• Can encourage superficial engagement with scientific material, depending on how assignment is structured</td>
</tr>
<tr>
<td></td>
<td>• Encourages development of musical and digital skills (Chapter 5)</td>
<td>• Huge time costs if during class time, much of which is devoted to art skills rather than science skills (Chapter 5)</td>
</tr>
<tr>
<td><strong>Teacher-written</strong></td>
<td>• Content will be accurate and perfectly suited to class level (Chapter 6)</td>
<td>• Huge time cost to already over-worked teachers (Chapter 6)</td>
</tr>
<tr>
<td></td>
<td>• Enhances teacher’s relationship with students (Chapter 6)</td>
<td>• Many teachers are not musically inclined. (Chapter 6)</td>
</tr>
<tr>
<td><strong>Outside professional organization-written</strong></td>
<td>• Minimal use of class time (Chapter 3)</td>
<td>• Content may not be perfectly suited for given instructional level (Chapter 6)</td>
</tr>
<tr>
<td></td>
<td>• Songs &amp; videos will often be catchy, popular, and well-produced (Chapter 3)</td>
<td>• Might be in a style/genre that is not popular with students or appears corny</td>
</tr>
<tr>
<td></td>
<td>• Can be incorporated into in-depth classroom activities in a wide variety of ways (Chapter 6)</td>
<td></td>
</tr>
</tbody>
</table>
References


Kimball, K., & O’Connor, L. Engaging auditory modalities through the use of music in information literacy instruction. Reference & User Services Quarterly, 49, 316-319.


Likert, R. (1932). A technique for the measurement of attitudes. *Archives of psychology*.


Appendices

Appendix 3A: California Grade Seven Earth & Life History Standards

4. Evidence from rocks allows us to understand the evolution of life on Earth. As a basis for understanding this concept:

   a. Students know Earth processes today are similar to those that occurred in the past and slow geologic processes have large cumulative effects over long periods of time.
   b. Students know the history of life on Earth has been disrupted by major catastrophic events, such as major volcanic eruptions or the impacts of asteroids.
   c. Students know that the rock cycle includes the formation of new sediment and rocks and that rocks are often found in layers, with the oldest generally on the bottom.
   d. Students know that evidence from geologic layers and radioactive dating indicates Earth is approximately 4.6 billion years old and that life on this planet has existed for more than 3 billion years.
   e. Students know fossils provide evidence of how life and environmental conditions have changed.
   f. Students know how movements of Earth’s continental and oceanic plates through time, with associated changes in climate and geographic connections, have affected the past and present distribution of organisms.
   g. Students know how to explain significant developments and extinctions of plant and animal life on the geologic time scale.

All California science standards available at:
www.cde.ca.gov/be/st/ss/documents/sciencestnd.pdf
Appendix 3B: “Fossil Rock Anthem” Lyrics

“Fossil Rock Anthem” can be seen at http://youtu.be/CIj5lwl_wM0

**CHORUS:** Fossil rocks are in the ground tonight.
They’ve been down there for a really long time.
They contain the history of life.
They’ve been down there for a really long time.
Fossil rocks are in the ground tonight.
They’ve been down there for a really long time (They’re the schist*)
They are literally on the grind.
Take your hammer out and... break that.

**VERSE 1:** Look at the ground. Partly rock.
Plus plants and animals stuck in their spot. Huh.
Each new layer stackin’ up,
So the oldest on the bottom and the newest on top.
“So how old is your fossil, bro?”
Well it was pretty far down so it’s pretty darn old.
And I dated this one, so I gots to know.
It’s from 3.5 billion years ago.
Yo. I got that lava flow, Volcano.
Air full of particles & smoke.
There goes life as we know.
Now that’s a blast! But most rocks ain’t movin’ that fast,
The sediment’s evidence. Like a present tellin’ us of the past.

