OLOGISM: NORMALISING SCIENCE ONE LYRIC AT A TIME

By:
Dan Callahan
Alex Clemens
David Mihal
Tyler Mott

Ologism: Normalising Science One Lyric at a Time

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by

Daniel Callahan
Alexander Clemens
David Mihal
Tyler Mott

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Report Submitted to:

Chris Krishna-Pillay
Carly Siebentritt
CSIRO Education Victoria

Professors Dominic Golding and Andrea Bunting
Worcester Polytechnic Institute

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Abstract

Like many other countries, Australia is concerned about the public's declining interest and performance in science. Many agencies and organisations, including Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO), are exploring ways to engage the public in science. CSIRO Education sponsors a band called *Ologism* that writes and performs songs about science. Our goal was to develop a website to display the band's lyrics and interpret and embellish on the science concepts they present to better engage adults aged 17–30. Through rapid prototyping we evaluated the content, design, and functionality of the website, and determined how *Ologism* and CSIRO Education could develop the site further to engage a larger audience more effectively.

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We would like to thank a number of people for their help throughout this project. They gave a great deal of their time and effort to help us complete this project and it would not have been possible without them.

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We would also like to thank Dr Gregory Crowther for his input on our project. He gave us some good ideas of ways to improve the website and his input was very helpful for the completion of our project.

Lastly, we would like to thank the band *Ologism*. Their songs and lyrics provided the groundwork for us to build our project off of. Without them there would not have been a project for us to do.

Executive Summary

Purpose

Many developed countries are becoming increasingly worried about the declining interest and engagement in science. The Australian Industry Group found that Australian employers are finding it more difficult to recruit people with Science, Technology, Engineering, and Mathematics (STEM) backgrounds, especially when recruiting technicians and trade workers. This problem is only projected to get worse because the majority of the fastest growing occupations require STEM background knowledge. This is a major issue because science innovation produces increased national economic growth.

Along with the decrease in studying science, there has also been a decrease in general scientific literacy. This is a problem because without a basic understanding of science concepts it is easy for people to misunderstand the actual capabilities of science. In addition to a better understanding of science, science literacy also enables people to take advantage of new job opportunities. The advantages of being scientifically literate also expand beyond the working domain. Understanding basic science concepts enables people to have intelligent conversations regarding elections and debates. Questions pertaining to nuclear power, global warming, and energy conservation are often brought up and having a basic understanding of science helps the general public be more informed with regards to these issues.

Methods

To counteract this declining interest the science rock band, *Ologism*, is trying to normalise science. By using music, *Ologism* tries to change people's perceptions of science in order to get them interested and engaged. They target people ages 17–30 who are disengaged from science. In order to do this they have created a website to spread their music to a wider audience. Our project was to interpret and explain the science concepts present in the lyrics and develop a website to display the lyrics and added information. We created science-based content connected to their songs and designed the lyrics page to attract people to the site and encourage them to engage them with the lyrics page.

Before we could create the lyrics page, we needed to develop the content for the site. We did this by using Lyric Guides as a template for each song. The template was in a table format and had the lyrics one side with our additional information on the other. We went through the lyrics and highlighted the key concepts that needed further explanation. Then we did background research on these topics to better understand them. Following this, we created short 50-word descriptions for each concept.

We created the lyrics page using a rapid prototyping process, where we used highly qualitative evaluations to get feedback about the website content and design. The prototyping process involved soliciting participants in the Melbourne Central Business District. We asked people to listen to a song and look at the page and then answer a few questions about their opinions of the site. This allowed us to fix problems with the website and make it more intuitive and more interesting to the people visiting the site.

After the rapid prototyping process we created a final design that we tested using a large-scale evaluation. To gather data for the large-scale evaluation, we developed a survey that was sent out via *Ologism's* Facebook page. The survey randomly assigned to each participant one song out of six of *Ologism's* songs. Participants were given the opportunity to listening to the song and look at the page, and then we asked them to participate in the survey. We first asked for some demographic information and then gauged participants' prior interest and engagement in science. We then asked participants to rate the website, including its ease of use, relevance, appearance, clarity of content, and their willingness to return, and recommend the website to others. We also used A/B testing to compare two different designe of displaying the content on the website. One design of the site was randomly assigned to each survey participant.

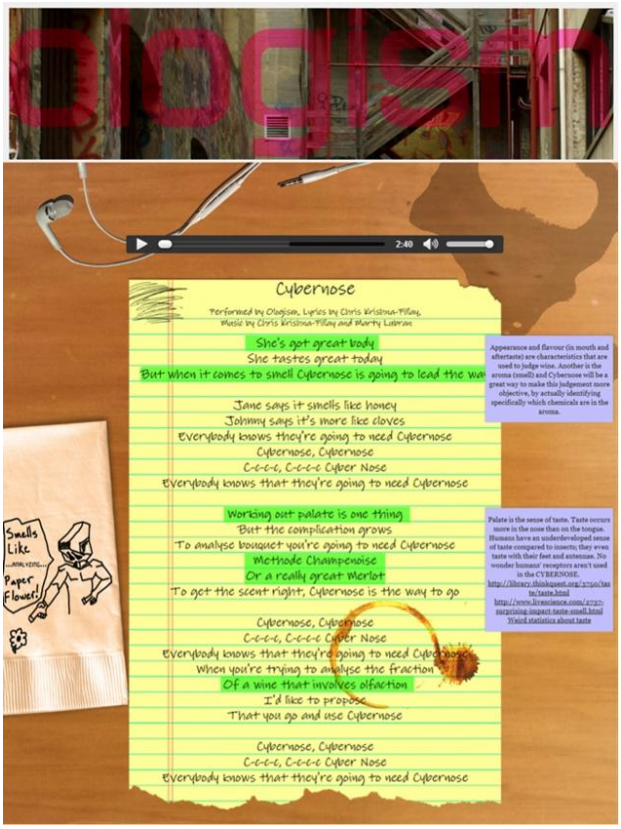
Findings and Recommendations

Using the data from both sets of preliminary evaluations we created a final design of the webpage. We also created an editor that will allow the band to update existing song content or create new content or add new songs to the site easily.

Using data from the large-scale evaluation we examined participants' opinions of *Ologism's* site. We found that people generally had high opinions of the site. We looked at the

science interest and engagement of the participants and compared that to the opinions of the webpage. We found that interest and engagement positively correlated with opinions of the site. Age correlated positively with opinions of the site as well. From all the data we concluded that there were no significant differences in opinions based on gender or the A/B design of the page.

We made a set of recommendations to *Ologism* based on our findings from the survey. These recommendations included expanding the audience to include younger people, continually updating the site to keep people coming back for more information, and adding more interactive features to the page including a marker following along with the lyrics as the song plays or a karaoke option on the site. These recommendations were developed to help *Ologism* and CSIRO better reach their target audience and attract people to the website.



Final Design

Example Doodles

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Introduction

Like many developed countries, Australia is increasingly worried about declining interest and participation in science. Studies have confirmed that fewer students each year are choosing to study science. Between 1976 and 2007 the percentage of year 12 students who took biology, chemistry and physics dropped steadily (Ainley, Kos, & Nicholas, 2008). Nationally, only 51% of year 12 students chose to take a science course in 2010. This trend extends into the Australian universities as well, with the percentage of degrees in Science, Technology, Engineering, and Mathematical (STEM) fields falling from 22.2% in 2002 to only 18.8% in 2010 (Office of the Chief Scientist, 2012). The declining interest in science has been accompanied by a decline in science literacy. In 2013, only 59% of Australians correctly answered the question "How long does it take for the Earth to go around the Sun?" Furthermore, the number of 18-24 year old students who answered that question correctly declined by 12% between 2010 and 2013 (Wyatt & Stolper, 2013).

The Education branch of Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO Education) provides and supports science outreach programs across Australia as a response to this falling interest in science. In order to help CSIRO normalise science and get more people involved, they sponsor a band named *Ologism* that develops and performs music with science-themed lyrics. The members of *Ologism* are in the process of creating online resources to interpret and supplement their songs with related information about science and scientific concepts. To facilitate their efforts, our team developed educational content to complement the lyrics of selected songs and built and evaluated a prototype website to present this content in an attractive and engaging fashion to key audiences between 17 and 30 years old. An easily accessible webpage with quick information provides *Ologism* with educational material for users desiring more information on science concepts in their songs.

This project included in depth research on multiple areas of learning and media since *Ologism* uses multiple mediums to present science. Our team researched informal education and music in education to better understand the strengths and weaknesses associated with *Ologism's* style of teaching. Through research and discussions with staff at CSIRO Education Victoria our project team identified the desired themes and subjects in the lyrics while we collected

information for the website. We developed informational content for the website by conducting research on the scientific topics and identified links to reputable sources for further information. In order to make the content more understandable to our audience, we studied readability and high impact writing styles to provide a guideline on how to best compose the educational substance. We assessed and redeveloped the content through an iterative process of review with CSIRO Education staff and a rapid prototyping evaluation of the website content and functionality. Then, we tested the prototype on a large scale to measure the website's effectiveness and useability. The end product is a design that engages and educates the target audience of young adults between 17 and 30 years old.

Literature Review

In the Literature Review, we further detail the declining interest in science in Australia and what programs have been developed to help prevent this. We also explain how teaching science through music can be beneficial, although the research findings on the effectiveness of music are still relatively limited and focus particularly on information retention. Following this, the Methods section will explain our process of data collection, content development, and evaluation of results. Through these methods, we plan to help *Ologism* reach a larger audience and help engage their target audience in science.

Declining Interest in Science

Why is it important people to study science? Science and other related fields are important for innovation and job creation in the modern world. Individuals with science and technology backgrounds are necessary for new high tech industries to form (Office of the Chief Scientist, 2012). These new industries are important for the economic development of the world. A report from the US Department of Labor estimated that "Scientific innovation has produced roughly half of all U.S. economic growth in the last 50 years" (US Department of Labor, 2006). This implies that science is an integral part of economic growth and that it is important to promote science education in order advance the economy. The Australian Industry Group found that Australian employers are having trouble recruiting people with STEM backgrounds, particularly when trying to recruit technicians and trade workers (Australian Industry Group, 2013). This problem will only get worse as "75% of the fastest growing occupations require STEM skills and knowledge" (Australian Industry Group, 2013, p. 1). Given the lack of STEM background among many members of the workforce, governments and industry leaders have to respond to prevent a decline in scientific innovation and economic competitiveness. The Australian Industry Group's report makes a number of recommendations to promote STEM learning including "The adoption of a more innovative pedagogy which teaches STEM in an engaging and innovative way" (Australian Industry Group, 2013, p. 12). The Australian Industry Group cites Hawker College (a secondary school in the Australian Capital Territory) as an example of how to use innovative and engaging ways to teach STEM subject. Hawker College instituted a new mathematics program that moves away from formal education and instead uses

an online mathematics website with interactive software and videos to better engage students (Australian Industry Group, 2013).

Scientific literacy enhances a nation's well-being by enabling competition in international markets. "Eight in ten (81%) [Australians] agree that scientific research makes a direct contribution to economic growth in Victoria" (Sweeney Research Pty. Ltd, 2012) In order to compete in international markets, a nation needs to create a national research and development program to develop new technology. To maintain a program such as this, an ample number of scientists, engineers, and technicians need to be provided. Having a scientifically literate public would help supply a nation with the needed amount of scientists to compete in international technology markets and produce new technologies (Laugksch, 2000, p. 84).

Declining Interest in Studying Science

Several of the developed nations are concerned about the decline in students' interest in the sciences. In the US a 2013 survey of high school students showed that only 46% wanted to pursue careers in STEM fields representing a large decrease from 2012 when that percentage was 61% (Junior Achievement USA, 2013). Similar trends are evident in Australia. For example, the Australian Council for Education Research found that between 1976 and 2007 there has been a steady decline in the percentage of year 12 students enrolled in science including biology, chemistry, and physics. The percentage of students enrolled in biology dropped from around 55% in 1976 to 25% in 2007, chemistry from 29% to 18%, and physics from 28% to 15% (Ainley, Kos, & Nicholas, 2008). This apparent decline may reflect the changes in the number of students who stayed in school and the fact that a wider variety of subjects are now offered in schools. Nevertheless, from 1992 to 2007, a period where the rates stayed fairly constant at 75% the proportion of students who were enrolled in biology fell by 29%, chemistry by 22%, and physics by 26% (Lyons & Quinn, 2010). More recently, the Office of the Chief Scientist in Australia detailed the decline in science (Office of the Chief Scientist, 2012). The report notes that internationally 26.4% degrees awarded in 2002 were in STEM fields, while in Australia only 22.2% of degrees awarded were in STEM fields, and by 2010 this figure had dropped to 18.8% (Office of the Chief Scientist, 2012).

By contrast, Sweeney Research Pty Ltd conducted another study for the state government of Victoria that study found Victorians over 18 years old have become *more* interested in science since 2007 with 73 percent stating that they are "either very or quite interested in science" (Sweeney Research Pty. Ltd, 2012). Furthermore, to this, the proportion of people over 18 who actively search for science related information has also increased from 50% in 2007 to 60% in 2011, and 72% of people who searched for science or technology information do it weekly. Even though these results seem quite positive, it must also be noted that 60% of participants had a Technical and Further Education (TAFE) qualification or a university or a post graduate degree and have studied sciences post school. This introduces a potential bias on the results of the study because those interested in science are more likely to have participated in this study (Sweeney Research Pty Ltd, 2012).

Declining Levels of Scientific Literacy

Scientific literacy is another important issue that goes hand-in-hand with participation in STEM fields at schools and universities. There are many different interpretations of scientific literacy due to different opinions as to who the public is and what the public ought to know about science. Scientific literacy can be easily defined as what the general public must know about science. However, there is more to this definition. Often times it can also include having a greater appreciation for the aims and limitations of science and an understanding of other more important scientific ideas. As Laugksch states, it can be argued that maintaining and promoting scientific literacy is essential to ensure personal and economic well-being (Laugksch, 2000, p. 84).

Oftentimes, the capabilities of science can be misunderstood in society. This leads to a decreased interest in, and withdrawal from science. An increase in understanding of science can help alleviate this problem by educating society on the actual capabilities of science. "The more the public understands about … science, the less likely the public will be to acquire unrealistic and unrealizable expectations of science" (Laugksch, 2000, p. 85). When people have unrealistic expectations regarding science, and these expectations are not fulfilled, some people may no longer believe in certain aspects of science. Dismissing the misconceptions about science would be mutually beneficial to both science and society. It would help increase participation in science

because people would have more realistic expectations regarding scientific discoveries, and they would see how science has enhanced technology and their lives.

As previously stated, science and technology are constantly advancing and growing. As more positions open up, people need to stay updated with the most current scientific advancements. "Scientifically literate individuals may therefore be in a favourable position to exploit new job opportunities and be able to take full advantage of technical developments in their place of work" (Laugksch, 2000, p. 86). By taking advantage of new job opportunities and increasing science literacy, people increase their own well-being and the nation's economic well-being at the same time by filling more jobs.

Science literacy is not only important in obtaining a job. To be "a well-informed, cultured, [and] literate individual [one] must know something about the way the natural world works, about the scientific way of thinking, and about the effect of science on society" (DeBoer, 2000, p. 592). Understanding the natural world is important because it enables people to have more informed experiences with the world around them. Concepts such as friction, electricity, and light are things that people experience everyday and directly impact how we live our lives. While an understanding of topics such as these offers a sense of personal satisfaction, being informed of human anatomy or health and disease helps people understand medical advice so they can act accordingly. In addition to someone's own personal health, being scientifically literate can also impact communities as a whole when it relates to voting and policies. Questions pertaining to nuclear power, global warming, and energy conservation are often discussed. People need to be aware of the basic concepts behind these larger ideas so they can make intelligent decisions. Even popular media often has reports or discussions about science. Being scientifically literate allows people to read and understand different scientific discoveries, follow the ethics of science, and it even enables people to have conversations about what they have heard with one another. In the end, science is just another way of looking and understanding the world around us to make us more aware, and more appreciative of the diversity of life (DeBoer, 2000). While these concepts are used in a science education setting, they are also used in everyday life outside of school.

Science Literacy: Australia

The Australian Academy of Science conducted a follow-up scientific literacy survey in May 2013. This survey was used to assess the level of scientific literacy among Australians and how it has changed in three years. A sample size of 1515 was used and was weighted to be representative of Australia's population (Wyatt & Stolper, 2013, p. 3).

While the majority of Australians know basic scientific facts, many still answered questions incorrectly. In the survey, 59% knew that the earth revolves around the sun in one year, 73% of Australians correctly knew that humans never coexisted with dinosaurs, and one quarter of Australians do not know the percentage of fresh water on Earth (9% correctly answered 3%) (Wyatt & Stolper, 2013, pp. 6,9,13). While many of these results are similar to the 2010 results, there were some statistically significant decreases in knowledge of key scientific facts. For example, there was a 4% decrease in the proportion of Australians that knew that 3% of water on Earth was fresh water (Wyatt & Stolper, 2013, p. 4).

Wyatt and Stolper found that, "Generally younger respondents, men and those with a higher education level were more likely to answer the questions correctly". While younger people generally were more likely to answer questions correctly, the literacy level among young people has dropped more than the other groups. For example, the number of 18–24 year olds who knew the Earth orbits the sun in a year decreased by 12% from 2010 to 2013.

These results are interesting because even though there was a decrease in science literacy in several topic areas, 79% of Australians agree that science is "absolutely essential or very important" for the Australian economy (Wyatt & Stolper, 2013, p. 4). In addition to this, 74% also agree that the adoption of new technologies lead to further economic growth (Sweeney Research Pty Ltd, 2012). Evidently, many people in Australia believe science is important, but 52% of people believe studying science will not help in obtaining a good job. (Sweeney Research Pty Ltd, 2012). This is a cause for concern, as people who do not believe that studying science can help them obtain a good job are unlikely to pursue a career in any field of science. Thus, strategies to increase people's interest in science must be further explored.

Strategies to Encourage Interest in Science

Fearing a decline in economic competitiveness, many countries like Australia have initiated a variety of programs and policies to encourage students to pursue STEM subjects in school and at university. These efforts range from curriculum reforms and teacher training to grants and scholarships for those willing to pursue STEM subjects and careers. In addition to efforts within the formal education sector, however, many organisations, including museums, professional societies, and community groups, have been promoting a greater interest in STEM subjects through a variety of programs and initiatives in informal science education. In this section, we focus on informal science education (ISE) initiatives, as these relate most closely to the approach taken by *Ologism*. The National Science Foundation (NSF) provides a useful definition of informal science education, "Informal learning happens throughout people's lives in a highly personalised manner based on their particular needs, interests, and past experiences. This type of multi-faceted learning is voluntary, self-directed, and often mediated within a social context. It provides an experiential base and motivation for further activity and subsequent learning." (Center for Advancement of Informal Science Education, 2013). Informal science education is meant to attract people to science and motivate them to continue learning, either through more formal education or other informal learning techniques. There are a wide range of different types of informal education techniques including museums programs, after school science programs, science televisions shows, and interactive science-based websites like the one developed by *Ologism*. Museums encourage 'free choice' learning, while after school programs offer more structures but typically open-ended hands on explorations of science concepts. Television shows and websites allow the students more choice in what they learn about; by letting them choose which show or site to view. Recently, the US National Science Foundation's Informal Science and Education (ISE) program changed its name to "Advancing Informal STEM Learning" (Center for Advancement of Informal Science Education, 2013) to reflect new emphasis on not just science but also associated STEM field. The change also reflects a shift in emphasis from didactic to more constructivist approaches in the informal education sector.

While informal scientific learning extends to many aspects of our lives, for this literature review we are focused on efforts made by institutions to increase in the knowledge and understanding of the sciences. These institutions and organisations may have a variety of goals.

Some large science museums aim to simply engage their visitors and inspire them to learn more about the sciences in general. Others, such as zoos and aquariums, may aim to promote support for conservation among their visitors.

One challenge regarding informal science education at a museum is that individuals must voluntarily choose to learn about this information. It can be difficult to create experiences that are engaging enough to compel individuals to travel to a museum. A successful alternative to on-site learning is the use of media for informal education. Television shows and documentaries have been popular ways to inform and educate a wide variety of audiences on a diversity of topics. Media can be more effective at reaching new audiences as the time and financial commitments of watching a television program or video are much lower than visiting and buying a ticket for a museum. Since most households in the US, Australia, and other Western countries own at least one television, science programs offer an easy and effective way to provide scientific material to a large audience. Additionally, electronic media allows individuals to have greater control over what subjects they chose to learn about. Educational shows on publicly owned networks in the US, Europe, and Australia, such as the US Public Broadcasting Service (PBS)[1] have been successful in increasing both interest and understanding of science in children and young adults (Bell, Lewenstein, Shouse, & Feder, 2009).

While scientific film and television has existed for a relatively long period of time, the emergence of the Internet as well as the World Wide Web over the past two decades has created a new outlet for educational resources. These new technologies allow near limitless possibilities for virtual interactive education, with everything from online articles and journal entries to video games that feature educational content. While these technologies present new opportunities for information to be presented, some worry that the abundance of information available online can leave people overstimulated and disconnected from the real-world connections of this science (Bell, Lewenstein, Shouse, & Feder, 2009).

With the rise of interactive media as a form of informal education, many museums and other organisations are using technology to supplement their existing educational resources. Many museums make use of mobile phone applications to give visitors additional information

[1] PBS is a non-profit, public television network that produces a number of educational programs

while they explore exhibits. While sometimes challenging to implement, this system allows individuals to connect prepared digital information to their real world experiences (Bell, Lewenstein, Shouse, & Feder, 2009).

CSIRO's Educational Outreach Programs

To encourage increased engagement and understanding of scientific topics among Australian school students, the Commonwealth Scientific Industrial and Research Education branch (CSIRO Education) develops and provides a number of hands-on programs. The organisation has nine Science Education Centres throughout Australia, at which students can attend any of 30 different educational programs. "The Science Education Centres hosted over 374,000 students and teachers in 2011" (CSIRO, 2012b). Additionally, many of these programs can be taught on-site at public schools. As of 2011, approximately 7% of primary and secondary school students in the populated state of Victoria attended a CSIRO educational event. All the programs are intended to supplement existing educational curriculum (Carney, Hyman, Mello, & Snieckus, 2011).

CSIRO Education aims "to engage, enthuse and educate students, teachers and the wider community about science and its applications" (CSIRO, 2013). One of CSIRO Education's programs is called CREST (CREativity in Science and Technology). CREST is a non-competitive awards program that enables students to undertake real-life, open-ended science investigations. This program supports the Australian curriculum and allows students to develop an appreciation for science and technology investigations to show them the possibilities for future careers in science and engineering (CSIRO, 2013).

