SCIENCE AT THE CROSSROADS

Enhancing students' interest in science through a community learning centre

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Banksia Gardens Community Centre

Science at the Crossroads:
Enhancing students' interest in science through a community learning centre

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ABSTRACT

Banksia Gardens Community Centre, located in Broadmeadows, Victoria, Australia, aims to increase science interest through the development of an informal science education program. By analysing surveys, interviews, and observations, our team concluded that students in Broadmeadows favour specific science topics as well as hands-on learning; however, they have little belief that they can pursue science themselves. To motivate these students to want to be scientists, our team developed a program framework tailored towards their current science interests.

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EXECUTIVE SUMMARY

Science plays a major role in society as scientific advancements have stimulated economic and technological changes through newfound knowledge. Despite major contributions made by science towards society, student interests towards science have declined globally over the past few decades. The number of individuals interested in pursuing a career within this field has also decreased.

Several organisations in Australia offer science education programs. Many of these organisations have ample funds, allowing their programs to only be accessible at a substantial cost. However, some populations are not as privileged and cannot afford these programs. In order to reverse this science interest decline, it is necessary for the other organisations to provide similar programs, at a much lower cost.

Banksia Gardens Community Centre, located in Broadmeadows, Victoria, Australia, is a neighbourhood house and is considered to be located in one of the most disadvantaged communities in the state of Victoria. This centre desires a science program tailored to the underprivileged youth in the Broadmeadows community. In order to address these issues, Banksia Gardens Community Centre has made great strides in strengthening its connection with the community through its many offered programs. The centre aims to broaden the local students' perspectives of science and enhance their interests in the field through the implementation of an informal science education program consisting of hands-on activities.

As Worcester Polytechnic Institute students performing our Interactive Qualifying Project (IQP), we partnered with Banksia Gardens Community Centre to develop the framework of an informal science education program directed towards increasing science interest in the local community of Broadmeadows. In order to achieve our final deliverable of a science education program framework, we outlined the following objectives for our seven-week stay in Australia:

- To research other comparable informal science education programs
- To gain an understanding of Banksia Gardens' organisation and community it serves

- To evaluate the students' science interest levels and preferred content areas as well as the preferred structure of educational programs in the Broadmeadows community
- To create and implement a science pilot program in order to further our understanding of the most favourable type of activities amongst the students as well as the structure of a program

By analysing other informal education programs, we gained a better idea about how to structure our own program. We examined various program areas such as content, format, budget, and available resources, as all those key components aided us in the development of a framework for a new program. In order to develop a program tailored to Banksia Gardens Community Centre and the community of Broadmeadows, we initially gained a better understanding about the centre's purpose and accomplishments, along with the demographics of the local community. We evaluated students' science interest levels by distributing surveys to local schools. The students' opinions gave us insight as to what type of activities should be incorporated into the framework of the program. During our seven-week stay in Australia, our team also coordinated and facilitated a one-day pilot program, called "Magic Science," as part of the Holiday Program at Banksia Gardens. The goal of this one-day science program was to expose young people to various aspects of science in attempts to heighten their interest in the subject. The strategy was to treat the day as a trial run to analyse the most favourable type of program.

Results and Analysis

Based on our research and analysis, we conclude the following:

- Students believe science is important for society, but they do not want to pursue a science career.
- Students prefer experiential learning as it is the most effective learning method for the young individuals of Broadmeadows.
- Students' most favourable content areas are: stars, galaxy, and the universe; the human body; and elements, compounds, and chemical reactions.

The young individuals of Broadmeadows have narrow views as to what types of careers and opportunities are available within science. Although many of the surveyed students displayed an interest towards the field, a majority of them declined the possible pursuit of a science career. We speculate that students are not interested in a science career due to the lack of exposure, education, and guidance.

Many individuals in this community lack a proper education, making it difficult for them to obtain a job. With a high unemployment rate, there is a limited number of people who inspire the students, which then causes a lack of exposure to the many opportunities available to them. Through analysing the student surveys, discussing teaching methods with program coordinators, and facilitating a pilot program, we propose that experiential learning is the most ideal learning method in exposing students to science.

To interest the students in science, we determined the most favourable science content areas, which are: stars, galaxy, and the universe; the human body; and elements, compounds, and chemical reactions. We incorporated these topics into our own program framework because we wanted to build off of existing interest as opposed to trying to create interest that does not currently exist.

Recommendations

Based on our findings, we recommend that Banksia Gardens Community Centre structure a science education program as follows:

- Divide the program structure into five different units (wow factors, competitions, workshops/labs, field trips, and career exploration) with each unit consisting of its own set of activities.
- Concentrate, but do not limit, the activity topics of the program to be related to stars, galaxy, and the universe; the human body; and elements, compounds, and chemical reactions.

We conclude experiential learning to be the most effective method to fully engage the students of Broadmeadows, and therefore, the first four units of the program structure (wow factors, competitions, workshops/labs, and field trips) encompass hands-on learning concepts. The wow factor unit represents short demonstrations that will quickly and easily grab the attention of the audience. Competitions encourage groups or individuals to develop the most ideal design depending on the nature of the competition. This type of activity motivates the students to strive to do their best. Workshops/labs include step-by-step activities to craft or build something. Lastly, field trips involve taking a group of students to local places for long scientific demonstrations or interactive displays.

The fifth unit, career exploration, is included in the program structure to broaden the students' perspectives of science careers. From our research, the students of Broadmeadows demonstrate an interest in science, but no interest in pursuing a science career. Broadmeadows is a disadvantaged community so the students' perceptions and expectations about science careers are limited. With the 90% unemployment rate in the community, many parents do not have jobs. Consequently, this makes the pursuit of a science career seem impossible to many students in this community. By establishing a career exploration unit, the program framework will expose the students to the wide variety of science opportunities that are available.

We also recommend that Banksia Gardens concentrate many of the program's activities around stars, galaxy, and the universe; the human body; and elements, compounds, and chemical reactions. According to the data from the local student surveys, these three science topics were the most popular. By incorporating more activities around these topics, students may be more engaged and interested in the future science program. Specific activity descriptions for each unit corresponding to these science content areas can be found in Appendix E.

In order to maintain the science program, we recommend Banksia Gardens Community Centre do the following:

- Expand upon the activities for the program by referencing the supplied list of general activities and external resource websites presented in Appendix E, and use the provided detailed activities as a guideline.
- Adapt and revise the executive summary of this report into a marketing package that can be presented to local businesses in Broadmeadows or to the Victorian government.

Due to time constraints, our group was only able to provide a total of twelve detailed activity descriptions for the program structure, but we encourage Banksia Gardens to expand upon the activity list based on the appendix we provided. Along with expanding the program structure, we encourage Banksia Gardens Community Centre to convert the executive summary of this report into marketing package to be presented to local businesses in Broadmeadows and the Victorian government.

1.0 INTRODUCTION

Science provides the foundation for increasing economic growth, improving living standards, and modernizing infrastructure around the world. However, despite the advances within science, student interest in these fields has declined over the years. The international organisation Relevance of Science Education (ROSE) surveyed students from over 40 different countries concerning their attitudes towards science. According to ROSE's research, children around the world perceive science as an important subject for society (Schreiner & Sjoberg, 2005). Despite their positive attitudes, more than half of children displayed little to no interest in pursuing science-related careers. Other studies have also revealed similar trends. The students of the United Kingdom indicated little interest in science education (Jenkins & Nelson, 2005), and the United States of America (USA) reported that only 8% of all USA college-level degrees were in the fields of engineering, mathematics, or physical sciences (Jones, 2008). Despite the benefits that these fields have to offer, science interest has decreased on an international scale, both educationally and professionally.

On a more local scale, Australia is also impacted by this decline. A comparison of Australian students enrolling in university for science, as opposed to other majors, was conducted from 1989 to 2002. Results of this study state that science enrolees never surpassed 75,000 in this time span. In contrast, enrolees in all other university courses rose from approximately 400,000 to 750,000 (Dobson, 2006). A study by Marshall Gough and colleagues (1998) conducted in Victoria found that 35.9% of teachers agree with secondary students statements saying that science is interesting to them. The most glaring statistic is that only 3.8% of these secondary students have an out-of-school interest in science and only 15.2% think a career in science is worth pursuing (Tytler, 2007). There is clearly a need to increase science enthusiasm due to the large demand for science professionals in an ever-changing scientific and technological world.

In order to enhance science interest, many organisations in Australia offer a wide variety of supplementary science education programs. The Commonwealth Scientific and Industrial Research Organisation (CSIRO) provides interactive exhibits and hands-on activities that encourage people to pursue science (CSIRO, 2012). Another location providing science-related programs is Scienceworks. Its resources incorporate a variety of science fields including astronomy, chemistry, physics, and earth sciences (Museum Victoria, 2012). CSIRO and Scienceworks have supporting organisations, ample funds, and materials; as a result, their programs are only accessible at a substantial cost. On the contrary, small-scale educational programs are designed to be easily accessible due to their lower costs, but they are likely to encounter challenges such as a lack of funds and participants. In order to increase the level of science interest amongst underprivileged communities, it is necessary to provide affordable programs that are available to people from diverse economic backgrounds. These programs could allow for more attendance and participation in activities, which may spark students' interest and inspire them to pursue science (Fedler, 1988).

Banksia Gardens Community Centre, a local neighbourhood house located in Broadmeadows, Victoria, Australia, is attempting to reverse this declining interest in science by reaching out to the surrounding disadvantaged and diverse demographic. Ideally, Banksia Gardens would like to implement an informal after-school and community-based science education program. Currently, there is no program of this nature available to the students of the Broadmeadows community. Our program is designed to engage local students in an informal manner through hands-on activities, as opposed to lessons learned in the classroom.

The goal of this project was to design an educational program geared towards enhancing students' interest in science for Banksia Gardens Community Centre. Our IQP group observed day-to-day operations of Banksia Gardens in order to understand the organisation. We also researched comparable informal education programs which aided us in constructing our program framework. In addition, we identified available resources that Banksia Gardens can use in the program. Taking community interest levels into consideration, we determined various optimal structures for the program. Through the establishment and implementation of this project, we provided materials and activities for the framework of a new science education program at Banksia Gardens Community Centre.

2.0 BACKGROUND

2.1 Interest in Science

Science plays a major role in society as scientific advancements have stimulated economic and technological changes through newfound knowledge. Surveys reveal that 84% of the public agrees that science is improving society and the lives of individuals (Quantum Market Research, 2007). Despite these positive opinions regarding science, there is an evident decline of interest in this field.

2.1.1 International Decline

On an international scale, the decline of science interest is evident in several countries. The main purpose of an organisation referred to as Relevance of Science Education (ROSE) is to study and compare the learning levels and contributing interest factors towards science in about 40 countries. ROSE surveys secondary school-aged children from various countries and asks them to rate given statements on a scale of 1 (disagree) to 4 (agree) (Schreiner & Sjoberg, 2005). One of the many statements included in the survey read, "I would like to be a scientist" and the data collected from this particular statement can be seen in Figure 1. Although the data shows a positive response towards science in countries like Uganda and Ghana, the children in 15 other countries displays little interest in the field of science and related careers. There is an evident trend of lower interest among the more developed countries. The data also displays a noticeable difference between male and female responses. The females from every country represented, excluding Uganda, have a more negative response towards science than males.

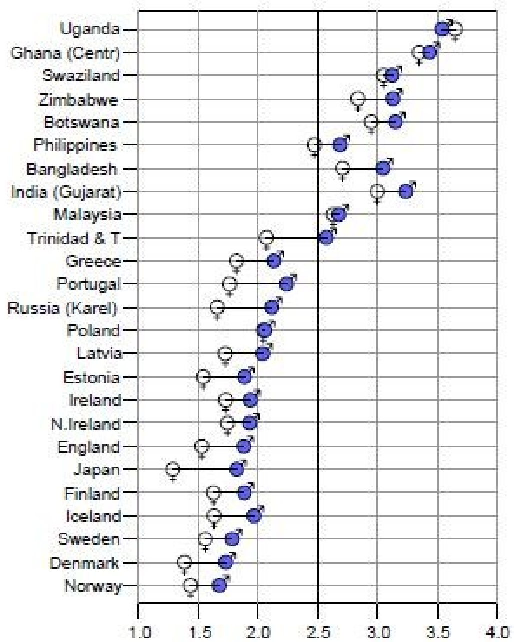


Figure 1. A graph displaying international children survey responses (1-disagree, 4-agree) to the statement "I would like to be a scientist." Image used with the permission of Asia Pacific Forum on Science Learning and Teaching. (Source: Schreiner & Sjoberg, 2005, pg. 12, Figure 4)

2.1.2. Australian Decline

In recent decades, the people of Australia have displayed a decrease of interest towards science. Decreasing percentages are evident in the number of students entering university with science-related majors, along with those participating in additional science-related courses (Tytler, 2007). During the 2006 Australian Council for Educational Research (ACER) conference, Geoff Masters summarised statistics concerning the percentage of Year 12 Australian students that had majors in the fields of science (Masters, 2006). The percentage differences between the years of 1978 and 2002 are summarised in Table 1.

Table 1. Percentage of Year 12 students who went on to major in select science fields (Source: Masters, 2006).

Year 12 Students	Biology	Chemistry	Physics
1978	55%	30%	27%
2002	20%	15%	12%

2.2 Australian Curriculum

According to the Australian Government, one contributing cause to the science interest decline can be traced back to the primary and secondary education (Dobson, 2006). In order to better understand this decline, one must examine the Australian National Curriculum as school education is structured around this standard. The Australian National Curriculum is the basis of which all schools in Australia derive their science curriculums and programs. The parts of this curriculum that pertain to our development of a science program framework are: the main goals of the curriculum; the topic layout; the breadth and depth of the content; and pedagogy and assessment. The learning principles of the Australian National Curriculum are essential guides towards the development of our informal science education program. Throughout this section we will address the limitations within the National Science Curriculum of Australia and how we can structure our program to account for and overcome these limitations.

2.2.1 Main Goals

According to the science section of the Australian National Curriculum, all of the science education programs in Australia must be organised around three main principles: science understanding, science inquiry skills, and science as a human endeavour (National Curriculum Board, 2009).

Science understanding can be observed when a student is able to apply their scientific intellect to describe and forecast events and use this knowledge to predict new phenomena. The curriculum states, “Science knowledge refers to facts, concepts, principles, laws, theories and models that have been established by scientists over time” (National Curriculum Board, 2009). Students and citizens should understand that science is an ever-evolving field, as well as desire to update their scientific knowledge.

Science inquiry skills are based on “posing questions, planning, conducting and critiquing investigations, collecting, analysing and interpreting evidence and communicating findings” (National Curriculum Board, 2009). The goal of science inquiry is that students will be able to assess research and hypothesise realistic conclusions. Students should also realise that scientific information varies as scientific discoveries are constantly being made.

Science, as a human endeavour, shows students its effects on the community through replying to public and moral issues. This principle of science is centred on the necessity for knowledgeable, factual-based decision making regarding present and future applications of science. Science, as a human endeavour, also recognises that in making decisions around scientific practices, ethical and social consequences must always be considered. The Australian National Curriculum acknowledges that science is a progressive field, which has been moving forward through the wealth of contributions by different people from a variety of cultures throughout history. The field of science is always open to new additions of research knowledge, and the field offers multitudes of fulfilling careers (National Curriculum Board, 2009).

2.2.2 Layout of Principles for Years 7 through 10

Figure 2 displays the three principles of the science section of the curriculum. Students between the ages of 12 and 15 are required to learn the age-specific topics that implement the science understanding principle. The students must also gain science inquiry skills and be able to apply this understanding to real-world applications and societal issues.

Science understanding	*Physics and chemistry* • nature of matter, including particle theory • forms of energy, energy transfer and storage • forces and motion • acids and bases • metals and non-metals • elements, compounds and chemical reactions. *Biology* • cells and living things • the human body • ecosystems • theory of evolution and the diversity of living things. *Earth science* • structure of the earth and geological history • plate tectonics and geological phenomena • stars, galaxies and the universe.
Science inquiry skills	• formulate scientific questions or hypotheses for testing • design and conduct science investigations involving measurement and repeated trials • gather and organise data from a variety of sources • analyse and test models and theories based on the evidence available • explain and summarise patterns in data using science concepts.
Science as a human endeavour	• be aware of contemporary issues such as water and its management, climate change, stem cell research, nanotechnology, gene technology • apply scientific understandings to make responsible, ethical and informed decisions about issues • be aware of the nature of science and research of Australian scientists • appreciate that science provides rewarding careers • appreciate the diversity of people who have contributed to, and shaped the development of, science.

Figure 2. Science section of the Australian National Curriculum outline for years 7 through 10 (Source: National Curriculum Board, 2009).

2.2.3 Breadth and Depth of Content

The Australian National Curriculum attempts to be thorough in breadth and depth in terms of what the students should learn and know. Students may not recognise the relevance of science topics to their lives, as educators can only describe the foundations of the topics due to the wide variety included in the curriculum. During lessons, teachers should pinpoint important concepts and increase the students' knowledge and abilities in these particular areas, as opposed to having the students memorise an enormous amount of material. Teachers should also recognise how much of their classroom time is allotted towards science and decide a suitable variety of important basic skills and concepts to teach. Teachers could reorganise their curriculums to encompass scientific principles in a way that incorporates the expanding body of knowledge.

Educators must take into account the expectations of the academic rigor of the curriculum; they should try not to overload the curriculum with excessive knowledge. The Australian National Curriculum realises the necessity of engaging the students in learning science; however, the curriculum does not place a large emphasis on this. Supplementary science education programs can compensate for this limitation by assuring that the programs focus on captivating the students' attention. The structure of the programs should allot time for educators to help students who require extra assistance in learning and understanding specific concepts.

The framework of a successful science education program will overcome the challenges faced by the Australian National Curriculum. In a classroom environment, teachers find it difficult to engage the students in science while teaching them what they are required to know. The strength of community programs, like the one we hope to design, is that they focus on increasing the local students' personal interest with the subject. The students can learn the skills and concepts in the classroom; meanwhile, they can apply this knowledge to real-world applications and further engage their school studies by attending a program of this nature.

2.2.4 Pedagogy and Assessment: Some Broad Assumptions

Curriculums developed by teachers are structured around the alignment of pedagogy (the method and practice of teaching), content, and assessment. These curriculums not only encompass the necessary principles put forth by the Australian National Curriculum, but each of these is followed up with a demanding, yet flexible program (National Curriculum Board, 2009).

These demanding curriculums can potentially be intimidating to students, which can deter them from pursuing science.

In order to fulfil the intentions of the Australian National Science Curriculum, there must be a decreased level of transmission pedagogy and an increased level of student involvement and inquiry. The transmission model is based on teacher explanation, as opposed to the inquiry-based model which is based around the teacher posing questions to students and the students having a discussion about the questions. Teacher explanation is still pertinent to every curriculum; however, this explanation should be balanced with all other types of teaching.

The curriculum also points to the importance of explanation, exploration, and application. In such a curriculum, students should be encouraged to be enthusiastically involved in their lessons. Background knowledge may differ based on the students, location, or school, but this knowledge is necessary in order for students to connect the ideas they learn in the classroom to real-world applications. Once this point of relevance has been set, the teacher should offer the students science activities so that they can experience the concepts in a hands-on fashion (National Curriculum Board, 2009).

Science inquiry is the most efficient way for students to effectively learn science. One of the most important aspects of science inquiry is the students' ability to pose and investigate scientific research questions. Therefore, just as the National Curriculum states, a successful program allows students the opportunity to ask questions and to develop and implement their own experiments (National Curriculum Board, 2009).