**CHORUS**

VERSE 2: Brush it off and hear the story of life as told through rock.
The story of the earth as told through life. Now stop... do the trilobite.
Continental plates (are driftin’).
Mountains in the states (upliftin’).
Tend to isolate (species).
By affecting who you mate with (believe me)
Slow moves. Long time. Push up mountains to the sky.
Slow moves. Long time. Open up a great divide.
Slow moves. Long time. Fossils found on either side.
Fossils found they tell us why... tell the history of life....
Slow moves. Long time. Slow moves. Long time.
Slow moves. Long time. Slow moves. Long time.
Plates are driftin’ at ya boy. Plates are driftin’ at ya boy.
Plates are driftin’ at ya boy. Now boom. There's an asteroid
Appendix 3C: Copyright Request to Manager of LMFAO

The following letter requesting copyright permission was sent on November 11, 2012 from Joseph Pineda (a friend and record executive) to the manager of LMFAO, Ian Fletcher. As of December 6, 2012, Mr. Fletcher has not responded.

INTRODUCTORY LETTER FROM MR. PINEDA TO MR. FLETCHER

Dear Ian,
Hope this finds you well! My name is Joseph Pineda and am reaching out to you on behalf of a good friend and science educator, Tom McFadden--who is currently in New Zealand pursuing his Masters in Science Communication.

Tom is passionate about using music to get students to fall in love with science--and has created a remix to LMFAO’s “Party Rock” called “Fossil Rock.” “Fossil Rock” is a song that teaches students about fossils and Earth science and follows the actual 7th grade curriculum from the California department of education.

- You can view the video here- “Fossil Rock” video: http://youtu.be/ClJ5Iwl_wM0

Please find attached a formal request to use the song as a teaching tool for students around the world.

Tom asked for my assistance to contact you because I have spent my career in the music industry, starting at the major labels and now currently manage several independent bands/artists. That being said, I can only imagine how many LMFAO-related requests you receive on a daily basis and understand that a request for gratis usage is not ideal.

However if allowed, we truly believe the value and benefit of this new teaching method will be proven beyond doubt. The value this could provide to the education system is immeasurable.

Thank you for your time. We wish you and LMFAO continued success. Please let us know if you have any questions or need any additional information.

Kind Regards,
JP
Appendix 3C continued: Formal Copyright Request Attached to Email

8 November 2012

303a Great King Street
Dunedin 9010
New Zealand

To Whom it May Concern,

I am a science educator hoping to motivate students to fall in love with learning. I am currently studying Science Communication at the University of Otago in New Zealand, and my Masters thesis examines the use of music to get young people hooked into science. The goal is essentially to harness the catchiness, popularity, and all around awesomeness of “Party Rock Anthem” to educate kids.

I have created a lesson on fossils and Earth science that utilizes the basic structure, though not the actual backing track, of “Party Rock Anthem” by LMFAO. The song is called “Fossil Rock Anthem.” Its backing track, inspired by “Party Rock Anthem”, was re--imagined by an electronic musician in San Francisco. The lyrics of “Fossil Rock Anthem” follow the basic lyrical structure of “Party Rock Anthem”. LMFAO are cited whenever the video is shown or performed. The full “Fossil Rock Anthem” video can be seen here: http://www.youtube.com/watch?v=ClJ5lw1_wM0.

For my master’s thesis, I have gathered data on the educational impact of this video on middle school students in New Zealand. I have also uploaded the animated music video lesson onto YouTube so that teachers in California can use it as well.

I am looking for royalty--free permission to use my re--imagined version of “Party Rock Anthem” for educational purposes. Specifically I would like to use “Fossil Rock Anthem” in the following contexts:

1. 1.) Most importantly/urgently, I would like permission to include the “Fossil Rock Anthem” music video as the “creative component” of my Master’s thesis here at the University of Otago. The animated video would be included on a DVD with my hardbound thesis as part of the “creative component” of my thesis. My thesis is due on 1 December 2012, and getting permission on this item before that date would be tremendously helpful.

2. 2.) I would like permission to perform “Fossil Rock Anthem” live at both schools and science festivals. The goal is to educate people and get them excited about learning more about science. I will continue to cite the original work whenever the song is performed live.

3. 3.) I would like permission to leave the animated “Fossil Rock Anthem” music video on YouTube, freely available to teachers and students. The content of the song is based on the 7th grade Earth science standards and the song will be a valuable teaching tool for teachers around California, the United States, and the world. I am happy to add any other citations to individuals or organizations that should be cited.