In addition to CSIRO Education's education outreach programs, they are also involved in national science events, such as National Science Week, and they fund a television show, SCOPE. CSRIO's Experiment-a-thon exceeded previous years' attendance with 20,000 participants during the 2011 National Science Week. SCOPE is a weekly national science television program that is broadcast on Tuesday afternoons (CSIRO, 2012b). Each week, Dr Rob (the program's host) explores the science behind another every day activities or items such as, technology, food, clothes, medicine, and even athletes that children admire. The show provides videos and even experiments and activities for use in classrooms and at home. Students can also

"research the ideas introduced in each episode and 'Ask Dr Rob' for more information" (CSIRO, 2012b).

CSIRO's goal is to educate the community, and after looking at the education performance reports, it is clear that they have been quite successful. In a survey of 6,500 teachers in Australia, 99% percent agreed that CSIRO's programs were both "engaging and educational" (CSIRO, 2012a). Participation in CSIRO's Discovery Centre has even increased to 43,000 students visiting in 2011-12. Independent evaluations also indicate that CSIRO's outreach programs have high levels of success (CSIRO, 2012a, p. 57).

Ologism

Ologism is a science rock band sponsored by CSIRO and funded by Inspiring Australia[2] to help promote science learning through music. Inspiring Australia's goal is to create a more scientifically engaged Australia. "The Inspiring Australia strategy was developed through national consultations with a wide range of science communicators, educators, journalists and scientists in all states and territories" (Inspiring Australia, 2013). Inspiring Australia believes that *Ologism* can help promote engagement in science. *Ologism* plays a variety of music including rock, punk, pop and soul music. In keeping with the goals of Inspiring Australia, *Ologism's* mission is to get people to be more engaged and informed in the scientific field. Playing this wide range of music increases *Ologism's* chances of reaching a wider audience.

Generally their target audience is people between the ages of seventeen to thirty who are disengaged from science; however, the target audience is not limited to this range. Through the use of music and some on stage demonstrations, *Ologism* seeks to promote long-term interest in science. These fun and engaging performances enable *Ologism* to create a new perspective of science to the general public. By portraying science in a fun way, they are able to change people's perspective of science in the general public. They are also able to attract a greater audience due to their alternative approach to teaching science, including people who otherwise appear not to be interested in science. Using music as in informal education technique enables *Ologism* to create engaging content for a diverse range of people.

[2] Inspiring Australia is a program run by the Australian Government to promote scientific engagement

Using Music in Education

Incorporating multiple mediums in learning often improves one's recall of information by increasing the data to available remember and the available connections for recall (Crowther, 2012). Multiple mediums help by providing context clues in which time, sequence, and framework are added to the original material. Combining the information creates outlines for one's memory to follow when recalling the information. Therefore, using music as an extra medium can increase students' memory.

Other than memory, music is used to connect students with their teachers. Although examples are not frequent, teachers use music to promote a personal relationship with their students. When students form a personal connection with their teachers, the content is easier to approach, which may encourage interaction and subsequently more interest in learning. The incorporation of music in educational activities increases enjoyment, while establishing a better environment for educators to teach.

The many advantages and uses of music in the classroom can greatly assist *Ologism's* work. However, the uses are for a formal education setting, and *Ologism's* website is an informal education setting. Consequently, the advantages may be different or non-existent when applied outside the classroom.

Although there are numerous benefits to using music in education, there are also many challenges, including the favouring of music genres and the creation of original song material. *Ologism's* music will not coincide with these concerns during our project.

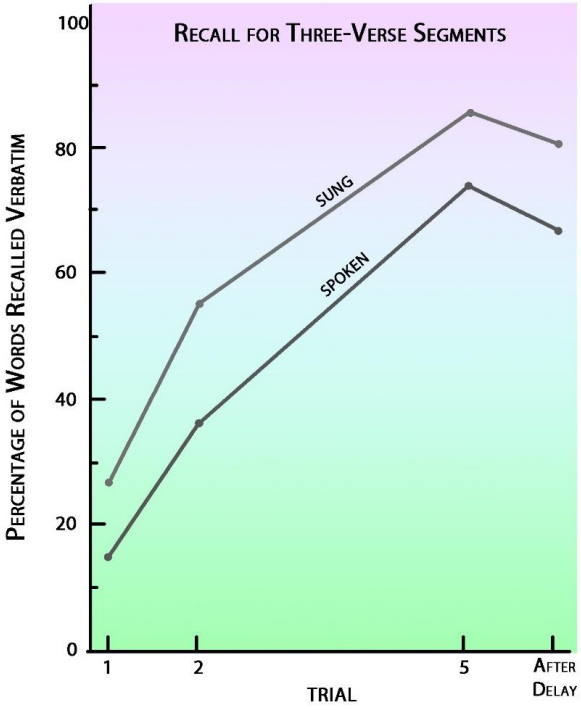
Advantages of Music in Education

Crowther (2012) identifies five major benefits of using music in an educational setting to promote learning. He asserts that music can be used effectively to (1) enhance recall of facts and concepts; (2) reduce stress; (3) increase enjoyment; (4) provide multi-modal learning opportunities; and, (5) promote in-depth exploration of content. Many of the studies on the benefits of music in an educational setting are relatively limited and they focus on the formal education setting, but we review the basic findings here since they have implications for using music in informal educational environments to promote engagement and learning.

Enhancing Recall

"The close relationship students have to [music]… often begins with memorizing lyrics" (Emdin, 2010, p. 2). This desire that people have to link lyrics to melodies is used to teach various topics, especially science. Crowther states that music can be used as a mnemonic device to memorise "key lists, formulas, definitions, and relationships" (Crowther, 2012), which is why teaching science through music might be very effective. Science has a lot of technical terms, formulas, and relationships, and it can be difficult to keep track of them all. Students may become less interested in science due to this difficulty. Using music to help memorise terms can help overcome this obstacle.

Figure 1: Wallace's results for word recall from a ballad



An example of this advantage is a study comparing two groups of subjects recalling words from a ballad when it was sung versus when it was spoken. The control group that heard the spoken ballad recalled words at a lower rate than the group that heard the sung ballad (*Figure 1*).

These results show a more rapid association with the given ballad but a similar drop in retention over time. The general trend implies the amount of retained information raises with the use of musical cues. Moreover, scientists noticed that the group that heard the sung version specifically counted the number of syllables in the ballad by using the music's rhythm (Wallace, 1994). This provided the subjects with a framework to count the missing words and assist in a better recall (Wallace, 1994). The music helps the mind handle more than memorisation of words by including the spacing and structure they were used in. These results support the use of music as a powerful mnemonic device for recalling words, syllables, and timing.

Reducing Stress

Making people feel comfortable in a learning environment is important in nurturing a positive emotional response. In some learning environments people feel out of place and uncomfortable inhibiting the desire to learn. Music is an effective way to help lighten the mood and make people feel comfortable. Christopher Emden states that when students feel alienated from school and science, music provides an escape. With music, students will delve into learning the lyrics to songs from different artist (Emdin, 2010, p. 2). The music should be used to connect them back to education or possibly teach the material, prevent people to from feeling alienated.

Alber and Bach (2003, p. 238) used music to restructure the formal expectations of a sociological classroom. At the beginning of each class, music was played to introduce that day's topic. The study identified very positive audience responses and concluded music enhanced the comfort level for 75% of the students and produced four beneficial results.

1. Encouraging students to participate during class;
2. Creating a friendly environment for student expression;
3. Humanising the instructors; and
4. Linking the students to the class material.

The relaxed setting created a more informal classroom that engaged the students and made the teacher more approachable (Albers & Bach, 2003). Overall, the research found that redefining the classroom as informal and personally relevant to students promoted participation and willingness to understand the class topics.

Increasing Enjoyment

Music elicits strong emotional responses, which have an impact on memory. An emotional response for the subject is different than the comfort felt in the classroom. Relating recognisable music to the subject matter produces increased enjoyment. Therefore, the student forms a personal bond from their music to the topic at hand.

Schulkind, Hennis, and Rubin (1999, p. 952) found that older adults had “stronger emotional responses to the music popular during their youth in comparison with music later in life” It was also found that the older adults remembered more about these songs due to the

emotional connection they had to the song. This can be especially useful when trying to connect with older audiences. Incorporating music that reminds them of their youth can be used as a hook, depending on what kind of emotional response they have, to draw them back into learning.

Students studying in Human Resources Development (HRD) were assigned homework involving the research of music and its relevance to HRD. Students choose songs they knew and thought were relevant to HRD, which gave them a personal connection with their research (Madsen, 2007). At the end of the assignment students were surveyed to rate the effectiveness of the project including interest level and retention of information. Responses were positive in that the lesson motivated the students to research the song and its HRD relevance. The general consensus of the research reported a higher interest in the HRD material and its connection to outside material, specifically music. The assignment made students consciously relate their music to the corresponding chapters (Madsen, 2007). Madsen did not identify an improvement in the understanding of HRD, but she found an increased willingness among students to learn the material.

Engaging Multi-Modality

Not all methods of learning are effective for every person. There are people who are visual learners, people who learn through writing, people who learn through audio, and combination learners. When using music to teach, it is possible to "engage students through multiple modes (verbal vs. nonverbal) and modalities (auditory vs. visual vs. kinaesthetic) simultaneously" (Crowther, 2012, p. 26). This kind of flexibility should be utilised to its full extent in order to help people learn.

Similar to mnemonic device, multiple-modalities ask the brain to take in different but similar information at one time to increase memory retention. The numerous modalities provide information in separate formats to force the mind to form a relevant relationship between them (Crowther, 2012). For example, historical documentaries can associate visual, audial, and chronological aspects for a viewer to take in. The mental process of recording the multiple-modalities requires the different regions of the brain to form a web of connected memory. When the brain attempts to retrieve that information, the brain has a wider range of stimuli to find.

Even though multiple-modalities go beyond music, the advantages are similar or directly involve music.

Promoting In-Depth Exploration of Content

In-depth exploration of content is often the application of existing information onto different or new ideas. For example, lectures allow teachers the option of explaining examples from textbooks in a different manner to increase student comprehension. This forces the student to either adapt their current understanding of the topic, or relearn it (Crowther, 2012). Both results spread the same concept to multiple regions of the brain because it is learning the information in a different format. The additional understanding of the same subject is similar to multiple-modalities since it is forming a larger web for recollection. Sometimes this new understanding varies with the initial thought processes; in any case, the opposing concepts force the brain to revise each understanding into a synthesis, indicating a better conceptualisation of the material (Crowther, 2012).

Frank Tinari and Kailash Khandke (2000) set up an experiment in which students used music to understand economic concepts. The students related economic situations to the circumstances presented in specific songs. Each student chose a song from a predefined list; the students then connected their economic terms with ideas presented in the music. Students who related more strongly to the music stated that they found more enjoyment in the assignment (Tinari & Khandke, 2000). Students also created mnemonic devices by relating their outside knowledge of the music with the information needed for class (Tinari & Khandke, 2000). The researchers found that the student's own choices in the songs instigated more research for the project because the students had more interest in the material (Tinari & Khandke, 2000). The conclusion is that students became more engaged with their work and developed better connections to the material because they related to the music.

Challenges of Learning with Music

While teaching through music can be fun and engaging, incorporating music as a learning tool also presents challenges. There are many different genres of music and everyone has preferences. Because music is so diverse, Crowther asks, "Does one need to offer a hip-hop version, a techno version, a country version, and a hard rock version [of each class or

assignment]?" (Crowther, 2012, p. 29). Developing teaching materials around one genre of music might alienate rather than engage students that prefer other artists or genres.

Once a genre of music is decided on, someone creating his or her own song must also decide on a melody and a presentation style. In order for the music to be effective, the melody of the song must be fairly simple. If the melody is too complex, or has multiple melodies for different verses, it will place an extra strain on attention and may detract from the educational material (Wallace, 1994, p. 1473). Also, often times the way in which teaching materials are presented determine their effectiveness, and it can be very difficult to emulate the success of others who have presented the material in an effective way (Crowther, 2012, p. 29). Wallace also mentions, "When heard only one time, music may be more of a distractor… [people] may need more than one exposure to a melody (Wallace, 1994, p. 1475)" in order to use it effectively in learning.

People will run into more complications when not using original material. When trying to take current, popular songs and manipulate them, one has to contend with the various copyright laws. Any portion of the work that is used must be substantiated "in relation to the copyrighted work as a whole" (Crowther, 2012, p. 29). This can make it substantially more difficult when trying use the songs to reach the general public instead of a particular class in school. However, these slight complications are well worth the effort when it comes to teaching.

While these certainly are all reasons for concern, *Ologism* is immune to many of these issues. In order to appeal to a larger audience, *Ologism* uses a wide range of musical styles. They play rock, punk, pop, and soul music and they create all of their own music to avoid copyright issues. Their lyrics are designed to both promote scientific concepts and appeal to their audience. In addition to this, most of their songs are fairly short and have catchy melodies with clear vocals.

Bloom's Taxonomy

Bloom's Taxonomy is a method that was developed to measure different levels of learning. This enabled us to better understand the multiple levels of the learning process. A committee under the educational psychologist Dr Benjamin Bloom created Bloom's Taxonomy

in 1956. It is an educational tool that places the learning of educational activities in a hierarchy. The committee identified three domains to group every educational activity (Clark, 2013):

- Cognitive: mental or knowledge-based skills
- Affective: development of feelings, attitudes, or emotions
- Psychomotor: physical and manual skills

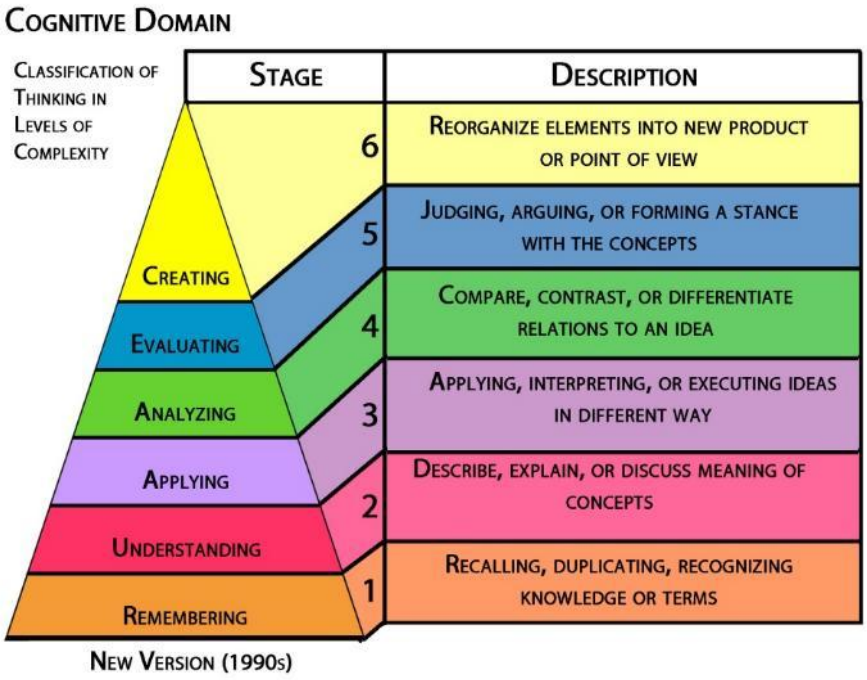
The committee extensively covered progress in the Cognitive and Affective Domains; however, the Psychomotor Domain was omitted because they had little experience with teaching physical skills (Forehand, 2005). Therefore, only the Cognitive and Affective Domains were well devised for educational fields. Many other scientists later established categories for the Psychomotor Domain, but the vast educational field have not agreed upon which classification to use. In relation to the web-based format of the project, the Cognitive and Affective Domains cover the intended educational activities.

The Cognitive Domain

The Cognitive Domain organises the development of knowledge into six levels of learning

The Cognitive Domain organises the development of knowledge into six levels of learning in ascending order of complexity, shown in Figure 2. The Cognitive Domain is based around knowledge acquisition; it models the progression a person makes to reach full comprehension of a concept.

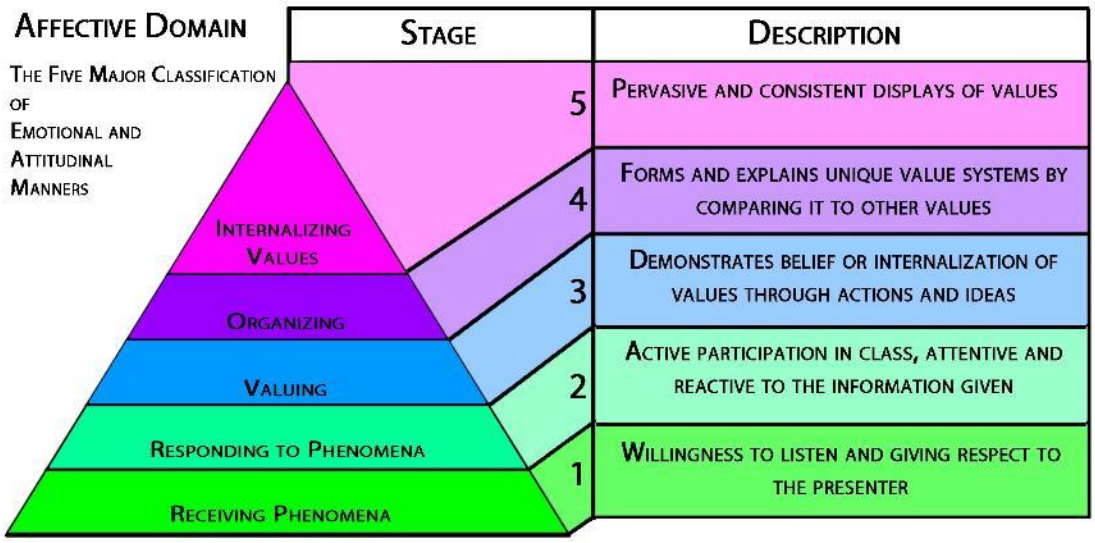
Figure 2: Bloom's Six Stages of Cognition



The Affective Domain

The Affective Domain divides a person's growth in feelings, values, and motivations (Clark, 2013). There are five major divisions ordered from the simplest to the most complex, *Figure 3*. Each stage is used to describe one's attitudinal progression, and higher levels of this domain accordingly demonstrate higher levels of interest in a subject. This domain functions well with learning because students who progress higher are more willing to understand the associated materials.

Figure 3: The Affective Domain



Examining the Use of Music with Bloom's Taxonomy

The usages of music in education pointed out by Crowther (2012) are plentiful but are difficult to relate to teaching scenarios. This is because the usages are beneficial in to different learning styles. A better application for reviewing the scenarios is directly relating to the circumstances an educator. For example, a maths teacher requiring students to know formulas for a test could use music as a mnemonic device so students can recall the information better. A philosophy teacher, on the other hand, may prefer to use music for an in-depth exploration of ideas for students to produce a logical presentation of thought. For the maths teacher, these requirements may only reach Stage One of the Cognitive Domain in order for students to remember formulas and equations; while the philosophy students may reach the Analysing stage during the composition of a paper. The differing use of music does not mean one subject is more demanding than the other, it means the teachers is more effectively teaching by having the students learn the material the same way it will be used. In the end, both classes reach the desired level of learning. For other teaching styles, the most effective use of music relies heavily on the method in which the information will ultimately be used. By understanding the desired stages of the Cognitive and Affective Domains, the method or mixture of methods are more easily comprised to teach effectively.

Ologism is a part of the informal education domain, therefore requiring more emotional involvement to keep viewers interested in learning. Unfortunately, the previous research examples of music in education were in formal setting and not informal. As with other teaching styles, Crowther's five usages should be adapted to address the intended material. Since *Ologism* is situated outside the classroom, it must retain viewers with the website's engagement and then lead them to the educational aspects. Therefore usages with progressions in the Affective Domain are advantageous, such as:

- Reducing stress
- Increasing enjoyment
- Promoting in-depth exploration of content

However, these benefits have only been demonstrated in a classroom setting. Consequently, the adaption of these techniques to an informal location may yield differing results. In conclusion,

the advantages of music in an informal setting are not well established and may provide diverse results when implemented for *Ologism's* intention online.

Literature Review Conclusion

Government agencies and numerous organisations are increasingly concerned about the levels of scientific literacy in Australia and the numbers of students pursuing careers in STEM subjects. Several programs and strategies have been developed in order to address this problem. Informal Science education is one strategy that is being implemented in order to promote science engagement. Music is one form of informal science education that is currently being used because it offers an innovative way to engage audiences. *Ologism* is interested in further developing their website to help promote science learning. Our project team will help *Ologism* in this endeavour by developing website content that will provide an engaging forum for the interpretation of their songs and lyrics.

Methodology

The goals of this project were to interpret and evaluate *Ologism's* song lyrics and connect them to relevant, interesting, and educational content to inform people who are disengaged from science. We also developed the content, design, and functionality of a website to engage and inform people disengaged from science. CSIRO Education intended for this website to reach a target audience of individuals whose ages range from 17 to 30, with little connection to the field of science. To influence the target audience as desired, five objectives were met:

1. Characterised the state of the art;
2. Clarified *Ologism's* goal;
3. Developed the initial prototype;
4. Evaluated and revised the web prototype; and
5. Developed final design.

Accordingly, we researched material relevant to the lyrics, which served as our foundation of knowledge to include on the webpage. Then Chris Krishna-Pillay (Victorian Manager, CSIRO Education) and Carly Siebentritt (Inspiring Australia Project Officer) reviewed the material to ensure that our information was relevant and had character. To add character to the content, we tried to keep the tone of the material light and use some slight humour. Second, we needed to develop the content and presentation on the website. The desired content was created using our research in high impact writing and based upon our target audience; these criteria provided the limitations on and guidelines for the website's design. Third, we developed and iteratively tested the content to ensure users could intuitively navigate the site and easily comprehend the information. To accomplish this, we performed a series of rapid prototyping and evaluations to improve the original content and design; each prototype worked towards a final product that accomplished our main goals. Fourth, we tested a final prototype on a large scale and obtained both qualitative and quantitative data. The qualitative data included the users' opinion and the quantitative data included statistics of the users' activity on the site as well as different ratings about their interests and the site. The final objective was to provide CSIRO Education and *Ologism* with a final product along with the data that provided insight on what made the website more intuitive, engaging, and educational.

Objective 1: Characterise the State of the Art

Our Literature Review has helped us realise what the state of the art in using music in education. The vast majority of studies suggest that currently using music in school learning is one of the easier ways to implement this kind of teaching. However, we are able to incorporate many of the same concepts from these other programs into our project. We are trying to use music to help normalise science and change people's attitudes towards science. The studies from our background show that music can help reduce stress, increase enjoyment, and engage multiple styles of learning. All of these things can help make science seem more normal to the general public and promote more in-depth exploration of science content.