The Australian National Curriculum Board emphasises the importance of a simple and accurate view of the assessment process. This process is "referred to as 'backward design', in which one works through three stages — from curriculum intent, to assessment expectations, to finally planning learning experiences and instruction" (National Curriculum Board, 2009). The main focus of the assessment is to provide an overall better educational experience for the students by evaluating what the students learn, comprehend, and express. Teachers assess their curriculums by distributing tests and exams to students as these assessments are vital tools for any program.

Supplementary education programs have the ability to enhance students' interest by expanding upon and utilising the solid principles of the Australian National Curriculum.

Neighbourhood houses, such as Banksia Gardens Community Centre, are designed with the flexibility to implement these principles within their after-school programs.

2.3 Banksia Gardens Community Centre

Banksia Gardens Community Centre is a neighbourhood house located in the suburbs of Broadmeadows, Victoria, Australia. Banksia Gardens was built in 1981 and over the years, the centre transformed into a publicly accessible building and now offers 48 different programs, many of which encompass principles of informal education. Some of these programs include sewing, jewellery making, playgroups, and Turkish dancing. The Study Group, the largest study program in Hume and one of the largest in Melbourne, offers one-on-one tutoring in any school subject (Banksia Gardens Community Centre, 2012).

Through these programs, Banksia Gardens' main goal is to serve the needs of the culturally and linguistically diverse (CALD) community. Broadmeadows consists of many people whose ethnicities include Turkish, Syrian, and Arabic, and it is common that English is their second language. A large majority of this population are disengaged youth, newly arrived immigrants, and refugees. Unfortunately, Broadmeadows has an extremely low rate of education and employment, and is deemed one of the most disadvantaged communities in the state of Victoria. Banksia Gardens aims to strengthen its connection with the community by increasing the number of programs it offers (Dougall, 2012). In order to fully engage its participants, the centre seeks to utilise the best practices of informal education.

2.4 Types of Education

Education consists of two types of learning: informal and formal. Examples of informal and formal education are after-school programs and the Australian National Curriculum, respectively. Informal learning predominantly takes place outside the classroom, but the location is not the determining factor which differentiates informal education from other types of education. Students in an informal education setting typically learn in places that are part of their day-to-day routine such as at a park, at home, or at a local community centre. Unlike formal education, informal education does not necessarily require a mediator to control what the student should learn and how the learning process should be carried out. Informal education involves hands-on activities, whereas formal education consists of a strict lecture and textbook setup. Through hands-on learning, students become more involved, and this active involvement positively contributes to their newfound knowledge (Eschach, 2007).

On the contrary, formal education is characterised by a structured educational system which includes institutionalised environments, graded coursework, standardised tests, and rigid curriculums. This type of education incorporates a tiered structure, required attendance, admission prerequisites, uniform curriculum, and degrees (Belle, 1982).

2.4.1 Benefits of Informal Education

Gerber and colleagues (2001) define informal learning as "the sum of activities that compromise the time individuals are not in the formal classroom in the presence of a teacher." Informal learning can benefit people throughout their lifetimes and also has the advantage of occurring all the time, all around (Eshach, 2007). A major benefit to informal learning is that it can supplement and enhance formal, or structured, learning by encouraging students to cooperate with one another, ask questions, make observations, and attempt to explain those observations (Satterthwait, 2010). Informal education allows students to be involved and observe natural phenomena while asking questions and reaching their own conclusions. Sometimes, in informal learning settings, students are so entertained and involved that they do not even realise they are learning (Wellington, 1990). A study done by students at Worcester Polytechnic Institute shows that most teachers claim hands-on material is very effective in getting students excited and interested in science. In fact, 33% of teachers rate hands-on learning the highest of all choices on the survey (Snieckus et. al., 2011). Jeffs and Smith (1999) say, "By becoming part of the familiar and everyday, educators can embed relationships, values and ways of being with each other, that foster understanding, democracy and learning. That is the promise of informal education." Informal learning has the ability to provide additional materials and assets that a standard curriculum cannot provide (Snieckus et. al., 2011).

Hands-on exploration and discovery within education have been in existence for more than 200 years (Satterthwait, 2010). Hands-on exploration allows students to gain a better understanding of the world as opposed to concepts taught in a classroom. At the very least, hands-on activities can expose students, who are not necessarily interested in science, to lessons they would not ordinarily encounter. These activities also provide them with knowledge that can be applied in all aspects of their lives (Wellington, 1990). Satterthwait (2010) states, "The experiential value of hands-on activities in science education has long been recognised as significant in engaging students."

2.4.2 Various Divisions of Informal Education

Informal education programs offer opportunities to expand the participants' knowledge of themselves and of the world, as these programs communicate knowledge to individuals in an effective manner. An important component of informal education is experiential learning which is complex as it consists of multiple divisions. These divisions, specifically project-based and inquiry-based learning, can be incorporated into informal education programs similar to the one which will be implemented at Banksia Gardens.

In project-based learning, students tend to retain information for a substantial period of time by conducting a project which allows them to relate school subjects to real-world problems. When students are given a set of instructions to complete a task in a specific way, they often do not like performing the task. However, when they are asked to solve a more cognitively complex task, such as a real-world problem, there is decreased hesitation (Blumenfeld et, al., 1991). For each project, the students must determine the problem, objectives, methodology, and solutions. Research, hard-work, and trial and error are some of the many factors which expedite the process of achieving the final solution. Upon completion of the project, students gain valuable lessons which can assist in future aspects of education (Fedler & Prince, 2007).

Another division of experiential learning is inquiry-based learning, which is an essential component of learning science. By nature, many students feel the need to expand their knowledge outside the classroom. The process of inquiry-based learning involves "[finding] solutions to real problems by asking and refining questions, designing and conducting investigations, gathering and analysing information and data, making interpretations, drawing conclusions, and reporting findings" (Krajcik et. al., 1998). Some people find inquiry-based learning to be effective; without ever having been taught the background of a subject, a person is given a task to complete in which they must discover a solution alone. This suggests that the learner educates himself or herself (Fedler & Prince, 2007). Through research, trial and error, and experimentation, the learner develops exceptional problem solving techniques. Educating oneself leads to deeper critical thinking skills that are useful in all areas of life.

Various programs implement project-based and inquiry-based learning, including specific ones in the USA. These programs further the advancement of informal education, in hopes of encouraging the students' interest in science to soar. Communication, Science, Technology, Engineering and Math (CSTEM) and Operation Science, Math and Relevant Technology (SMART®) implement the project-based and inquiry-based learning approaches by encouraging experimentation and group collaboration (Afterschool Alliance, 2011). These programs broaden students' horizons as to all the opportunities that science-related careers can offer. The interactive learning approach applies to these programs as students who participate in experiments gain confidence through their ability to retain and utilise information.

An old proverb states, "Tell me, and I forget; Show me, and I remember; Involve me, and I understand" (Finelli et. al., 2001). As seen in Figure 3, people are apt to remember 90% of what both they say and do. This is large in comparison to people remembering only 10% of what they read and 20% of what they hear.

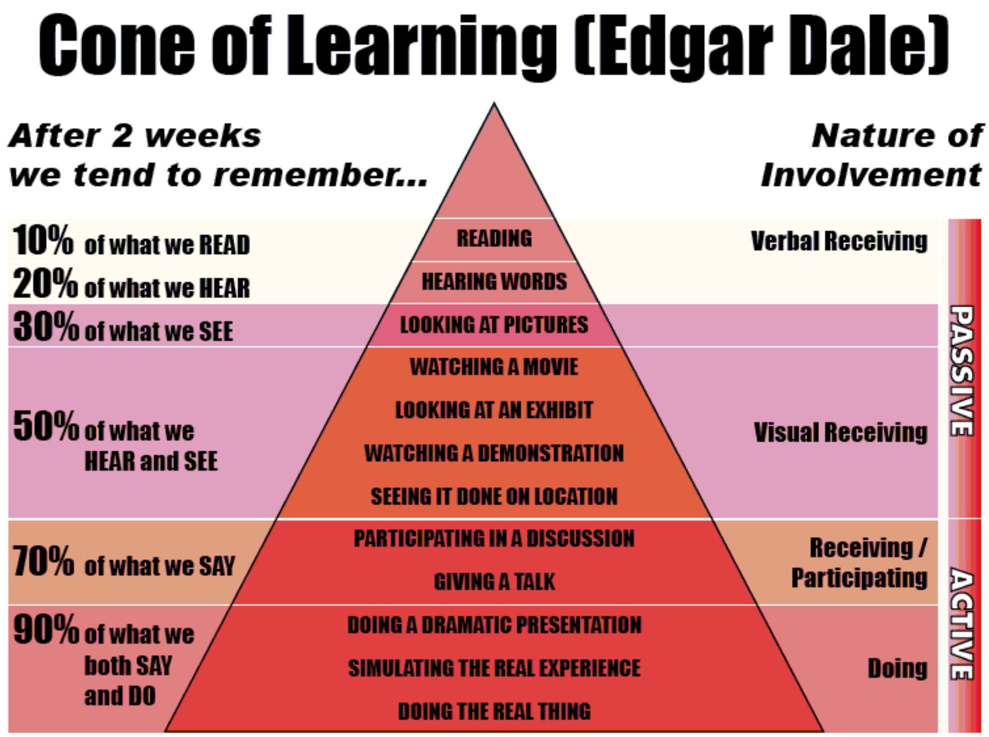


Figure 3. Edgar Dale's Cone of Learning (Source: Dale, 1954)

Through project-based and inquiry-based learning, students can participate in what they are taught, rather than contemplate the meaning of a real-world application. With the addition of more after-school programs aimed toward improving the science knowledge of students, informal education will continue to prosper and ultimately affect the career choice of students.

2.5 Summary

Society emphasises the importance of science; despite these claims, there continues to be a decline of interest within this field. Due to the strict limitations of the Australian National Curriculum, students are not able to fully explore the field of science. In order to enhance science interests amongst students, our IQP group aims to implement experiential learning in a new educational program which will be utilised by Banksia Gardens Community Centre.

3.0 METHODOLOGY

The essential goal of this project is to engage student interest in science at Banksia Gardens Community Centre as well as in the surrounding community. Our team developed a plan for establishing a science education program framework for Banksia Gardens.

We worked on this project from 13 March 2012 through 1 May 2012. We conducted research concerning similar science programs, Banksia Gardens, and local schools. In addition, we needed to test and evaluate the effectiveness of different learning methods and activities through a program trial run. We achieved this through the facilitation of a pilot program during Banksia Gardens' Holiday Program. The day, which was dedicated towards science, was referred to as "Magic Science" and was held on 3 April 2012 from 10 a.m. to 3 p.m. We used this program as a test run for our science education program framework which we hope will be utilised at Banksia Gardens Community Centre. We believe our project will benefit the centre and the local community by encouraging future generations to pursue scientific endeavours.

Our team developed the framework of a science education program through the objectives listed below:

- To research other comparable informal science education programs
- To gain an understanding of Banksia Gardens' organisation and community it serves
- To evaluate the students' science interest levels and preferred content areas as well as the preferred structure of educational programs in the Broadmeadows community
- To create and implement a science pilot program in order to further our understanding of the most favourable type of activities amongst the students as well as the structure of a program

We worked in Melbourne, Australia for seven weeks and designed a Gantt Chart, which displays our timeline of this project, as seen in Table 2.

Table 2. Gantt Chart of Project

TASK	WEEK							
	prep	1	2	3	4	5	6	7
Researched other comparable informal education programs								
Investigate Banksia Gardens organisation and community								
Evaluated science interest and preferred content								
Designed and implemented the pilot program								
Designed the overall program								

The main focus and final deliverable of our project was to design the framework of a high-quality science education program, which was tailored to Banksia Gardens. The program framework includes activities and resources as well as potential methods of funding. Now that the general framework is constructed for the program, we envision that it will be adapted such that the structure will remain the same while the content areas can be interchanged to fit the needs of the centre. Ultimately, our project has the ability to be integrated into holiday programs and after-school programs at Banksia Gardens, as well as in classrooms of local schools.

3.1 Researching Comparable Informal Education Programs

In order to develop a science education program framework for Banksia Gardens Community Centre, we needed to properly understand and analyse similar existing programs. By analysing other implemented science programs, we gained a better understanding of how to structure our own framework. Many science education programs exist around the world including the Science, Technology, Engineering, and Mathematics (STEM) related programs in the USA and Commonwealth Scientific and Industrial Research Organisation (CSIRO) programs in Australia. These programs are targeted to raise science awareness and engagement. We examined different program areas such as content, format, pace, budget, and available resources as all those key components aid in the development of a new program framework. We then utilised the obtained information to design the foundation of a science education program.

We researched other informal education programs through on-site visits and interviews. We interviewed the staff at Banksia Gardens regarding programs they were either in charge of or partook in. Although the programs run by the staff are not science-related, we still asked them how they interact with students of various ages and backgrounds. The staff members communicate with individuals of the Broadmeadows community on a daily basis so we wanted their insight on how to engage these individuals in the community centre's programs. The interview questions we asked concerned the types of activities that are implemented in the interviewee's program, the structures and formats they utilise, the maintainability of students' interest, and the assessment of the program's success. We may have obtained valuable information regarding programs in general, but we kept in mind that the interviewee's statements concerned programs without any science-related components. Nonetheless, their insight and advice provided us with valuable information on how to structure the framework of a newly developed science education program for Banksia Gardens.

The Banksia Gardens staff was not the only group we questioned as we wanted to obtain data concerning the program structure of other science-specific informal education programs. We interviewed a program coordinator at CSIRO, a science research agency, as well as explored programs offered at a branch of the Melbourne Museum named Scienceworks. Both organisations offer science-related education programs based on the informal learning approach. We chose to research both CSIRO and Scienceworks as they have vast knowledge and experience with a diverse range of students. We took this knowledge into account while we were developing the program framework for the diverse community of Broadmeadows.

During our interview at CSIRO, we asked the Victorian Manager of Education how the organisation engages students with diverse backgrounds, similar to the diversity of the Banksia Gardens community. We also inquired about how CSIRO budgets its programs in accordance to what the students and schools can afford because the community we are working with is extremely disadvantaged, especially in terms of income. We also gained useful information about how other informal science education programs are structured. Many of the same questions were asked during this organisation interview as with the Banksia Gardens staff interviews. We asked additional questions concerning the type of students who participate in the programs and the specific content areas that are covered in the programs. By asking these questions, we gained more insight as to the science topics that are popular with different age ranges and took this information into consideration while designing the framework of our science program. CSIRO provided us with knowledge about their programs and participants, but we kept in mind that this organisation serves communities that are dissimilar to Broadmeadows. The difference between CSIRO and Banksia Gardens was a matter of concern as CSIRO has access to more funding and resources and is more publicly advertised than Banksia Gardens Community Centre.

The information gathered during the research of these organisations had a great impact on our program framework. We took this data into consideration in order to tailor the costs and content areas to the disadvantaged community of Broadmeadows. Nonetheless, we gathered data concerning the basic elements and foundations of science education programs.

3.2 Understanding Banksia Gardens and the Surrounding Community

In order to develop a program tailored to the Broadmeadows community, it was imperative that we understood the organisation of Banksia Gardens Community Centre. Upon our initial arrival, the Community Development Coordinator, Jaime de Loma-Osorio Ricon, gave us a tour of the community centre, providing detailed information about the community. To initially immerse us in the centre, Banksia Gardens included us in Turkish Lunches that were held every Friday. The lunches were designed in a way that everyone would gather and pray, then enjoy a meal provided by the Turkish ladies. Despite the appearance that this was a causal social hour, this contact allowed us to converse and interact with various ethnicities of the Broadmeadows community.

Through interviews and day-to-day interactions with the Banksia Gardens staff, we assessed the need of a science education program within the Broadmeadows community. With each interviewee, we asked a general set of questions in order to obtain multiple perspectives and gain an overall understanding of this community. These questions concerned the demographic of Broadmeadows, science interest and education, and structure of programs currently offered at Banksia Gardens. To better comprehend the centre, we asked specific questions related to the role of each interviewee.

We chose to interview the Centre Manager and the Community Development Coordinator as they have a wide range of knowledge about the community itself and the programs which are offered at Banksia Gardens. In order to provide relevant activities within our program, we asked questions directly related to the science content interest of students. We also had the interviewees describe previous programs in order to obtain an overview of a successfully run program. We interviewed the Community Connections Manager in order to learn more about the Banksia Gardens housing estate, which is located in close proximity to the centre. From this interview, we determined how to structure the program to accommodate the needs of the community. We inquired about statistics of the housing estate which helped us expand our thinking process while designing our program framework. With all of the information obtained from the interviews, we were well-guided in tailoring our program to fit the needs of the Broadmeadows community. We found that immersing ourselves within the community was equally important in gaining in-depth knowledge about the individuals of Broadmeadows.

In order to further understand the community, we made observations and volunteered as tutors at Banksia Gardens. We immersed ourselves and observed the community through participation. However, before immersing ourselves, it was beneficial to externally observe the community by simply noting the students' behaviour, without interfering with the flow of the programs. By observing the operation of the Banksia Gardens Study Group program from afar, we noticed the interactions amongst the students themselves, along with those between students and tutors. As tutors, we interacted with the students and assisted them with their homework which aided us in recognising the lack of motivation present among these students. We spoke with some of the same students on a weekly basis, which allowed us to gain insight into their lives apart from school. Without directly interacting with the students, we would have been making assumptions based on second-hand information.

Although we did not have the ability to fully assimilate with the community, we were still able to gather valuable information through conducting interviews, making observations, and immersing ourselves in the community centre. Despite a shortage of time, we were able to speak with many members of the community and understand their lifestyles. We obtained information from various programs which contributed to the development of our own program framework. A combined effort of these numerous methods helped us design a comprehensive program in which the perspectives of the students, community, and tutors were all considered.

3.3 Evaluating Community Interest Levels

One of the main goals of our project was to assess local science interest levels and opinions of students in the Broadmeadows community. In the background section, we previously identified a decline of science interest levels throughout the world and specifically in Australia. Therefore, we decided to evaluate whether or not this trend also holds true within the surrounding community of Banksia Gardens. We believe this evaluation was necessary because this area is less privileged than most Melbourne suburbs. Many of the inhabitants of Broadmeadows originate from extremely disadvantaged families—such as those with unemployed parents, single parents, and non-English speaking parents. Due to the demographics of Broadmeadows being drastically different than that of the national demographic, it was crucial that we collected our own data regarding the preferences of the students in this particular locale. Through this objective, we desired to gain a better understanding as to which types of science content areas students like and dislike, which would confirm our suspicion that informal education would work best in this community. We accomplished this goal through general student surveys which aided us in determining the community interest levels.

For these general student surveys, we developed a range of different types of questions which measured the students' views on various aspects of science. We created ranking statements in which students ranked science relative to other school subjects. From this information, we wanted to gather data regarding how the students feel about science in comparison to all other school subjects. We also designed "check box" options which requested that the students check off five content areas within science that interest them the most. Examples of these options include: forces and motion; cells and living things; and acids and bases. Our reasoning behind this survey question was to gain a better understanding of which topics within science interest the students the most. Based on our assessment of their interests, we designed a program framework incorporating the most popular science topics. We wanted to incorporate the students' current topics of interest in order to engage them in science, as opposed to attracting them with topics they are not interested in. We also had another "check box" option to find out how they prefer learning science. This specific question gave the students the ability to choose as many or as few choices as they wanted from the options of: textbooks; in-class activities/experiments; field trips; videos; websites; lessons; homework, worksheets, and tests;

and other. The results of this question were used in structuring the program around the most popular methods of learning science. Based on the students' responses, we provided the most popular types of activities within our program framework. In addition, this question was used to validate our research in regards to students preferring informal learning methods.