I believe that you are currently one of the holders of copyright. If you do not currently hold the rights, please provide me with any information that can help me contact the proper rights holder.

Thank you so much for considering my request. It would be great to have a positive response back, particularly on request #1, as soon as possible. If you have any questions do not hesitate to contact me.

Sincerely,
Tom McFadden tomcfad@gmail.com
Cell: (+64) 027--816--7229
Appendix 3D: Transcript of “Just-the-facts” Video Text

*Just-the-facts video can be seen at: http://youtu.be/ydNmAavzwDc*

If you go outside and look at the ground, it is partly made of rock. But the ground also contains remains of ancient plants and animals that have been covered in sediment. Given enough time, these remains can solidify as rock and be preserved as fossils.

Sedimentary rock, where fossils are typically found, form in layers. First, one layer of debris solidifies into rock. Then a new layer deposits and solidifies on top of the older layer. This allows us to tell the relative age of fossils. A fossil that is found in a lower layer will be older than a fossil found in a layer closer to the surface.

If we want to know *exactly* how old a fossil is rather than it’s relative age, we use something called radiometric dating. Because we know the rate at which certain radioactive atoms change, we can look closely at the mixture of atoms in a rock to see how old it is. The oldest fossil ever found is from 3.5 Billion years ago.

The collection of fossils from all over the world helps us to tell the story of life on Earth, and the history of the earth itself. For example, if a volcano erupts and blows smoke and dust particles into the air, it can change the temperature of the earth and lead to mass die-off of species. Such a catastrophic event then becomes recorded in the fossil record.

Although events like volcanic eruptions or asteroids can cause rapid change, most changes in the earth occur very slowly. Whether it’s fossils forming, continents moving, or mountains uplifting, geological processes require long periods of time to make changes.

For example, the continental plates of the earth are slowly moving. Some continents are getting further and further apart, while others are moving slowly toward each other. By looking at fossils, we can get evidence about where these plates were located millions of years ago. The fact that fossils of the same species of dinosaur are found in South America, Africa, and Antarctica is a good indicator that these continents used to be united in one great land mass.

The people who look for fossils in the earth are called paleontologists. They search for fossils using many tools including hammers and shovels to dig, and brushes to clean off fossils that they find. By finding fossils around the world, these scientists help to reconstruct the history of life on Earth - and the history of the earth itself.
Appendix 3E: Scientific Content Test on Fossils and Earth History

The following test of scientific knowledge was included on the pre-, post-, and delayed post-test.

Delayed Post Questionnaire (E)

* Required

Earth Sciences Questions

INSTRUCTIONS: For each question, select what you think is the correct answer. If you have no idea what the correct answer is, select “Don’t know.” If you think you know, go ahead and choose the answer you think is correct.

Slow geologic processes require ________ in order to have a dramatic effect on the Earth. *

- long periods of time.
- short periods of time.
- Don’t know.

In an area where a river has cut deep into the Earth, several layers of very different rock become exposed. The oldest rock layer is most likely to be the layer that is... *

- below the other layers.
- the thickest layer.
- the most rich in fossils.
- igneous intrusive rock.
- Don’t know

Which of the following physical events on Earth is most likely to cause a sudden mass extinction of life? *

- Uplift of mountains
- Eruption of a volcano
- Movement of continental plate
- Formation of new sediment
- Don’t know

A fossil of one of the oldest life forms on Earth would most likely be: *

- 3,500 years old.
- 3.5 million years old.
- 3.5 billion years old.
- 3.5 trillion years old.
- Don’t know

If ancient bones from a certain dinosaur species are found on different continents separated by an ocean (for example, on South America and Africa), this is most likely because.... *

- That species swam across the ocean millions of years ago.

https://docs.google.com/spreadsheet/formResponse?formkey=dThhcC0tXlFLXld5dScjzSQo1WHJzdF...
That species independently evolved on both continents.
Those two continents used to be part of the same land mass and were later separated by continental drift.
Those bones must not actually belong to the same species of dinosaur.
Don’t know.