We also were able to identify experts in music education. One such expert is Dr Gregory Crowther who is not only a leader in this field, but he is also a medical academic in the United States of America. After contacting Dr Crowther through email (Appendix B), he informed us that it is effective in schools to allow the students to be the songwriter or performer. This helps the student have a feeling of owning the material and thus, encourages them to learn and recall the material.

By looking at other science education websites, we determined important design qualities for our site and developed methods of incorporating them into our project. When we examined these sites, we looked for the ways that those sites present the information. A key to this part of our research was defining what aspects of these websites were crucial in engaging us as the user, as well as what features allowed users to explore more content. Our findings were consistent with our research into well-designed user interfaces. Mainly, our findings supported the principle that users should be able to perform their desired actions with minimum amount of effort or clicks.

Additionally, we examined other websites with similar goals as ours to gather further information about design methods. The most analogous website we were able to find was RapGenius.com, a music annotation website. The site features music lyrics as well as explanations of the song lyrics. When a user clicks on a highlighted section of a song, a popup appears on the side with additional information and links, as seen in *Figure 4*. As a modern and

popular website, evaluating RapGenius.com allows us understand the current state-of-the-art for this type of lyric website.

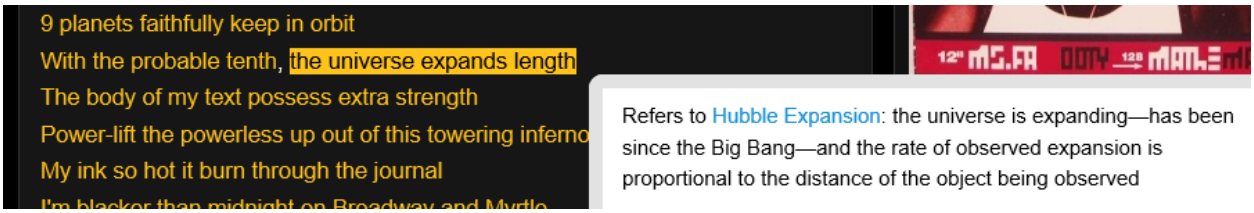


Figure 4: RapGenius, a popular lyric annotation website

Objective 2: Clarify *Ologism's* Goals

In order to gain a better understanding of our project, we conducted face to face informal interviews with Mr Krishna-Pillay and other pertinent CSIRO Education staff to clarify their goals for the website. We were unable to meet the band as a whole to discuss what has already been done and how they chose the concepts in their lyrics, as the other band members live in different regions of Australia. In this interview, we looked to clarify some other details, such as the following points:

- What is the band's target audience?
- How to reach *Ologism's* target audience?
- Are there any songs in particular that should be highlighted?
- What are the key concepts in each song?
- How should the website to be designed?
- What other features should the website include?
- Are there any technical requirements or limitations of the website?

Our group needed to ascertain who the target audience was in order to determine what style we should use for the website. Having the band clarify the key concepts in each song gave us an idea of what they want on the site and of what they believe to be the essential parts of the songs. This confirmed to us what concepts they intended us to emphasise when we developed the website content. While we were unable to meet with the whole band, Mr Krishna-Pillay was able

to clarify all of the previously mentioned topics for us. He also communicated with the band's IT personnel for us. This enabled us to have access to the site so we could implement the necessary changes. With all of this information provided, it allowed us to ensure that the materials we developed have met the expectations and needs of *Ologism* and CSIRO.

Objective 3: Develop Initial Prototype

To make the website educationally effective, we determined that the site should be engaging, user-friendly, visually attractive, and scientifically accurate. Building on what we learned from our background, we developed the content and designed a prototype website in an attempt to suit those characteristics. For this design, we (1) identified key science concepts in the lyrics, (2) Identified engaging and explanatory material for the lyrics, (3) Developed concept synopses using a 3 pass system, (4) followed writing efficiency guidelines, (5) incorporated age neutral readability strategies, and (6) designed a friendly web interface to work with our information. This is our attempts all of this while still maintaining a user-friendly and attractive website.

We envisioned a system similar to Rapgenius.com for the lyrics on *Ologism's* website to place our description into. We decided to display the lyrics on the page and highlighting certain sections of the lyrics. When the user scrolls over and clicks on the highlighted section additional information about the science concepts scroll out from the side of the screen. Our pages would include the soundtrack, accompanied by the lyrics, a brief 50 words or less description of the song's concepts and any associated illustrations and links to other sites for viewers to find more information.

Identifying Science Concepts in Song Lyrics

The first step in developing content for the website was identifying the fundamental science concepts portrayed in the lyrics. For each song, we identified the key concepts using three rounds of analysis.

First, we listened to the songs without seeing the lyrics. This placed our project team in the position of an attendee to a concert or casual listener of *Ologism's* music. From that point of we identified lyrical phrases that are discernable and peak interest for a listener. Since these

lyrics are more distinguishable a listener may specifically investigate that information on *Ologism's* website.

Second, we listened to the song again while reading the lyrics. Viewing the lyrics would be the next step a follower of *Ologism* would do if they were interested in the song. Similarly we followed the lyrics and listened to the music simultaneously. This allowed us to identify important concepts that may have been lost when following only the audio version.

Third, we compared the themes we identified to the ones *Ologism* flagged as the key themes they to impress on the audience. We checked with Mr Krishna-Pillay who, as our *Ologism* representative, ensured that the ideas we noted included all their intended concepts.

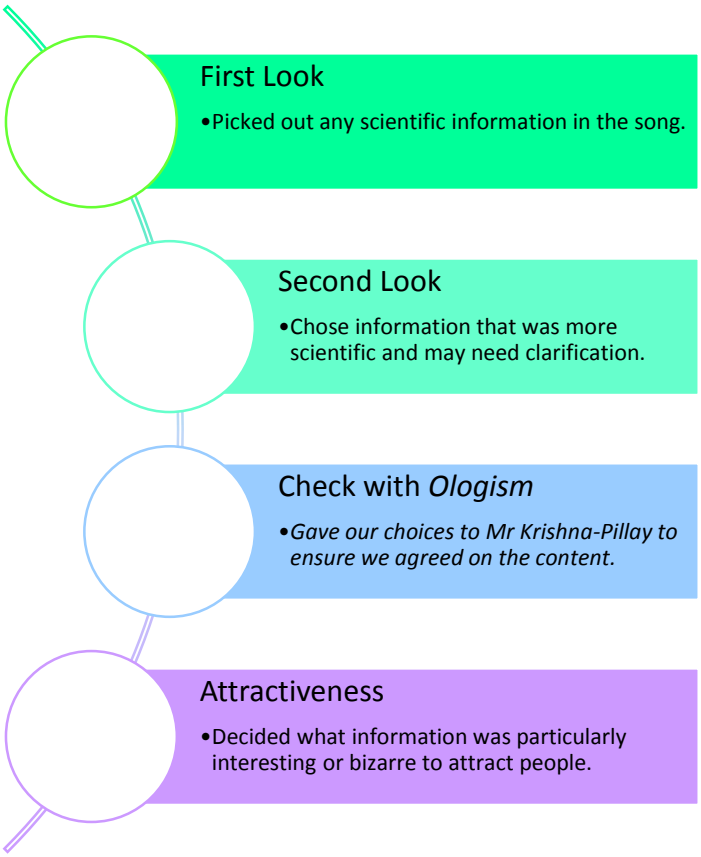


Figure 5: Content Development Process

Since the lyrics frequently reference scientific concepts and terms, Mr Krishna-Pillay and our team limited the focus to five distinct concepts in each song. We limited the number of concepts highlighted to prevent visual cluster on the webpage and prevent the overload of information for the reader. To narrow down which concepts we should display we followed the criteria we developed in *Figure 5*.

After we selected the concepts we would highlight for each song, we constructed lyric guides to facilitate the process of gathering background information on each concept; which included graphic materials, appropriate videos, and reputable links for more information. The structure uses a table format to separate the concepts from the lyrics and place adjacent boxes for research, references, and additional content such as images. Also, we used the structure because it

facilitated the transition of the material to our web format. The next process was researching and developing the content for the lyric guides

Identify Explanatory Materials for Each Concept

After the target concepts were identified, the project team conducted research for each of the scientific concepts to find high quality explanations from reputable sources. In this process, ensured that the material we found was both engaging for our target audience, and that it captured the key messages and ideas that the band is trying to convey. At the same time, it was important to find trustworthy sources for the information we were gathering. To balance our content between interesting and educational, we supplemented material with fun yet informative statistics and graphics where applicable, as well as any video footage that provided high quality information. Overall, there was extensive work put into making the information engaging to our target audience while still providing sound information.

Museum studies have shown that audiences engage better with objects and narratives that are unique, evoke nostalgia, and 'connect' with their everyday lives (Texeira, 2009). Accordingly, we tried to identify materials that might 'connect' with our target audience. Wherever applicable we used information relating to Australia or Melbourne specifically. This ensured that the target audience has a connection to the material, which made it more relevant and engaging for the user. We also looked for information that may relate to a specific time or event in history; this can invoke a feeling of nostalgia in an audience, which also helped increase the level of engagement and relevance to our target audience. By connecting the viewer to the material they will effectively be kept in the early stages of the affective domain so that they remain interested in learning the content. In addition to this, we also looked for information that we thought was bizarre or impressive to know in order to attract the user and make the information more likely to be remembered.

Originally we planned on targeting all the information at the target audience's age bracket (17–30) or to the nation of Australia; however, we realised that not all the topics directly relate to them. Instead, we attempted to associate such information to larger more worldly issues. For example, we discussed Colony Collapse Disorder in beehives to the wider problem where in species of flowers could die off without bees to pollinate them. By describing these larger

problems, the information can appeal to the emotions of a reader and keep them in the lower levels of the affective domain to retain their attention throughout the web page.

In order to ensure accuracy and credibility, we gathered our information on the science content from reputable sources. Mr Krishna-Pillay specified that not all of the information needed to come from pure science journals. Often times the information in these kinds of sources, while quite good, can be difficult for many people to understand. Some topics were more complicated or technical in nature and since we could not find good supporting information elsewhere, we were obliged to refer to the more technical information in scientific journals. In general we looked for sites that were knowledgeable and trustworthy. Such sites may include a page for a school or an organisation website. At no point in this project did we use information that came from a site that would not be considered reputable, such as a blog.

Develop Concept Synopses

One of the most important, and most difficult, aspects of developing the content was keeping explanations short. We linked important lyrics to pop-ups with short (fifty word maximum) descriptions of the key concepts presented in that portion of the song. In addition to this, we provided users with links to other sites they can visit if they wish to learn more about a particular topic. The idea behind this method was to allow users to learn more in areas that interest them, while providing them the freedom to avoid the areas that do not.

We developed a three-pass system in order to create the content. We used the multiple passes system to ensure that the material was appropriate, accurate, and had character to draw people in. The first pass of our system is where one member of our team would research the identified science topics. Once we identified a reputable source, we then began writing the 50-word description in the Lyric Guide. For the second pass, we would give our lyric guide to another member on our team. The second member proof read the document for grammatical errors and ensured that the material was not too scientific or boring. Once we decided that the Lyric Guides were adequate, the third pass of the guides went to Mr Krishna-Pillay and Ms Siebentritt. In addition to checking the grammar, they checked the information and informed us if we needed to elaborate or if we needed to lighten the mood in any of the descriptions. They

also advised us on adding slight sarcasm or humour into each description without degrading the scientific content. The final descriptions that we wrote were well versed and quite amusing.

During our development of the pop-up descriptions we used guidelines to make the process more logical for production purposes and to make sure that the reader easily understands our product. Our research to create guidelines for ourselves delves in high impact writing and an understanding of readability for the web.

High Impact Writing and Plain Language

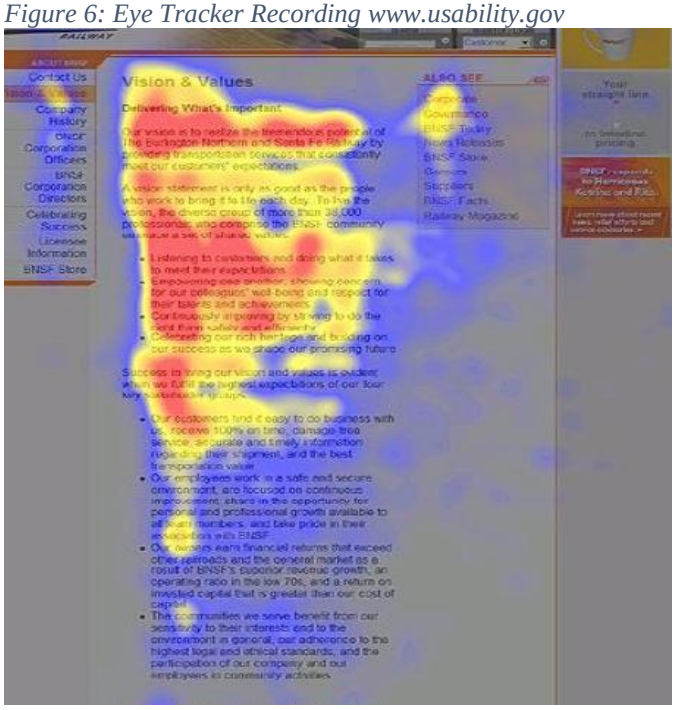
Because the target audience is people who are typically not involved or interested in science, we developed short and concise explanations that were designed to attract and keep their attention. We tried to adopt the style of high-impact writing (Hart, 1996) with short, declarative statements. We also adopted a style that was less formal than typical academic or textbook prose and that included humorous asides and references to contemporary events and activities. In this fashion, we hoped to provide the user with easily accessible facts in the most effective and engaging way possible.

According to Jack Hart (Senior Editor, *Portland Oregonian*), high-impact writing can be mastered with five rules. First, the average sentence length must be kept short. This does not mean that longer sentences cannot be used, but sentence length should be varied to keep the reader interested. Second, using strong action verbs will add energy to the writing. Verbs can generate flow and contain power too. Third, active voice should be used, not passive. Active voice adds power and confidence to writing. The fourth rule is to be specific. "Concrete nouns, verbs and modifiers add energy". Finally, the fifth rule is to 'cut the flab' since using unnecessary words reduces the impact of the current statement (Hart, 1996).

Many English-speaking governments have produced similar guidelines as high impact writing for legal documents, known as 'plain language.' The principal goal of plain language is producing "Clear Government communication that the public can understand and use" (United States of America, 2010). Plain language writing was developed for drafting laws; however, the guidelines are applicable to other high impact writing styles. The United States government also adapted the technique to develop content for public websites.

There are still many issues with using any writing on the web. For one, Readers obtain significantly less information through web-based environments. Often the lack of communication through a browser may occur because visitors read only 18% of the words on a page (The Plain Language Action and Information Network (PLAIN), 2013). Similar results are noticeable *Figure 6* where nearly half of the page is barely glimpsed at, or even read through. A contributing factor is that it takes readers an average of 25% longer to read the same number of words on a monitor than on paper (PLAIN 2013). For these reasons, we chose our words carefully to create flow using the active voice. However, a more abbreviated style is necessary to engage the readers and keep them engaged to grasp the intended concepts. One issue is that only 16% of web viewers read word by word; on the other hand 79% skim the new pages (PLAIN 2013). So we encouraged the viewer to continue reading by using verbs to create action and remove extraneous remarks. The main use of plain language on the Internet is to provide viewers information and material in a faster and more simplified format. In addition to words, our project developed images and highlighted words for skimmers to quickly identify key topics and draw their interest in the material. Many other web specific guidelines we included are:

Figure 6: Eye Tracker Recording www.usability.gov



1. Using quick to read passages are used for informational blurbs
2. Including interesting questions so readers will continue reading
3. Presenting points separately to avoid confusion
4. Limiting the amount of information per page
5. Making use of 'white space' to direct eye flow
6. Not assuming the reader knows the material, so the viewer is not forced to leave the page to find the information elsewhere
7. Using interesting names for links; never use "click here"
8. Eliminating unnecessary words for quicker reading

9. Using ‘timeless’ text to avoid letting information to become out-dated
10. Interacting with the audience, by using personal pronouns
11. Structuring information to flow or tell a story
12. Using graphs and graphics whenever necessary

Having applied these high impact guidelines to the blurbs and the additional graphics the concepts were better summarised for the reader. The guidelines were highly beneficial in the production of efficient and concise passages that explained the information. Using illustrations, no matter how clichéd, are always worth a thousand words, and portrays concepts using multiple mediums to better engage the viewer. The graphics also benefited our development because, as we found in our research, science and its jargon is misunderstood, confusing, or both and a picture should portray a distinct, concise thought.

Readability

Because the age range of the target audience is so large (17–30) and scientific writing can be very technical at times, we needed to assess the readability of our content. Readability is assessed using certain criteria. These include the length of sentences, number of syllables in words, and vocabulary diversity. As Edgar Dale and Jeanne Chall have said, readability is:

> *The sum total (including all the interactions) of all those elements within a given piece of printed material that affect the success a group of readers have with it. The success is the extent to which they understand it, read it at an optimal speed, and find it interesting. (DuBay, 2004, p. 3).*

Even though our audience is from year twelve students and up, not everyone has the same reading capability. Therefore we worked to make the material understandable using simplified words or images. Along with our research of high impact writing to help clarify meanings, we looked into ways of reaching different reading levels, and also using graphics to further break communication barriers across age ranges.

Many different formulas have been developed over the years to help educators assess readability. One of today’s most popular formulas is the Flesch-Kincaid grade-level (GL) formula. The result is a number that will correspond to a grade level. This formula can predict

significant differences between different pieces of literature less than one grade level apart by using both comprehension scores and learning times. This formula was authorised in 1978 by the U.S. Department of Defence "for validating the readability of technical manuals for the Armed Services" (DuBay, 2004, p. 50). Because calculating the grade level of each description would have been very time consuming, we decided to follow some general guidelines for readability. These rules are as follows:

- "Use short, simple, familiar words"
- "Avoid jargon."
- "User culture-and-gender-neutral language."
- "Use correct grammar, punctuation, and spelling."
- "Use simple sentences, active voice, and present tense."
- "Begin instructions in the imperative mode by starting sentences with an action verb."
- "Use simple graphic elements such as bulleted lists and numbered steps to make information visually accessible" (DuBay, 2004, p. 2).

Ideally, we had planned to use a reading level between year six and eight. However, after some discussions with Mr Krishna-Pillay we altered this decision slightly and decided to not target a specific grade level. We used the readability guidelines to keep the descriptions simple while adding in some more scientific words on the page. This was done in an effort to enable further research from the user. If the user saw the word and was interested, they could find out more; if they didn't care for the word, than it would not negatively impact their experience.

Readability of Graphics

Images add two beneficial functions. They allow for additional information without the stress of reading and provide more interesting sections to keep the viewer engaged. These factors work together to keep the user wanting to continue enjoying the website. Essentially this keeps the viewer in the first level of the affective domain. As long as they can be kept in that stage, they are more receptive to continue browsing the page and, as a by-product, picking-up the informational content.

Images provide a lot of information, often with few words. On a website, it gives the reader a break from reading text and gives a break from the black and white dichotomy of text. Instead the reader can visualise the information as the author intends and add colour and creativity to a possibly bland page. The use of graphics can also be misleading because the

viewer is allowed to develop their own meaning for the image. Because *Ologism* is connected to a multitude of organisation, all related images must be appropriately released by their creator and approved by Mr Krishna-Pillay, or created directly for use by *Ologism*. Overall, graphics provide an engaging substitute for lengthy topics, but require thorough review of their content.

When a graphic is used properly, the placement of an image can help break up long periods of text or attract the viewer to certain regions of the page. Images are also used to balance the look of the page so a viewer is not concentrating on one section, this is also associated with a dead space in which a viewer will neither look at a section of the page nor find it visually attractive. For the use along scientific information, the graphic must not distract the reader entirely while they read the information, but must also attract the user to continue evaluating that information.

Interface

To create an attractive and effective interface to display the lyrics and science content to the users we followed the "Five Es" framework (Stone, Jarrett, Woodroffe, & Minocha, 2005). "*The Five Es*" is a well-known framework in the field of user interface design that allows designers to focus on the key aspects that make web-based interfaces effective as a communication medium. The first aspect is ensuring the site is *effective*. This means that the goal of the site is met; for us, interesting and relevant scientific information should be the clear focus of the site. The interface must also be *efficient*, meaning that the user can access the information easily and quickly. Considering the short attention span of many web users, the site must allow users to access the variety of content with minimal delay. For our situation, one of the most important principles was ensuring that the site is *engaging*. One of the primary goals of *Ologism*, and our project, is to engage users in with science content in in non-traditional methods. The "fourth *E*" is *error tolerant*, which means that a design should gracefully respond to incorrect use by the user. While this principle is not as relevant for our site compared with more interactive interfaces, it was still a concept that we kept in mind during the design process. Finally, an interface must be *easy to learn*: users in our target demographic should be able to develop an understanding of the interface very quickly (Stone, Jarrett, Woodroffe, & Minocha, 2005). With respect to our site, we designed the interface to be easily learned by a range of users across a wide age-range (17–30 years).

To allow our prototype to be easily accessed by online users, we built a website using standard HTML, CSS and JavaScript technologies. Since our project was for research purposes, we ensured its compatibility with older web browsers, but this did not hold a key role in the development in the site. Using HTML5 technologies allowed our prototype to have high levels of interactivity and animation with minimal effort. As of November 2013, only 15.84% of Internet users in Australia use web browsers that are not comparable with all the features of the site (StatCounter, 2013). If our interface is to be published online in the future, efforts should be made to ensure that it works in non-HTML5 compliant web browsers.