We also included "feeling statements" which asked the students to read a statement and choose whether they strongly agree, agree, disagree, or strongly disagree with it. As an example, one of the statements read, "Science lessons and experiments are fascinating and fun." Through this question, we hoped to measure students' opinions and attitudes towards science as a school subject and as a career field. We wanted to determine whether the international and national declines of science interest, as stated in the ROSE study and ACER conference, were evident within this community (Schreiner & Sjoberg, 2005; Masters, 2006). The last question on the survey was an open-ended question that requested the students illustrate what they thought a scientist looks like. This question was used to observe the students' perceptions of a scientist. Based on these drawings, we tailored our program to show the students that anyone in society can pursue a career in science. We used the combination of these types of questions in order to gain a broad and holistic view of these students' attitudes and feelings towards science.

The survey's main audience consisted of 10 to 17 year old students who attend local schools in the community. We focused on determining their interest levels in science, what areas of science interest them the most, and what type of programs they would be most interested in attending. An example of the secondary student survey can be found in Appendix A.

Surveys are an ideal method of assessing opinions and attitudes of a sample population; therefore, they we used surveys to determine the science interest levels of students in the Broadmeadows community. Since surveys are an effective way of assessing these community interest levels, we will be able to interpret any trends in the responses which will aid us in the creation of our science education program framework. However, it is impossible to meet the needs and wants of everyone in the community. Ultimately, our goal was to accommodate the majority of the community in terms of program content, structure, and informal education format.

3.4 Designing and Implementing a Science Pilot Program

During Australia's two-week school holiday, Banksia Gardens hosted a holiday program consisting of various themed days. On 3 April 2012, we coordinated and facilitated one of these days, titled "Magic Science." The day started at 10 a.m. and proceeded until 3 p.m. with a one hour lunch break from 12 p.m. to 1 p.m. The goal of this one-day science program was to expose young people to various aspects of science in attempts to heighten their interest in the subject. The strategy was to use the pilot program as a trial run to analyse the most favourable type of activity, whether it be an engineering design problem, a lab experiment, or a data collection and analysis activity. The implementation of the pilot program allowed us to observe first-hand if our background research regarding experiential learning held true within the Banksia Gardens community. Based on these observations, we were able to draw valuable conclusions from the pilot program. The pilot program supplied us with a strong basis that served as a model in constructing the final structure of our program framework, which was tailored to fit the young audience of Banksia Gardens.

We began the day with a pre-survey to evaluate the students' science interest levels and motivations for attending the program. The day was set up with four different science activities in order to give a general idea of the different concepts of the scientific method: the phonebook friction demonstration to highlight the topic of friction and how it applies to everyday life, the egg drop experiment to illustrate the iterative design process of science, the bouncy ball experiment to show the experimental process, and finally, the physical traits activity to demonstrate data collection and analysis as well as interpreting trends. For a more detailed description of materials, preparation, processes, key terms, and takeaways of each activity for the holiday program, see Appendix C. At the end of the day, we distributed a post-survey to determine the students' favourite part of the program and to find out if their opinions on science changed after the activities were completed.

The drawback of this program, like any program with various components, is some activity types (i.e., engineering design problems, lab experiments, etc.) will vary in popularity. We were able to analyse the popularity of each activity by making observations regarding the students' reactions and feedback. The popularity levels of different activities were taken into account while developing our science education program framework.

4.0 RESULTS AND ANALYSIS

Based on our interviews, surveys, and observations, the following section encompasses all of our findings. We conclude that the students at Banksia Gardens are interested in science, but they cannot imagine themselves as scientists. We used experiential learning, the preferred learning method amongst students, to improve their perceptions of science. In order to enhance their interest in a science-related field, we determined their three most favourable content areas. With the information gained from these findings, we developed the framework for an informal science education program. Further details supporting our evidence of these three findings can be found in Appendix A.

4.1 The Disconnect between Science Interest and the Pursuit of a Career

We conclude that students believe science is important for society, but they do not want to pursue a science career.

4.1.1 Influence of Broadmeadows

In order to tailor a program for Banksia Gardens Community Centre, we needed to understand the surrounding community. We ascertained that Broadmeadows is one of the most disadvantaged and diverse communities in the Melbourne area. Through Banksia Gardens' Community Connections Project, an 18 month progress report, we obtained valuable statistics concerning the Banksia Gardens housing estate. These statistics provide substantial support as to why students are interested in science, but do not choose to pursue it.

Currently, there are 378 people that reside in the Banksia Gardens housing estate with 78% of the families governed by single parents, predominantly mothers. According to the Australian Bureau of Statistics, it has been suggested that single parent households are at higher risks of unemployment, low economic status, poor education, and lack of social participation (2007). Single mother households are more vulnerable in being subjected to these types of risks. Evidence shows that there is a large number of single-parent households within this estate, which leads to a high population of unguided juveniles. In fact, 57% of the people are under the age of 25. Children often follow the examples set forth by a family member or close friend. We speculate that these children may not have anyone who is of inspiration to them, making it likely for these children to follow the surrounding community that they are immersed in, which could misguide their future. Children typically base their career aspirations around other jobs they have seen. In Broadmeadows, the number of experienced scientists and engineers is limited; therefore, we hypothesise that these children may not have any exposure to the wide range of science-related careers that exist. Due to their limited exposure, the children might be unaware of the various science-related opportunities that await them.

Many people living in Banksia Gardens housing estate are from culturally and linguistically diverse backgrounds, with 45.5% of these people being born overseas in non-English speaking countries. These diverse backgrounds include, but are not limited to, people from the Middle East, Europe, and South America. With this diverse population, it is a commonality that English is their second language. Approximately 30% to 40% of the population are unable to read financial statements and official documents. All of these statistics conclusively demonstrate an extensive language barrier which inhibits the educational advancement of these students. This language barrier makes it difficult to guide the housing estate residents to a bright, hopeful future.

Through tutoring at the Study Group program, we were able to understand the significance of the statistics emphasised to us. For example, when some of the students asked us questions, we were able to understand exactly how strong the language barrier is. This barrier makes communication difficult for those who need assistance, which may discourage students to be involved with such a complex subject, such as science.

One day in particular, we learned the seriousness of how disadvantaged the community is. We were working in a classroom at Banksia Gardens when a young man walked in and introduced himself. He interrogated us about who we are and our purpose for being there. After we explained our project to him, he replied, “What are you doing here? You should not be here. You should be working in the city.” He emphasised to us that we should not go to the housing estate nearby, as violence and drugs are abundant in that area. Spoken from the perspective of a man who lives in and is knowledgeable about the surrounding community, we immediately realised the severity of the disadvantaged population.

In order to fully understand the extent of the disadvantaged and diverse community, we found it ideal to integrate with the people of Broadmeadows. Surveys and interviews can be conducted, but nothing is more valuable than experiencing the community first-hand. By familiarising ourselves with the community, we noticed that students have a lack of encouragement and exposure to the field of science. They realise that science is important, yet do not know enough about the field to want to pursue a science-related career.

4.1.2 Evidence from Student Responses

To evaluate the science interest of students, it was necessary to create surveys and distribute them to local secondary schools. In trying to understand the students' own interest towards a science career, we examined their perceptions of what a scientist looks like in everyday life. As shown in Figure 4, most students perceive a scientist as a man with scraggly, pointy hair, wearing glasses and a lab coat, sometimes accompanied by beakers and tubes. Additional scientist drawings can be found in Appendix A.

Figure 4. Student drawing examples of stereotypical scientists.

While the drawings depicted the students' perceptions of a scientist, the science-related statements on the surveys measured the students' personal thoughts about the field. For each statement, the students had the option to strongly agree, agree, disagree, or strongly disagree. When given the statement, "Science is important for society," 45% of the students stated they strongly agree and 10% stated they agree, as seen in Figure 5**Error! Reference source not found.**. In total, more than half of the surveyed population agree that science is important, implying that students understand that science is necessary to their lives and relevant to their everyday activities.

On the other hand, when given the statement, "I would like to have a science-related career in the future," 31% of the students strongly disagreed and 32% of the students disagreed, as seen in Figure 5. Combined, 63% of the students do not have the desire to pursue a science-related career.

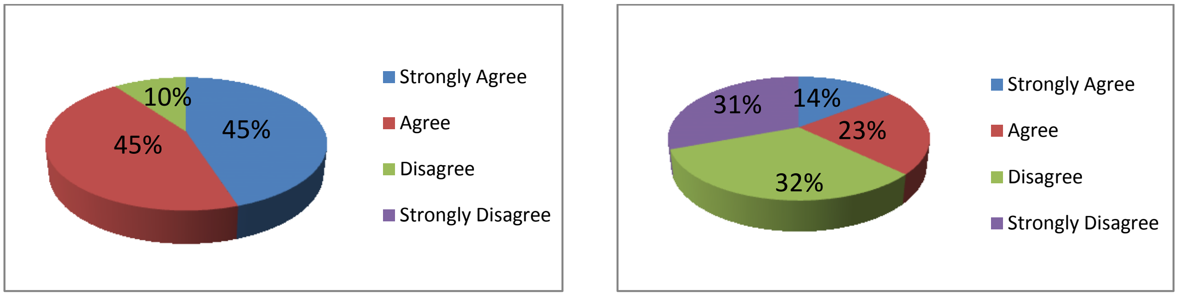


Figure 5. General school survey results of the statement "Science is important for society" (left) and "I would like to have a science-related career in the future" (right).

During the "Magic Science" pilot program at Banksia Gardens, program-specific surveys were distributed before and after the program. Similar to the general surveys, the students who participated in the pilot program also viewed science as important, yet did not see themselves as scientists in the future, as shown in Figure 6**Error! Reference source not found.**.

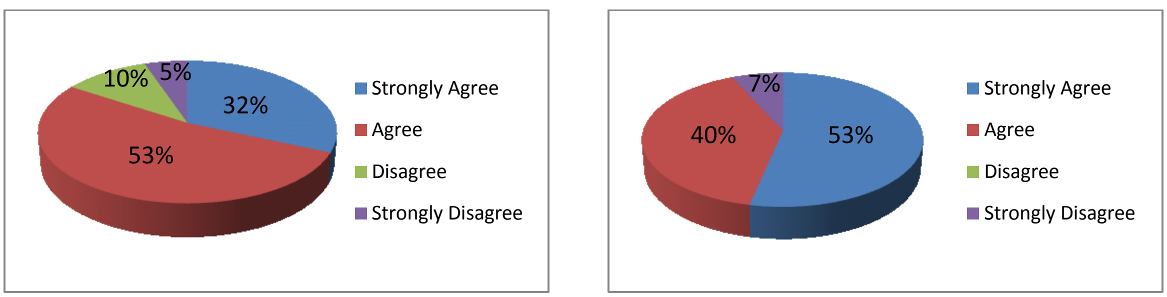


Figure 6. Pilot program pre-survey (left) and post-survey (right) results of the statement "Science is important."

The same students disagreed with the statement, "I want to be a scientist when I grow up." Both before and after the program, more than 80% of the students negatively responded to wanting to be a scientist, as shown in Figure 7**Error! Reference source not found.**.

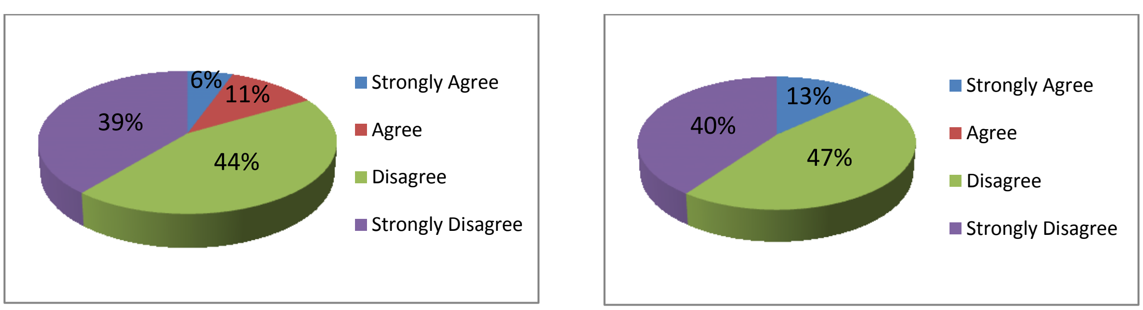


Figure 7. Pilot program pre-survey (left) and post-survey (right) results of the statement "I want to be a scientist when I grow up."

As the majority of students disagreed with this statement, we speculate children may not choose to pursue their science education due to the lack of encouragement from their parents. Research has shown that in comparison to the Melbourne average of 48.5% of people completing Year 12, the Banksia Gardens housing estate average is an exceptionally low 25% (Banksia Gardens Community Centre, 2011). Dropping out of school is a continuous trend which we believe has manifested itself within the Banksia Gardens housing estate. With a mere 15% of people holding a university qualification, this housing estate falls short of the Melbourne average by 35%. Without completing secondary education or continuing on to tertiary education, there is certainty that these people do not have high expectations for their future careers, never mind a career specifically related to science.

With the lack of education, it is understandable that there would be a high unemployment rate. Notably, Banksia Gardens housing estate has an unemployment rate of 90%, which places this estate in the first percentile for disadvantage in Victoria and in the second percentile nationally (Banksia Gardens Community Centre, 2011). As a result of this disadvantage, many of these people rely solely on welfare as poverty continues to be inter-generational. Therefore, the lack of education continues to spread across this population.

The findings from the general surveys and from the program-specific surveys demonstrate that students believe science is important, but they do not want to pursue a career in it. We conclude that the disadvantaged backgrounds of these people, their little exposure to science and science-related careers, along with a severe lack of encouragement, all contribute to the unrealistic perception of a scientist that is held by the people of Banksia Gardens housing estate. This misconception deters the students from pursuing a science career. The findings of this community correspond with the research of an international study which observed that students think science is important for both them and society, but they do not want to be scientists themselves (Sjoberg & Schreiner, 2005). In attempts to rectify the students' misconception, we incorporated a career exploration section within our program framework.

4.2 The Positive Effect of Experiential Learning

We conclude that students prefer experiential learning as it is the most effective learning method for the young individuals of Broadmeadows.

During the experiential learning process, students fully engage themselves in the concepts they are learning, as opposed to reading a textbook or listening to a lecture. One essential characteristic of experiential learning is that a student with no prior knowledge of a subject can still complete a given task. In order to incorporate this characteristic, our program framework focuses on enhancing students' interest in science through hands-on learning activities as well as accommodates a wide variety of students of all age ranges and knowledge levels.

We believe that experiential learning is significant to the Broadmeadows community, where English is often a second language, because hands-on activities will allow the students to learn through experimentation as opposed to understanding verbal communication. Based on the low completion rate of secondary education, we speculate that students might already be resistant to learning. Through the implementation of hands-on activities, the students will be more inclined to learn science. Underprivileged students in this community may not have sufficient educational resources or the opportunity to participate in extracurricular activities; therefore, an experiential science education program will provide these students with enjoyable and productive activities to do in their spare time.

Through surveying students at local schools, we found a trend which supports the research that claims experiential learning is preferred amongst students and is effective in the learning process. These surveys were distributed to students enrolled in various secondary schools throughout Broadmeadows, including Gladstone Park Secondary College and Hume Central Secondary College. We also gathered pertinent data from the results of the pre- and post-surveys of our pilot program.

The first question on these surveys asked students to rank nine different school subjects, 1 being their most favourite and 9 being their least favourite. The subjects included: science, math, english, history, art, music, physical education, computers, and foreign language. The data of 60 students' opinions regarding these subjects can be seen in Figure 8. We observed an interesting trend while examining which subjects were ranked number 1 most frequently. Physical education is the most favourable subject among this group of students, as it was ranked number 1 by 23 out of 60 students; whereas, foreign language is the least favourable subject, as it was ranked number 1 by only one student.

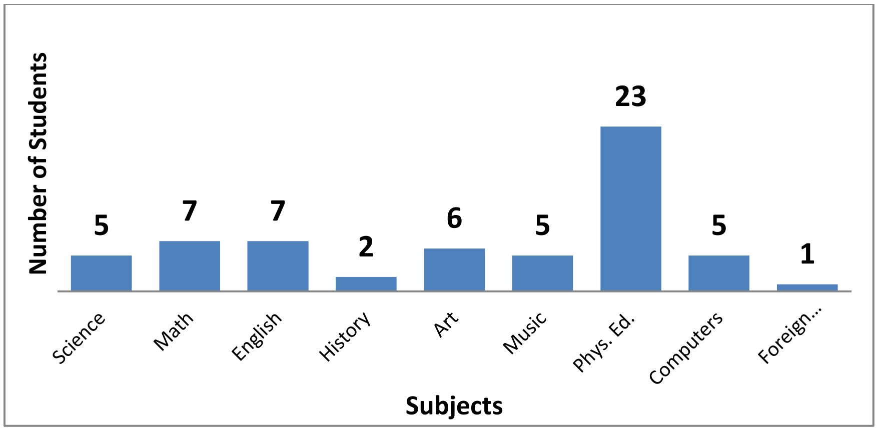


Figure 8. Frequency of number 1 ranking subjects on the general school surveys.

We conclude that physical education is most popular because it involves active and engaging activities. In physical education, whether or not students recognise it, they experientially learn communication, cooperation, sportsmanship, and teamwork skills. The other subjects on the survey do not incorporate as many experiential activities as physical education does, thus explaining them being ranked lower by the students.

Notably, only 5 out of 60 students chose science as their favourite subject. Moreover, science was most commonly ranked fifth favourite, with 13 out of 60 students choosing this rank, as seen in Figure 9.

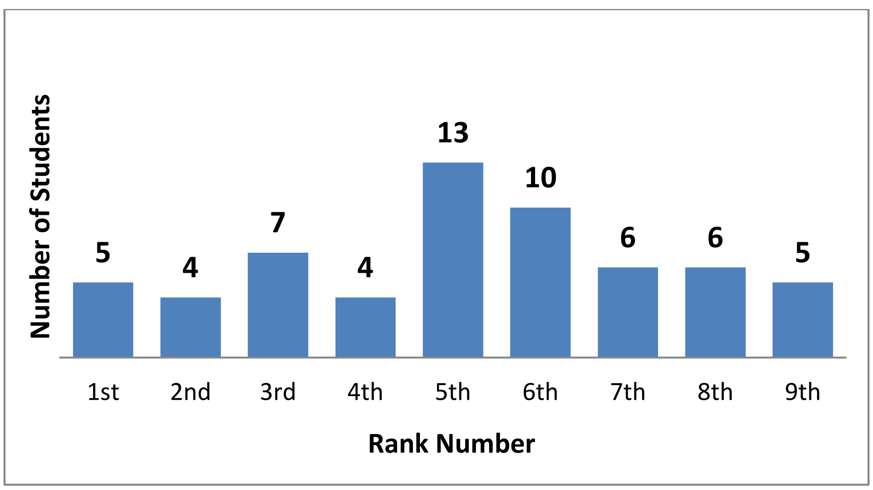


Figure 9. Frequency of science rankings on the general school surveys.

Science may have been ranked as a median subject because it is partially experiential. As mentioned in the background section, the science section of the Australian National Curriculum is a rigid and structured document which discourages flexibility; the educators must mainly teach science concepts through textbook learning and are only allowed to host a few experiments. As a result, these students are unable to fully engage with these concepts through the implementation of experiential learning processes.

To determine the preferred learning formats, we framed a question on the survey to read, “How do you like to learn science? Please check off all that apply.” The options were: textbooks; videos; homework, worksheets, and tests; in-class activities/experiments; websites; field trips; and lessons. The students were asked to check off as few of or as many of these options as they desired. For example, some students checked off one of the options whereas others checked off all of the seven options listed. The student responses about how they like to learn science can be viewed in Figure 10.