True or False Questions

Fossils can tell us about the history of life on Earth. *
True
False
Don’t Know

Some fossils have been underground for millions of years. *
True
False
Don’t Know

An animal or plant currently living today is a fossil. *
True
False
Don’t Know

« Back  Continue »

Powered by Google Docs
Report Abuse • Terms of Service • Additional Terms
Appendix 3F: Post-test of Attitude & Engagement

### Post-Lesson Questionnaire (E)

* Required

#### Name

Please re-enter your name.

**First Name** *

**Last Name** *

#### Section 1: Reaction to Lesson

INSTRUCTIONS: Please read each statement carefully. For each statement, choose the number that best describes what you think about these statements. There are no “right” or “wrong” answers. Your opinion is what is wanted.

For each statement, choose one of the following:

1. if you Strongly Disagree with the statement
2. if you Disagree with the statement
3. if you are Not Sure about the statement
4. if you Agree with the statement
5. if you Strongly agree with the statement

Be sure to give an answer for all questions. If you change your mind about an answer, just change your answer before hitting “submit” on that page. Some statements in this questionnaire are fairly similar to other statements. Don’t worry about this. Simply give your opinion about all statements.

#### During the lesson on fossils I just received... *

<table>
<thead>
<tr>
<th>1 Strongly Disagree</th>
<th>2 Disagree</th>
<th>3 Not Sure</th>
<th>4 Agree</th>
<th>5 Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>... I learned something new</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>... I learned something interesting</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>... I learned something relevant to me.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>... I understood what was being taught.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>... I enjoyed learning.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

https://docs.google.com/spreadsheet/viewform?formkey=df2b9101b2b02b31c0f70d70602c0F1...
### Now that I have learned a bit...

<table>
<thead>
<tr>
<th></th>
<th>1 Strongly Disagree</th>
<th>2 Disagree</th>
<th>3 Not Sure</th>
<th>4 Agree</th>
<th>5 Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>... I would like to learn more about fossils.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>... I would like to learn more about the history of Earth.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>... I will seek out more information on fossils and the history of the earth.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Lessons like the one I just had....

<table>
<thead>
<tr>
<th></th>
<th>1 Strongly Disagree</th>
<th>2 Disagree</th>
<th>3 Not Sure</th>
<th>4 Agree</th>
<th>5 Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>... are valuable ways to learn about science.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>... are better than learning from my normal textbook.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>... should be used in science class more often.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Post-Lesson Questionnaire (E)

* Required

SECTION 2: Attitudes toward Song and Video

The song “Fossil Rock Anthem...” *
NOTE: this question is only asking about the song’s audio, not the animations in the video.

<table>
<thead>
<tr>
<th></th>
<th>1 Strongly Disagree</th>
<th>2 Disagree</th>
<th>3 Not Sure</th>
<th>4 Agree</th>
<th>5 Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>... is catchy.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>... is memorable.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>... is still stuck in my head.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

While I was listening to the song “Fossil Rock Anthem...” *

<table>
<thead>
<tr>
<th></th>
<th>1 Strongly Disagree</th>
<th>2 Disagree</th>
<th>3 Not Sure</th>
<th>4 Agree</th>
<th>5 Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>... I was paying close attention to the sound of the lyrics.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>... I was paying close attention to the meaning of the lyrics.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>... I was not listening to the lyrics.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>... I was comparing the song to “Party Rock Anthem” by LMFAO.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Do you have any other comments on the song's audio? If so, please write them in the box below.
Note: If you have comments on the visuals in the video, please save for the next question.

The animated video for “Fossil Rock Anthem”...

<table>
<thead>
<tr>
<th></th>
<th>1 Strongly Disagree</th>
<th>2 Disagree</th>
<th>3 Not Sure</th>
<th>4 Agree</th>
<th>5 Strongly Agree</th>
</tr>
</thead>
</table>
12/6/12

<table>
<thead>
<tr>
<th>Question</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>... moved too fast.</td>
<td></td>
</tr>
<tr>
<td>... was distracting.</td>
<td></td>
</tr>
<tr>
<td>... was fun.</td>
<td></td>
</tr>
<tr>
<td>... was lame.</td>
<td></td>
</tr>
<tr>
<td>... was boring.</td>
<td></td>
</tr>
<tr>
<td>... was memorable.</td>
<td></td>
</tr>
<tr>
<td>... got me excited.</td>
<td></td>
</tr>
<tr>
<td>... is something I would tell my friends about.</td>
<td></td>
</tr>
<tr>
<td>... is something I would share online.</td>
<td></td>
</tr>
<tr>
<td>... is something I would watch again at home.</td>
<td></td>
</tr>
</tbody>
</table>

Do you have any other comments on the animated music video?