Objective 4: Evaluating and Revising Web Prototype

Once we generated the desired content and assembled a prototype website, then tested the site on individuals from the targeted demographic. Gaining this information allowed us to check the website's usability, functionality, and levels of engagement. The evaluation procedure is outlined in *Figure 7.*

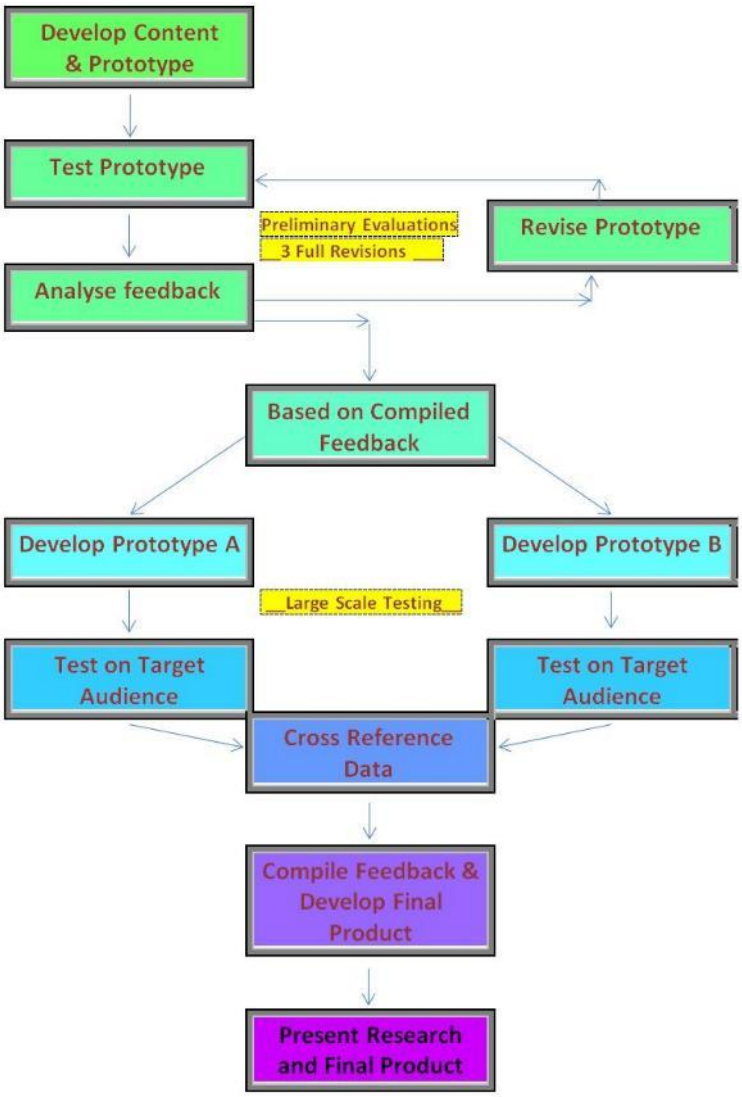


Figure 7: Developing and Prototyping Process

Preliminary Evaluations and Rapid Prototyping:

As we developed content, we continually updated prototype of the website. We went to four locations to recruit participants who would evaluate the website.

Location	Reason to Recruit	Optimum Time to Solicit
Federation Square	Public attraction	Early and mid-day
The QV centre	Lunch break	Lunch time
The State Library of Victoria	Popular study site	Late evening, after business hours
Milano Apartment Residence	Accessible private residence	Late evening through dinner time

Figure 8: Evaluation Locations

In choosing these locations, in the Central Business District of Melbourne, we attributed their potential of participants during meal times and after work hours. These participants were usually off work or on break, that way we could elicit about ten minutes from them to interact with the web page. Once our participants finished exploring the website, we asked them some preliminary questions which enabled us to evaluate the prototype for usability, content relevance, level of engagement, and site attractiveness (See Appendix C for Preliminary Questions). We performed two evaluation sessions with a total of 30 participants, and improved on our content and interface after each round of testing. To better assess user engagement, our evaluations and revisions of the site were done in an iterative fashion.

We found individuals within *Ologism's* target demographic and asked them if they had time to take a quick study. It is generally impossible to know how interested a person is in science just from looking at them, so while we looked for participants we focused on recruiting participants in the target age range. We then explained the study and presented them with a consent form (see sample in Appendix D). Throughout each survey, team members were careful to protect the anonymity of participants. We did not collect any identifiable data because it was unnecessary for our study. At the beginning of each evaluation we asked if individual was willing to participate, and proceeded only when permission was granted. None of the data we collected can be associated with any of the participants in our study.

To ensure that we gathered useful information from these trials, we followed a number of established procedures for user testing. While the participants were using the application, we encouraged them to talk about their thoughts as they explored the interface. This technique is known as the *think-aloud protocol* and it allowed us to gather immediate feedback on the different aspects of the site. Since one of our goals was to have information that is attractive and eye-catching, hearing "*this looks interesting*" or "*I don't feel like reading that"* was very helpful in regards to evaluating our content.

Following this test, we conducted a brief interview with each participant. The group member observing the participant asked them a few questions related to how much information is retained as well as what the user thinks about the presentation of the content. For our preliminary evaluations we used two methods of approaching participants. The first time we went in groups of two and approached individuals taking lunch. One person would approach the participant and introduce the project to them while the other team member would hold the laptop. The second time we had more success using a different approach. So instead we went in a group of four and approached groups of two participants. In this approach one team member would approach the participants and ask for permission to conduct the evaluation. Then a second team member would explain what the project was and recite the preamble. The last two members were there to hold the computers while the surveys were conducted. In all of the evaluations the participants were given a laptop and had headphones on to eliminate other distractions as much as possible. No pre-test was undertaken to increase likelihood of participation and a prior knowledge of the science concepts was not necessary for our evaluations. We also asked the participant if they currently worked or studied in a scientific field, which gave us some insight on their prior knowledge.

Using the data gathered from each evaluation, we worked to improve the prototype. Areas of focus were operations that the users found confusing as well as which content was the most interesting. Additionally, any ideas presented by the users were considered.

Webpage Editor

In addition to changing the design of the webpage itself, we also designed an editor for the page. While working on the project we found that it would be time consuming for us to

create the content and wait for Mr Krishna-Pillay's IT person to put it up on the page. To bypass this issue we have designed a page that allows for easier editing. Now many people are able to change the content on the page without any knowledge of programming (Appendix E). This editor is quite valuable to both *Ologism* and CSIRO. There is some information on the pages that may change over time. This editor enables quick and easy adjustments to the content. Also, not all of the songs have been recorded and are not ready to be put up on the page. Once these songs have been recorded it will be much easier to put them up on the page. Our editor enables anyone in the band or at CSIRO to edit the pages and create new pages, not just people with computer or programming experience.

Larger Scale Tests

After evaluating the feedback from our tests, we established a refined web page. Our next step was conducting a larger test to collect quantitative and qualitative data sets. This test was conducted in the form of an A/B test, meaning that users will be randomly shown one of two sets of content. The first design is a slide-in peek-in approach. When the user scrolls over active lyrics, part of the sticky note slides out from the right time of the page. Provoking users to click the lyrics by showing that the link pulls the sticky note onto the page. This approach was designed to be intuitive for the user. We decided on this approach after observing user interaction with the site. The second implementation more directly encourages users to click on the highlighted lyrics. When the user hovers the cursor over a highlighted lyric, the associated sticky note will completely slide in from the right. The sticky note features a line of text reading, "Click lyric to stick to page". Clicking the lyric will lock the note from sliding back off the page. This design is in contrast to Design A as it directing the user how to use the slide-in note.

We then evaluate the results of the users consuming each set of information and determine the advantages and problems with each. A/B Testing is regarded as one of the most effective methods in commercial web development, and has been shown to be very effective in regards to creating educational content (Kohavi, Longbotham, Sommerfield, & Henne, 2009). The evaluation prototype assigned participants randomly to either of these designs.

Our aim was for approximately 150 participants to take part in our large test. At the conclusion of our testing, we were able to obtain 250 people who visited the site and 105

participants took the survey. Our primary method of recruiting participants was to use the advertising features of Facebook. First, we created a post that *Ologism* posted on their Facebook page to recruit participants. This post included some wording to attract participants and a hyperlink to the interface. Then, we used the Facebook's "Page Post Ad" feature to advertise this post to users across Australia. By purchasing this ad, it allowed the post to reach users who have not already subscribed to the *Ologism* Facebook page. This advertising campaign operated on a fixed budget that was determined by CSIRO. Additionally, some participants were recruited by email if they chose to provide their email address online or at an *Ologism* event. Each individual received an email containing a hyperlink to the interface and brief instructions (see Appendix F).

Upon reaching the page, a popup appeared that briefly describes the study and mentions the data that would be collected. It stated that, while the user's interactions with the web page were to be recorded, any personal, identifying information was not stored. The user had the option to start the survey, or opt-out and view the web page as a typical user.

After consuming the information on the page, we redirected the individuals to a survey (see Appendix G). This survey collected demographic data, and prior engagement and interest in science, as well as different ratings of the site such as ease of use, relevance, appearance, clarity of content, amount of information, and willingness to return and recommend. This data was collected using a seven point Likert scale, with seven indicating a high rating.

Additionally, data was collected from the user as they were viewing the content. Scripts in the web page recorded clicks, scrolling activity and mouse movement. This gave us a greater understanding of how users interacted with the web page in order to get a better sense of their engagement with the site. This data collection was limited to the user's interactions with our web page, if they left the webpage no data was recorded, and users were informed that their activities were recorded.

Objective 5: Develop Final Design

The design of the final product was developed in response to the feedback from the large scale testing. We evaluated the responses from the test based on the following categories:

Ask question about	Information question will ascertain
Attractiveness	The visual appeal and viewer impression of the site.
Ease of use	Navigable and intuitive panels and tools, or is the website confusing
Content Relevance	The viewer's relation to the content
Content Clarity	The website's ability to be understood
Engagement	The viewer's interest to read more or explore the site
Interest of target audience	The extent people of ages 17–30, distant from science fields, engage with the material on the website

Figure 9: Evaluation questions

We analysed quantitative data from our large scale testing to rate the website on these aspects. From those ratings, the design that rates highest across the categories will be chosen as the end product. The submission to CSIRO Education and *Ologism* included the finished product and a review of the surveys and tests that support the development choices made to the product, as well as suggestions and recommendations for future modifications to the site and its ongoing development.

Findings

Throughout the process of designing the webpage and creating the content we were gathering data about the user's opinions of the webpage and ideas about how to improve the site. During our preliminary evaluations we gathered mostly qualitative data about how to improve the webpage and what the participants thought of the content. We used these data to adjust the website content and layout, and create a final design of the webpage. With this final design we sent out a large-scale survey to gather qualitative and quantitative data on opinions about the website. The data collected from this survey was then used to evaluate the final design, form conclusions about its usefulness as an informal science education tool, and make recommendations about how to improve the quality of the site.

Creation of Lyric Synopses

Bringing science into the lives of people who chose or do not engage with science is one of *Ologism's* biggest challenges. To reach this audience using the website, we designed a three pass process to connect our audience with (1) interesting or relevant information (2) that is easily understandable (3) with *Ologism's* cheeky personality. We found the three steps effective in forming concise descriptions for the website while still including an enjoyable personality.

Pass One

For pass one, a research member received an individual song to research about key concepts and provide hyperlinks to additional material. Since the concepts and hyperlinks each associated to a line in the lyrics, we placed the information into a table. We dubbed these tables Lyric Guides (Appendix H) for their guiding layout in associating the song, the lyrics, and the concept information.

Cybernose
Lyrics by Chris Krishna-Pillay
Music by Martin Lubran
Performed by *Ologism*

Lyrics	Content explanations and links, corresponding to highlighted sections on the left
She's got great body She tastes great today	Appearance and flavour (in mouth and aftertaste) are characteristics that are used to judge wine. Another is the aroma

Figure 10: Sample Lyric Guide

Pass Two

In the second pass, a different project member edited the lyric guide for its content and understanding. This pass included ensuring the content followed our high impact guidelines and checked that the links were useful and engaging. We used this step to put the synopses at the view of a reader in order to find which words could be cut-out or altered to make a shorter, more concise description for online readers. (Reference Methodology: Objective 3 for our readability and high-impact guidelines)

Pass Three

To finalise the content synopses, the lyric guides were sent to our *Ologism* and CSIRO representatives Chris Krishna-Pillay and Carly Siebentritt. They worked with our project team to have the information reflect CSIRO's views and alter the text to include the sassy-and-smart attitude that *Ologism* attempted to express. Often *Ologism's* quips were displayed inside parentheses to separate them from the significance of the text. A demonstration of the lyrical quips used in 'Air Shower', 'Ant Establishmentism', and 'Sheep Burpin' Blues' are in Figure 11.

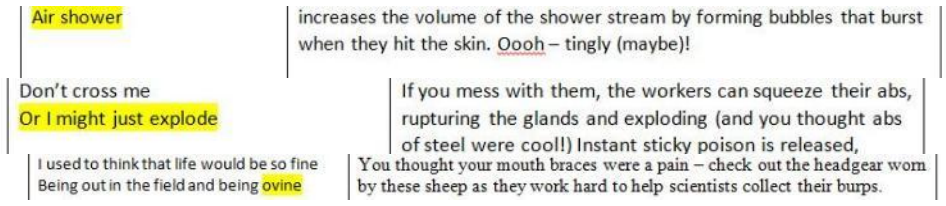


Figure 11: Selected lyrics and content

Overall the three pass production of the lyric guides contributed to the successful understanding of the key concepts. During evaluations, participants commented that the description were entertaining to read because of the witty attitude in the writing. Throughout testing, our synopses were commended for being understandable and easy to read. This demonstrated that our process we implemented clearly and humorously conveyed the necessary concepts and is a viable process for future productions.

Preliminary Evaluations

Our preliminary evaluations allowed us to collect a substantial amount of qualitative data for the initial development and modification of the prototypes. The qualitative data we collected

helped us in deciding the most effective way to display the information. We were also able to determine if the content was easily understood. The user feedback gained in these evaluations allowed us to improve the usability of the site and scientific information presented before performing our final large-scale test.

Initial Webpage Draft

Upon arrival, Chris Krishna-Pillay provided us the initial draft of the webpage, developed by Ologism.com webmaster Markus Viskich. This draft contained song lyrics written in a handwriting font, displayed over the background of yellow notebook paper. Chris Krishna-Pillay informed us that he intended that the page be presented as the handwritten notes of a musician. Additionally, a number of lyrics on the page were highlighted. When the user hovered their cursor over the highlighted lyrics, a popup bubble appeared. These popups were to hold the relevant scientific information that we would create.

We discussed our plans to engage users by providing relevant links with Mr Krishna-Pillay. However, these links could not be presented in the popups with their initial implementation, as moving the cursor towards the link would cause the popup to be closed. We concluded that we would look into developing a better method of displaying our content on the page.

First Prototype

Initial Webpage Changes

Before we performed our first evaluation, we made changes to the webpage to address our concerns discussed with Mr Krishna-Pillay. Primarily, this involved removing the popups of the original design and adding a slide-down pane to display content. With this new design, the user would click on a line of the song and a box would expand underneath the line. This box contained the informational passage we have written as well as links to relevant sites.

Additionally, we changed highlighted lyrics to underlined lyrics. This was done to simplify the appearance of the page, as well ask to make the sections appear like a standard hyperlink.

Highlighted Lyrics	Underlined Lyrics

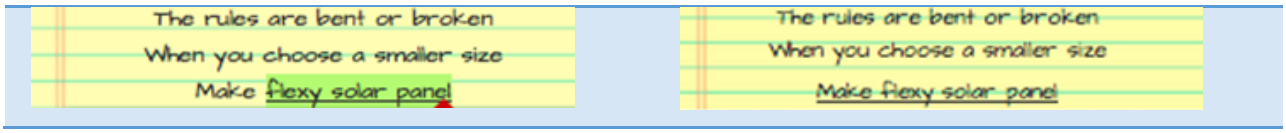


Figure 12: Highlighted and Underlined Lyrics

Prototype Testing and Evaluation

The initial round of prototype testing allowed us to refine our methods for sampling individuals. To find individuals to evaluate the site, we visited public areas such as shopping centres and the local library. We found it most effective to approach individuals in groups of two, with one member carrying the laptop with the site open, the other member carrying the evaluation form.

As we anticipated a the lack of Internet connection while testing, the webpages were loaded on to each laptop so the site could be used in the field. However, we discovered that users were unable to open the relevant links. With no Internet connection, we were unable to make assessments on the engagement value of the referenced sites.

In addition to this public testing of the site, we evaluated our prototype with several WPI engineering and science students because they were a convenient and willing audience from whom we could easily gather feedback quickly. Unfortunately this introduces a degree of bias into the findings because WPI students are studying technical fields, have a degree of technical competence, and are interested in science and technology. Thus, they are substantially different than the target audience for the *Ologism* website.

Evaluation Findings

A common suggestion in this evaluation was that the page would be more engaging if it had more images and possibly a different background. Many other respondents indicated that they liked the simplicity of the page. As designers, we were faced with a conundrum: how could we keep the simple, clean design while adding more graphic interest.

Additionally, a number of people had difficulty discovering the additional content on the page. Based on this observation, we were able to conclude that simply underlining the text does not *afford* for a user to click on it.

Finally, we observed that when a user clicked an underlined song lyric, it was very easy and clear for them to read the information and click the links. However, a number of users noted that the slide-down panes broke up the flow of the page by creating a large gap in the lyrics.

Second Prototype

Initial Webpage Changes

We addressed a number of issues with the first prototype before our second round of testing. The most notable change is that the slide-down panels were replaced with a note that slid in from the right side. This design ensured that the additional content would not obstruct the song lyrics, and their "sticky note" appearance was consistent with the "notebook paper" design of the site.

Additionally, we made a number of changes to ensure that users would notice and click on the song lyrics. We replaced the underlined text with an orange highlighted bar. When the user hovered the cursor over this text, the "sticky note" would peek out from the right margin of the page. This functionality was intended to show that the link could be clicked on to bring the note fully onto the page.

Finally, the controls for the music player were allowed to "float" at the top of the users' window while they scrolled down. This ensured that the user could easily control the playback of the audio while they view the page.

Prototype Testing and Evaluation

Once again, we tested our prototype by approaching individuals in public locations having them try the prototype on one of our laptops. To allow participants to open the links on the site, each laptop was equipped with a wireless USB modem so the computer could link to the internet regardless of where we were conducting the evaluation. We learned several lessons for soliciting participants during our first evaluations of the prototype, so we were able to more easily solicit a larger number of individuals for the second round of prototype evaluation. In particular, we found that it was easier for the four of us to approach groups of two.

Findings

At the end of our second evaluation, many participants again noted that the page needed more colour and graphics to draw the user in. We found that people also thought the slide-in note feature complimented the theme of the page and was more fluent than the slide-down approach that we used previously. While the note feature is not capable of displaying as much information, the motif of the notes and notepad fit well together and created a more cohesive and integrated feel to the site.

When the highlighting was added to the prototype, the highlighting spanned the full width of the page. This was intended to make the highlighted section large and noticeable. However, a number of people confused the highlighting for a page break and did not click on them.

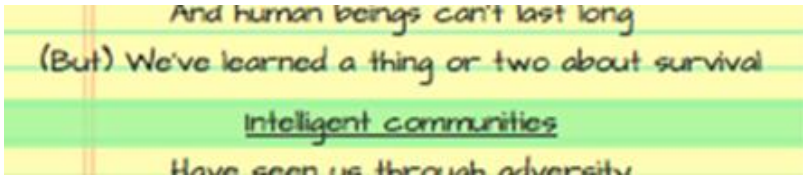


Figure 13: Highlighted lyrics

Overall, people found that the information on the site was easy to understand and that the short length of the popups made them easy to read.

Limitations of Testing Prototypes

While the prototype testing was very successful overall and provided us with much helpful information, there were some limitations. In particular the locations where we were able to recruit people to evaluate the site were not ideal. Typically a computer user uses a familiar computer; however many of our participants were eating lunch or sitting outside when they were handed one of our laptops. Additionally, oftentimes we were outside, making it difficult for the participant to focus on the computer screen due to sunlight, street noise, and other distractions. Lack of familiarity with the computer keyboard, keypad, and operating system may also have affected how comfortable our participants felt while interacting with the prototype website.

Final Design

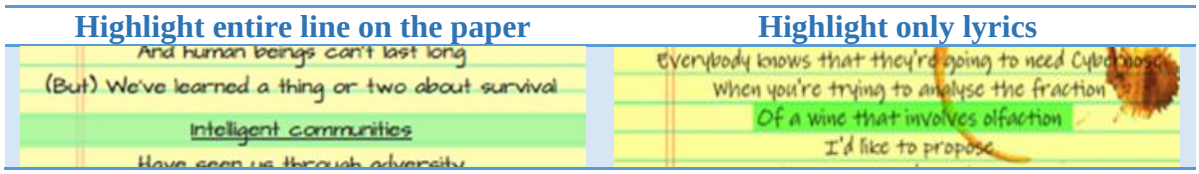
Based on the feedback we received during the second round of prototype testing, we built the revised webpage design we would use in the final large-scale evaluation.

The most significant change to this design was adding more graphics to the webpage in response to the user feedback that the previous version appeared boring and empty. Accordingly, we added background graphics so the notepad appeared to be sitting on a wooden desk. This design seemed to match well with the theme of the notepad, and allowed us to place visually interesting "doodles" on the desk. The doodles are overlayed on a variety of items commonly found on desks, such as napkins, paper, notebooks, and photos (Appendix I). We designed the doodles and desk items to be interchangeable for use with future projects. Some of the doodles directly related to the song lyrics, while others loosely connected to the concepts. This kind of design concept that depicts real world objects is called skeuomorphism[3].

The final design also featured a number of tweaks to the interface, intended to improve usability. One change affected the position of the music player controls to keep them visible, but unobtrusive. While the previous design featured highlighted bars spanning the width of the page, the final design only highlighted the song lyrics to avoid confusion.

Figure 14: Sample "Doodle"

Figure 15: Lyric Highlighting



[3] Skeumorphism is the concept of creating designs that appear like real world objects

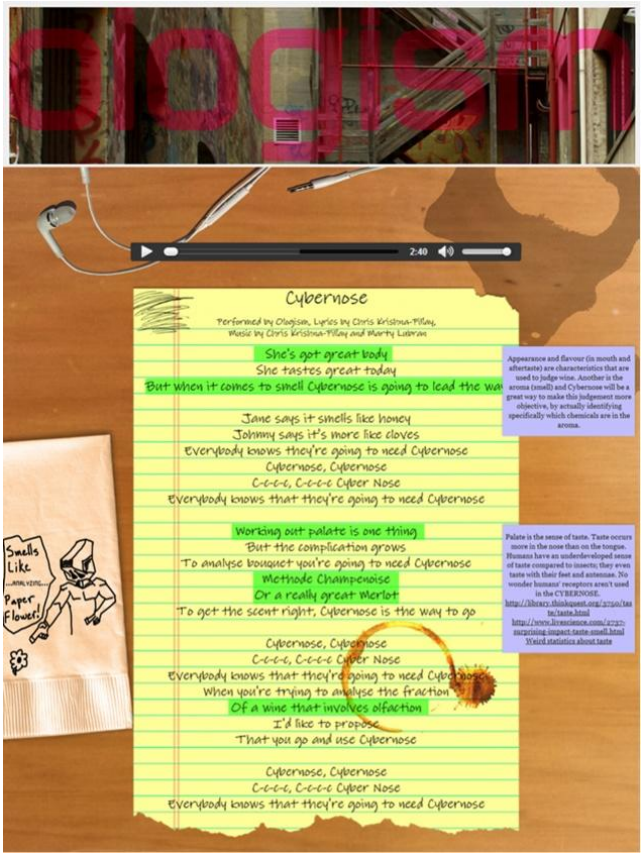


Figure 16: Final Design

Large Scale Evaluation

After refining our website prototype, we developed a large-scale, online survey to reach more individuals and gather more quantitative feedback about the content, design, usability, and attractiveness of the site, allowing us to evaluate the site. Participants were directed to a web page where they could interact with our final prototype, before completing a survey about the site. A set of questions in the survey were designed to allow us to categorize respondents according to their interest in science using categories CSIRO had used in previous assessments.