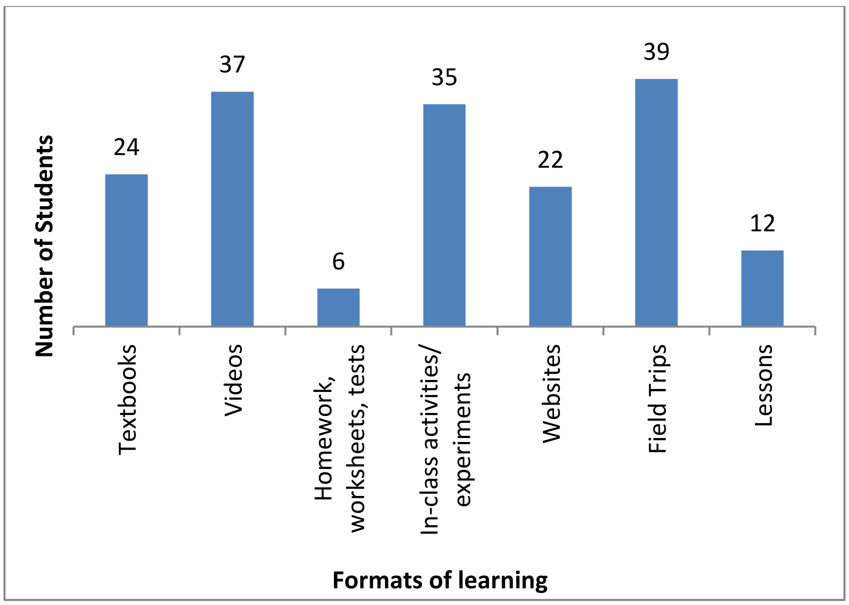


Figure 10. Student responses to “How do you like to learn science?” from the general school surveys.

We conclude that field trips, in-class activities and experiments, and videos are the most favourable learning methods amongst students as they encompass two divisions of experiential learning: project-based and inquiry-based learning. Field trips and in-class activities/experiments allow students to understand the relevance of science in real-world applications through project-based learning methods. Videos exemplify inquiry-based learning by encouraging students to ask questions within the context of the video while simultaneously answering these questions with their own logic. This data advances the argument that students prefer experiential learning.

The data collected from another question on these surveys continued to support our finding that experiential learning is most popular amongst students. This question provided the students with thirteen different statements regarding their feelings about science as a whole. For each statement, the students were asked to indicate whether they strongly agree, agree, disagree, or strongly disagree.

As shown in Figure 11, the data collected from the statement, “Science lessons and experiments are fascinating and fun,” resulted in 38% of students strongly agreeing and 45% of students agreeing. This data shows that the majority of students genuinely enjoy learning science through lessons and experiments. Lessons can involve experiential learning through demonstrations and models, while experiments are based around the experiential learning theory.

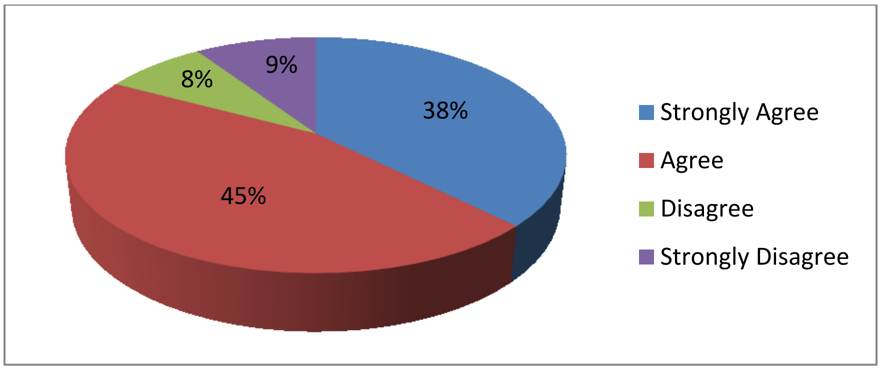


Figure 11. General school survey opinion percentages based on the statement "Science lessons and experiments are fascinating and fun."

A significant piece of data was gathered from the statement, “I would rather agree with other people than to do an experiment to find out myself,” as seen in Figure 12. 33% of students disagree and 29% of students strongly disagree with this statement. This data supports our research that students prefer hands-on learning rather than lecture learning. The data from these statements further supports our conclusion that experiential learning is highly favoured amongst the majority of students.

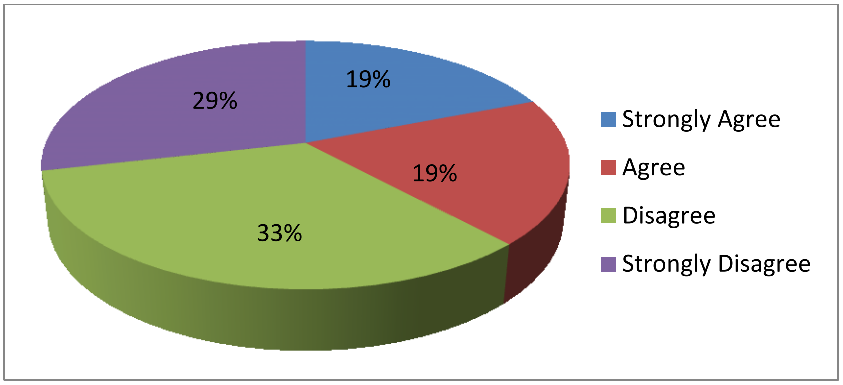


Figure 12. General school survey opinion percentages based on "I would rather agree with other people than to do an experiment to find out myself."

After interviewing the staff at Banksia Gardens about their opinions regarding ideal learning methods for students, we conclude that hands-on learning activities are effective. We also learned that participants are more interactive in group activities, thus promoting engagement and participation. Youth Study Group volunteer, Abdi Aden, mentioned how the centre's Holiday Program has tested hands-on learning versus worksheets, lectures, etc. In general, the students learned more from the hands-on activities as they felt more engaged and involved, and they better understood the importance of the activity.

Banksia Gardens' Holiday Program was only one of the many programs that utilises experiential learning. The centre's Community Development Coordinator, Jaime de Loma-Osorio Ricon, described a few successful activities which he had facilitated during this program. These activities included students creating acid-base indicators, playing soccer, and cooking meals. His main advice was to keep everything as hands-on as possible because the students learn more while doing something themselves as opposed to being lectured.

An interesting remark in regards to the connection between hands-on learning and worksheets was discussed during our interview with Jonathan Chee, the Bring the Gardens to the Valley Project Coordinator. This project is a joint program between Banksia Gardens and Hume Valley School which focuses on supporting students with intellectual disabilities. Chee mentioned how the students in his program use M&Ms to practice addition and subtraction, a hands-on approach, but then have trouble switching this concept to using math symbols on a piece of paper. He stated that "trying to teach the kids the 'code' [of numbers and mathematical symbols] is quite different and quite difficult." He also said that students find the "code" to be difficult to comprehend compared to the physical learning with M&Ms.

Since Banksia Gardens does not offer science-related programs, we gained insight about informal science education programs from the well-known Australian science organisation, CSIRO. Chris Kishna-Pillay, the Victorian Manager of CSIRO Education, claims hands-on learning is the superior method utilised in their programs. The CSIRO school programs are all hands-on where the students are given several opportunities to participate in group discussions and activities. Kishna-Pillay stated that it is ideal for the students to get a better sense of the concepts through hands-on learning as they “can make something, do something, or watch something change” instead of reading textbooks and filling out worksheets.

Finally, our pilot program solidified our finding that students prefer experiential learning over other types of learning. During “Magic Science,” we observed distinct behaviour between hands-on learning and worksheet learning. A great way to gain the attention of the students was by starting the day with the phonebook tug of war, which involved students attempting to pull apart two interwoven phonebooks. They viewed this activity as more of a competition, wondering who was going to win, rather than analysing the science behind it. However, despite the competition, we were still able to gather the students for a science discussion. This interactive activity involved all participants of the program and proved to be effective in grasping their attention. However, only one student was able to tell us that friction was holding the books together; everyone else thought it was nails, tape, or glue. The students were persistent in their reasoning, but we assured them with explanation and further demonstration that it was solely friction.

During the egg drop activity, the students were initially interested in the task at hand. At first, they were not thinking much about the scientific process, but were rather quick to wrap all of the provided materials around the egg and hope for the best. Later in the day, we better captured the attention of the students by repetitively questioning them about the different steps of the scientific method that they used during the experiment. We led them to think in a scientific manner by providing them with fewer materials to improve upon their initial designs. The students enjoyed this challenge, and we could tell that they were interested in the science of it, as after a while, they were questioning the process themselves.

We observed that the students were not interested in the data analysis component of the physical traits activity. Although they were initially having fun while determining their traits, the overall message we received from their behaviour was that they did not enjoy filling out the worksheet and discussing the results. This activity was designed to engage the students in an interactive manner while involving the thinking process of analysing results. The physical traits activity proved to be ineffective in the sense that we lost their interest not even mid-way through the activity. We speculate that this activity was ineffective because it was not as hands-on as the other activities in the pilot program. This activity did not involve project-based or inquiry-based learning, and as a result, they were not as engaged or interested. Their lack of interest caused them to rush through this activity so they could move onto the next one.

The bouncy ball activity was extremely popular during "Magic Science." This activity contained a hands-on science component within an experimental process. Throughout this activity, the students were intrigued by the fact that they could make something themselves. They were asking questions pertaining to the consistency of their ball in comparison to the consistency of other's bouncy balls. After they completed the experiment, they continued to ask questions about how the ball bounced and about the mixture of ingredients. From an observational standpoint, we noticed that this activity was much more effective in capturing the students' attention than the aforementioned activities. At the end of the bouncy ball activity, we made "goop" out of corn flour and water. This mixture was also effective in engaging the children. They felt the "goop" and immediately asked multiple questions about it. At the end of the day, most of the students came back to the bouncy ball activity station wanting to make another one. Their excitement and initiative in wanting to create another bouncy ball was a positive sign, as once again, we noted that hands-on experiments were the preferred amongst the students.

Through surveying the students at the local schools, interviewing the staff at Banksia Gardens, and observing the behaviour of the students during the four activities in the pilot program, we designed the framework of a program that attracts and maintains the interest of the participants. We desire to have the students be completely engaged and interested throughout all aspects of the activities. Therefore, we structured our informal science education program framework around experiential learning, specifically using "wow factors," field trips, workshops/labs, and competitions.

Our findings thoroughly support the results of previous research which states that hands-on experiments are often an effective way in teaching science and engaging the students. We speculate that the framework of an informal education program, such as the one we created for

Banksia Gardens Community Centre, should enhance the students' interest. In order for this program framework to be as effective as possible, we tailored it towards the desires and interests of the students. Therefore, our program predominantly includes experiential, or hands-on, learning activities. Based on our data analysis, we conclude that experiential learning, specifically through design and creation, is the most popular and effective learning method.

4.3 Preferred Science Content Areas

We conclude that students' most favourable science content areas are: stars, galaxy, and the universe; the human body; and elements, compounds, and chemical reactions.

As part of the general surveys, we determined the most popular science disciplines amongst the students. With this data, we designed the framework of our program to encompass a variety of activities suited towards the science interests of students in the surrounding community.

One question on the general surveys, which was distributed to the students in local secondary schools in Broadmeadows, asked them to choose five of the science topics that interest them the most. The topics to choose from were: forms of energy, energy transfer and storage; ecosystems; stars, galaxy, and the universe; forces and motion; the human body; plate tectonics and geological phenomenon; acids and bases; genetics; electricity and magnetism; structure of the Earth and geological history; metals and non-metals; cells and living things; conduction, convection, radiation; elements, compounds, and chemical reactions; theory of evolution; and other. We asked this question in order to gain an understanding of the preferred areas of science interest in hopes of gearing our program towards the specific interests of the students.

After analysing the data collected from this question, we observed that the three most popular topics within science are: stars, galaxy, and the universe; the human body; and elements, compounds, and chemical reactions. From this data, we designed a program framework which focuses on these three topic areas of science. All of the data from this survey question can be observed in Figure 13Figure 13.

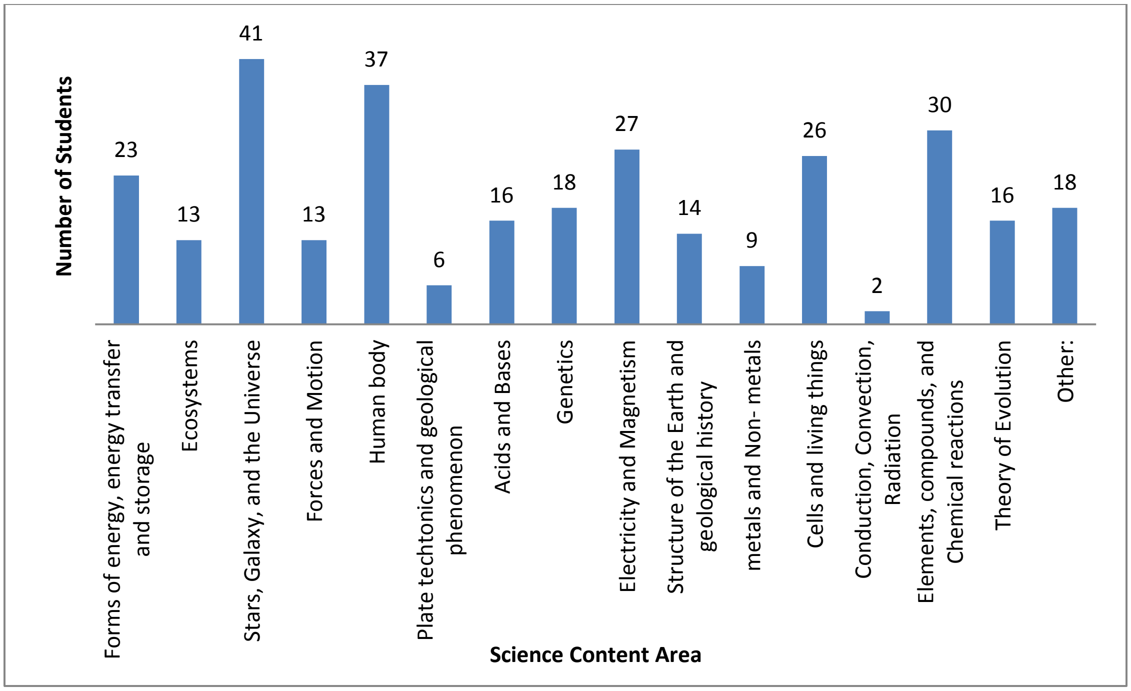


Figure 13. Preferred science content areas of secondary students on the general school surveys.

Choosing topics in which students are most interested can make a large difference in the retention of information. Students tend to be more engaged in topics they have some prior knowledge of and can adopt, adapt, and apply it to their everyday lives; therefore, we incorporated the most favourable topics into our own program framework because we wanted to build off of existing interest as opposed to trying to create interest that does not currently exist. Chee commented on this idea saying, “It’s partly about engaging their prior knowledge and making it meaningful for them. They might already have some experience with [science] so you want to link what they know with what they’re trying to learn.” Nick Mac Hale, the Community Connections Manager at Banksia Gardens, further supports this point by saying, “Science is used in a lot of instances, but we need to create a practical application to what the kids are learning.” Activities and topics students can relate to will not only be more interesting to them, but they will care to learn more about them as well. Aden stated that many secondary students come into the Study Group with science-related homework and describe the subject as “boring.” They typically avoid taking extra science courses and only enrol in the required subjects. Aden also stated that students with no interest in science often dislike the subject due to it being so broad. Science does not follow such a structure as students “[cannot] take the knowledge from the last chapter and carry it onto the next chapter." This field differs from the maths, which has a structure where the concepts build upon one another.

After analysing the information collected from the surveys, we deduced that the most favourable science content areas are: stars, galaxy, and the universe; the human body; and elements, compounds, and chemical reactions.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Science Program Structure

During the seven-week time span of our project, we distributed surveys, conducted research and interviews, and facilitated a science education pilot program. After analysing the collected data, we developed the framework for an informal science education program, tailored to Banksia Gardens Community Centre and the community of Broadmeadows. Banksia Gardens will be able to utilise this framework to host a variety of informal science education programs.

We learned through the students' behaviour and survey responses that they enjoy hands-on activities more than worksheet-related activities; this behaviour was especially observed during the pilot program. Based on these observations and the student responses, we created the framework to be comprised of five units, with each unit designed around the principles of experiential learning. These units, as shown in Table 3, are: wow factors, competitions, workshops/labs, field trips, and career exploration. We distributed surveys to determine the most popular science content areas of the students. Based on the results, we designed our program framework around the students' interest levels in hopes of engaging them in science. Through these surveys, we conclude the most favourable science content areas to be: stars, galaxy and the universe; the human body; and elements, compounds, and chemical reactions. Therefore, we have provided activities which are focused on these three content areas. However, the activity topics are not limited to these three areas; additional activities in other science content areas can be found in Appendix F.

Table 3. The science program structure which consists of five different units.

Science Content Area	Unit 1: Wow Factor	Unit 2: Competitions	Unit 3: Workshops/Labs	Unit 4: Field Trips	Unit 5: Career Exploration
Stars, Galaxy, and the Universe	Planet Distance Activity, 5-10 mins, pg. 68	Soda Bottle Rocket Launcher, 2 hours, pg. 75	Build Your Own Solar System, 2 hours, pg. 83	Escape From Andraxus, 45 minute show-time pg. 91	Career Fair pg. 97
The Human Body	Hot and Cold, 10 mins pg. 71	Great Australian Bone Off, 2 hours, pg. 78	Deep Breath, 1 hour, pg. 86	Measuring Heart Rate, day activity pg. 93	Science Professional pg. 97
Elements, Compounds, and Chemical Reactions	Exploding Plastic Bag, 3-5 mins, pg. 73	Inflating Balloon, 30 min, pg. 80	Make your own Bouncy Ball, 45 mins, pg. 89	Cool Stuff, 30 minute show-time pg. 96	Job Shadow pg. 97

Wow factors are short demonstrations that quickly and easily grab the attention of the audience. This aspect of a program is significant because we found, through the implementation of the pilot program, that it is difficult to initially engage students in the field of science. Therefore, a brief demonstration or activity to amaze the audience will be extremely pertinent to the success of the remaining part of the program. Competitions are activities in which students compete as individuals or as a group to either design or build a structure. When the instructor finds it necessary to motivate the students about science, competitions are beneficial as they often maintain the students' interest for the duration of the activity. Based on our interviews and data from the pilot program, we found it crucial to maintain the students' interest and attention. Workshops/labs are step-by-step activities in which the students craft something. Through analysing the results of the surveys, we believe that this unit is significant because the majority of students prefer hands-on learning by conducting labs. In addition, workshops and labs are advantageous because the students learn how to follow a given procedure; this skill will prepare them for real-world situations. The field trips unit is designed for an instructor to take a group of students to a nearby science facility for demonstrations and interactive displays. We believe this aspect is essential to the framework of our informal science education program because students need to explore everyday applications of science. Activities within Units 2, 3, and 4 contain a closing exercise which discusses corresponding science-related careers.

To emphasise the importance of science-related careers, we designed the career exploration unit in order to expose students to possible careers in the field of science. This unit is vitally important as, through interviews and surveys, we found that Broadmeadows is an extremely disadvantaged community. Since we speculate that students think a science-related career is unattainable, we designed this unit to educate them about the connection of science to real-world applications and to show them the wide variety of careers within the field of science. The career exploration unit will obtain the students' interest, encourage them to further their education, and ideally inspire them to become scientists.

Within each unit of Table 3 are three activities with their corresponding time durations. These times are estimated for the activity alone; they do not include any discussion that may occur before or after the activity, so the actual times may vary depending on the extent of the discussion or expansion of the activity. In addition, the outlines of these activities are referenced by a page number and are detailed in Appendix E. The activity descriptions include the time duration, the materials needed for the experiment, the preparation involved, the procedure, key terms and definitions, a takeaway/discussion, ways to expand upon the activity, and finally, a career connection section. This information allows anyone at Banksia Gardens to facilitate this program, as not every staff member has a background in science. Since each activity differs in length of time, Banksia Gardens will have the flexibility in designing multiple programs, depending on the centre's schedule.