![Comment Box]

« Back  Continue »

Powered by Google Docs

Report Abuse - Terms of Service - Additional Terms

https://docs.google.com/spreadsheet/formResponse?formkey=dF82b290Q2NzZHRiZC1qc0dNoGR2x3... 2/2
Appendix 3G: Follow-up Emails

MUSIC group follow-up email:

Fossil Video Follow-up

Dear << Test First Name >>,

Thank you for your participation in our research on science education!

If you’d like to watch the video about fossils you watched the other day, please click here.

- Feel free to watch it as many times as you like! Share it with your family and friends (though please don’t share with other classmates until we complete the final research session in a few weeks. I’ll let you know when it’s OK to share it more widely).

If you’d like to learn more about fossils and the history of the earth, please click here.

- The link above sends you to an eBook that goes alongside the “Fossil Rock Anthem” music video. The eBook explains all the stuff that the song is singing about. After you click on the link above, just click “Download” in the upper right corner and then “Direct Download.”

Feel free to respond to this email if you have any questions.

Thanks again,

Tom McFadden
Fossil Video Follow-up

Dear << Test First Name >>,

Thank you for your participation in our research on science education!

If you'd like to watch the video about fossils you watched the other day, please click [here].

- Feel free to watch it as many times as you like! Share it with your family and friends (though please don't share with other classmates until we complete the final research session in a few weeks. I'll let you know when it's OK to share it more widely).

If you'd like to learn more about fossils and the history of the earth, please click [here].

- The link above sends you to the Wikipedia page on “Geological history of life on earth.” This is a great jumping off point for exploring more about fossils and earth science.

Feel free to respond to this email if you have any questions.

Thanks again,

Tom McFadden
Appendix 3H: Fossil Rock eBook

The following url links to the complete Fossil Rock eBook that I created during my first year of my Master of Science Communication course. This eBook was created for the eBook assignment in SCOM 403 with Lloyd Davis, so has already been submitted to another class for grading and credit. However, because I used this eBook during my thesis research and it represents one of the ways teachers can incorporate science music videos into their lessons, it is included here in the appendices.

https://www.dropbox.com/s/ix9r8cd42gnfdqx/Fossil%20Rocks%202012.pdf
Appendix 4A: Science Idol Paper Entry Form

Enter

Like science? Like music?
Combine the two and see what happens.
Anyone can enter, but only residents of New Zealand will be eligible to win.

How to Submit

1.) Upload or post us your video

Upload your video to Vimeo or YouTube
(copy and paste the link into your online submission form)

or

Post your video on a DVD or USB to this address

2.) Online Submission Form at www.scifest.org/idol/howtosubmit

3.) Sign and Send (post, email, or fax)

i. Entry Submission Form on back of this page

ii. Your Research Consent Form

iii. Parental Research Consent Form

Please send materials to:
Attn: NZISF 2012
Level 1
138 Lower Stuart Street
Dunedin 9016
New Zealand

www.scifest.org/idol
Entry Form

Project Details

Title of Song: ___________________ Age: 8-14 15-22 23+  
(CIRCLE ONE)  

Your Name(s): ___________________  

Date of Birth: ______  Phone: ___________________  

Email: ___________ Mobile: ___________________  

Contact Address: ___________________  

What’s the best way to contact you? ___________________  

If you are a student, what school do you attend? ___________  

(CIRCLE ONE): Primary  Intermediate  Secondary  Tertiary  

How did you find out about this competition? ___________________  

IN ENTERING A VIDEO (‘THE VIDEO) FOR THE SCIENCE IDOL 2012  
COMPETITION (‘THE COMPETITION) I, THE UNDERSIGNED:  

Understand that the New Zealand International Science Festival, which is running the Competition, will seek to  
achieve a widespread audience for some of the videos entered in the Competition.  