To reach a larger audience, we recruited participants online using *Ologism's* fan base on Facebook. By recruiting participants through the Internet we were able to address many of the limitations of the previous prototype evaluations. Having the participants take the evaluation during their free time and without a surveyor to converse with, the participants filled out longer surveys and provided more detailed written answers. The survey allowed us to measure the science interest and engagement of participants; and we were able to segment the responses

between the target audience (people disengaged from science and from the ages of 17 to 30) and other participants. Addressing these areas of concerns allowed us to target the intended audience and provide useful data about the design of the webpage.

Large Scale Evaluation Findings

During the six days we gathered the results, we received 105 completed survey responses out of 252 people who accepted the consent form. We received between 10 and 27 responses for each song we tested. The data we gathered is meant to characterise the participants and further delineate their opinions of the webpages for statistical use. The survey separates the personality questions from the usability analysis; however the sections work together to answer to understand *Ologism's* target audience.

Website usability questions

In the survey we asked participants to rate *Ologism's* website in terms of ease of use, clarity, amount of information, relevance, and whether they would return to or recommend the website on a scale of 1 to 7 with 7 indicating a high rating. Open response options encouraged our respondents to explain their ratings and elaborate on their opinions about the usability of the site. The questions give us a good, though limited idea of what people thought of the overall website.

Appearance	*Ease of Use*	*Clarity*	*Amount of Information*	*Relevance*	*Return to Site*	*Recommend to Others*
5.40 (1.13)	5.96 (1.13)	5.50 (1.34)	5.12 (1.42)	4.38 (1.71)	3.51 (1.97)	4.08 (2.00)

Figure 17: Data from large-scale-survey, responses ranged 1 to 7 reported as Mean (Standard Deviation)

The appearance, ease of use, clarity, and amount of information all had means above 5; which suggests that in general the people thought the site looked attractive, was clear and easy to use, and had sufficient information without being overwhelming. While the means for these responses was above the midpoint, the means for content relevance, willingness to return to the site, and willingness to recommend the site are either just above or just below the midpoint suggesting that people tend not to not want to return to or recommend the site, and tend not to find the content relevant. We then examined whether there was a relationship between these scores and participants.

To analyse the relationships between the type of people and their answers to the website usability questions, we report the Pearson correlation coefficient (r) and whether the result was statistically significant. The latter is reported using the p-value, with values less than 0.05 regarded as statistically significant.

The desire to return to the website was correlated with many of the other website aspects. It exhibited a medium correlations with the clarity of the page, ($r = 0.33;\ p < 0.001$), strong correlations with appearance ($r = 0.35;\ p < 0.001$) the amount of information ($r = 0.52;\ p < 0.001$), content relevance ($r = 0.59;\ p < 0.001$), and a small correlation with ease of use ($r = 0.23;\ p = 0.016$). Desire to recommend the site to friends also had strong correlations to clarity of the page, ($r = 0.43;\ p < 0.001$), amount of information ($r = 0.59; p < 0.001$), content relevance ($r = 0.62;\ p < 0.001$), and ease of use ($r = 0.41;\ p < 0.001$). The willingness to return to or recommend the site was highly connected to participants' opinion of the website.

Participant Personality Questions

We asked questions to gauge the participant's interest and engagement in science, which we used to give each participant an interest score and an engagement score suing a 7-point scale. We calculated the interest score by averaging the responses to questions in the survey relating to people's interest in science topics and we calculated the engagement score by averaging responses to questions about their likely to do science-related activities.

We asked three questions to gauge the respondent's *interest* in science:

- How interested are you in medical research?
- How interested are you in the environment?
- How likely are you to visit a psychic? (reverse scored)

We asked three questions to gauge the respondent's *engagement* in science:

- How likely are you to look for science information?
- How likely are you to listen to a science or technology podcast?
- How likely are you to upgrade your phone before your contract ends?

We calculated scores for interest and engagement by averaging the responses on a 7-point scale across the component questions and used these to categorize the participants for subsequent analysis. For example, we examined whether these scores correlated with the responses on usability question in order to determine what type of person might find the site more appealing.

Our data indicated that there is a significant positive correlation between interest and engagement, ($r = 0.39;\ p < 0.001$). This corresponds with the idea that people who are engaged with science are interested in science. Both interest and engagement in science correlates significantly with content relevance: $r = 0.31;\ p = 0.001$) for interest and ($r = 0.30;\ p = 0.0015$) for engagement. There was also a significant correlation between willingness to return and both interest ($r = 0.29;\ p = 0.002$) and engagement ($r = 0.29;\ p = 0.002$). Willingness to recommend the site to a friend also correlated with science interest ($r = 0.35;\ p < 0.001$) and engagement in science ($r = 0.34;\ p < 0.001$). Clarity and amount of information were also correlated with science interest (clarity: $r = 0.22;\ p = 0.022$ amount of information: $r = 0.25;\ p = 0.0104$) and engagement (clarity: $r = 0.23;\ p = 0.018$, amount of information: $r = 0.20;\ p = 0.038$). All of the above correlations were small to medium in size. Given that interest in science and engagement in science were moderately correlated (suggesting an association between these characteristics), it is not surprising that both these variables exhibited similar correlations with other variables. In this case the relevance, clarity, amount of information, return, and recommend attributes are a good indication that the site's information is more appealing to people who are more actively involved with science. This may indicate that people who are less engaged with science are not as interested in the website as those who are more engaged with science. Unfortunately, this indicates that the target audience may be so attracted to the website, as low scores on science engagement and interested were associated with low scores on the website variables.

Age

We examined the differences between responses of younger and older participants' opinions of the website using independent t-tests. We divided the age groups into 24 and below and 25 and above. The younger group did not correspond exactly to our target audience; however our participants included too few people above 30 years and hence we chose a lower cut-point.

This test indicated that the only statistically significant differences between younger and older participants were in terms of content relevance, ($t(103) = 3.3;\ p = 0.0014$), and willingness to return to the site, ($t(103) = 3.2;\ p = 0.0017$). The older age group was also significantly more interested in science, ($t(103) = 3.6; p < 0.001$). This data indicated that the older age group were more interested in science, found the content generally more relevant, and were more likely to return to the site in the future. They were not, however, more likely to be engaged in science.

Time

The distribution of the total time people spent on the webpage was extremely skewed, which violated the normality assumption for correlations. We therefore transformed the data to obtain a normal distribution by adding twenty to the time and then taking the base ten logarithm. We found that time spent on the website correlated positively with content relevance ($r = 0.25;\ p = 0.011$) and willingness to recommend the page ($r = 0.23;\ p = 0.021$). These correlations indicate that people are more likely to spend extra time on the webpages if the content was relevant to them and were more likely to recommend the page if they spent time with it and really interacted with the page. The time also positively correlated with the percentage of informational popups that were opened on the page ($r = 0.28;\ p = 0.003$). We believe this is a fair indication that the use of popups is extending the user's time because they are reading or interacting with the sites features. These factors may contribute to the user's recommendations for returning by elevating their enjoyment with the site.

Gender

To compare the groups of participant, for example males and females, we use t tests to determine if they were significantly different. When we examined the t test for gender we found that men and women did not have significantly different answers to any of the questions regarding the website design or content. There was also no significant difference between males and females with regard to science engagement or interest.

A/B Testing

Each participant in the survey was randomly assigned one of the two A/B designs. This resulted in sample sizes of 51 individuals and 54 individuals for the "Pop-in Peek-in" and "Action Announcement" designs, respectively. We compared the differences between the two

designs of the website. We found that the only significantly different data was the percentage of popups clicked was greater on the slide-in peek-in design, $t(103) = 4.7, p < 0.001$. This was due to not having to click the lyric to see the slide-in. Because of this, the difference is most likely not relevant.

Open response analysis

In addition to collecting quantitative data about the website design and content we asked some qualitative questions about the website. We asked what people liked most and least about the website, their reasons to return or not return, as well as their reasons to recommend the site or not recommend the site. The aspects most people liked about the website were the scientific descriptions (26 responses). Similarly, most people would recommend the site because they liked the concept of using music to teach science (9 responses). People stated they were most likely to return to the site because it was interesting and informative (15 responses).

Amongst the different responses, many were not in keeping with findings from our quantitative data. For example, the most criticised feature of the website was that the links to the scientific descriptions were not obvious enough or respondents did not understand that they had to click them (13 responses). Also, the most common reasons that respondents gave for not wanting to return to the site was that there was not enough interesting content (11 responses), or that they were already knowledgeable about the information provided (10 responses). People who indicated they would not recommend the site to others often said they learned little and/or there was not enough content on the site (8 responses). Additionally, a significant number of respondents said they would recommend the site to a younger age group than the target audience (9 responses).

Songs

During our data analysis we noticed some differences between songs. We added the responses to the questions about appearance, ease of use, amount of information, clarity, and relevance, and willingness to return or recommend to get a value representing each user's rating of the site. The song 'Ant Establishmentism' had the highest score (37.6) while 'Croc of Golden Staph' had the lowest score (30.9). 'Ant Establishmentism's' score was significantly higher than

all of the other songs except 'Air Shower' when compared using an independent groups t-test. The p and t values for these t-tests can be found in *Figure 18*.

	Air Shower	*15 Milliseconds of Fame*	*Croc of Golden Staph*	*SKA Man*	*Spud Love*
T value	1.2	2.5	3.0	2.4	2.7
P value	0.23	0.018	0.0042	0.023	0.010

Figure 18: Results of t-test comparing total score for each song with score of most popular song 'Ant Establishmentism'

Conclusions and Recommendations

There is a continuing concern about the declining interest and proficiency in STEM in Australia. This can be seen in a recent news article in "The Age National" on mathematics results in the Program for International Student Assessment (PISA) schools written by Craig Butt. As noted in this article, Australian 15-year-olds are continuing to fall behind in maths. At the same time, there is a large gap in performance between rich and poor students. It was found that more than 20 percent of Australian students were unhappy in school and felt as though they do not belong. When students have this sort of attitude toward school, they are less likely to perform well. This is consistent with this report because it was also found that Australian students are more disruptive than students in other countries as well (Preiss & Butt, 2013).

Many organisations have been focusing on improving performance in the formal education sector. However, many other programs and activities have been developed in the informal science education sector as well. Museums have promoted 'free choice' learning which enables the audience more choice in what they would like to be taught. Television programs have also been used in informal education. These programs can reach a large number of people and educate them in a more engaging way. Programs like CSIRO's SCOPE provide videos and experiments to help introduce new science concepts to a younger audience.

Ologism is favourably positioned in this debate because they are focusing on a neglected demographic. Their target audience is people who are outside of the formal education sector, between ages 17 and 30, and disinterested in science. They produce a wide variety of styles of music to help reach out to people. It has have been shown that music can be effective in enhancing the recall of science and mathematics facts in the formal education sector. However, there has been much less research done on the cognitive and affective impact beyond the formal education sector. With continued effort, *Ologism* has the ability to reach out to the general population and help change their opinions about science by putting the 'fun' back in science for people.

Explanation of Findings

In creating the large-scale survey we developed questions around the main features of the site, the people who use it, and the overall design of the page. With our findings we concluded our results for the questions in the following fields:

1. A & B design comparison
2. Demographic comparisons
3. General design

A/B Testing Design Comparison

After analysing the correlation between the design version and answers to questions, we found there was no statistically significant difference in the responses. Additionally, the time spent viewing the page was not statistically significant either. The one notable difference between the two designs was the amount of popups that were opened by clicking. Our data showed that substantially more people clicked on the lyrics in the "Pop-in Peek-in" design than in the "Action Announcement" design. This can be attributed to the fact that users of "Action Announcement" design could view the informational popups without clicking on the links, and our evaluation site does not record this activity. Additionally, the written user feedback shows that a small but substantial amount of users with design A had difficulty understanding how to show the popups.

Based on the statistical data from the A/B testing, both designs appear to be similar in regards to usability and engagement. Since a few users seemed to have trouble understanding how to open popups "Pop-in Peek-in" design, we would recommend that *Ologism* implement the "Action Announcement" design. The primary issue with this implementation is that it may be more difficult for users to click on the relevant links in the popups.

Demographic Comparisons

From our data we concluded that the website appealed slightly more to older age groups. Age groups significantly differed in science interest as well as their opinions on content relevance and willingness to return to the site. From this we can conclude that the participants' age was a factor in their opinion of the website. *Ologism's* target audience is an older age group,

17-30 years old, so the website is appealing to a slightly older audience than anticipated however it is still attracting part of the target demographic, which is important. Also even people out of the target age group could benefit from more science engagement.

We found that opinions of the website were positively correlated with engagement. This indicates that the engaged had a more favourable opinions of the website. The *Ologism's* target audience was people who were disengaged from science so the website appealing more to the engaged indicates the website may be missing the target audience. However, you would expect that those who are engaged in science to have a better opinion of a science based website, so this may not mean that the disengaged do not like the website. In fact the amount of time that was spent on the webpage was not correlated to science engagement which means that the engaged and disengaged spent the same amount of time on the page.

We also found that opinions of the website were not significantly different between the engaged and the disengaged. Because the opinions of the engaged and disengaged are not significantly different the site can be appealing to both people who are actively involved in science and people, like our target audience, who are not engaged in science. The website having a wide appeal enlarges the number of people it can engage and inform. While our target audience is not more interested in the website than other groups, it is beneficial to the site that it appeals to a wide range of people.

We also found that the participant's gender did not impact their opinion of the site. The website appeals to both men and women. This is a positive conclusion for the site because this shows that the site is not more appealing to one gender.

General Design

Using the data gathered in the evaluation, we looked to determine the factors affecting whether a user will return to the site. This evaluation was primarily based on the answers to the survey questions on how likely users are to return to the site or refer the site to a friend. We checked the correlation between this data and other factors, such as the number of popups opened. This suggested that the likelihood of a user returning or referring the website to a friend was affected by their experience and interactions with the site. Additionally, time spent on the site was strongly correlated with content relevance, amount of information, ease of use, and

clarity. This suggests that these website elements contribute to the desire to return and recommend the site, although this could also be due to prior science engagement. The desire for a user to return or recommend the site also had a stronger correlation with the users' interest and engagement with science and technology. Specifically, users with a higher interest and engagement were more likely to return to the site or share the site.

Songs

When we examined the survey data we noticed that there were differences between the songs in terms of participant's rating of the website. We added together the seven categories we asked people to rate about the website to get a total website evaluation score and then found the average of these for each song. 'Ant Establishmentism' was rated higher than all the other songs. This suggests that something about 'Ant Establishmentism's' page drew participant's attention more. This could have been due to people liking that particular song or style of song more, better content on the specific page, or liking the image on that page better. This warrants further investigation.

Recommendations for the Future

After our final evaluation and analysis, we determined what other features can be implemented the site to help engage a wider audience. Many of these suggestions involve changing the user interface and implementing new, or updating old, features of the website. These sorts of changes will cause more people returning to the site and will increase their enjoyment while on the site.

In order to keep people coming back to the site, *Ologism* will need to continually update the content on the site and create more content. Some of the content on the site will change over time. As a result of this, the content will need to be checked periodically to ensure the information on the site is still accurate and up to date. Many participants noted that they would not return to the site because they felt they had received all the information they could from the site. This shows that *Ologism* will need to periodically create and release new songs to draw people back to the site.

Often times Internet users are multi-tasking while surfing the web. This causes them to have a limited attention span for each task they are performing. To keep their attention on the *Ologism* page, we suggest implementing a follow along feature on the site. This would be an indicator to show the listener their position in the song. Another feature to be explored for the site would be for the notes to slide-in automatically when the listener reaches that particular lyric in the song. In this case the user would click the lyric to close the slide-in. However, one of the complications with this feature on the current site is that some of the slide-in notes overlap when opened. One way to overcome this issue could be to have the notes come in on alternating sides of the page.

After our conversation with Dr Gregory Crowther, he suggested to make a karaoke option for the site. To do this *Ologism* would need to have the background music playing and allow the user to sing and follow along with the song. This would make the website much more interactive and would appeal to a younger audience as well. Dr Crowther also suggested making the header and navigation bars on the Ologism.com homepage smaller. This would enable users to find content on the page easier and without needing to scroll down the page.

We recommend that *Ologism* expand their target audience to include younger students. While it was an older audience that found the site more relevant, many of those participants suggested using *Ologism's* music for younger students. A number of individuals noted in their survey responses that they felt the music, along with its website, would be useful in an educational context. Some self-identified educators noted that *Ologism's* music could be helpful in their classroom. And others felt that they would have enjoyed hearing the music in the context of a science class. According to Mr Krishna-Pillay, *Ologism* targets their music towards those outside of the educational system. Reaching out to teachers would enable *Ologism* to be a more well-known source for quick, easy, and understandable science content. When trying to normalise science, it is better to try and accomplish this as early as possible; instead of waiting for students to become disinterested in science and then reaching out to them. Catching them too late may make it more difficult to rekindle their science interest.

References

Ainley, J., Kos, J., & Nicholas, M. (2008). *Participation in Science, Mathematics and Technology in Australian Education.* Australian Council for Education Research.

Albers, B. D., & Bach, R. (2003). Rockin'soc: Using popular music to introduce sociological concepts. *Teaching Sociology, 31*(2), 237-245.

Australian Industry Group. (2013). *Lifting Our Science, Technology, Engineering, and Maths (STEM) Skills.* Retrieved from http://www.aigroup.com.au/portal/binary/com.epicentric.contentmanagement.servlet.ContentDeliveryServlet/LIVE_CONTENT/Publications/Reports/2013/Ai_Group_Skills_Survey_2012-STEM_FINAL_PRINTED.pdf

Bell, P., Lewenstein, B., Shouse, A. W., & Feder, M. A. (2009, January 14). *Learning science in informal environments: People, places, and pursuits.* National Academies Press.

Carney, K., Hyman, A., Mello, E., & Snieckus, K. (2011). Teachers' Insights into Informal Science Education Programs (Undergraduate Interactive Qualifying Project No. E-project-050211011702). *Worcester Polytechnic Institute*. Retrieved from Worcester Polytechnic Institute Electronic Projects Collection: http://www.wpi.edu/Pubs/E-project/Available/E-project-050211-011702/

Center for Advancement of Informal Science Education. (2013). *About Informal Science Education*. Retrieved October 5, 2013, from Center for Advancement of Informal Science Education: http://www.informalscience.org/about/informal-science-education

Clark, D. (2013). *Bloom's Taxonomy of Learning Domains.* Retrieved October 8, 2013, from http://www.nwlink.com/~donclark/hrd/bloom.html

Crowther, G. (2012). Using science songs to enhance learning: an interdisciplinary approach. *CBE-Life Sciences Education, 11*(1), 26-30. doi:10.1187/cbe.11-08-0068

CSIRO. (2008, February 6). *The History of CSIRO*. Retrieved September 02, 2013, from CSIRO: http://www.csiro.au/Portals/About-CSIRO/Who-we-are/History/CSIROHistoryOverview.aspx

CSIRO. (2011, February 22). *The Governance of CSIRO*. Retrieved September 10, 2013, from CSIRO: http://www.csiro.au/Portals/About-CSIRO/How-we-work/Governance/Governance-Overview.aspx

CSIRO. (2012b). *CSIRO Annual Report 2011-12.* CSIRO. Retrieved from http://www.csiro.au/~/media/CSIROau/Corporate%20Units/CSIROau_Annual_Report/1112/CSIRO_AR2012_Full_updated.pdf

CSIRO. (2012b). *SCOPE: Science Television for Kids*. Retrieved from http://www.csiro.au/Portals/Education/Programs/SCOPE.aspx

CSIRO. (2013). *CSIRO Education, Victoria*. Retrieved from http://www.csiro.au/Portals/Education/Teachers/Classroom-activities/CREST/Overview.aspx

CSIRO. (2013, September 2013). *CSIRO Education,Victoria*. Retrieved from CSIRO: http://www.csiro.au/Portals/Education/Teachers/Incursions-and-excursions/education-centres/Education-VIC.aspx

CSIRO. (n.d.). *Where We Are*. Retrieved September 2, 2013, from CSIRO: http://www.csiro.au/Portals/About-CSIRO/Where-we-are.aspx

DeBoer, G. E. (2000). Scientific literacy: Another look at its historical and contemporary meanings and its relationship to science education reform. *Journal of Research in Science Teaching, 37*(6), 582-601.

DuBay, W. H. (2004). Unlocking Language The Classic Readability Studies. *Impact Information*, 1-76. Retrieved from http://www.impact-information.com/impactinfo/research/classics.pdf

Emdin, C. (2010). Affiliation and alienation: hip-hop, rap, and urban science education. *Journal of Curriculum Studies, 42*(1), 1-25. doi:10.1080/00220270903161118

Forehand, M. (2005). Bloom's taxonomy: Original and revised. In M. Orey (Ed.), *Emerging perspectives on learning, teaching, and technology.* Retrieved from http://projects.coe.uga.edu/epltt/

Hart, J. (1996). Five steps to high-impact writing. *Editor & Publisher, 129*(42), 25.

Inspiring Australia. (2013, September 29). *Inspiring Australia Strategy*. Retrieved from Inspiring Australia: http://inspiringaustralia.net.au/about-us/inspiring-australia-strategy/

Junior Achievement USA. (2013). *2013 Teens & Careers Survey.* Junior Achievement.

Kohavi, R., Longbotham, R., Sommerfield, D., & Henne, R. (2009). Controlled experiments on the web: survey and practical guide. *Data Mining and Knowledge Discovery, 18*(1), 140-181.

Laugksch, R. C. (2000). Scientific literacy: A conceptual overview. *Science education, 84*(1), 71-94. doi:10.1002/(SICI)1098-237X(200001)84:1

Lyons, T., & Quinn, F. (2010). *Choosing Science: Understanding the Declines in Senior High School Science Enrolments.* Armidale, NSW: University of New England.

Madsen, S. N. (2007). Innovative Teaching Ideas for HRD Education. Retrieved from http://works.bepress.com/susan_madsen/61

Office of the Chief Scientist. (2012). *Mathematics, Engineering, and Science in the National Interest.* Retrieved from http://www.chiefscientist.gov.au/wp-content/uploads/Office-of-the-Chief-Scientist-MES-Report-8-May-2012.pdf

Ologism. (2012). *About Ologism*. Retrieved September 10, 2013, from Ologism: http://ologism.com/page5/index.html

Preiss, B., & Butt, C. (2013, December 4). *Maths results a concern in PISA schools study.* Retrieved from The Age: http://www.theage.com.au/national/education/maths-results-a-concern-in-pisa-schools-study-20131203-2yoq3.html

Schulkind, M. D., Hennis, L. K., & Rubin, D. C. (1999). Music, emotion, and autobiographical memory: They're playing your song. *Memory & Cognition, 27*(6), 948-955.