Banksia Gardens Community Centre implements programs of various structures throughout the year. If the centre desired to host a day program, it could select a variety of activities with differing time durations. For example, as shown in Table 4, the program could open with a wow factor activity, such as "Exploding Plastic Bag," to initially capture the interest of the students. Then the "Build Your Own Solar System" workshop could occupy a long three hour morning period before lunch. After lunch, the shorter "Great Australian Bone Off" workshop and "Make Your Own Bouncy Ball" competition could span the afternoon. A workshop and competition are beneficial as the workshop will guide the students in a step-by-step process, and the competition will motivate them to stay focused for the duration of the activity. Finally, the end of the day could be dedicated to a visit from a science professional as part of the Career Exploration unit. The combination of an activity from each unit is beneficial to a day program as the changing atmosphere of watching a demonstration, following instructions, and competing, will collectively maintain the interest of the students.

Table 4: Sample full-day science program

Time	Type of Activity	Activity
9:00-9:30 a.m.	Wow Factor	Exploding Plastic Bag
9:30-11:30 a.m.	Workshop/Lab	Build Your Own Solar System
11:30-12:30 p.m.	Lunch	Eat/drink
12:30-2:30 p.m.	Competition	Great Australian Bone Off
2:30-3:30 p.m.	Workshop/Lab	Make Your Own Bouncy Ball
3:30-5:00 p.m.	Career Exploration	Science Professional

Another example program, as displayed in Table 5, is a situation in which Banksia Gardens has a half-day time structure. Based on our experience, we determined that beginning the program with a wow factor will always initiate interest amongst the students. Since the day is short, a competition serves as a good selection as, once again, it will keep the students motivated to do well in science and be focused on the activity, all the while that they will not realise time is passing. The students can then follow the steps of a workshop/lab, as hands-on activities incorporate the preferred experiential learning method. These activities will provide connections between the activity's areas of discussion and the relevance it has on the students' everyday life.

Table 5: Sample half-day science program

Time	Type of Activity	Activity
9:00-9:30 a.m.	Wow Factor	Hot and Cold
9:30-10:30 a.m.	Competition	Inflating Balloon
10:30-12:00 p.m.	Workshop/Lab	Deep Breath

A final example of a program that Banksia Gardens can implement is shown in Table 6, and it is a stand-alone activity, which spans a two-hour time period. Suggested in the sample two-hour program is a competition. This type of activity has the capability to engage students for a longer period of time than wow factors, but does not require as much time as field trips. There are also other options available for a two-hour science program. A workshop/lab or a career exploration is also possible as these units can occupy a two-hour time frame. In a similar fashion to these guidelines, Banksia Gardens has the ability to implement a science program with any desired time structure.

Table 6: Sample two-hour science program

Time	Type of Activity	Activity
1:00-3:00 p.m.	Competition	Soda Bottle-Rocket Launcher

Regardless of the flexibility, one should not design a program made entirely of wow factors, as this unit is designed to grasp the attention of the audience as well as to gain their interest in science. The competitions, workshops/labs, and career exploration units are used to fill time periods throughout a day or can be used solely when a single activity is desired. The field trip option can be incorporated into any desired program, as it may take either a full-day or a half-day, depending on the location to which the students are traveling along with the duration of the trip. Based on the survey responses, and despite the unit classification, we provided activities pertaining to the most favourable science content areas.

These sample programs are merely examples of the many programs that Banksia Gardens can utilise. The centre has the flexibility to choose any activities from any unit to suit its available schedule. The wide selection of time durations provides the option of creating numerous programs whether it is in the structure of a full-day, a half-day, or a two-hour period. With these recommendations, we believe that we have provided Banksia Gardens Community Centre with a strong framework for a science education program that will enhance the science interest of students.

5.2 Recommendations

5.2.1 Additional Activities and Resources

As previously shown in Table 3, we have provided fifteen activities that can be incorporated into any desired science education program. However, these are just a few options of the many activities that can be utilised. With limited time, we were unable to provide details for every activity that we suggested. Moreover, the information found in Appendix F is sufficient for Banksia Gardens to formulate a science program of their choice. In Appendix F, we have provided a list of activities that the centre can use as a resource when implementing an informal science education program. The sources that are supplied suggest the format and procedure of the activity. These activities encompass a wide variety of science content areas and various time frames; therefore, making these activities easily adaptable for any given program.

5.2.2 Exploring Partnerships and Funding Opportunities

We have delivered a framework for a low-cost program which will work within Banksia Gardens' limited budget. In order to expand and fund our science education program framework, we recommend that Banksia Gardens creates a marketing package, as the centre does not have the internal funds to support a high-cost program. The centre can develop this package by revising our executive summary with data from our interviews, surveys, observations, and findings. This package should include a brief description regarding the science program and its importance to Banksia Gardens and the local community. We hope that Banksia Gardens will utilise this marketing package as a tool to gain funding for the materials and resources needed for the science education program. This package can be presented to any local business in Broadmeadows or to the Victorian government.

We suggest that Banksia Gardens uses this marketing package to form partnerships with local businesses. We believe that these partnerships will benefit the community centre, the Broadmeadows community, and the local businesses. We also recommend that Banksia Gardens uses this marketing package and IQP report when applying for government grants. Banksia Gardens can simply extract information and data from this report and use it for the requirements of the grant application.

There are organisations which act as liaisons between education and businesses, one of which is the Business Working with Education Foundation (BWEF), an independent charitable institution. This government sanctioned agency works to increase engagement between schools and businesses. BWEF is particularly interested in determining what works best for both schools and businesses in such a way that both parties are equally benefitted. Since our science program is educational, we recommend that Banksia Gardens delivers the marketing package to BWEF, allowing them to develop an understanding of our project. BWEF can then bring the marketing package to businesses in order to build partnerships for Banksia Gardens. This would be an ideal option for the centre to utilise as the people at BWEF are knowledgeable in regards to building relationships between businesses and schools. BWEF is a superb resource for this goal because they fully understand the business aspect of these partnerships; they recognise the motivations of the businesses.

We recommend that Banksia Gardens seeks partnerships with businesses that would be able to help students explore career options in the field of science. For example, the centre could find local businesses which have scientists and engineers working for them. As a result, these relationships will help the students of Broadmeadows by providing them with knowledge regarding the opportunities available within the field of science and by providing them with networking opportunities with people in the field. These students will have many of the tools necessary to pursue a career in a science-related field. These partnerships will benefit the businesses by allowing them to build their community connection and engagement, as well as increase advertisement throughout the community.

5.3 Closing Remarks

Our program framework will ideally interest and engage the local students in science. With this increased interest, these students may feel inspired to complete their secondary education and to pursue a science degree at university. This science degree will provide them with the qualifications to obtain a science-related career, which will reduce the unemployment rate as well as improve the economy in Broadmeadows. In the long-term, their science interest may reverse the decline of science interest in Victoria.

ACRONYMS

ACER	Australian Council for Educational Research
AUD	Australian Dollar (currency)
BWEF	Business Working with Education Foundation
CALD	Culturally and Linguistically Diverse
CSIRO	Commonwealth Scientific and Industrial Research
CSTEM	Communication, Science, Technology, Engineering, and Math
GPSC	Gladstone Park Secondary College
IQP	Interactive Qualifying Project
LLEN	Local Learning Employment Network
ROSE	Relevance of Science Education
SSEP	Student Science Enrichment Program
STEM	Science, Technology, Engineering, and Mathematics
USA	United States of America
WPI	Worcester Polytechnic Institute

REFERENCES

Afterschool Alliance. (2011). *STEM Learning in Afterschool: An Analysis of Impact and Outcomes.* Afterschool Alliance.

Banksia Gardens Community Centre. (2010). Retrieved 2/13/2012, from http://www.banksiagardens.org.au/index.php

Banksia Gardens Community Centre. (2011). Community Connections Project: 18 Month Progress Report.

Belle, Thomas J. (1982). Formal, nonformal and informal education: A holistic perspective on lifelong learning. International Review of Education. Springer Netherlands.

Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palinesar, A. (1991). Motivating Project-Based Learning: Sustaining the Doing, Supporting the Learning. *Educational Psychologist*, 26(3&4), 369-398.

Dale, Edgar. (1954). Audio-visual methods in teaching. Holt, Rinehart, and Winston.

Dougall, Gina. (2012, March). *The Launch of the ACFE Capacity and Innovation Fund Round 3*. Speech presented at Banksia Gardens Community Centre, Broadmeadows, Victoria, Australia.

Eschach, Haim. (2009). Bridging in-School and out-of-school learning: formal, non-formal, and informal education. *Journal of Science and Education Technology*. 16(2): 171-190.

Finelli, C. J., Klinger, A., & Budny, D. D. (2001). Strategies for Improving the Classroom Environment. *Journal of Engineering Education,* pp. 491-497.

Gough, A., Marshall, A., Matthews, R., Milne, G., Tytler, R., & White, G. (1998). *Science baseline survey research report.* Melbourne: Deakin University.

Gerber, B. L., Marek, E. A., and Cavallo, A. M. L. (2001). Development of an informal learning opportunities assay. International Journal of Science Education 23(6): 569–583.

Jeffs, T., Smith, M., & YMCA George Williams College. (1999). *Informal education: conversation, democracy and learning.* Education Now Ticknall.

Jenkins, E., & Nelson, N. W. (2005). Important but not for me: student’s attitudes toward secondary school science in England. *Research in Science & Technological Education*, 23(1), 41-57

Jones, R. B. (2008). Science, technology, engineering, and math. *State Educational Technology Directors Association (SETDA)*.

Krajcik, J., Blumenfeld, P. C., Marx, R. W., Bass, K. M., Fredricks, J., & Soloway, E. (1998). Inquiry in Project-Based Science Classrooms: Initial Attempts by Middle School Students. *The Journal of the Learning Sciences, 7*(3&4), 315-350.

Masters, G. (2006). Opening address: Boosting science learning – the challenge. *Australian Council for Educational Research (ACER) Conference*.

National Curriculum Board (2009). Shape of the Australian National Curriculum: Science. Australian Curriculum, Assessment and Reporting Authority.

Quantum Market Research. (2007). Community interest and engagement with science technology in Victoria: research report 2007." Prepared for the Department of Innovation, Industry, and Regional Development (DIIRD).

Satterthwait, D. (2010). Why Are "Hands-On" Science Activities so Effective for Student Learning? *Teaching Science (Deakin West, A.C.T.), 56*(2), 7-10.

Smith, M. K. (2001). David A. Kolb on experiential learning. *The Encyclopedia of Informal Education*.

Snieckus, K. R., Mello, E. A., Hyman, A. R., & Carney, K. M. (2011). *Teachers' insights into informal science education programs.* (IQP Project Report, Worcester Polytechnic Institute).

Sjoberg, S., Schreiner, C. (2005). How do learners in different cultures relate to science and technology? *Asia-Pacific Form on Science Learning and Teaching*, 6 (2), 1-17.

Tytler, R. (2007). Re-imagining science education: engaging students in science for Australia's future. *Teaching Science*, 53 (4).

Wellington, J. (1990). Formal and informal learning in science: the role of the interactive science centres. *Physics Education, 25*, 247.

APPENDIX A: SUMMARISED SURVEYS

Please note that the number of responses for certain questions do not match the total number of surveys collected and analysed as some received surveys contained incomplete answers

<u>Secondary School Student Surveys – Blank Form</u>

STUDENT SURVEY

Age: ______________________________________

School: ____________________________________

Grade: _____________________________________

Gender: ☐Male ☐Female

Rank the following subjects 1 through 9 (1 being your favourite and 9 being your least favourite):

____English	____History	____Physical Education (Gym)
____Math	____Art	____Computers
____Science	____Music	____Foreign Language

Check off only <u>5</u> items below that interest you the most:

____Forms of energy, energy transfer and storage
____Ecosystems
____Stars, galaxy, and the universe
____Forces and motion
____Human body
____Plate tectonics and geological phenomenon
____Acids and bases
____Genetics
____Electricity and magnetism
____Structure of the Earth and geological history
____Metals and non-metals
____Cells and living things
____Conduction, convection, radiation
____Elements, compounds, and chemical reactions
____Theory of evolution
____Other:

How do you like to learn science? Please check off any choices which apply.

____Textbooks ____In-class activities/experiments ____Field trips

____Videos ____Websites ____Lessons

____Homework, worksheets, and tests ____Other: _______

In the boxes below, please place in "X" the box which describes how you feel about each statement.

Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
Too much money is being spent on science				
I would prefer to find out why something happens by doing an experiment than by being told				
Science lessons and experiments are fascinating and fun				
Scientists do not have social lives				
I dislike science lessons				
I would prefer to do experiments than to read about them				
I would like to have a science-related career in the future				
I'm curious about the world				
Scientific discoveries are doing more harm than good				
I would rather agree with other people than to do an experiment to find out myself				
Scientists like sports and recreation as much as other people do				
Science is important for society				
I would like to belong to a science club				

Secondary School Student Surveys – Data Summary

Total number: 64
Age(s): 12-18
School(s): Gladstone Park Secondary College, Hume Central Secondary College
Grade(s): 7-12
Gender: 35 Male 29 Female

Table 7. Ranking of favourite school subjects (1 = most favourite and 9 = least favourite)

	Ranking Number								
Subject	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
English	7	7	8	5	5	4	9	12	3
Math	7	3	12	9	8	5	4	3	10
Science	5	4	7	4	13	10	6	6	5
History	2	8	1	11	7	9	11	4	4
Art	6	11	7	9	4	6	10	4	3
Music	5	3	8	5	8	9	4	7	6
Physical Education	23	7	3	6	12	4	2	3	7
Computers	5	13	7	6	8	4	5	8	2
Foreign Language	1	4	6	3	3	7	6	10	16

Table 8. Science content areas which interested the students the most (students were allowed to choose up to five areas)

Science Content Area	Number of students
Forms of energy, energy transfer, and storage	23
Ecosystems	13
Stars, galaxy, and the Universe	41
Forces and motion	13
Human body	37
Plate tectonics and geological phenomenon	6
Acids and bases	16
Genetics	18
Electricity and magnetism	27
Structure of the Earth and geological history	14
Metals and non-metals	9
Cells and living things	26
Conduction, convection, radiation	2
Elements, compounds, and chemical reactions	30
Theory of Evolution	16
Other	18

Table 9. Methods which students preferred when learning science (students were allowed to choose as many choices that applied)

Learning Method	Number of students
Textbooks	24
Videos	37
Homework, worksheets, tests	6
In-class activities/experiments	35
Websites	22
Field Trips	39
Lessons	12

Table 10. Statements concerning science which students had to either strongly agree, agree, disagree, or strongly disagree to

Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
Too much money is being spent on science	3	12	40	7
I would prefer to find out why something happens by doing an experiment than by being told	38	19	2	3
Science lessons and experiments are fascinating and fun	24	29	5	6
Scientists do not have social lives	4	10	29	18
I dislike science lessons	3	8	30	20
I would prefer to do experiments than to read about them	43	11	4	3
I would like to have a science-related career in the future	9	14	20	19
I'm curious about the world	23	29	5	4
Scientific discoveries are doing more harm than good	2	13	30	19
I would rather agree with other people than to do an experiment to find out myself	12	12	21	18
Scientists like sports and recreation as much as other people do	9	23	25	3
Science is important for society	27	27	6	0
I would like to belong to a science club	6	12	19	22

“Magic Science” Pilot Program Pre-Survey – Blank Form

PRE-SURVEY

Age: ______________________________________

Year: ______________________________________

Gender: ☐Male ☐Female

Do you want to participate in this program? ☐Yes ☐No

Do you like science? ☐Yes ☐No

Have you participated in a science program before? ☐Yes ☐No

In the boxes below, please place in “X” the box which describes how you feel about each statement.

Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
Science is fascinating and fun				
I look forward to science class				
Science is boring				
Science is interesting to me and I enjoy it				
I do not like science				
I want to be a scientist when I grow up				
I’m curious about the world				
I enjoy discovering new things				
Science is important				
I do not enjoy science experiments				
I would like to learn more about science				

“Magic Science” Pilot Program Pre-Survey – Data Summary

Total number: 18
Age(s): 7-15
Grade(s): 2-10
Gender: 9 Male 9 Female

Table 11. Intro questions and results from the pilot program pre-surveys

Question	Yes	No
Do you want to participate in this program?	18	0
Do you like science?	16	2
Have you participated in the science program before?	10	8

Table 12. Pilot program pre-survey statements concerning science which students had to either strongly agree, agree, disagree, or strongly disagree to

Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
Science is fascinating and fun	3	12	2	1
I look forward to science class	6	8	3	1
Science is boring	2	1	8	7
Science is interesting to me and I enjoy it	7	8	1	2
I do not like science	2	1	7	8
I want to be a scientist when I grow up	1	2	8	7
I’m curious about the world	3	5	5	2
I enjoy discovering new things	8	7	2	0
Science is important	6	10	2	1
I do not enjoy science experiments	1	1	4	12
I would like to learn more about science	6	9	1	1

"Magic Science" Pilot Program Post-Survey – Blank Form

POST-SURVEY

Age: ______________________________________

Year: ______________________________________

Gender: ☐Male ☐Female

Are you glad you participated in this program? ☐Yes ☐No

After the program, do you like science…? ☐More ☐Less ☐No change

Would you want to participate in any similar future science programs? ☐Yes ☐No

Rank the following activities (1 being your favourite and 5 being your least favourite):

____Phonebook
____Egg Drop
____Bouncy Ball
____Physical Traits
____Career Discussion

In the boxes below, please place in "X" the box which describes how you feel about each statement.

Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
Science is fascinating and fun				
I look forward to science class				
Science is boring				
Science is interesting to me and I enjoy it				
I do not like science				
I want to be a scientist when I grow up				
I'm curious about the world				
I enjoy discovering new things				
Science is important				
I do not enjoy science experiments				
I would like to learn more about science				

“Magic Science” Pilot Program Post-Survey – Data Summary

Total number: 16
Age(s): 7-15
Grade(s): 2-10
Gender: 9 Male 7 Female

Table 13. Intro questions and results from the pilot program post-surveys

Question	Yes	No	
Are you glad you participated in this program?	14	2	
Would you want to participate in any similar future science programs?	14	2	
	More	**Less**	**No Change**
After the program, do you like science…?	13	0	3

Table 14. Pilot program post-survey results of activity rankings by the students

Activity	Ranking Number			
	1	**2**	**3**	**4**
Phonebook	1	3	5	3
Egg Drop	6	5	1	0
Bouncy Balls	6	3	3	0
Career Discussion	0	0	3	9

Table 15. Pilot program post-survey statements concerning science which students had to either strongly agree, agree, disagree, or strongly disagree to

Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
Science is fascinating and fun	9	5	0	1
I look forward to science class	9	3	0	1
Science is boring	1	0	5	9
Science is interesting to me and I enjoy it	9	5	0	1
I do not like science	1	0	6	8
I want to be a scientist when I grow up	2	0	7	6
I’m curious about the world	3	4	5	2
I enjoy discovering new things	8	5	1	1
Science is important	8	6	0	1
I do not enjoy science experiments	2	0	6	6
I would like to learn more about science	8	3	3	0

Scientist Drawings

All surveys distributed included the following questions:

In the space below (or on the back), draw what you think a scientist looks like (optional: you can also list out the traits):

Samples of scientist drawings by students:

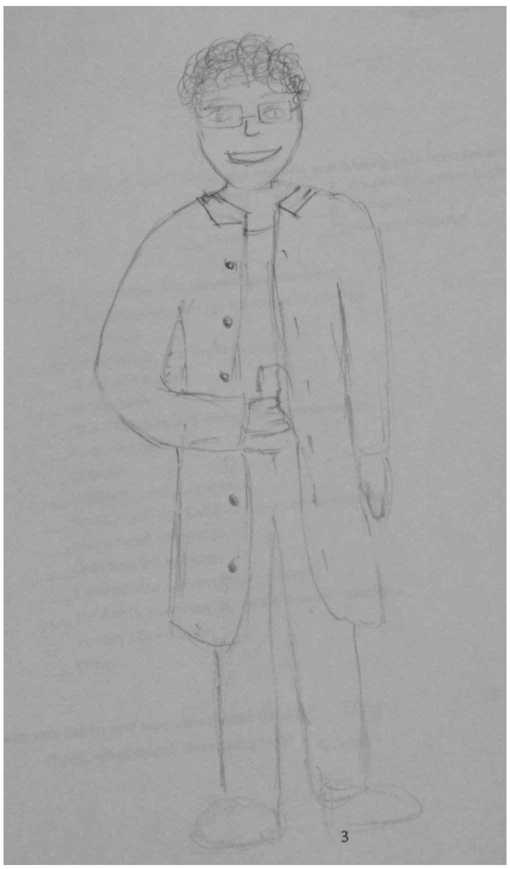


Figure 14. Stereotypical scientist drawing by a student

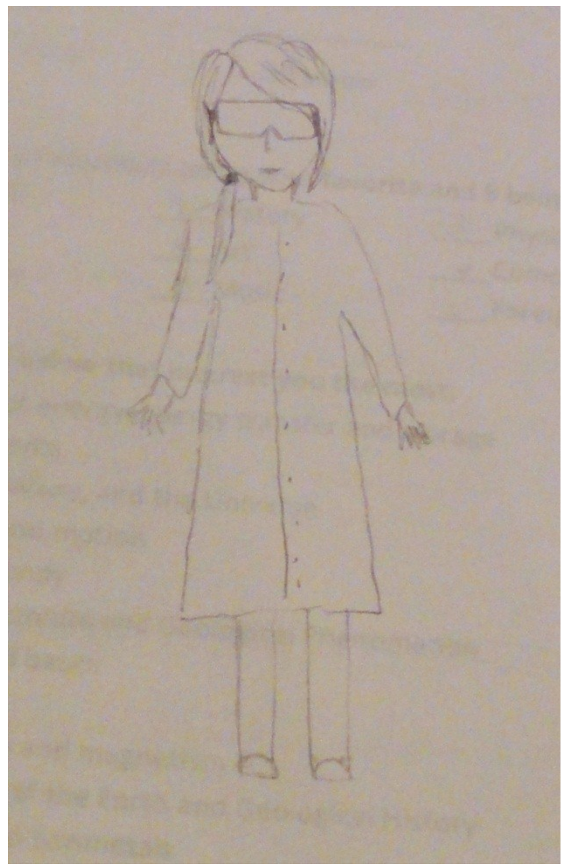


Figure 15. Female scientist drawn by a student

Figure 16. Student drawing of a scientist

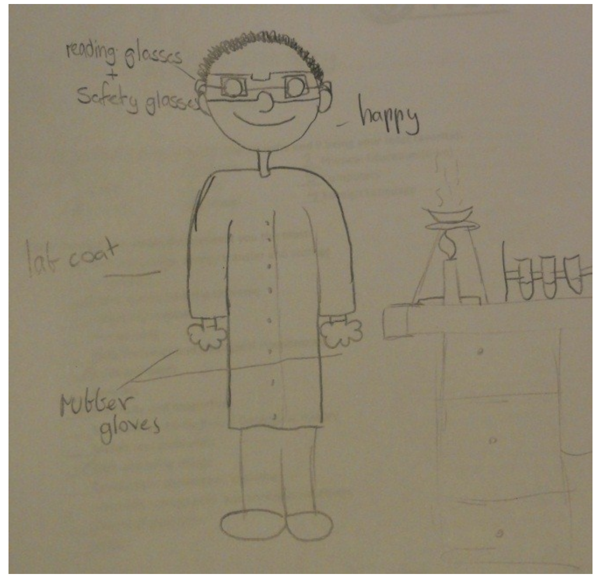


Figure 17. A student's perception of a scientist in drawing form

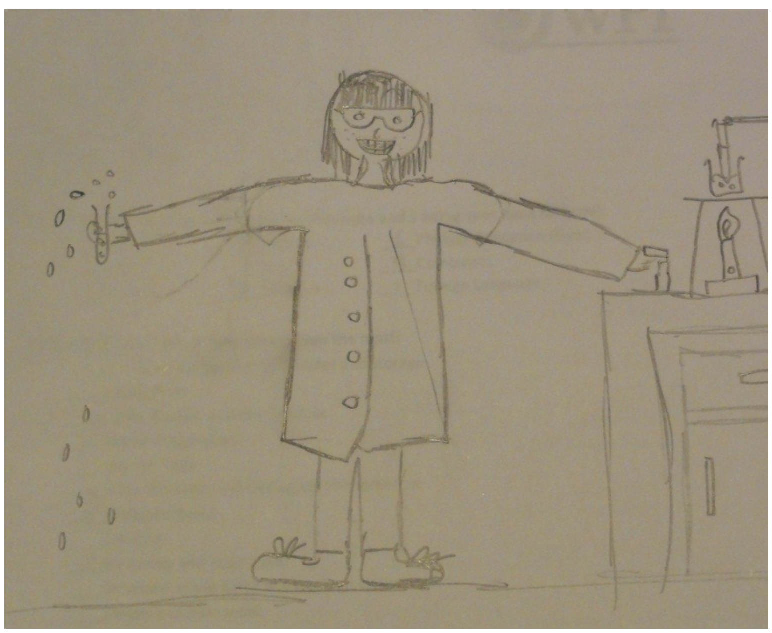


Figure 18. Another student drawing depiction of a female scientist

APPENDIX B: OBSERVATIONAL JOURNAL ENTRIES

Journal Entry #1

13-25 April 2012
Banksia Gardens Community Centre
Study Group (Tutoring)

For the seven weeks we were working at Banksia Gardens, we were involved with their Study Group, held every Tuesday. The Study Group is a program Banksia Gardens runs for the local community that offers tutoring for students of all ages. Typically, four or five tutors will walk around to aid any of the students in need of help. These tutors are not necessarily educated teachers, but with the level of work the students bring in, they can help the student's reason through it without too much trouble. Sometimes, however, students will require the assistance of Banksia Gardens staff with higher, specific education on their more advanced homework.

Usually, twenty-five kids on average would come on any given day. While all of us helped both primary and secondary students, we all tended to work better with the secondary students as the weeks went on. Working with them on a weekly basis gave us an interesting perspective as to the type of work the students were doing in school as well as seeing first-hand what type of students utilise Banksia Gardens facilities. Some students spoke English when in the study group with us, however as soon as their parents came to pick them up, they would speak their native languages. This could be due to most students being from immigrant families. In addition, most kids would come to the study group with siblings. Overall the experience was good to see the type of students Banksia Gardens usually caters too as well as the structure of a program of this kind.

Journal Entry #2

3 April 2012
Banksia Gardens Community Centre
Holiday Program: Magic Science

Phonebook Tug of War

We started the day off with an interactive demonstration with the two phonebooks woven together page by page. We started with just two kids, one on either side of the two phonebooks and had them pull with no effect to the books. We then added three more people to either side and had them pull, again with no effect. Next, we split up the whole group and had half on one side and half on the other. They pulled and while the rope stretched and creaked, the phonebooks still didn't break. Finally, we tied one end of the rope around a nearby tree and had the entire group pull together on one side and again the phonebook did not pull apart or break. We then brought the group together and asked them why they thought the phonebooks stayed together. Only one child came up with the idea of friction. Most of the other kids thought the book was nailed or glued. Many kids did not believe it was just the pages against each other, so we opened the book and showed them that each page was unhampered. One child thought the tape holding the end covers together was the reason the books wouldn't come apart, but when it was pointed out to the group that the entire group of kids could not break one piece of duct tape, the child realized something else was at play. We then briefly explained what friction was and the two types: static and kinetic. We gave a few examples of each and how friction is used everyday all around us. The kids seemed to really enjoy the "Tug of War" part of the experiment without fully understanding that they were pulling on nothing more than two phonebooks.

After this demonstration we split the group into two groups and divided off into each section for the day, one group for the egg drop experiment and one group into the classroom for the bouncy ball and traits experiments.

Egg Drop

During the morning session of the Egg Drop activity, eleven kids were separated into groups of two or three. Before we even explained the activity, many kids were questioning what they were going to do. Many kept asking whether they would get to throw the eggs at each other or at something else, and all these ideas were turned down. Eventually, we demonstrated an egg dropping from the top of a ladder, approximately 3.5 metres high, which resulted in it splattering on the newspaper covered pavement. The kids were given the task to design some sort of mechanism that would prevent the egg from breaking when dropped from the top of the ladder. During the first round, each group was given twenty cotton balls, a thin stack of newspapers, four pieces of paper towel, two plastic cups, a piece of string, a small strip of duct tape, and of course, one egg. Most kids immediately went straight to wrapping their egg with all the supplied materials. They all kept asking for more materials despite us saying, over and over again, that they only had the given materials to work with so they needed to rationalise and think about how they were going to utilise their supplies.

At the end of the first round, all egg protection designs were dropped from the ladder and all, but one, broke upon impact. During the second round, everyone was given another chance to re-design another mechanism for their egg. We reminded the kids to think about their previous designs and how they could improve upon it, but many groups ended up copying the successful design from the first round rather than improving upon their own. When testing all the new designs, all but one made it through the fall and was successful. As soon as kids realised the activity was finished, they started their own early recess before lunch had started.

The afternoon session of this activity ran in a more structured manner, and the kids gained more insight out of it. The first two rounds were similar to the ones conducted in the morning session: kids made their own original designs in the first round and then improved upon them in the second round. The new change we made to the afternoon session was the addition of another round. For the third round, the kids were given about 1/3 of the amount of materials they had previously received during the first two rounds. We challenged the kids to think of a design that would successfully protect the egg from the fall with the very limited amount of supplies. The kids took more time thinking about their designs compared to the earlier rounds. A couple of the designs during this round succeeded, including the first attempt all day of a mock parachute.

In general, the kids got bored rather quickly after the first two rounds during both the morning and afternoon session, but it certainly did not help the afternoon session kids who were standing out in the sun. Many of the kids involved in this activity were ten to twelve years old. Meanwhile, the younger ones were aided by older kids, and the very few older kids of ages fourteen to fifteen were more involved with helping us out in conducting the activities and keeping the younger children in control. In terms of the activity takeaway, the kids gained more knowledge out of the egg drop during the afternoon session. The morning session involved no scientific method questions so many of the kids were bored and the overall experiment did not last long. On the other hand, during the afternoon session, we repetitively asked each group about the steps of the scientific method in regards to this activity and their design. Although the questioning was repetitive, the kids were more directly involved and they had to apply the scientific method to what they were doing.

Physical Traits

When planning the physical traits activity, we thought the kids would have fun exploring their physical traits and comparing them with their friends. However, this exercise did not capture the children's attention as well as we had hoped; we struggled to maintain their attention throughout this exercise. Rather than observing the pictures and examples of the traits provided at each station, they simply asked us which traits they have. For example, they kept saying they did not know what a hitchhiker's thumb and widow's peak are, even though we had pictures clearly expressing what they are. The kids seemed like they rushed through this exercise by writing down their traits on the worksheet in hopes of moving on to the next activity quicker. When we had them sit down to discuss the science aspect of the activity and compare who had which traits, they neither cared nor paid attention. For example, when we asked them to raise their hands regarding which traits they had, they hesitated and were confused by what we were asking them. Even though we tried to explain the science behind dominant and recessive genes, it seemed as though they did not understand the relevance between it and the activity. Overall, they seemed uninterested and disengaged in this particular activity. We concluded that kids need every activity to be more interactive and hands-on as opposed to walking around looking at pictures and filling out a worksheet. Therefore, when planning the framework for our science program, we will not include this activity or any like this one in the content of it.

Bouncy Ball

The children were ecstatic during the “Make Your Own Bouncy Ball” activity. During this lab experiment, they were able to make their own bouncy balls by mixing water, borax, food-colouring, white glue, and corn flour. While making their bouncy balls, they listened well to our instructions and took our advice. They constantly asked questions to ensure that their experiment would have a positive result. If the consistency of their mix was not correct, they showed frustration and handed it to us, asking if we could do it for them. They did not specifically care about the science behind making the ball, but they asked multiple questions regarding why it only bounced so high and why it made the sound it did. It was thrilling to observe how inquisitive they were about the bouncy balls. After their bouncy balls were made, they had a great time playing with them; they bounced them everywhere and tossed them back and forth to one another. After the kids finished the bouncy ball activity, there was some extra time, so we decided to make “goop” out of cornflour and water. The kids had just as much fun playing with the “goop” as they did with the bouncy balls. It lasted for a long while before we had to tell them to wash their hands and move on to the next activity. In general, they were extremely enthusiastic about making their very own bouncy ball. It was an extremely messy activity, but it was well worth it. Some of them were so intrigued by the activity; they even decided to write down the ingredients and took our instruction sheet home to make more. While the kids were taking part in other activities, they repeatedly said, “I just want to make bouncy balls.” Therefore, at the end of the day, after they had completed all the activities, they all came back to the bouncy ball station and made another bouncy ball. Even after making two bouncy balls each, we still had multiple kids coming up to us asking if they could make a third one. This activity was a huge success of our “Magic Science” day; therefore, we will definitely be adding this experiment and comparable ones to our science program framework.

APPENDIX C: DESCRIPTIONS OF "MAGIC SCIENCE" PILOT PROGRAM

Tuesday, 3 April 2012
10AM-12PM, 1-3PM
Expected Age group: 10-16 year olds
Actual Age group: 4-15 year olds

Schedule

10:00AM – 10:30AM	Pre-survey + Opening Wow Factor
10:30AM – 12:00PM	Group 1 – Activity 1 (Egg Drop)
	Group 2 – Activities 2+3 (Bouncy Ball & Physical Traits)
12:00PM – 1:00PM	Lunch
1:00PM – 2:30PM	Group 1 – Activities 2+3 (Bouncy Ball & Physical Traits)
	Group 2 – Activity 1(Egg Drop)
2:30PM – 3:00PM	Post-survey

Wow Factor

Phonebook Rope Pull

Materials:

- 2 phonebooks (of equal size)
- Drill
- Really long, really strong rope

Preparation:

1. Overlap all the individual pages between each phone book (i.e., Page 1 of the first phone book overlaps Page 1 of the second phone book. Page 2 of the first phone book overlaps Page 2 of the second phone book, and so forth).
2. Drill three holes on the binding of each of the phonebooks.
3. Weave one strong, long rope through the holes of one phone book binding, and then another rope for the other phone book binding.

Activity:

1. Explain how the two phonebooks are put together (remind them there is no adhesive involved) and the ropes are strictly through the binding and have nothing to do with holding the phonebooks together.
2. Ask for two volunteers and have them hold a rope on each end and pull at the same time in opposite directions.

3. Ask for some more volunteers to help pull the rope on each end, but make sure there are an equal number of volunteers on each rope. Eventually have everyone pull on one of the two ropes.
4. Tie one end around a tree and have everyone pull the other rope all at once. Encourage as many people to participate in this as possible.

Key Terms and Definitions

Friction	the force resisting the relative motion of two surfaces
Static Friction	the force keeping two stationery objects from moving
Kinetic Friction	occurs when two objects that are already moving, rub up against each other

Takeaway/Discussion:

1. Ask the audience why they think that happened? Why didn't the phonebook pull apart despite the number of increasing people pulling on it?
2. Ask "what is friction?" and "what are the different types?" Whether someone is able to answer or not, still explain the proper definitions and how it applies to the phonebook.
3. Explain other real-life situations and encounters which involve friction.

Activities

Activity 1 – Egg Drop (length = 1 hour 30 minutes)

Materials:

- Eggs
- Filler materials (paper towels, napkins, tissues, newspaper, cotton balls)
- Fastening materials (string, tape)
- Plastic cups
- Tools (scissors)

Preparation:

- Set up a kit for each group to use (limit the materials offered to them). The kit should contain the following:
    - 10 pieces of paper towels or newspapers
    - 5 tissues
    - 10 cotton balls
    - 2 plastic cups
    - 50 cm of tape
    - 50 cm of string
    - Pair of scissors

Procedure:

1. Demonstration: Drop an egg.
2. Explain the goal of the activity: Prevent the egg from cracking when dropped.
3. Briefly explain scientific method and designing process (further details in Takeaway/Discussion)
4. Give more detail instructions:
    a. Groups of 2-3 will get 30 minutes to construct their first design (but do not inform them that they will get another chance to refine/test their design).
    b. Spend 10 minutes dropping everyone's egg designs from the roof.
    c. Give the groups another 20 minutes to revise/re-design their designs.
    d. In the next 10 minutes, re-test everyone's designs.
5. Go through step 3 again, but provide the participants with fewer materials (about 1/3 less of all materials). Be sure to warn them to think about what they design first as their amount of materials is limited.
6. Throughout all these steps, ask them relevant scientific method questions as explained in the Takeaway/Discussion section.

Takeaway/Discussion:

- Briefly describe the scientific method and the design process
    - Creating, testing, analysing, refining, and re-testing
- Apply the scientific method to each group's design by asking them what the question is, what their hypothesis is, what the result is, what may have caused the result, and how they think they could improve their design to alter the results in the future.

Activity 2 – Bouncy Balls (length = 42 minutes)

Materials:

- Borax
- Corn starch (or corn flour)
- White or transparent glue
- Food colouring
- Warm water
- Measuring spoons
- Plastic spoons (to stir mixture)
- Small plastic cups
- Markers
- Plastic zip bags
- Plastic containers

Preparation:

- Put Borax, corn starch, and warm water into smaller plastic containers which will be situated at two different table stations
    - One station will be dedicated to the Borax, warm water, and food coloring
    - One station will be dedicated to the corn starch/flour and glue
- Each participant station should be set up with the following:
    - 2 plastic cups (one labelled "Borax Solution" and the other labelled "Ball Mixture")
    - 1 spoon
    - 1 plastic bag
- Remainder materials will be shared by everyone
- Print out copies of procedure (activity list) for each station

Procedure:

1. Pour **2 tablespoons warm water** and **1/2 teaspoon borax powder** into the cup labelled 'Borax Solution'. Stir the mixture to dissolve the borax. Add 2-3 drops of food colouring, if desired.
2. Pour **1 tablespoon of glue** and **1 tablespoon of corn flour** into the cup labelled 'Ball Mixture'. Mix thoroughly so there are no clumps.
3. Pour 'Borax Solution' into 'Ball Mixture' cup. Mix the clump of 'Ball Mixture' in the solution while it is still in the cup.
4. Afterwards, remove the ball mixture from the cup and start rolling the ball in your hands to form a sphere. The ball will start out sticky and messy, but will solidify as you knead it.
5. Once the ball is less sticky, go ahead and bounce it!
6. You can store your ball in a sealed plastic bag when you are finished playing with it.
7. Don't eat the materials used to make the ball or the ball itself. Wash your work area, utensils, and hands when you have completed this activity.

Key Terms and Definitions:

Mixture	material made up by 2 or mores substances which are physically mixed, but not chemically combined i.e., Chex Mix, sand/dirt, cereal and milk
Solution	homogenous mixture of 2 or more substances i.e., cake batter, salt water, household cleaners

Takeaway/Discussion:

- Briefly explain experiment process (i.e., different amounts and different ingredients can lead to different properties).