Agree that the New Zealand International Science Festival, its licensees and assignees have the right (and are  
licensed) to use the video or any part of it as it may be edited by or on behalf of Inspiring Stories at its discretion,  
for showing throughout the world on television and via the Internet and in/on any other media.  

If I win the Grand Prize in Science Idol 2012, I may need to make changes to my song and backing track, in part to  
make sure that I have the rights to use all material involved in my output during the New Zealand International  
Science Festival.  

Signed ___________  
Date: ___________  

If under 18, parent or guardian must sign  

Signed ___________  
Date: ___________  

Please send this  
form to:  

Attn: NZISF 2012  
Level 1  
138 Lower Stuart Street  
Dunedin 9016  
New Zealand  

www.scifest.org/idol
Science Idol 2012 Entry Form

Thanks for participating in Science Idol 2012! In order to be eligible to win a prize, you must currently be living in New Zealand and you must successfully submit this form (make sure you make it to the final page and click SUBMIT).

* Required

Your Full Name *
If you worked as a team or group, please select one representative.

What is your date of birth? *

Age Group *
Choose one, based on your age as of 17 June 2012.
- Age 8 - 14
- Age 15-21
- Age 22 and above

Title of Your Song/Performance *

Video URL (Copy and Paste) *
Upload your video to Vimeo or YouTube and copy and paste the link here (please make sure the link works, though you may leave it as "unlisted" if you would prefer that it is not public). If you would rather not upload your video online, you may post an electronic copy of your video on DVD or USB drive to PO Box 5819 Dunedin 9058. If you do post your video to us, please write POST below.

Lyrics - Please copy and paste the lyrics to your song below *

https://docs.google.com/spreadsheet/viewform?formkey=dfsJ2dQXxWkzJbukxQW RJ8ERRY%3FOGc3MEQligid=0
Where did your backing track come from? If you've parodied another song, please include the name of the artist and the song you've used. *
If it's original, who made it? If spoken word, just write "spoken word".

Email Address *

Home Phone: *

Mobile Number: *

Contact Address *

What is the best way to contact you? *
- Home Phone
- Mobile
- Email

https://docs.google.com/spreadsheet/viewform?formkey=dFd2QUtXeFBsalcxQVRjWERYb19FOGc6MQ#gid=0
If you are a student, what type of school do you attend? *
- Primary
- Intermediate
- Secondary
- Tertiary
- I am not a student
- Other:

What is the name of your school?

How did you find out about this competition?

Was this a school assignment?
- Yes - it was required
- Yes - but it was optional
- No - but my teacher mentioned it
- No - but Tom McFadden performed at my school
- Other:

Are you submitting from within New Zealand (in which case you are eligible to win) or from outside of New Zealand (in which case this will be a much appreciated but honorary submission)? *
- Within New Zealand
- Honorary International Submission

CONSENT: Are you below the age of 18? *
- Yes. I am below the age of 18.
- No. I am 18 or older.
### Science Idol 2012 Judging Criteria

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(Including their delivery of lyrics and/or actual presence on screen)</td>
</tr>
<tr>
<td>• Scientific Message is confusing or inaccurate. No “take home” message</td>
<td>• Very simple lyrics</td>
<td>• Delivery is severely off rhythm</td>
</tr>
<tr>
<td>• Examples are seemingly unrelated to main message</td>
<td>• Lyrics do not flow/rhyme when performed</td>
<td>• Performer is overly embarrassed - not projecting confidence</td>
</tr>
<tr>
<td>• Viewer leave video without having learned much</td>
<td>• Too much jargon that is unexplained</td>
<td></td>
</tr>
<tr>
<td>• Not too many inaccuracies</td>
<td>• Not enough lyrics to effectively convey message</td>
<td></td>
</tr>
<tr>
<td>• There is a clear scientific message</td>
<td>• A few chuckles at lyrics</td>
<td>• Delivery is competent but average</td>
</tr>
<tr>
<td>• Examples are loosely related to each other and larger theme</td>
<td>• Competent rhyme/flow</td>
<td>• Performance gets the job done, but not that extra “something” / “star power”</td>
</tr>
<tr>
<td>• Not too many inaccuracies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Clear scientific message/theme</td>
<td>• Clever laugh-out-loud puns</td>
<td>• Performance full of confidence, gusto, and swag</td>
</tr>
<tr>
<td>• Good examples or supporting details that convey message</td>
<td>• Creative rhyme schemes</td>
<td>• Delivery is within basic standards of rhythm and tone</td>
</tr>
<tr>
<td>• Near 100% accuracy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Viewer leaves video having learned something</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Science Score: | Lyrics Score: | Performance Score: |