StatCounter. (2013, December 4). *StatCounter Global Stats*. Retrieved from StatCounter Global Stats: http://gs.statcounter.com

Stone, D., Jarrett, C., Woodroffe, M., & Minocha, S. (2005). *User Interface Design and Evaluation.* Morgan Kaufmann.

Sweeney Research Pty. Ltd. (2012). *Community interest and engagement with science and technology in Victoria 2011.* Sweeney Research Pty Ltd. Retrieved from http://www.business.vic.gov.au/__data/assets/pdf_file/0018/23832/prtl-sti-ciestv-2011-at-a-glance.pdf

Texeira, T. (2009). *Audiences and Objectives in Museums* (Unpublished Manuscript ed.). London, England: London Science Museum, National Museum of Science and Industry (NMSI).

The Plain Language Action and Information Network (PLAIN). (2013, 11 7). *Web-Writing that Works*. Retrieved from Plain Language: www.plainlanguage.gov

Tinari, F. D., & Khandke, K. (2000). From rhythm and blues to Broadway: using music to teach economics. *The Journal of Economic Education, 31*(3), 253-270.

United States of America. (2010, 10 13). "The Plain Writing Act of 2010". *Public Law 111-274*. United States of America: United States Government Printing Office.

US Department of Labor. (2006). *The STEM Workforce Challenge: the Role of the Public Workforce System in a National Solution for a Competitive Science, technology, Engineering, and Mathematics (STEM) Workforce.* US Department of Labor. Retrieved from http://www.doleta.gov/youth_services/pdf/STEM_Report_4%2007.pdf

Wallace, W. T. (1994). Memory for music: Effect of melody on recall of text. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20*(6), 1471.

Wyatt, N., & Stolper, D. (2013). *Science Literacy in Australia.* Australian Academy of Science. Retrieved from http://www.science.org.au/reports/documents/ScienceLiteracyReport.pdf

Appendices

Appendix A – Sponsor Description

History

CSIRO was born out of a number of smaller Australian organisations dating back to the early 20th century. In 1916, the Australian government created the "Advisory Council of Science and Industry", which would be renamed the "Council for Scientific and Industrial Research" (CSIR) in 1926. This organisation was tasked with advancing the nation's farming, mining and manufacturing industries through scientific research. The organisation continued to expand its size and reach by conducting research in fields such as liquid fuels and diseases. With Australia's involvement with World War II in 1939, CSIR began lending aid to the Australian Defence Forces. In 1949, the organisation was restructured and renamed the "Commonwealth Scientific and Industrial Research Organisation", or CSIRO. At this point, the organisation stopped doing classified research and focused on a range of areas for scientific research. (CSIRO, 2008)

Size

CSIRO is an Australian Government Statutory Authority established by the *Science and Industry Research Act 1949* (CSIRO, 2011). CSIRO's mission, as outlined by the act, is "We deliver great science and innovative solutions for industry, society, and the environment. The purpose of CSIRO is to perform scientific research in order to benefit Australia's industry and its community. With 6500 staff, it is one of Australia's largest employers of scientist, and it is Australia's largest research organisation. There are 5 different divisions within CSIRO:

1. CSIRO Information sciences group
2. Energy group
3. Environment group
4. Food, health, and life sciences industry
5. Manufacturing, materials, and minerals.

CSIRO has 56 sites across Australia and

Figure 19: Location of CSIRO Facilities

worldwide. In Australia they have three national research facilities; the Australian Animal Health Laboratory at Geelong, the Australian Telescope at Parkes, and the oceanographic research vessel *Southern Surveyor*. CSIRO also has more than 30 research facilities located in Australia. These facilities are located in all six states and two territories, but mainly centred on the east coast, of Australia. Their corporate headquarters is located in the Australian Capital Territory. The locations of the facilities can be seen in *Figure 19*. They also have an international laboratory in France (CSIRO, n.d.).

CSIRO Education, Victoria

The entire CSIRO Education department spans across each state of Australia. Every locale supports their states with community outreach programs that promote science education. Within the state of Victoria the Education sector works on bringing science to the youth and educators of the territory. Although CSIRO oversees these sectors, there are two main sponsors that allow the Education department in Victoria to continue. The sponsors within Victoria are the Department of Education and Early Childhood Development and the Catholic Education Office Melbourne.

CSIRO Education Victoria provides innovative programs for students and teachers in all years. The programs are meant engage students with innovative science. The Education department aims to develop interests and continued enthusiasm for sciences and their applications in communities.

Special programs are held around Australia and the Victoria state to bring hands-on activities to families, schools, and communities. CSIRO orchestrates events that promote family engagement with science such as Family Science Evenings. Curriculum-relevant material is brought to schools with professional teacher development and professional research partnerships with schools. Larger demonstrations are provided through CSIRO's Double Helix Science Club. The Club hosts many events for both Club members and other

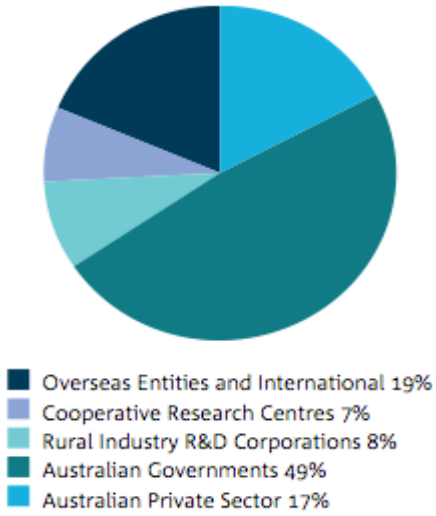


Figure 20: Sources of Revenue

local children (CSIRO, 2013).

CSIRO is one of the largest research agencies in the world and is still increasing today. The total revenue for the 2011–12 year was $1,476.0 million AUD ($724.9 million from government and $751.0 million from other sources) with their expenses totalling $1,275.5 million. This results in a surplus of $200.5 million for the 2011–12 year and a 50.1 percent increase over the previous year. Most of CSIRO's funding comes from government funding as shown in Figure 20. Compared with 2010–11, CSIRO's net non-financial assets increased by $52 million due to an increase in construction of new assets. These numbers prove that CSIRO has grown over the past year (CSIRO, 2012b). CSIRO's total financial performance since 2007 is detailed in Figure 21.

Figure 21: Total Revenue

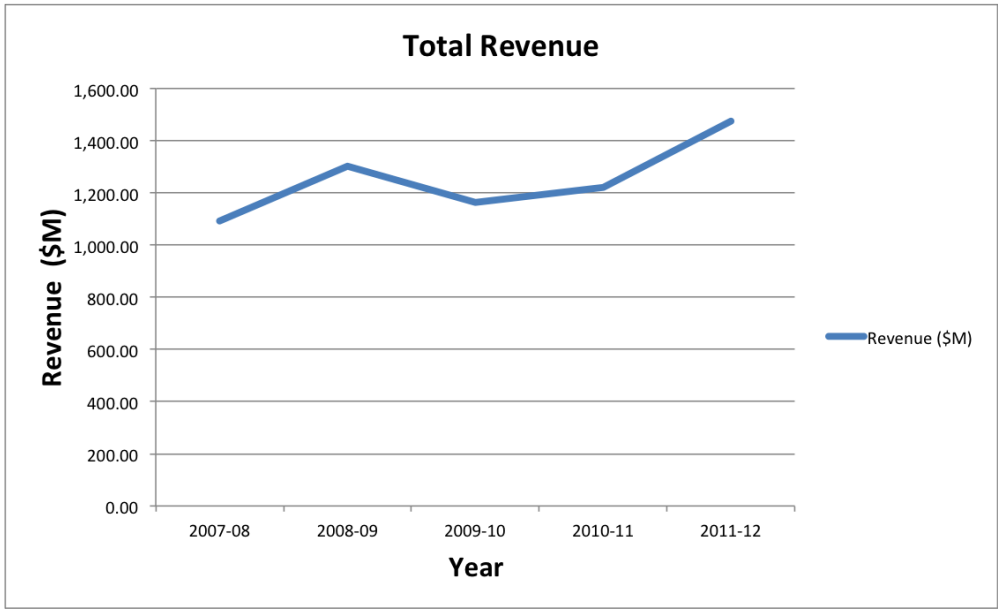


Figure adapted from CSIRO Financial Performance 2011–12

Ologism

Ologism is an innovative rock band that aims to encourage greater public interest in science through music. The band's music repertoire developed out of almost ten years of the "Great Big Science Gig" that was performed across Australia for almost ten years. The shows are

used to present science and technology in an enthusiastic and rousing way. Currently the band is backed as an educational tool by the Australian Government through the Inspiring Australia program, which is supported by the Department of Industry, Innovation, Science, Research and Tertiary Education, and CSIRO. With the help of CSIRO Education, *Ologism* plans on bringing science to the people with popular music and hands-on demonstration of science (Ologism, 2012).

Appendix B – Email to Dr Gregory Crowther

Hello Dr Crowther,

We are a group of students from Worcester Polytechnic Institute (WPI) currently working on a music project. Right now we are in Australia working for the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) educational branch. Our team is working with a band named *Ologism* and they make science themed music to try and get more young people engaged in science (specifically ages 17–30). They currently want to get their lyrics online and we have created some background scientific content and have designed a website for them to use. We have seen quite a bit of your work with music in education and were wondering if you could look at our page and give us some feedback. We will include a link to our page and a survey that we currently have running. You may take the survey if you would like to but that is not necessary. If you have any comments for us about our page or any suggestions about what is new and upcoming in this form of teaching, we would greatly appreciate and email back at csiro-b13@wpi.edu.

Here is the link,
http://ologism.com/lyrics/evaluation.php

Thank You,
Alex Clemens
Daniel Callahan
David Mihal
Tyler Mott

Appendix C – Preliminary Evaluation Sample Questions

Song: _____

Date: _____

Age: _____

How easy was it to find information on the site?

How easy was it to understand information on the site?

What did you take from the song?

What did you think of the song?

How engaging was the site?

(Not Engaging) 1 2 3 4 5 6 7 (Very Engaging)

If it was engaging, please explain how. If not please explain why not.

What was your favourite aspect of the site?

What would you change about the website?

A) Did the drop down information that is attached to the title help your understanding of the lyrics and the related blurbs?

B) Would attaching drop down information to the title help your understanding of the lyrics and the related blurbs?

When you have looked for information about science & technology on the internet in the past, have you generally been able to find what you are looking for?

Yes, and it tends to be easy to understand

Yes, but it is often difficult to understand

No, I can't often find what I am looking for

Don't know

I've never looked for info

Do you currently work or study in a scientific field? (Y/N)

Introduction for Preliminary Prototype Testing

Online Science Rock Music, IQP done by:

Dan Callahan
Alex Clemens
David Mihal
Tyler Mott

Appendix D – Preliminary Evaluation Preamble

Good morning/afternoon/evening. My name is _____. I am an American student working on a project for C-S-I-R-O (say out the letters) Education. I am studying the impact and engagement of the rock band *Ologism*. We are asking participants to listen to one of their songs and answer a few questions. The whole process should only take about 10 minutes. Are you able to help?

If not: Thank you, have a nice day.

If yes: Continue

Briefing

Ologism is a rock band. They have a website and are putting their music and lyrics online. We are testing the levels of engagement to make the webpage better.We will have you listen to a song; you may listen to the song a second time if you wish. Then, you are free to browse the webpage as long as you like.

Confidentiality

Afterwards, I have a few questions related to the webpage's usability and engagement. All answers are kept confidential. We only ask for your age and your opinion on *Ologism's* webpage. Rest assured that all information is being used for research purposes.

Although, we would prefer you to stay and answer all of questions, if you would rather stop or if there are any questions that you would not like to answer, that is perfectly okay, just let me know and we can skip that part.

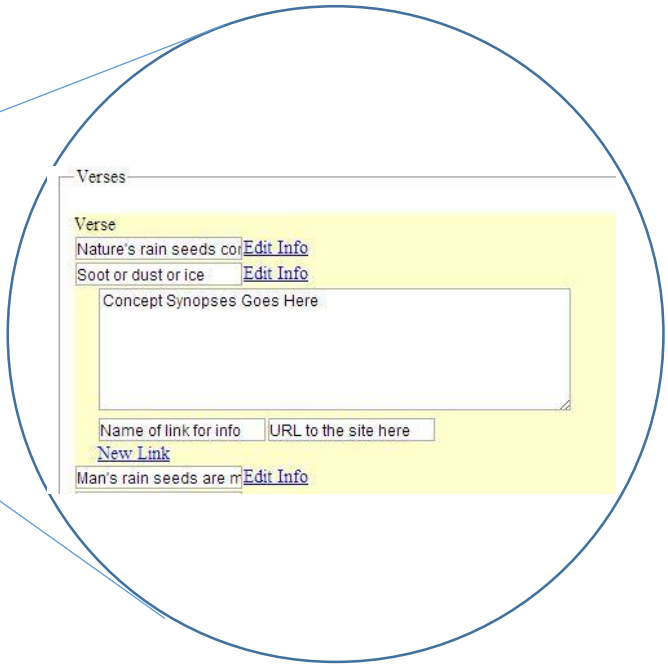
OK, let us begin.

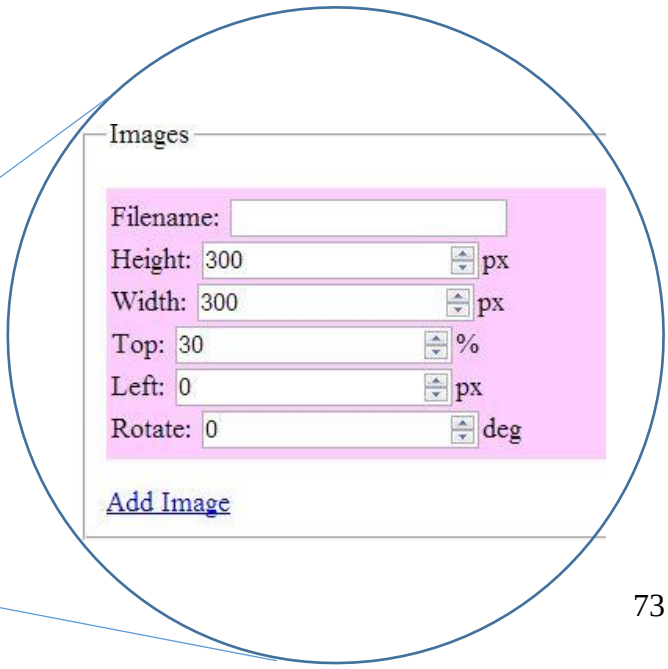
(Bring up webpage of song, hand laptop to participant)

Appendix E – Lyric Page Editor

1st: Choose song to edit

2nd: Select song elements to edit





Appendix F – Large Scale Test Consent Form

We are a student group from Worcester Polytechnic Institute (WPI), a university in Massachusetts. For our project, we are conducting research for the band *Ologism* and are evaluating the content on their website. *Ologism's* goal is to reach out to young people who are not currently engaged in science.

For this study, you will be given a page from *Ologism's* website. We ask you to listen to the song and interact with the page for as long as you want. After, you will be directed to a short survey about the page. The entire process should take about 10 minutes.

All information gathered will be kept confidential, and we will not record any personally identifiable information. If there are any questions that you do not feel comfortable answering, feel free to omit the question(s). Upon completion of this project, all data will be destroyed

If you have any questions about this study, you may contact the student research group and advisors at ologismstudy@wpi.edu

You may also contact the affiliated professors directly, Dr Andrea Bunting (abunting@wpi.edu) and Dr Dominic Golding (golding@wpi.edu).

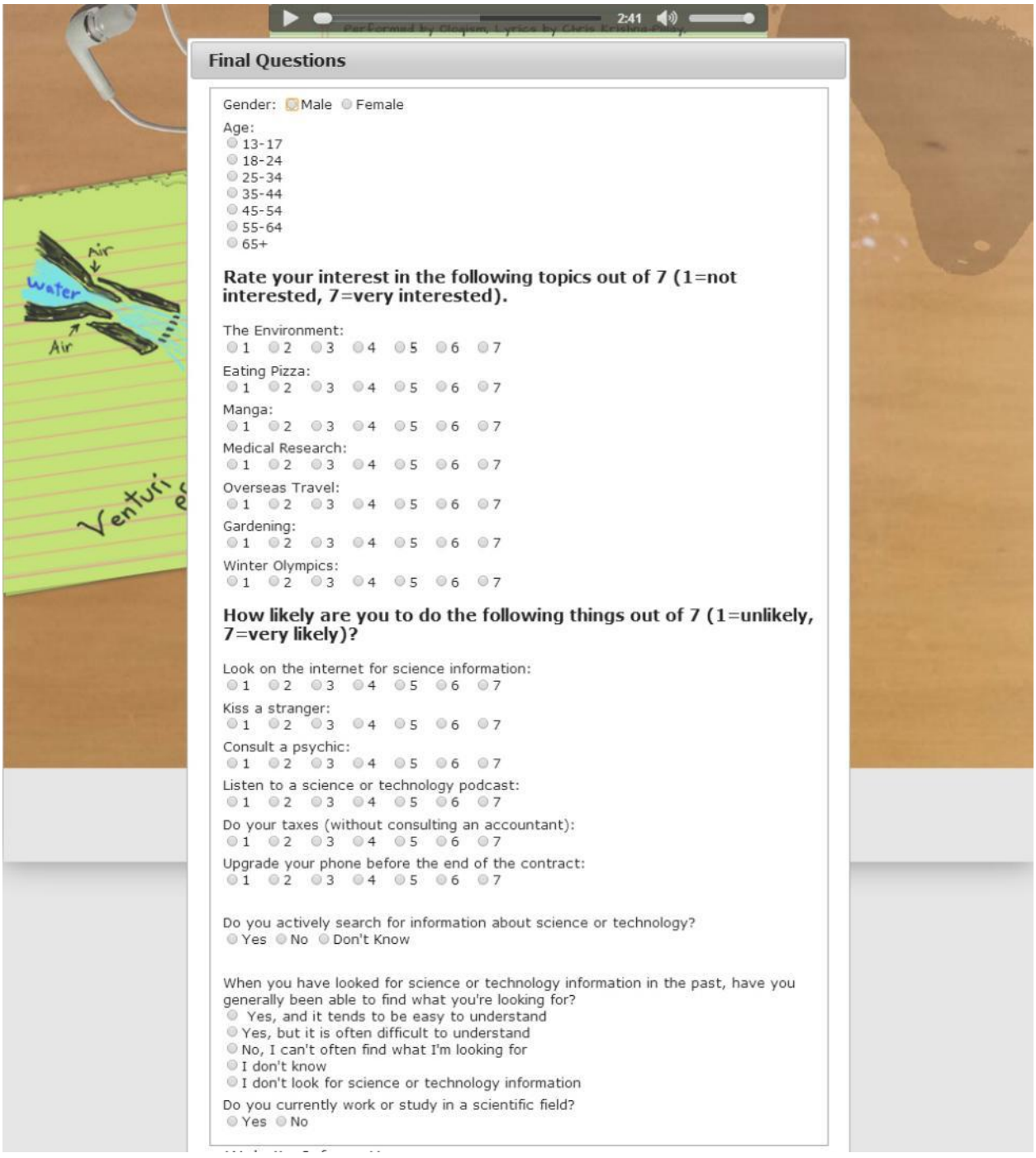
Participant's Agreement:

I am aware that my participation in this evaluation is voluntary. I understand the intent and purpose of this research. If at any time, or for any reason, I wish to stop, I may do so without providing an explanation.

I am aware that the data will be used in an academic project that will be publically available on the internet. The data gathered in this study is confidential with respect to my personal identity. I am free to copy and paste this agreement for my own records.

I have read the above form and, with the understanding that I can withdraw at any time and for whatever reason, I consent to participate in this evaluation.

Appendix G – Sample Survey



Final Questions

Gender: Male Female

Age:
- 13-17
- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65+

Rate your interest in the following topics out of 7 (1=not interested, 7=very interested).

The Environment: 1 2 3 4 5 6 7

Eating Pizza: 1 2 3 4 5 6 7

Manga: 1 2 3 4 5 6 7

Medical Research: 1 2 3 4 5 6 7

Overseas Travel: 1 2 3 4 5 6 7

Gardening: 1 2 3 4 5 6 7

Winter Olympics: 1 2 3 4 5 6 7

How likely are you to do the following things out of 7 (1=unlikely, 7=very likely)?

Look on the internet for science information: 1 2 3 4 5 6 7

Kiss a stranger: 1 2 3 4 5 6 7

Consult a psychic: 1 2 3 4 5 6 7

Listen to a science or technology podcast: 1 2 3 4 5 6 7

Do your taxes (without consulting an accountant): 1 2 3 4 5 6 7

Upgrade your phone before the end of the contract: 1 2 3 4 5 6 7

Do you actively search for information about science or technology?
Yes No Don't Know

When you have looked for science or technology information in the past, have you generally been able to find what you're looking for?
- Yes, and it tends to be easy to understand
- Yes, but it is often difficult to understand
- No, I can't often find what I'm looking for
- I don't know
- I don't look for science or technology information

Do you currently work or study in a scientific field?
Yes No

Website Information

Here are some questions about the Ologism Lyrics page that you just viewed.

On a scale of 1-7 (1=poor, 7=excellent), please rate the following aspects of the Ologism Lyrics Page.

Appearance of the page:
1 2 3 4 5 6 7

Ease of use:
1 2 3 4 5 6 7

Interest of content to you:
1 2 3 4 5 6 7

Clarity of content:
1 2 3 4 5 6 7

On a scale of 1-7 (1=poor, 7=excellent), how informative did you find this page?
1 2 3 4 5 6 7

What did you like most about this lyrics page?

What did you like least about this lyrics page?

On a scale of 1-7 (1=not likely, 7=very likely), how likely are you to return to Ologism's website in the future?
1 2 3 4 5 6 7

Why or why not?

On a scale of 1-7 (1=not likely, 7=very likely), how likely are you to recommend Ologism's website to a friend who wanted to learn about science and technology?
1 2 3 4 5 6 7

Why or why not?