- Briefly explain how the Borax solution acted as the binder, the glue gave the ball its bounce, and the corn starch acted as the thickener.

Activity 3 – Physical Traits (length = 42 minutes)

Materials:

- Paper (printed pictures)
- Worksheets
- Writing utensils (pencils/pens/markers)

Preparation:

- Print out worksheets
- Print out sample pictures and hang up on walls as individual stations

Procedure:

1. Pass out worksheets to every participant.
2. Explain how there are different numbered stations which match the numbers on the worksheets. Participants will have to go to each station and write down the corresponding trait they have by referencing the pictures at each station.
3. Assign 2-3 participants per station and allow participants to stay at the station for about 2 minutes.
4. After every 2 minutes, have participants rotate stations until all stations are completed.
5. Gather everyone into a group for an ending discussion.

APPENDIX D: "MAGIC SCIENCE" PILOT PROGRAM BUDGET

The following consists of the materials used for the "Magic Science" Day. All purchased items were obtained at the local Big W, Cole's, and Bunnings Warehouse. Many of the more general materials (i.e., paper, writing utensils, workshop tools) were provided by the centre and its staff.

Table 16. Budget list of all materials used for the pilot program in Australian Dollars (AUD). Any items that were already provided have omitted costs.

Activity	Item	Cost per Item	Quantity	Total Cost of Item
Phonebook Rope Pull	Phonebook	$0.00	2	$0.00
	Drill	-	1	-
	Pulling rope	$4.90	1	$4.90
	Attachment rope	$8.86	1	$8.86
	Duct tape	$5.24	1	$5.24
	¼" Hex nut	$0.09	8	$0.72
	2" x ¼" Bolt	$0.30	8	$2.40
	¼" Flat washer	$0.06	8	$0.48
Egg Drop	Carton of eggs (12 pack)	$1.69	3	$5.07
	Paper towels (8 pack)	$6.98	1	$6.98
	Box of tissues	$0.88	1	$0.88
	Plastic cups (24 pack)	$1.00	2	$2.00
	Newspaper	-	-	-
	Bag of cotton balls	$3.86	2	$7.72
	Tape	$4.62	1	$4.62
	Pack of string	$5.64	1	$5.64
	Scissors	$1.88	5	$9.40
Bouncy Ball	Borax container	$6.98	1	$6.98
	Box of corn starch (corn flour)	$1.95	1	$1.95
	Bottle of white glue	$5.36	2	$10.72
	Food colouring set	$3.49	1	$3.49
	Set of measuring spoons	$2.94	2	$5.88
	Plastic cups (24 pack)	$1.00	3	$3.00
	Box of plastic spoons (24 pack)	$1.00	2	$2.00
	Box of plastic bags	-	1	-
Physical Traits	Pencils/pens/markers	-	20	-
	Paper	-	-	-
TOTAL COST				$98.93

APPENDIX E: DETAILED ACTIVITIES OF SCIENCE PROGRAM FRAMEWORK

UNIT 1: Wow Factors

Planet Distance Activity

Activity Type: Wow Factor
Topic: Stars, galaxy, and the universe
Duration: 5-10 Minutes

Materials:

- Measuring device
- Flash cards
- Marker

Preparation:

Distances of each planet from the sun:

Planet	Distance from the sun (x million)	Distance in cm	Distance in metres
Mercury	57.9 Km	57.9 cm	.0579 m
Venus	67.2 Km	67.2 cm	.0672 m
Earth	149.6 Km	149.6 cm	.1496 m
Mars	227.9 Km	227.9 cm	.2279 m
Jupiter	778.3 Km	778.3 cm	.7783 m
Saturn	1,427.0 Km	1427.0 cm	1.427 m
Uranus	2871.0 Km	2871.0 cm	2.871 m

Neptune	4497.1 Km	4497.1 cm	4.4971 m
Pluto	5913 km	5913.0 cm	5.913 m

Procedure:

5. Choose one volunteer to be the Sun
6. Choose one volunteer for each planet
7. Have them stand the appropriate distance away from the sun
8. Point out the fact that the distances are drastically scaled down

Key Terms and Definitions:

Orbit The curved path, usually elliptical, described by a planet, satellite, spaceship, etc., around a celestial body, as the sun

Planet Also called a major planet. Any of the eight large heavenly bodies r evolving about the sun and shining by reflected light

Solar System The Sun together with all the planets and other bodies that revolve around it

Milky Way The spiral galaxy containing our solar system. With the naked eye it is observed as a faint luminous band stretching across the heavens, composed of approximately a trillion stars, most of which are too distant to be seen individually.

Takeaway/Discussion:

4. Ask which planet will each student weigh more on, Earth or Jupiter? Earth or Mercury? Why? Jupiter because it its gravitational force is more (mass times acceleration which will be more on a bigger planet). Mercury because its gravitational force is less (mass times acceleration which will be less on a smaller planet)
5. How long is one day on Venus? 243 days! Because the rate at which Venus spins on it's own axis is much slower.
6. Does a year get longer or shorter the farther away from the sun you travel? Longer because it takes longer to make one rotation around the sun

Career Connection:

Planetary scientist A scientist who studies planets, moons, and planetary systems

Astronomer A scientist who studies celestial bodies such as planets, stars and galaxies

Information found from:

http://www.enchantedlearning.com/subjects/astronomy/planets/

Definitions extracted from:

http://en.wikipedia.org

http://dictionary.reference.com/

Hot and Cold

Activity Type: Wow Factor
Topic: The Human Body
Duration: 10 minutes

Materials:

- 3 bowls
- Water (warm, cold, and room temperature) – enough water to fill bowls

Preparation:

1. Fill each bowl with water. There should be a bowl filled with warm water, another with cold water, and the third with room temperature water.
2. Set the bowls up on a station/table so the bowls were arranged left to right as follows: warm, room, temperature, and cold.
3. ***NOTE***: *You may have multiple stations of this setup if there is a larger student audience.*

Procedure:

1. Explain the setup of the bowls to the children and how each bowl has either warm, cold, and room temperature water.
2. Have one student at a time try this activity. The student should place his/her left hand in the left bowl of cold water and at the same time, place his/her right hand in the right bowl of cold water.
3. After the student's hands are in the bowls of water for about 30 seconds, he/she should place both hands into the middle bowl of room temperature water. Have the students observe the temperature differences before and after moving their hands from the outer bowls to the middle bowl.

Takeaway/Discussion:

1. Ask the students how their left hand felt in the left (warm water) bowl and then how that same hand felt when moved into the middle (room temperature water) bowl. Ask them how their right hand felt moving from the right (cold water) bowl to the middle (room temperature bowl).
2. Ask the students why they think their left hand felt cold in the room temperature water, but their right hand felt warm in that same room temperature water.
3. Explain how hot and cold are just ways of comparing what we are used to with what we are feeling. In this activity, their left hand was used to the warm water in the left bowl, so the room temperature water, which was cooler than the warm water, caused their left hand to feel cold. Meanwhile, their right hand was used to the cold water in the right

bowl, so the room temperature water, which was warmer than the cool water, caused their right hand to feel warm.

4. Start a group discussion by asking the students if they can think of any other situations which they noticed different temperature changes that were dependent on their own temperature. A few examples could include the following:
    a. Moving in and out of a pool – Before going into the pool, you may feel comfortable, then cold upon entering the pool. After a period of time, you will get used to the water and feel warm again, but then cold again upon exiting the pool.
    b. When taking a bath or shower – the bathroom air feels different before entering the shower and exiting the shower.

Experiment adapted from:
http://www.netplaces.com/kids-science-experiments/the-human-body/try-this-hot-and-cold.htm

Exploding Plastic Bag

Activity Type: Wow Factor
Topic: Elements, compounds, and chemical reactions
Duration: 3-5 minutes

Materials:

- Plastic Ziploc freezer bag
- Baking soda
- Warm water
- Vinegar
- Measuring cup
- 1 tissue

Preparation:

1. Measure out ¼ cup of warm water
2. Measure out ½ cup of vinegar
3. Measure out 3 teaspoons of baking soda

Procedure:

1. Put the warm water into the plastic bag
2. Add the vinegar to the water in the bag
3. Pour the baking soda into the middle of the tissue and wrap the tissue up
4. Zip up the bag just far enough so you can fit the tissue in it
5. Put the tissue with the baking soda in the bag and quickly zip the bag up completely sealing the bag shut
6. Put the bag down and step back

Key Terms and Definitions:

Acid	A compound usually having a sour taste and capable of neutralizing alkalis and reddening blue litmus paper, containing hydrogen that can be replaced by metal or an electropositive group to form a salt
Base	A chemical compound that combines with an acid to form a salt and water. A solution of a base and in water turns litmus paper blue, produces hydroxyl ions, and has a pH greater than 7.
Carbon dioxide	A colourless, odourless, incombustible gas,CO_2, present in the atmosphere and formed during respiration, usually obtained from coal, coke, or natural gas by combustion

Takeaway/Discussion:

1. What happened? Why?

2. Examples of different types of acids? Lactic acid(milk), citric acid(orange juice), hydrochloric acid(stomach fluid), acetic acid(vinegar), sulphuric acid (batteries)
3. Examples of different types of bases? Sodium bicarbonate (baking soda), ammonia, sodium hydroxide (drain cleaner)

Career Connection:

Chemist	One trained in chemistry
Chemical engineering	Engineering dealing with the industrial application of chemistry

Experiment adapted from:

http://www.sciencebob.com/experiments/bagbomb.php

Definitions adapted from:

http://dictionary.reference.com/
http://www.merriam-webster.com/

UNIT 2: COMPETITIONS

Soda Bottle-Rocket Launcher

Activity Type: Competition
Topic: Stars, galaxy, and the universe
Duration: 2 hours

Materials:

- See attached PDF file

Preparation:

1. See attached PDF file

Procedure:

1. See attached PDF file
2. Have the kids experiment with how much water they want to put into the bottle. Let them discover the most efficient amount.

   Alternative – shoot the rockets off at different angles with fixed amount of water to discover what angle provides optimal distance.

Key Terms and Definitions:

Rocket	Any of various simple or complex tubelike devices containing combustibles that on being ignited liberate gases whose action propels the tube through the air
Combustion	the act or process of burning
Outerspace	space beyond the atmosphere of the earth

Takeaway/Discussion:

See attached PDF file

Career Connection:

Aerospace Engineer	The branch of engineering that deals with the design, development, testing, and production of aircraft and related systems and of spacecraft, missiles, rocket-propulsion systems, and other equipment operating beyond the earth's atmosphere
Astronaut	a person engaged in or trained for spaceflight

Experiment adapted from:

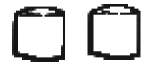
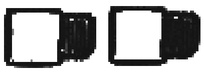
http://users.soe.ucsc.edu/~karplus/abe/soda-bottle-rocket.pdf

Definitions extracted from:

http://dictionary.reference.com/

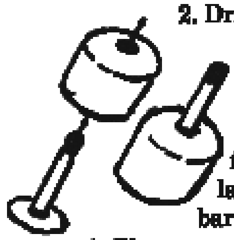
How to make a soda-bottle rocket launcher

You need

- about 6' (2 meters) of 1/2" PVC water pipe
- plumbing connectors for 1/2" PVC pipe:
  - 1 tee (two glue connections and one female thread connection) 
  - 1 elbow (two glue connections) 
  - 2 end caps (glue connections) 
  - 2 male-thread adapters 
- 1 valve stem (cut out of an old inner tube or bought at an auto parts store) 
- Barge cement or bathtub sealer
- PVC pipe glue
- some electrical tape
- 1-liter or 2-liter plastic soda bottles for rockets
- a bicycle pump with a hose (preferably a floor pump).

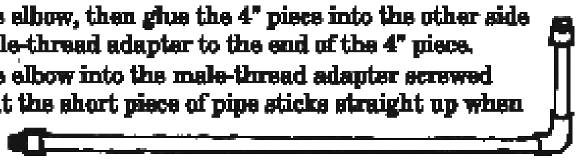
To build

1. Cut the pipe into 4 pieces, approximately 3' (1 meter), 1' (30cm), 1'(30cm), and 4"(10cm)—exact lengths don't matter.



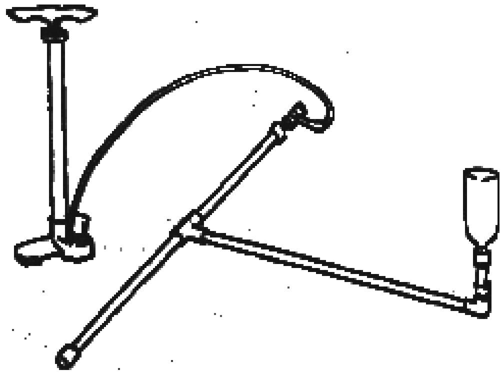
2. Drill a hole in the center of one of the end caps, large enough to put the valve stem through. Put some barge cement (or bathtub sealer) on the base of the valve stem to glue the valve stem to the end cap from the inside.
3. Use the PVC glue to glue the two 1' pieces of PVC into the tee to form the top bar of the final T-shaped launcher. Glue an end cap on each end of this bar. Screw one of the male-thread adapters firmly into the base of the tee.

4. Glue one end of the 3' pieces into the elbow, then glue the 4" piece into the other side of the elbow, and glue the remaining male-thread adapter to the end of the 4" piece.
5. Glue the other end of long piece with the elbow into the male-thread adapter screwed into the base of the tee, making sure that the short piece of pipe sticks straight up when the tee is laying flat on the ground.



6. After the glue has all dried, wrap a couple of turns of electrical tape around the exposed male-threads, to make a good friction fit when a soda bottle is screwed on.

To use



1. Make sure the long pipe is firmly screwed into the base of the tee, and the short pipe sticks straight up when the tee is flat on the ground. (The launcher can be unscrewed at the tee for easier storage and carrying.)
2. Connect a bicycle pump to the valve stem.
3. Fill a soda bottle about 1/4 full of water.
4. Screw the water bottle onto the exposed male-thread adapter, trying not to spill too much of the water.
5. Pump the pump until the pressure in the bottle causes it to shoot off of the launcher (about 30 pounds/square inch).

Questions and Experiments (not just for kids)

- Where should we stand to be able to watch the rocket without looking into the sun?
- How can we estimate how high the rockets go? How could we measure it more precisely?
- Do larger or smaller soda bottles go higher?
- Does the launcher work with no water in the bottles?
- Does the launcher work if the bottles are filled completely full of water?
- What amount of water gives the highest flight?
- How could we redesign the launcher to get higher pressure in the bottles before they took off?
- How could we modify the soda bottles to get longer or higher flights?
- How can we estimate or measure the speed of the rocket as it leaves the launcher?

Safety Notes

Rockets go up 30 feet (10m), so do not launch the rockets indoors! The rockets are very light and pose no real hazard coming down, but they have a lot of water in them and are moving fast as they leave the launcher, and so observers should stand well back when the rocket is being pumped up. No one should start pumping until everyone else is several feet back. The rocket should always be shot straight up. Children under 10 should not use the rocket launcher without adult supervision.

There are reports on the web of soda-bottle rockets exploding, but these reports refer to a different launcher design, where the bottle is locked to the launcher. The friction-fit launcher used here will release before pressure builds up enough to be dangerous.

Great Australian Bone Off

Activity Type: Competition
Topic: The Human Body
Duration: 1-2 hours

Materials:

- Human skeleton (all 206 bones)
- Piece of lined paper
- Pencil/paper

Preparation:

1. Place the bones, all mixed up, on tables around a room.
2. Create a small sheet with a number (1-206) and a short description of what the bone does.
3. Have the kids number a sheet of paper 1-206.
4. Have a large picture of a skeleton with each bone labelled, but without a description.

Procedure:

1. Have the kids walk around and examine each bone.
2. Using the description on the bone, write down the name of the bone under the corresponding number on the piece of paper.
3. First student to get them all correct wins some sort of prize.
   Alternative – person to get the most correct wins the prize.

Key Terms and Definitions:

Bone	One of the structures composing the skeleton of a vertebrate
Skeleton	The bones of a human or animal considered as a whole, together forming the framework of the body
Osteoblasts	A bone-forming cell

Takeaway/Discussion:

1. What does the skeleton do? Gives the body structure rigidity
2. How many bones does a normal adult have? 206
3. How many phalanges do you have in your hands and feet? 56 total
4. What bones in the body is the biggest? Smallest? Femur, Stapes

Career Connection:

Doctor	A person licensed to practice medicine, as a physician, surgeon, dentist, or veterinarian

Orthopedics	The medical specialty concerned with correction of deformities or functional impairments of the skeletal system
Orthopedic	A specialized type of surgeon who performs surgery to the muscles and bones

Definitions extracted from:

http://dictionary.reference.com/

Inflating Balloon

Activity Type: Competition
Topic: Elements, compounds, and chemical reactions
Duration: 30 minutes

Materials:

- Vinegar
- Baking soda
- 2-litre soda bottle (for each student)
- Measuring cups and spoons
- Balloons

Preparation:

1. Set up individual stations for each participant. Each station should contain the following:
   a. A 2-litre soda bottle
   b. 1 balloon
2. Set up a main station where all participants will have to go to in order to obtain vinegar and baking soda.
3. Set up a demonstration station that will be utilised at the beginning of the activity. It should contain the following:
   a. 2-litre soda bottle
   b. 1 balloon
   c. Measuring cups and spoons
   d. Vinegar
   e. Baking soda

Procedure:

1. Start the activity off with a demonstration at the corresponding station:
   a. Place a few tablespoons of baking soda into the bottom of the soda bottle.
   b. Fill the bottle with 1 cup of vinegar.
   c. Quickly place the balloon over the open top of the soda bottle.
2. The balloon should inflate after the demonstration. Tell the students that they will attempt to do the same and that they will compete as to who can inflate their balloon the most.
3. Tell the students that each student will receive a soda bottle and balloon, but the amount of vinegar and baking soda they get will be limited. Each student will receive a total of 1 cup of vinegar and baking soda combined, but it is up to the student to decide how to divide that total 1 cup between the vinegar and baking soda (i.e., a student could choose to have ¾ cup of vinegar and ¼ cup of baking soda so the total is 1 cup). The student

must decide as to whether he or she wants more vinegar or more baking soda. DO NOT let the students know how much you used during the demonstration.

4. After the students obtain their 1 cup of vinegar and baking soda combined (provided by the instructor) from the main station, then they can return to their stations with their supplies.
5. Have the students label their soda bottles with their name and instruct them to ONLY put their BAKING SODA into the bottle and to leave the vinegar to the side.
6. Have the students line up their soda bottles in a row on the floor or on a long table. Keep the soda bottles
7. On your count, have the students fill their respective bottles with vinegar and quickly cover the bottle top with their balloon. After putting the balloon on the bottle, the students should step aside quickly.
8. Observe and determine which balloon inflated the most amongst all the students.

Key Terms and Definitions:

Acid	a compound usually having a sour taste and capable of neutralising alkalis and reddening blue litmus paper, containing hydrogen that can be replaced by a metal or electropositive group to form a salt
Sodium Bicarbonate	a white, crystalline, water-soluble solid, in powder of granules, $NaHCO_3$, usually prepared by the reaction of soda ash with carbon dioxide, or obtained from the intermediate product of the Solvay process
Chemical reaction	a process that involves changes in the structure and energy content of atoms, molecules, or ions, but not their nuclei

Takeaway/Discussion:

1. Ask the students what happened when the vinegar and baking soda were combined?
2. When vinegar (acid) and baking soda (sodium bicarbonate) are combined, the two components chemically react by producing carbon dioxide gas. The bicarbonate gas is visually seen by the inflation of the balloon.
3. Ask the students what combination caused the largest inflation? Did having more vinegar or more baking soda cause it? What combination caused the smallest inflation?