Total: __________
Appendix 4D: “Covalent Love” by James Mustapic & Tom McFadden

**VERSE 1:** If we were covalent I'd never let you go,
We could share electrons so our valence would be full
Baby you want eight, but you need a couple more
Got electrons in my shell that I'd really like to show

SCIENCE, SCIENCE, SCIENCE. On you.
We could be together, we could be like $\text{N}_2$
So how many you need, baby? 3? 2? (*whisper: SCIENCE*)

**PRE-CHORUS:** I’d like to bond covalently,
Hey atom, let me bond with you!

**CHORUS:** If we shared electrons
I’d never let you go!
Our bond would be much stronger, than ionic or dipole
We could be stable
Our valence would be full.
If we shared electrons, I’d never let you go
Until we react some mo’.

The thing about sharing electrons with me
The bond’ll be stronger if we share ‘em equally,
If you hog ‘em all, with your negativity
I'ma get a partial charge, and be gettin frisky. (*whisper: POLAR*)
Dipole, Dipole, We would have a dipole.
Not quite ionic, but there would be a side show
Other polar molecules, knockin’ on our side door .
Rather keep it non-polar. Hydrocarbon style. (*whisper: SCIENCE*)

**PRE-CHORUS:** I’d like to bond covalently,
Hey atom, let me bond with you!

**CHORUS:** If we shared electrons
I’d never let you go!
Our bond would be much stronger, than ionic or dipoles
We could be stable
Our valence would be full.
If we shared electrons, I’d never let you go
until we react some mo’

**BRIDGE:** So give me a chance
Don't be so electronegative!
I think you're hogging ‘trons. Yes in fact I'm pretty positive (*POSITIVE, POSITIVE*)
Nonpolar covalent bond.... ing would be so grand.....
I Just wanna share my trons with you...

**CHORUS**
Appendix 5A: Science Idol Research Questionnaire

Science Idol 2012 Research Questionnaire Part 1

INSTRUCTIONS: Please read each statement carefully. There are no “right” or “wrong” answers. Your opinion is what is wanted.

Some of the questions ask how much you agree with a given statement. For such statements, choose one of the following:

1 if you Strongly Disagree with the statement
2 if you Disagree with the statement
3 if you are Not Sure about the statement
4 if you Agree with the statement
5 if you Strongly agree with the statement

Be sure to give an answer for all questions. If you change your mind about an answer, just change your answer before hitting “submit” on that page. Some statements in this questionnaire are fairly similar to other statements. Don’t worry about this. Simply give your opinion about all statements.

* Required

First name *

Last Name *

Song-writing experience *

Mark each statement with how strongly you agree or disagree.

<table>
<thead>
<tr>
<th>Statement</th>
<th>1 Strongly Disagree</th>
<th>2 Disagree</th>
<th>3 Not Sure</th>
<th>4 Agree</th>
<th>5 Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I enjoyed the process of making my own science song.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would like to make more science songs in the future.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would write a science song even if there was not a competition.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>While producing my song I learned a lot about my scientific topic.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I learned more from this experience than I would have from a textbook.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I was nervous because I wasn’t sure if the lyrics I was writing were accurate.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please share any additional thoughts on your song-writing experience:

https://docs.google.com/spreadsheet/viewform?formkey=dF1QTDQ2NE2ak2bmx2WFzE3Vv56M... 1/3

118
**Song-writing preferences**
Mark each statement with how strongly you agree or disagree.