What type of device did you use to interact with the page?
- Computer Mouse
- Laptop Trackpad
- Touchscreen

Submit

Appendix H – Song Lyric Guides

Air Shower

Not much water not much rain Air shower Using less should be the aim Air shower	Total water consumption in Australia in 2009-10 was 13,476,000,000,000 Litres. Australian households used 1,868,000,000,000 Litres of this alone. This means that Australian households in total use equivalent to 747,200 Olympic swimming pools of water. Each house individually uses 84,000 Litres of water. That's a lot of water! http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/148A40FCABAFBA12CA2579C100134C76/$File/4610_1.pdf
Limited precipitation Such a very rainless place Air shower	Australia is the driest inhabited continent. Major droughts disrupt crops and livestock, worsen water quality, and increase bush fire frequency. Dust storms also occur more often (Yup, it's so bad that even dirt can't stand it and leaves the area!). http://australia.gov.au/about-australia/australian-story/natural-disasters http://www.bom.gov.au/climate/drought/livedrought.shtml
Less use of your shower rose Air shower Even if you're on the nose Air shower	
Level 25 restrictions Not much rain is the prediction Air shower Instrumental break	Ok, so we've never actually seen level 25 water restrictions, but most areas have levels of restriction to use as water supply dwindles. During times of really limited water supply, water restrictions can get pretty, well . . . restrictive. Constraints and penalties are more severe at higher levels of restriction. See also below for more.
Level 25 restrictions Not much rain is the prediction Air shower	In northwest Victoria, the stage 4 restriction on vehicles means that only windows, mirrors, lights, and spots of corrosive substances (such as bird poo) may be washed by bucket of water, not a hose. Penalties for and offence can include jail time. Vehicle Stat http://www.gwmwater.org.au/information/customers/customers-water-restrictions Incarceration Stat http://www.gwmwater.org.au/information/publications/ground-and-surface-water/west-wimmera-gma/doc_download/1921-urban-water-restrictions-by-law-105 More information on restrictions in certain areas http://www.bom.gov.au/water/restrictions/ Developed with CSIRO, the Oxijet nozzle reduces water used while showering by up to 50%, but feels the same as a normal

	shower. It does this by using the venturi effect to draw air in the water stream, which increases the volume of the shower stream by forming bubbles that burst when they hit the skin. Oooh – tingly (maybe)! http://www.csiro.au/Portals/Media/Air-shower-saves-50-per-cent-water.aspx Video http://www.youtube.com/watch?v=7EQmA1lTugc
No more water in the well But there's no need for you to smell Air shower	

Ant Establishmentism

We were here before you were, you know More than 100 million years ago And now we number 20,000 species	
Adaptable, resilient You know we're . . . brilliant Our social systems use eusociality	Eusociality: a high level of organisation in a society. A queen (or queens) leads an ant community (but she doesn't wear a crown) and lays thousands of eggs to ensure some of her offspring survive, while worker ants find dinner and babysit the young. http://animals.nationalgeographic.com.au /animals/bugs/ant/ Ant Video http://www.youtube.com/watch?v=ELngWs3Web4
We've been stomped (And) we've been eaten But you know We simply can't be beaten	
With your one brain You think you know (But) you've got a long long way to go A million brains alive in side my nest	
Don't threaten me, no don't you dare (Or) acetophenones you will wear Don't cross me Or I might just explode	Watch out around carpenter ants (Camponotus Saundersi) - they have large jaw glands along their bodies and gasters (their bum). Messing with them can end with workers contracting their bodies and rupturing their glands and butt, releasing a sticky poison, immobilising the victim and killing the ant (abs of steel … but this won't harm a human ... hopefully). Depending on your German skill, this is an interesting article, and the abstract is in English. http://link.springer.com/article/10.1007/BF01039798 Complicated chemical explanation http://link.springer.com/article/ 10.1023%2FB%3AJOEC.0000042063.01424.28
We watched the dinosaurs move on And human beings can't last long (But) we've a learnt a thing or 2 about survival	A fossil discovery proves that ants lived about 90 million years ago, before dinosaurs went extinct. Where would we be without people that examine rocks…. http://www.nytimes.com/1998/01/29/us/fossil-shows-ants-evolved-much-earlier-than-thought.html
Intelligent communities Have seen us through adversity Famine, flood and predators and rivals	Animals can have different relationships with each other, including working together (mutualism), killing each other (competition), or being annoying

	(parasitism). Different animal populations may live alone (crocodiles), in groups (wolves), or colonies (ants). http://animals.about.com/od/zoologybasics/a/communitiesecosystems.htm
We've been stomped (And) we've been eaten But you know We simply can't be beaten	
With your one brain You think you know (But) you've got a long long way to go A million brains alive in side my nest	
Don't threaten me, no don't you dare (Or) acetophenones you will wear Don't cross me Or I might just explode	Acetophenone is a chemical commonly used in fragrances, flavouring in food, and as a solvent in plastics and resins. The carpenter ant also uses it in its exploding, sticky poison. For humans, short-term exposure may irritate the skin (ooh, it burns, it burns!) or injure the eyes (you might want to rinse that off immediately!) http://www.epa.gov/ttnatw01/hlthef/acetophe.html
Chorus With your one brain You think you know (But) you've got a long long way to go A million brains alive in side my nest	
Don't threaten me, no don't you dare (Or) acetophenones you will wear Don't cross me Or I might just explode	
Chorus With your one brain You think you know (But) you've got a long long way to go A million brains alive in side my nest	
Don't threaten me, no don't you dare (Or) acetophenones you will wear Don't cross me Or I might just explode	

Buzzed Off

Lyrics	
Just a little bee Meant everything to me They say that if you love them you should Set them free	Bees are separated into 3 groups/roles: • The Queen: The only fertile female in the hive • Workers: Infertile female bees, who perform the majority of chores • Drones: male bees, whose main function is to impregnate the queen http://agritech.tnau.ac.in/farm_enterprises/fe_api_castesofhoneybee.html
For weeks now I have waited My flowers are vacated Without my little bee they just Won't get pollinated	Pollination is the delivery of pollen from the male organs to the female organs of a plant. Most of the time this is done by insects (65% of plants). Without insects like honeybees and ants, plants could not pollinate and therefore could not reproduce, which would be sad for them and us. http://australianmuseum.net.au/Pollination
I feel half alive Without her in my hive But now she's buzzed off	In the hive, worker bees are female and do most of the work (hence the name). The queen lays all the eggs. The drones' primary function is mating with the queen. They are all essential to the hive. More about the hive community: http://beespotter.mste.illinois.edu/topics/social/
It's a sickening omen Just where did she go, and I miss her from his antenna, to Her abdomen	It's estimated that about one third of US honeybee colonies have vanished. This is a huge worry for agriculture. The United States would lose an estimated $15 billion in crops without bees to pollinate them, and people would be very hungry. http://www.nrdc.org/wildlife/animals/bees.asp
What's the point of me Without my honeybee? My heart and hive are weeping From this CCD	CCD: Colony Collapse Disorder. This is a phenomenon when honeybees disappear suddenly from a hive. This leaves the queen and larva defenceless. There's a video on this page about CCD. http://www.youtube.com/watch?v=Zgc5w-xyQa0
I feel half alive Without her in my hive But now she's buzzed off	
I feel half alive Without her in my hive But now she's buzzed off	

Cloud Seeds

Nature's rain seeds come from earth, they're Soot or dust or ice Man's rain seeds are made by man, but They will still suffice Drops need help to nucleate 'Round rain seeds they will congregate and	I know what your thinking, "How can man's seed produce rain?". However, rain is the key word here and rain seeds can be silver iodide, dry ice (solid carbon dioxide) or salts. These particles are used to help water condense and fall. Look out below! Video with idiot news people http://www.youtube.com/watch?v=Sn5g4Gt_EJw http://www.cmar.csiro.au/e-print/open/holper_2001c.htm Nucleate: To gather around a central point. You can see this process happen when you put your finger in a carbonated beverage (That was fizzy) or when making rock candy (Sweet!).
The rain falls down The answer is falling on the ground	
Long before we sowed the land and Long before used umbrella stands Clouds were made when Droplets formed from vapour, it was grand! With help from Silver iodide or Maybe carbon dioxide We can mimic Mother nature's favour	Before people came around (when things were much more simple) water could go undisturbed through the water cycle. The stages of the water cycle are evaporation (finally free from those hydrogen bonds!), condensation (Uhh Ohh, we're gaining weight…), and precipitation (that's a long way down!). http://www.melbournewater.com.au/getinvolved/education/Pages/Natural-water-cycle.aspx There are three methods of cloud seeding, two of which are quite boring and involve spreading a chemical in the air (static cloud seeding) or boosting vertical air currents (dynamic could seeding). However, hygroscopic cloud seeding spreads salts through flares or explosives (that's quite a bang for some rain). http://science.howstuffworks.com/nature/climate-weather/meteorologists/cloud-seeding1.htm
To make the rain fall down The answer is falling on the ground	
(But with) Man's seeds in Mother nature's cloud Orographic winds will Lift them high and proud Man's seeds in Mother nature's cloud	Orographic winds are just a fancy way of saying it relates to mountains. As the air is lifted up it cools and water vapor condenses, and subsequently falls. As the air falls down the other side it is warmed. Here is a video that explains it https://vle.whs.bucks.sch.uk/mod/page/view.php?id=52946 http://www.brockmann-consult.de/CloudStructures/orographic-clouds-description.htm

Water droplets that won’t freeze, as They make clouds above the seas Rain and snow remain a flight Of fancy	
And then the rain falls down The answer is falling on the ground	
(But with) Man's seeds in Mother nature's cloud Orographic winds will Lift them high and proud Man's seeds in Mother nature's cloud	

Croc of Golden Staph

Staphylococcus aureus In hospitals, notorious, but it's Really not your friend It could bring about your end	Staphylococcus aureus, or 'golden staph', is a bacteria that lives harmlessly on the skin and causes infections when it enters the body through an open wound, mostly when your immune system is compromised. Because some people have played fast and loose with antibiotics, some strains of staph have become resistant to many common antibiotics. http://www.betterhealth.vic.gov.au/bhcv2/bhcarticles.nsf/pages/Staphylococcus_aureus_golden_staph
Crocodiles will not shed tears Golden Staph it holds no fears With their immunity, they will Survive	Crocodile blood is shown to have antibacterial properties. When Crocodiles get in fights with other crocodiles they take chunks out of each other (Ouch!), but they don't get infections like HIV, E. Coli, West Nile Virus, and golden staph. They don't even go to the doctor! http://news.bbc.co.uk/2/hi/health/4155522.stm
Staphylococcus aureus The crocs come out victorious With their own antibiotic Their wounds don't go necrotic	
Crocodiles will not shed tears Golden Staph it holds no fears With their immunity, they will Survive	
Resisting penicillin We need some crocodillin Thanks to wisdom Reptilian	Researchers have isolated a substance in crocodile's blood, called crocodillin, which kills strains of bacteria that are resistant to common antibiotics. This may lead to a new drug that can treat these bacterial infections in humans (see, crocs are useful, not scary…). http://youtu.be/hWxViYUYnDw?t=11m20sThis video explains how crocodiles are being used to create new antibiotics. If you're really interested here is some of the research on crocodillin http://www.sciencedirect.com/science/article/pii/S1095643306000225
Crocodiles will not shed tears Golden Staph it holds no fears With their immunity, they will Survive	

Cybernose

Lyrics	Content explanations and links, corresponding to highlighted sections on the left
She's got great body She tastes great today But when it comes to smell Cybernose is going to lead the way	Appearance and flavour (in mouth and aftertaste) are characteristics that are used to judge wine. Another is the aroma (smell) and Cybernose will be a great way to make this judgement more objective, by actually identifying specifically which chemicals are in the aroma.
	The CYBERNOSE, being developed by CSIRO, mechanically mimics the nose. It uses smell receptors extracted from nematodes to send pulses to tiny lights. A computer uses those colours to differentiate smells. The CYBERNOSE will: Identify food toxins Distinguish good wine Sniff out explosives Diagnose diseases Check out this info and video about the CYBERNOSE http://www.csiro.au/Organisation-Structure/Flagships/Food-Futures-Flagship/Quality-Biosensors-Theme/Cybernose-overview.aspx
Jane says it smells like honey Johnny says it's more like cloves Everybody knows they're going to need Cybernose	
Cybernose, Cybernose C-c-c-c, C-c-c-c Cyber Nose Everybody knows that they're going to need Cybernose	
Working out palate is one thing But the complication grows To analyse bouquet you're going to need Cybernose	Palate is the sense of taste. Taste occurs more in the nose than on the tongue. Humans have an underdeveloped sense of taste compared to insects; they even taste with their feet and antennae. No wonder humans' receptors aren't used in the CYBERNOSE. http://library.thinkquest.org/3750/taste/taste.html http://www.livescience.com/2737-surprising-impact-taste-smell.html Weird statistics about taste: http://www.nidcd.nih.gov/health/statistics/smelltaste/Pages/stquickstats.aspx
Methode Champenoise Or a really great Merlot	Methode Champenoise is the oldest and most traditional way to make white wine. It was developed by a monk in Champagne, France. http://www.winesparkle.com/what.html

To get the scent right, Cybernose is the way to go	Merlot is a type of wine made from Merlot grapes. Merlot grapes: • Soften wines • Add a plum flavour • Have a shorter fermentation period http://www.wine-searcher.com/grape-275-merlot http://winemakermag.com/494-mastering-merlot
Cybernose, Cybernose C-c-c-c, C-c-c-c Cyber Nose Everybody knows that they're going to need Cybernose	
Instrumental break	
When you're trying to analyse the fraction Of a wine that involves olfaction I'd like to propose That you go and use Cybernose	Olfaction is the sense of smell. We can distinguish more than 10,000 smells and have up to 6 million olfactory receptors in our nose. However, our best friend the dog has 220 million. Yet, we cannot determine the exact fraction of smells we find. How good is our sense of smell? http://www.sirc.org/publik/smell_human.html
Cybernose, Cybernose C-c-c-c, C-c-c-c Cyber Nose Everybody knows that they're going to need Cybernose Everybody knows they're going to need Cybernose	

Dark Matters

What's the matter with all this lost matter? I can't find the matter that matters	When you look out a car on the freeway, things further away appear to move slower. Well, this isn't the case for planets orbiting the sun. Since gravity causes rotation, it means there is more gravity than scientists could predict. But gravity comes from objects that can't be found! TOO CONFUSING: Need to change Go with the expanding universe example (the lost matter is slowing it) 1 its expanding 2 at a certain speed 3 everything in the universe is pulling stuff in What?? http://abyss.uoregon.edu/~js/cosmo/lectures/lec17.html
Smash the particles, smash the atoms! You can't see it, but you need Dark Matter!	Like little kids, scientists smash stuff together too. However, this time they aren't smacking toy trucks together, they're smashing tiny particles taken from atoms. And YES, there is a purpose: to understand particle physics and test theories about how our universe started. Scientists do it for a better reason, play that up more You can learn here! http://www.bahighlife.com/Curious/An-idiots-guide-to-the-God-particle.html
Dark Matter! Dark Matter!	It makes up 80% of matter in the universe BUT NO ONE CAN SEE IT! Dark Matter: Fills the "empty space" between matter (like Space) Doesn't emit or interact with light It almost never collides with regular matter But it has gravity and affects us! What NASA says: http://science.nasa.gov/astrophysics/focus-areas/what-is-dark-energy/ http://physicsworld.com/cws/article/news/2009/sep/21/is-dark-matter-mostly-dark-atoms
Colliders we've built and they're getting bigger Equations don't work - the numbers don't figure The latest machine is known as the Hadron We made some small things and more will come later on	Particle Colliders are getting larger and larger, but why? For scientists to smash the smallest things mankind knows: The pieces of an atom. So why go bigger when working smaller? To smash harder! More room allows particles to speed up more before going Ka-BOOM. How big is the next one? http://www.nature.com/polopoly_fs/7.13697.1384267558!/image/vlhc-graphic.jpg_gen/derivatives/fullsize/vlhc-graphic.jpg
The cosmos ain't right, it should be much fatter	

There needs to be more my theory's in tatters Smash the particles, smash the atoms! You can't see it, but you need Dark Matter!	
Dark Matter! Dark Matter!	
Colliders we've built and they're getting bigger Equations don't work - the numbers don't figure The latest machine is known as the Hadron We made some small things and more will come later on	The Large Hadron Collider (LHC) is the highest-energy particle collider made! ... so far. The LHC has a 27km circumference yet, scientists are already planning one almost 4-times larger. Visit the LHC website to understand the unknown: http://www.lhc.ac.uk/ If you took high school science, see if you understand this: http://www.youtube.com/watch?v=eNdR8uL3ksg
Dark Matter! Dark Matter! Dark Matter! Dark Matter!	

DHA Trip

The Inuits eat whale and seal and salmon Their diabetes rates are very low A healthy diet (yes) in every facet Rich in Omega-3 fatty acids	There are three different types of omega-3 fatty acids with long names that can be simply written as EPA (or Eicosapentaenoic Acid), DHA (or Docosahexaenoic Acie), and ALA (or Alpha-linolenic acid). They have been shown to help prevent heart disease, stroke, and other conditions. That's strange; the names alone are enough to give you stroke… http://www.hsph.harvard.edu/nutritionsource/omega-3-fats/
The Incidence of Alzheimer's and asthma Might even be reduced if we eat smart Listen now as Marty starts to jazz it He's had Docosahexaenoic acid	It has been found that DHA can help reduce the decline in cognitive function over time. Increased consumption of DHA replenishes deficiencies in membrane phospholipids in the brain, which then helps you remember where you put your keys. http://ajcn.nutrition.org/content/85/4/929.full
These fatty acids don't just grow in grains though They come from microalgae in the sea (So) they moved some genes around until they has it They've got Docosahexaenoic acid	Scientists at CSIRO have been able to create plants (and canola oil) that can produce omega-3 fatty acids. They did it by a very complicated process of transferring microalgae genes to canola plants. Look out fish, you're not so unique anymore… http://www.csiro.au/science/Omega3-Canola-Collaboration
DHA DHA DHA	

Nanotechnology

Lyrics	Content explanations and links, corresponding to highlighted sections on the left	Links corresponding to highlighted sections
Underneath the cosmos In a world beyond your eyes The rules are bent or broken When you choose a smaller size		
Make flexy solar panels Target drug delivery Build lighter planes and spacecraft With nanotechnology	Imagine wearing a shirt that could recharge your phone. Researchers are working to develop solar cells that are just a few microns long (That's 1 millionth of a metre!). These cells will be woven into fabrics for clothing, hats, and backpacks without looking like a walking solar panel!	More on flexible solar cells! http://www.treehugger.com/solar-technology/nanotechnology-could-lead-ultra-thin-flexible-solar-cells.html
Save lives with filtered water Diagnose disease Make clothes with clever textiles And long lasting batteries	Nanotechnology is used to ensure drinkable water is more easily accessed in third world countries. Scientists use it to build water filters that can remove bacteria, viruses and other particles. The device has a microscopic cage that filters these contaminants toward the nanoparticles for cleansing.	The nanoparticle water filtering http://www.scientificamerican.com/article.cfm?id=cheap-nanotech-filter-water
At a billionth of a metre The macro world recedes It's a great big tiny step We call nanotechnology	To engineer nanotechnology, parts as small as one nanometre are manipulated; which is equivalent to one billionth of a metre. Objects this small are extremely difficult to maneuver and the technologies have only been available in the last few decades.	Can nanotechnology create a utopia? http://www.youtube.com/watch?v=RzgVWpa4fzU Timeline of Nanotechnology http://nanotechnology.americanchemistry.com/Nanotechnology-Timeline
At a billionth of a metre The macro world recedes It's a great big tiny step We call nanotechnology		
It's a great big tiny step We call nanotechnology		
It's a great big tiny step We call nanotechnology		

Sheep Burpin' Blues

Lyrics	CS suggestions
I am just a sheep (But) sometimes it's enough to make you weep Wrecking the atmosphere is not what I would choose I got the sheep burping blues	
Bacteria inside me amasses A nasty collection of gasses Of global warming I stand accused I got the sheep burping blues	Sheep require bacteria called methanogens for digestion. These bacteria create Methane as a product from digestion. Methane is a greenhouse gas that contributes to climate change. Sheep release multiple greenhouse gases each time they burp. Listen to them burp! http://www.youtube.com/watch?v=HYMYhUkzJCE http://online.wsj.com/news/articles/SB123561039911777481
I used to think that life would be so fine Being out in the field and being ovine But I sometimes start to burp when I am chatting up the ewes I got the sheep burping blues	Ovine means of or relating to Sheep. So have a guess what bovine, picine and canine are related to? http://www.thehindu.com/multimedia/dynamic/01072/03isbs_signpost_ne_1072609e.jpg You thought your mouth braces were a pain – check out the headgear worn by these sheep as they work hard to help scientists collect their burps.
Of global warming I stand accused I got the sheep burping blues	Gases like carbon dioxide and methane act like little greenhouses (hence the term 'greenhouse gas') and trap heat in the atmosphere, increasing global temperatures. Here is an interesting way to deal with climate change : http://www.youtube.com/watch?v=OqVyRa1iuMc More on the topic: http://www.climatechange.vic.gov.au/greenhouse-gas-emissions
Of global warming I stand accused I got the sheep burping blues	Climate change has already increased the earth's temperature by 0.8oC (trust us, that's actually super high!) This increase causes melting ice caps and rising sea levels. With sea levels rising people will run out of land to live on. Still, look on the bright side; your inner city apartment may soon have an ocean view! Some info on increasing Australian temperatures. http://www.bom.gov.au/climate/change/

SKA Man

Lyrics	Blurb
In the middle of nowhere You can hear yourself think You sense the scale of existence And the earth seems to shrink	To avoid radio interference (And human interference in this case), the SKA project facilitates in remote regions of Australia, Botswana, Ghana, Kenya, Madagascar, Mauritius, Mozambique, Namibia, South Africa and Zambia. Here's a map so you don't have to go find them yourself: http://www.skatelescope.org/skadesign/ Find which countries are in on it: http://www.smallerquestions.org/storage/ska_world.jpg?__SQUARESPACE_CACHEVERSION=1356625083742
Thousands of dishes In a far away place Searching for answers Looking deep into space	About 3,000 dishes and hundreds of Aperture Array Stations will be established as part of the SKA project. Aperture Arrays are just like satellite dishes only flattened, laid on the ground, and made of many individual receptors not just one (…so maybe they're not that similar). http://www.skatelescope.org/
Look past the sky Dare to ask why Look past the sky The SKA will be our guide	Square Kilometre Array, so named because the combined collecting surface from thousands of dishes in Southern Africa, Australia and New Zealand will be more than a square kilometre. You could get so many channels with a dish that big! Watch the video! http://www.youtube.com/watch?v=ZK2zrKJSSNk
The universe's intimate secrets Are in radio waves As the cosmos was forming That's the gift that it gave	Radio waves are made of electromagnetic radiation. This radiation is the light emitted by stars, a.k.a. starlight. Scientists find pulsars, quasars, nebulae, planets, and galaxies by tracking the electromagnetic radiation they emit. http://outreach.atnf.csiro.au/education/everyone/radio-astronomy/ Add moving image for radio wave?
Peering deep into space Looking deep into time Big thoughts for small people What will we find?	The SKA (Square Kilometre Array) should answer several big questions: Is there life beyond Earth? How were the first stars and galaxies formed? What happened immediately after the Big Bang? What is the nature of gravity throughout the cosmos? Who stole the cookie from the cookie jar? (Just kidding) SKA's site has (loads of) more info: http://www.skatelescope.org/
Look past the sky Dare to ask why Look past the sky The SKA will be our guide	

Spud Love

Lyrics	Content explanations and links, corresponding to highlighted sections on the left	Links corresponding to highlighted sections
Underneath the surface In the soil of planet Earth There is swelling in the roots Of a small plant It's wonderful, But it is nothing new It's a root tuber	Ever wonder where a potato comes from? When the weather gets colder, potato plants get ready for winter by storing nutrients in its roots. These nutrients accumulate in "tubes", which become DELICIOUS potatoes!	More information about potato growth http://www.cals.uidaho.edu/potatoes/potatoproductionsystems/topics/growth&development.pdf
In the dark and unassuming Tubers that we love consuming Grow in every corner Of the world From China and Peru To France and Cuba It's a root tuber	Originally cultivated in South America, potatoes are now grown and consumed in all parts of the world (and not just for deep fried fast food chains). It's considered by some to be the 5th most important crop worldwide.	What do people do with them? http://www.mashedtaters.net/ From dirt to dishes. http://www.smithsonianmag.com/history-archaeology/How-the-Potato-Changed-the-World.html
Feed the world, fill my senses Nutrients dispense – is this Spud love?	Everybody loves potatoes! The smell of a baked potato makes you happier. And, the potato alone has almost zero fats plus several of your recommended daily vitamins. Eat that!	Potato Inform-O-Graphic http://www.goireland.com/craic/potato-nutritional-facts.htm
Solanum tuberosum makes a Tasty food that's also wholesome With vitamins and Carbohydrates too Iron-rich and Low in fat – it's true It's a root tuber	Solanum tuberosum is the scientific name for the common species of the potato plant.	Get to know the solanum tuberosum before you take it for dinner. http://solgenomics.net/organism/12/view
Feed the world, fill my senses Nutrients dispense – is this Spud love?		