<table>
<thead>
<tr>
<th>Statement</th>
<th>1 Strongly Disagree</th>
<th>2 Disagree</th>
<th>3 Not Sure</th>
<th>4 Agree</th>
<th>5 Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I prefer to make science songs with a group of people.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would rather pick my own topic for a science song than have it assigned.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would rather work on a science song at home than during classtime.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Please share any additional thoughts on your science song-writing preferences:**

---

**Digital Technology**
Mark each statement with how strongly you agree or disagree.

<table>
<thead>
<tr>
<th>Statement</th>
<th>1 Strongly Disagree</th>
<th>2 Disagree</th>
<th>3 Not Sure</th>
<th>4 Agree</th>
<th>5 Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I had to learn new digital skills (like audio or video editing) in order to create my Science Idol 2012 submission.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have been inspired by this activity to improve my digital skills.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I wish I had had access to more digital technology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[https://docs.google.com/spreadsheet/viewform?formkey=dFQzTDQzNDE2akh2bmhxZWFrZEk3Vms6M...](https://docs.google.com/spreadsheet/viewform?formkey=dFQzTDQzNDE2akh2bmhxZWFrZEk3Vms6M...)

---

119
<table>
<thead>
<tr>
<th>My school was able to supply me with the digital tools I needed (i.e. computers, cameras).</th>
</tr>
</thead>
<tbody>
<tr>
<td>My family or friends were able to supply me with the digital tools I needed.</td>
</tr>
</tbody>
</table>

Please share any additional thoughts on the use of digital technology during the competition.

[Blank Field]

Continue »
Science Idol 2012 Research Questionnaire Part 2

Make sure that you have watched the “Fossil Rock Anthem” video twice before completing the following questions. For each of the following statements, we are just looking for your opinion (there is no “right” or “wrong” answer). As you did before, please indicate how much you disagree or agree with each statement.

* Required

**First Name **

**Last Name **

"Fossil Rock Anthem“ Questions *

<table>
<thead>
<tr>
<th>Statement</th>
<th>1 Strongly Disagree</th>
<th>2 Disagree</th>
<th>3 Not Sure</th>
<th>4 Agree</th>
<th>5 Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I learned something from that music video.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I enjoyed that music video.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I learned more from that music video than I did from writing my own song.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I am familiar with the song “Party Rock Anthem” by LMFAO.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I enjoy the song “Party Rock Anthem” by LMFAO.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I would rather make my own science song than listen to a science song like “Fossil Rock Anthem.”</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>The lessons I learned making my own song will stick with me more than what I learned from “Fossil Rock Anthem.”</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

Please share any other reactions you have to the “Fossil Rock Anthem” video and whether you’d like to see more videos like this.
In the box below, please write as many of the lyrics to “Fossil Rock Anthem” as you can remember.

Do not go back and watch the video again. Simply write as many of the lyrics (including the chorus or verses) as you can recall.

Submit

Powered by Google Docs

Report Abuse · Terms of Service · Additional Terms
Appendix 6A: Teacher Feedback Questionnaire

Teacher evaluation of student performance & engagement in science (Abbotsford Room 9 McGregor)

* Required

Science Music Video Questions

Would you use a video like “Fossil Rock Anthem” in your classroom? *
- Yes
- No

How would a video like “Fossil Rock Anthem” best be used in a science classroom? *
Select all options that apply.
- Introduction to a new unit
- Way to hook kids in
- Summary at the end of a unit
- Take-home activity for students
- Other: 

Feel free to comment here on your answer to the previous two questions.

Please finish the following statement. Music Videos like “Fossil Rock Anthem” would be more effective at teaching scientific content if...

Would you be willing to write and perform your own science song for your students? *
- Yes

https://docs.google.com/spreadsheet/formResponse?formkey=dG5sa3lwF2HcmFDc0NjAwY3U2R2... 1/2
Teacher evaluation of student performance & engagement in science (Abbottsford Room 9 McGregor)

No

If you answered NO, what would prevent you? (not enough time, I’m not very musical, I don’t like to be “goofy”) If you answered YES, what would motivate you to do it?  

Insofar as science songs are incorporated into the classroom, do you think they should be written by teachers, students, or outside organizations? Please explain your answer.

Powered by Google Docs

Report Abuse - Terms of Service - Additional Terms

https://docs.google.com/spreadsheet/formResponse?formkey=dC85aFjwDF2HcmFDc3N6aSY3UzRz... 2/2