Super Model

I saw a super model And she was really good She told me things were not progressing In the way they should	
Since we started burning oil, We've been warming up the Earth Now from New York to Afghanistan, From London down to Perth	Burning fossil fuels releases CO2 into the atmosphere, which is one of the biggest contributors to climate change. Climate change has many negative effects for the environment, including ecosystem changes and causing more extreme weather conditions. (On the bright side, maybe we'll have longer summers?) More info about global warming can be found here http://environment.nationalgeographic.com.au/environment/global-warming
We're talking 'bout wrong air Talking 'bout weird air (We're) talking 'bout wrong air Talking 'bout weird air	
I asked the super model, How bad could it get It won't change in my life will it? She said you wanna make a bet!	One extreme estimate of the effects of global warming predicts that within 100 years the sea level could rise a little more than 7 meters, enough to submerge Los Angeles and London (Maybe they could change their name to New Venice). http://ocean.nationalgeographic.com/ocean/critical-issues-sea-level-rise/
It's already getting hotter And the seas are rising now More droughts, more storms, more cyclones And worse ones – Holy Cow!	Water expands when it is heated. The expansion of water due to rise in global temperatures was responsible for half of the sea level rise over the past century. The melting of glaciers and ice caps also contributes to the rising sea levels. So instead of going to the beach you can wait for the beach to come to you. This Video gives a brief overview of thermal expansion of water. http://www.youtube.com/watch?v=fuvY5YG5zA4
We're talking 'bout wrong air Talking 'bout weird air (We're) talking 'bout wrong air Talking 'bout weird air	

Supertextural Energy Blues

Energy, pollution CO2 and warming Watch the weather channel Gonna be storm warnings	CO2, a.k.a. carbon dioxide, occurs naturally and retains heat in our atmosphere. It comes from using fossil fuels like: • Oil • Coal • Natural Gas • Petroleum • Not Dinosaurs Why is this affecting our climate? http://www.skepticalscience.com/Is-CO2-a-pollutant.html
Sea levels, rising tide Coral bleaching, suicide All's not so well Up to now we got a free ride	The sea level has been rising for decades. The increased climate temperatures have expanded the ocean volumes across the world (you can see the reverse effect by putting a warm water bottle into the fridge). http://oceanservice.noaa.gov/facts/sealevel.html http://www.youtube.com/watch?v=rkyLe_DPAJo When you don't feel well you might turn pale. Coral does the same thing if the water gets warmer, less salty, or the amount of light hitting the coral increases. This is called 'coral bleaching.' What's making the coral sick? http://www.reefed.edu.au/home/explorer/hot_topics/coral_bleaching Link for water expansion
Now, here's the problem Nowhere to hide	
Al Gore, Stern Report Kyoto meetings, what's it for Use less, use more Everyone's watching, keeping score	
Extinction rates, drive a car Isobars, go live on Mars CO2 is off the chart Don't sit back Let's make a start	Species are disappearing faster than before. Your favourite animal could be on the endangered list! http://worldwildlife.org/species/directory?sort=extinction_status&direction=desc Isobars are lines drawn on a map that group different levels of atmospheric pressure (Also they look trippy if you print one out and colour it in, seriously try it!). Check out a quick demo! http://weather.about.com/od/i/g/isobars.htm
Look out leaders, money bleeders It's all gone strange	

Did you need a scientist To see the climate change?	
Politicians, scandals Scientists, vandals Hey – Why not use a candle?	
Dry land, low crop yields No sure food Can't sow the fields Ice cores, food wars	An ice core is a long cylinder made of ice (duh) usually pulled from the arctic ice caps. Scientists can use cores to look at climate changes during the past thousand years.This is possible because density changes and debris (like ashes from a giant meteorite, like dinosaurs) cause layers of ice to form differently. Think DINOSAURS!
Erratic weather, Shrinking ice caps Population, polar bears Can't feed the nation	Polar bears have a tough time relaxing and drinking cola these days (They don't actually do that). The melting of their home (the Arctic ice) is driving food sources away. Now they wander for food, sometimes near humans. If you see one, it isn't angry, just hungry. But watch out! http://www.isciencetimes.com/articles/6269/20131104/why-polar-bears-attacking-canadians-melting-habitat.htm
GDP, the IPCC You know it's up to you and me	The GDP and IPCC rap-summary The Gross Domestic Product, Keeps the total dollar value we conduct By adding goods and products and more, To give our country a money score. Research and reviews, they arrange The Intergovernmental Panel on Climate Change For over 100 countries they watch and report, On climate change of the human sort
Get a new trade route Man in a pin suit	(Insert picture of Chris) "The song is visual, watch us live"
Want to stop the warming Be a success Got to save the Earth But don't want to stop the progress	
Use the sun, use the wind Geothermal, tidal power Hey, how about nuclear? Don't shout yet, take a cold shower (it's just a thought)	
Store the energy Now that the rap	What goes faster and further than any battery before? UltraBattery!

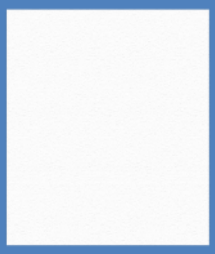
Part of the answer Could be the ultra battery	What's a hybrid battery that combines lead-acid technology with a supercapacitor? UltraBattery! Who cares? People who want long lasting batteries that charge ultrafast! What is it used for? Hybrid and electric cars Storing wind and solar power
Technical solutions, They can help, it's not that hard From the boardroom To your own backyard	
Part of the answer could just be Hybrid cars, that's a thought Hybrid cars that use less petrol Charged up with ultra batteries	Hybrid cars are electrifying! They combine multiple power sources, usually a combustion engine and an electric motor. Their efficiency is outstanding because the car produces electricity while using petrol, which then powers the electric motor! Interested in one, learn more. http://www.gogreenacademy.com/some-interesting-facts-about-hybrid-cars/
Part of the answer could be just that . . .	

Appendix I – Graphics and Doodles

Image Backing

Notepad paper

Construction



Photograph

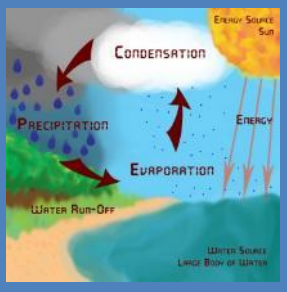
Napkin

Overlay Image

Cyber Nose

Sheep Burpin' Blues

Water Cycle

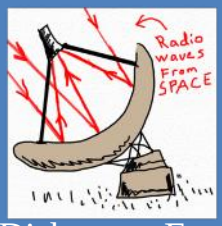


Wax Writing Utensils

On Notepad

Air Shower and Venturi Effect

On Construction Paper



Satellite Dish

Exploding Ants

Potato Meals

On Photograph

Fat Atom Awards

Coloured in Isobars

On Napkins

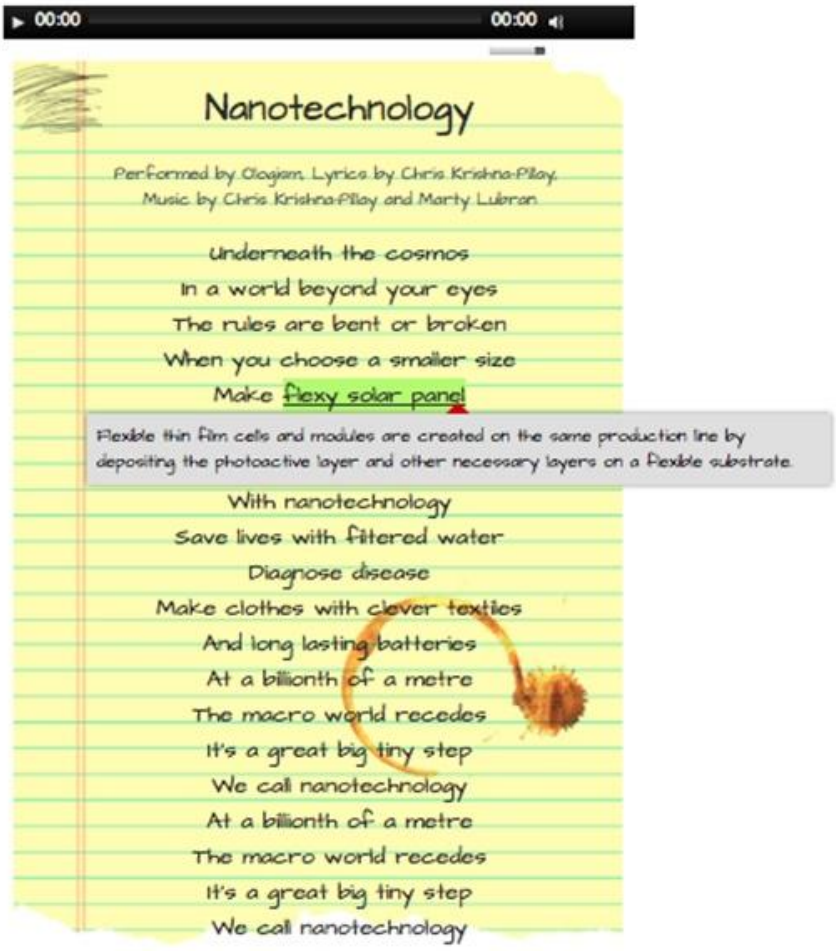
Bee Pollination

Healthy Crocodile

Appendix J – Web Interface Designs

Initial Draft

Play song



Prototype 1

Play song

0:00

Nanotechnology

Performed by Ologism. Lyrics by Chris Krishna-Pillay. Music by Chris Krishna-Pillay and Marty Lubran

Underneath the cosmos
In a world beyond your eyes
The rules are bent or broken
When you choose a smaller size

Make flexy solar panel

Flexible thin film cells and modules are created on the same production line by depositing the photoactive layer and other necessary layers on a flexible substrate.

Target drug delivery
Build lighter planes and spacecraft
With nanotechnology

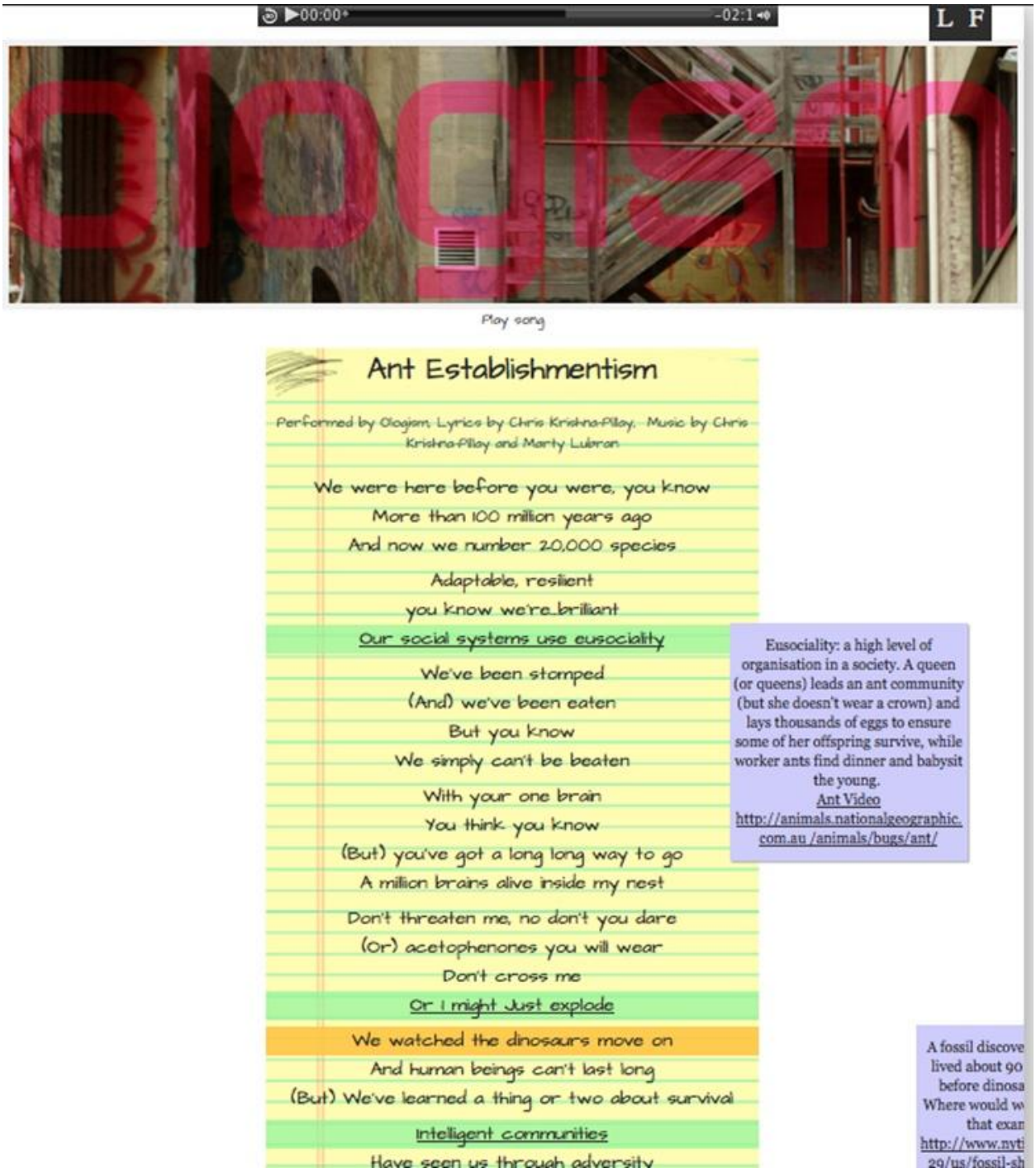
Save lives with filtered water
Diagnose disease
Make clothes with clever textiles
And long lasting batteries

At a billionth of a metre
The macro world recedes
It's a great big tiny step
We call nanotechnology

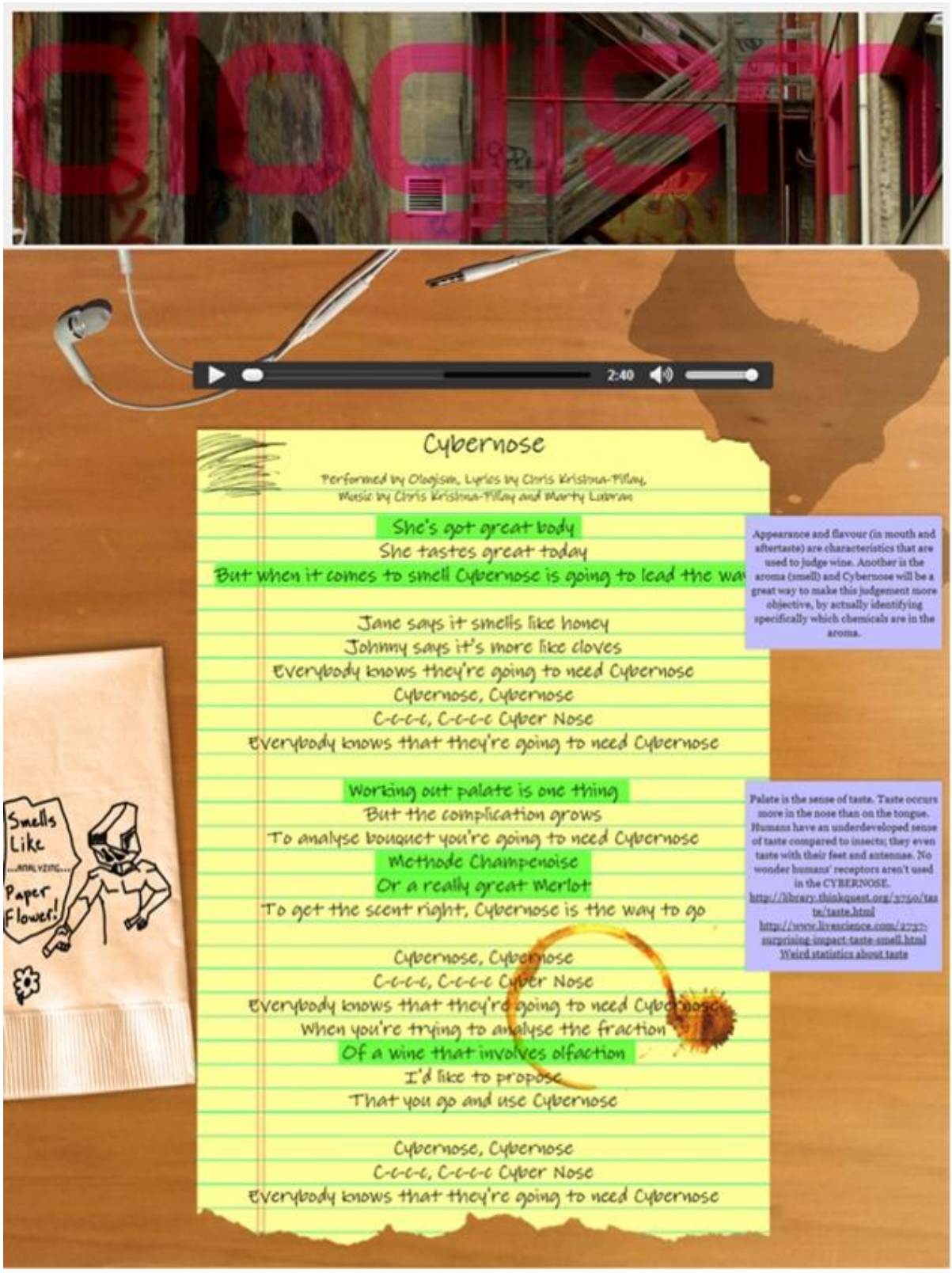
At a billionth of a metre
The macro world recedes
It's a great big tiny step
We call nanotechnology

© 2012 ologism Contact Ologism

Prototype 2


00:00
-02:1
L F
Play song
Ant Establishmentism
Performed by Glogism. Lyrics by Chris Krishna-Pillay. Music by Chris Krishna-Pillay and Marty Lubran
We were here before you were, you know
More than 100 million years ago
And now we number 20,000 species
Adaptable, resilient
you know we're brilliant
Our social systems use eusociality
We've been stomped
(And) we've been eaten
But you know
We simply can't be beaten
With your one brain
You think you know
(But) you've got a long long way to go
A million brains alive inside my nest
Don't threaten me, no don't you dare
(Or) acetophenones you will wear
Don't cross me
Or I might Just explode
We watched the dinosaurs move on
And human beings can't last long
(But) We've learned a thing or two about survival
Intelligent communities
Have seen us through adversity
Eusociality: a high level of organisation in a society. A queen (or queens) leads an ant community (but she doesn't wear a crown) and lays thousands of eggs to ensure some of her offspring survive, while worker ants find dinner and babysit the young.
Ant Video
http://animals.nationalgeographic.com.au /animals/bugs/ant/
A fossil discove
lived about 90
before dinosa
Where would w
that exan
http://www.nyti
29/us/fossil-sh

Final Prototype



Appendix K – Schedule

Monday	Tuesday	Wednesday	Thursday	Friday
October 28	29	30	31	November 1
Develop Content	Get Internet Extract lyrics from Chris's database	Extract more lyrics from Chris's database Research the scientific information in the lyrics Reassess Goals and Objectives	10am: Revised Goals & Objectives Continue research on lyrics Begin developing blurbs and resources for the webpage	3pm: CSIRO/Advisors
November 4	5	6	7	8
Recreation Day	Melbourne Cup	Develop Content Second Pass (4 Songs) Pass 4 songs to Chris Lit Review 7pm: Team Meeting	10am: Reassessed Lit Second Pass (4 Songs) Pass 4 Songs to Chris Check Preliminary Questions with Chris	Have 4 Songs Online Confirm Prototyping times Begin editing Lit
11	12	13	14	15
Prototype Testing 3:30: Meeting Agenda	3:30: CSIRO/Advisors	10am: Final Lit Revise & Develop		Have first pass on the rest of songs done.
18	19	20	21	22
Revise & Develop Second pass (4 songs) Pass 4 to Chris 3:30: Meeting Agenda	3:30: CSIRO/Advisors Second Pass (3 songs) Pass 3 to Chris	10: Reassess Intro and Methods 7pm: team meeting	Prototype Testing	Edit webpages Add Images
25	26	27	28	29
Revise & Develop 3:30: Meeting Agenda	Meet with Carly/Chris: Final Survey Discussion 3:30: CSIRO/Advisors	10:Revised Intro and Methods Final Survey Question design proofed by Carly	All 16 lyrics on webpages	Prototype Testing (Cannot get into office)
December 2	3	4	5	6
Revise & Develop 3:30: Meeting Agenda	3:30: CSIRO/Advisors	10: Preliminary Findings, Conclusions, & Recommendations	Large Scale Testing	
9	10	11	12	13
Final Product & Presentation 3:30: Meeting Agenda	3:30: CSIRO/Advisors	10: Draft Abstract & Exec Summary 7pm: Meeting	10: Final Reports	
16	17	18		
Online Submission	Presentation Day	Leave Melbourne		