Career Connection:

Chemists (specifically for chemistry, not pharmacy) work with chemical reactions on a daily basis. Whether it be for the development of new solutions, compounds, or mixtures, chemists must understand the basic chemical reactions upon combining different substances.

Experiment adapted from:

http://www.ehow.com/info_8659054_basic-kidfriendly-chemistry-reaction-experiments.html

Definitions extracted from:
http://www.dictionary.com

UNIT 3: WORKSHOPS/LABS

Build Your Own Solar System

Activity Type: Workshop/labs
Topic: Stars, galaxy, and the universe
Duration: 2 hours

Question: Have you ever wondered what the solar system looks like?

Materials per student:

- Two 4 ½” Styrofoam® Rings
- One each Styrofoam® balls
  (1", 2", 2 ½", 3", 4", 6")
- 2 each Styrofoam® balls
  (1 ¼”, 1 ½”)
- 12" x 36" Styrofoam® rectangle
- Acrylic paint
  (Bright Yellow, Black, Orange, Blue Danube, Ultra Blue, Christmas Green, Bright Red, Village Green, Nectar Coral, Terra Cotta, Seminole Green and Purple)
- 2 Wood dowel rods 36" x 1/8”
- Paint brushes
- Toothpicks
- Rulers
- Craft snips
- Tacky glue
- Paper plates
- Tape
- Little pieces of paper

Preparation:

1. Purchase materials.
2. Cut the dowel rods to the lengths shown on the chart below.
3. Set up one table per student. Place the above materials on each table. For shared materials—paint, glue, rulers—place those on a common shared table in the middle. Have the students share the rulers. Have the students put some paint and glue on their paper plates to bring back to their stations.

Procedure:

1. Paint the cut dowel rods Black and stand them in a Styrofoam sheet to dry.

2. Using the chart as a guide, glue the cut dowels into the corresponding Styrofoam balls then paint each ball. When two colors are given paint the ball with the first color, let it dry then dab on spots of the second color with your finger.
3. Glue the sun to the black ring and the coral ring around Saturn.
4. Place a rubber band around the sun about 21/2" above the base. This will be your guide for placing the planets. Starting with Mercury, glue the dowels into the sun about 1" below the rubber band. Remove the rubber band when all of the planets are attached.
5. Using tape, small pieces of paper, and toothpicks, have the students create labels for their planets.
6. Students can bring their new creation home!

Planet	**Size of Ball**	**Color**	**Dowel Length**
Sun	6"	Bright Yellow	
(Ring for Base)		Black	
Mercury	1"	Orange	2 1/2"
Venus	1 1/2"	Deep Danube	4"
Earth	1 1/2"	Ultra Blue/Christmas Green	5"
Mars	1 1/4"	Bright Red	6"
Jupiter	4"	Orange	7"
Saturn	3"	Village Green/Nectal Coral	8"
Saturn's Ring		Nectar Coral	
Uranus	2 1/2"	Terra Cotta/Seminole Green	10"
Neptune	2"	Seminole Green/Terra Cotta	11 1/2"
Pluto	1 1/4"	Purple	14"

Key Terms and Definitions: *(if applicable)*

Planet any of the eight large heavenly bodies revolving about the sun and shining by reflected light: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, or Neptune, in the order of their proximity to the sun.

Solar system the system containing the sun and the bodies held in its gravitational field, including the planets

Takeaway/Discussion:

1. This is a model of our Solar System, picturing the Sun and the eight planets and dwarf planet that orbit it: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto (a dwarf planet).
2. Nicolaus Copernicus (1473-1543) was a Polish astronomer who developed the Copernican system, a model of the solar system in which all the planets orbit the Sun.

(Facts obtained from:
http://www.enchantedlearning.com/crafts/astronomy/solarsystemmodel/)

Ways to Expand the Activity:

1. Have students take out the toothpick labels and try to name the planets.
2. Have the students try to name the planets in order while pointing to them on their models.
3. Have the students pick a planet and go onto the computer and research a planet and then share it with the group.

Career Connection:
Astronomers and Physicists are scientists who study stars, planets, and the Universe, ranging from the vastness of space to the smallest of subatomic particles. They develop new technologies, methods, and theories based on the results of their research that deepen our understanding of how things work and contribute to innovative, real-world applications. In order to help them conduct their research, astronomers and physicists will make models, some of which are models of the solar system with precise model measurements, very similar to the ones that you created in this activity! (Definition obtained from: http://www.bls.gov/ooh/Life-Physical-and-Social-Science/Physicists-and-astronomers.htm)

Experiment adapted from:
http://www.craftsforkids.com/projects/real_solar_system.htm

Definitions extracted from:
http://dictionary.reference.com/browse/planet?s=t
http://dictionary.reference.com/browse/solar+system?s=t

Deep Breath

Activity Type: Workshop/Labs
Topic: The Human Body
Duration: 1 hour

Question: How much air can my **lungs** hold?

Materials:

- Large, empty 1-gallon glass jar
- 32-ounce (quart) glass jar
- Water
- Large flat container, for example, an aquarium
- Permanent marker
- 3 flat stones or other flat items
- Sink or location that can get wet
- 18 to 24 inches of rubber tubing per student
- Sheets of paper
- Dry-erase markers
- Pencils

Preparation:

1. Purchase materials.
2. Fill the large jar by repeatedly filling the 32-ounce jar with water and emptying it into the large jar.
3. After each quart of water is added, make a mark on the jar indicating the height of one quart.
4. Fill the aquarium about three-quarters full of water and place the stones in a circle on the bottom.
5. Place the aquarium in the sink. Carefully turn the large jar over and place it on the stones on the bottom of the aquarium. Don't worry if some water spills out.
6. Set up a table in the middle of the room. Put the aquarium in the middle of the table. Place the dry erase markers and rubber tubing next to the aquarium so the students can reach these materials during the activity.
7. Put the sheets of paper at both ends of the tables so that after the activity is completed the students can mark down their initial and resulting marks on their paper.

Procedure:

1. Students will need to form a semi-circle around the table to watch each other do this activity.
2. Have the first student mark the initial water level in the jar. This will be the starting point.
3. Place one end of the rubber tubing into the aquarium and under the mouth of the jar. Let the other end hang over the side of the aquarium.
4. Take a deep breath and blow into the free end of the rubber tubing.
5. Measure the resulting mark of the water in the jar.
6. Subtract the original mark to find your lung capacity in quarts.
7. Have the other students' complete steps 2-6.
8. If time permits, have the students try the activity two or three times to see if they can improve their lung capacity.

Key Terms and Definitions: *(if applicable)*

Lungs	a pair of breathing organs located with the chest which remove carbon dioxide from and bring oxygen to the blood.
Lung Capacity	the total volume of air that the lungs are able to hold

Takeaway/Discussion:

1. When you blow air out of your lungs and into the jar, it replaces some of the water. The water level will rise in the aquarium. You can measure how much air was added to the jar to see how much air your lungs held. Try this experiment again and see if you can improve your results.

Ways to Expand the Activity:

1. Have the students compare their lung capacities. Are there any observable trends—do girls or boys have larger lung capacities? Do older or younger students have larger lung capacities?
2. They can collect results from each other and make a graph from it.
3. If the students are older, they can each make their own lab set-up.
4. Discussion—Ways to increase your lung capacity: http://www.wikihow.com/Increase-Your-Lung-Capacity

Career Connection:

A pulmonologist is a physician who specializes in the diagnosis and treatment of respiratory disorders. This doctor often uses a device called a **spirometer (speh-ROM-et-er)** to check patients' airways. This test is called **spirometry (speh-ROM-eh-tree)**. The test measures how much air and how fast he/she can blow air out of his/her lungs after taking a deep breath. This device does the performs the same duty as that we did in this activity! (Definitions obtained from: medical-dictionary.thefreedictionary.com/pulmonologist

Fun Fact:

Swimmer, Amy van Dyken, won four gold medals at the 1996 Olympic Games in Atlanta despite having only 65% of the lung capacity of an average person due to asthma.

Experiment adapted from:

http://www.netplaces.com/kids-science-experiments/the-human-body/try-this-deep-breath.htm

Definitions extracted from:

www.medterms.com/script/main/art.asp?articlekey=4209
http://www.patientlinx.com/asthmacopd/asthmadiagnosis.cfm
http://medical-dictionary.thefreedictionary.com/pulmonologist

Make Your Own Bouncy Ball

Activity Type: Workshop/Labs
Topic: Elements, compounds, and chemical reactions
Duration: 45 minutes

Materials:

- Borax
- Corn starch (or corn flour)
- White or transparent glue
- Food colouring
- Warm water
- Measuring spoons
- Plastic spoons (to stir mixture)
- Small plastic cups
- Markers
- Ziplock bags (plastic bag)
- Plastic containers

Preparation:

- Put Borax, corn starch, and warm water into smaller plastic containers which will be situated at two different table stations
    - One station will be dedicated to the Borax, warm water, and food coloring
    - One station will be dedicated to the corn starch/flour and glue
- Each participant station should be set up with the following:
    - 2 plastic cups (one labelled "Borax Solution" and the other labelled "Ball Mixture")
    - 1 spoon
    - 1 plastic bag
- Remainder materials will be shared by everyone
- Print out copies of procedure (activity list) for each station

Procedure:

1. Pour **2 tablespoons warm water** and **1/2 teaspoon borax powder** into the cup labelled 'Borax Solution'. Stir the mixture to dissolve the borax. Add 2-3 drops of food colouring, if desired.
2. Pour **1 tablespoon of glue** and **1 tablespoon of corn flour** into the cup labelled 'Ball Mixture'. Mix thoroughly so there are no clumps.
3. Pour 'Borax Solution' into 'Ball Mixture' cup. Mix the clump of 'Ball Mixture' in the solution while it is still in the cup.

4. Afterwards, remove the ball mixture from the cup and start rolling the ball in your hands to form a sphere. The ball will start out sticky and messy, but will solidify as you knead it.
5. Once the ball is less sticky, go ahead and bounce it!
6. You can store your ball in a sealed plastic bag when you are finished playing with it.
7. Don't eat the materials used to make the ball or the ball itself. Wash your work area, utensils, and hands when you have completed this activity.

Key Terms and Definitions:

Mixture material made up by two or more substances which are physically mixed, but not chemically combined
i.e., Chex Mix, sand/dirt, cereal and milk

Solution homogenous mixture of 2 or more substances
i.e., cake batter, salt water, household cleaners

Takeaway/Discussion:

- Briefly explain experiment process (i.e., different amounts and different ingredients can lead to different properties).
- Briefly explain how the Borax solution acted as the binder, the glue gave the ball its bounce, and the corn starch acted as the thickener.

Experiment Adapted from:
http://chemistry.about.com/od/demonstrationsexperiments/ss/bounceball.htm)

UNIT 4: FIELD TRIPS

Escape From Andraxus (Scienceworks)

Activity Type: Field Trip
Topic: Stars, galaxy, and the universe
Location: Scienceworks
Duration: 45 minutes (show-time)

Pricing:

Registered applicants- wave booking fee
Unregistered: $22 booking fee

1 to 8 teacher to student ratio =	$4.15 per student
	$16.00 for every adult if over the 1 to 8 ratio

Show description:

This show discusses how stars are made, what they do in the universe and how they are destroyed.

Key Terms and Definitions:

Red Giant	A star in an intermediate stage of evolution, characterized by a large volume, low surface temperature, and reddish hue
Supernova	The explosion of a star, possibly caused by gravitational collapse, during which the stars luminosity increases by as much as 20 magnitudes
Constellations	any various group of stars to which definte names have been given, as Ursa Major, Ursa Minor, Bootes, Cancer, Orion
Nebula	A cloud of interstellar gas and dust

Takeaway/Discussion:

1. Where are stars born? *Nebula*
2. Is our sun a star? *Yes, a red giant (type of star)*
3. The closest star to the earth other than the sun is…? *Proxima Centauri*
4. Can anyone name a constellation?
5. Which constellation is on the Australian National flag? *Southern Cross*

Career Connection:

Astrologist	A scientist who studies celestial bodies such as planets, stars and galaxies
Astrophysicist	A scientist who studies the physics of the universe
Astronaut	A person trained in human spaceflight

Cosmologist	Scientists that try to understand the origin, evolution, structure and ultimate fate of the universe

Experiment adapted from:

http://museumvictoria.com.au/planetarium/whatson/escape-from-andraxus/

Definitions extracted from:

http://dictionary.reference.com/

Measuring Heart Rate

Activity Type: Field Trip
Topic: The Human Body
Location: Public Swimming Pool
Duration: day activity (length can vary)

Materials:

- Timer or watch
- Paper/worksheets
- Pencils or pens

Preparation:

1. Print the following table out for each participating student to fill out throughout the activity (add more rows if necessary):

Activity	**Number of beats for 10 seconds**	**Heart rate (beats per minute)**
Example:	*11*	*11* **x 6** *= 66*
At rest		__ **x 6** = __
		__ **x 6** = __
		__ **x 6** = __
		__ **x 6** = __
		__ **x 6** = __

Procedure:

1. Before the students go into the pool, have them practice measuring their pulse as follows:
   a. Turn the palm side of your hand facing up.
   b. Place your index and middle fingers of your opposite hand on your wrist approximately 3 cm below the base of your hand.
   c. Press your fingers down in the grove between your middle tendons and your outside bone. You should feel a throbbing – your pulse. Students may require extra assistance with detecting the pulse.
   d. Count the number of beats for 10 seconds, then multiply this number by 6. This will give you your heart rate for a minute. All of this can be written on the worksheets/tables provided. Have the students write their numbers during this practice run under the "At rest" activity row. (*For example: If you count **11 beats** in the span of **10 seconds**, multiply **11 x 6 = 66**. This means your heart rate, or pulse, is **66** (or 66 beats per minute).)*
2. After all the students have measured their heart rate at rest, allow them to go swim in the pool. Have them measure their pulse again in the middle of and after performing various activities whether it is just swimming around the pool, swimming a lap, playing a water game, etc.

Key Terms and Definitions:

Pulse or Heart Rate	rhythmical throbbing of the heart; rate at which the heart beats
Resting heart rate	a heart range in the normal range of 60-90 BPM (beats per minute)

Takeaway/Discussion:

1. At the end of the day/session at the pool location, have the students compare and look over their different heart rates for different activities. Ask them if they notice any patterns. Do certain activities cause a higher heart rate than others? Why do they think that is the case? The students should notice that the more intense the activity, then the higher the heart rate was for them.

Ways to Expand the Activity:

1. Change the location and active activity. Try going to a playground and have the students test their pulse and breathing after playing. Or try having the students race against one another or possibly even jump rope for a long period of time.

Career Connection:

Doctors, nurses, veterinarians, amongst other medical-related measure the heart rates of the living organisms (i.e., humans and animals) which they work with. It is necessary in keeping the patients stable and understanding their body's current status in terms of well-being.

Cardiologists are doctors with a medical specialty concerning the conditions of the heart. They examine, diagnosis, and treat various heart disorders, and measuring a patient's heart rate is one of many factors which contribute to the diagnosis of a heart disorder.

Experiment adapted from:
http://www.nemahealth.org/programs/healthcare/heart_rate_pulse.htm

Cool Stuff (Scienceworks)

Activity Type: Field Trip
Topic: Elements, compounds, and chemical reactions
Duration: 30 minutes (show-time)

Pricing:
$3.30 per student plus education service fee

Key Terms and Definitions:

Solid	having three dimensions (length, breadth, and thickness), as a geometrical body or figure
Liquid	composed of molecules that move freely among themselves but do not tend to separate like those of gases
Gases	a substance possessing perfect molecular mobility and the property of indefinite expansion, as opposed to a solid or liquid

Takeaway/Discussion:

What's the difference between a solid and liquid? Solid has a definite shape and liquid takes the shape of its container.

Examples of Solids? Liquids? Gases?

Career Connection:

Chemist One trained in chemistry

Experiment adapted from:

http://museumvictoria.com.au/scienceworks/education/education-programs/cool-stuff/

Definitions extracted from:

http://dictionary.reference.com/

UNIT 5: CAREER EXPLORATION

Career Fair

One aspect of our fifth unit, Career Exploration, would be to set up a science-related career fair at Banksia Gardens. This event would bring multiple professionals in the field to Banksia Gardens Community Centre to speak briefly about what it is they do on a daily basis that relates to science. The purpose of this type of activity is for students to see, first hand, people working in scientific fields as well as how interesting and exciting a career in science can be.

Science Professional

Another aspect of the career explorations unit would be to have one science professional come in and give a general outline as to what it is he/she does on a daily basis. In our findings, we state that most kids see becoming a scientist is unattainable because they do not have someone to motivate them. This science professional could be the motivator and give the students tangible evidence that becoming a scientist of any kind can be achieved.

Job Shadow

The final career exploration activity would be to attempt to set up some sort of job shadowing program. This program would allow students to go work with a scientist for a day to get an idea of what it is that they do on a daily basis. This could not only show the students that becoming a scientist might not be as unattainable as perceived, but also give them an idea of what type of scientist they would like to become (i.e., work in a laboratory, with an engineering company, or out in the world making observations).

APPENDIX F: ADDITIONAL RESOURCES FOR SCIENCE PROGRAM FRAMEWORK

The following is a list of activity topic ideas for each unit of the program framework (wow factors, competitions, labs/workshops, field trips, and career exploration). Under each activity is a corresponding brief description and a supporting resource.

UNIT 1: Wow Factors

Diet Coke and Mentos

Drop a few pieces of Mentos into a bottle of Diet Coke and watch the bottle erupt!

Resource:

http://www.sciencekids.co.nz/experiments/dietcokementos.html

Lactic Build-up and Fatigue

Have students open and close their fists as hard and as fast as they can for a few minutes until they can feel the fatigue setting in.

Resource:

http://www.accessexcellence.org/AE/AEPC/WWC/1991/anatomy.php

Magic ketchup experiment

Students squeeze and release a bottle filled with water and a ketchup bag to see the bag sink and rise on command

Resource:

http://www.sciencebob.com/experiments/magic_ketchup.php

Optical illusions

Take a look at these many optical illusions and be amazed!

Resource:

http://www.sciencebob.com/experiments/illusions.php

Make a paperclip float

Solid metal objects shouldn't float in water. Watch as this experiment shows how to get to a paperclip to float

Resource:

http://www.sciencebob.com/experiments/paperclip.php

UNIT 2: COMPETITIONS

Gum-drop Bridge

Students construct bridge structures with only gumdrops and toothpicks (or pasta). Which students can make the strongest bridge? The longest? The highest? Etc.

Resource:

http://www.exploratorium.edu/science_explorer/geo_gumdrops.html

Human Body Cake

Students design their own representation of a randomly selected organ of the body with a flat piece of cake, frostings, food colouring, and candies.

Paper Tower

Students build the highest stand-a-lone tower possible with only 1-2 pieces of paper and 20 cm of tape.

Resource:

https://sjeyh.org/ThePaperTower.pdf

Paper Airplane

Students fold their own paper airplanes with varying designs. Which planes will fly the farthest? The highest? The longest? Etc.

Resource:

http://www.experiment-resources.com/paper-airplane-experiment.html

Garbage Sailboat

Students design and build a sailboat out of common trash pieces and race them in water to see which design works best

Resource:

http://www.optistuff.com/info/faq/articles/Teach%20Sailing%20the%20Fun%20Way%20Activity%20Guide%20Draft%5B1%5D.pdf

UNIT 3: LABS/WORKSHOPS

Baking Soda Volcano

Students create a volcano structure out of paper machete with a centre consisting of baking soda. The addition of vinegar to the baking soda will cause the volcano to erupt.

Resource:

http://www.utextension.utk.edu/4h/centersandcamping/resources/jrcamp09/Volcano/Build_Volcano.pdf

Balloon Breathing

Students use balloons to measure their vital capacity, and they can compare the circumference of their own balloons amongst each other.

Resource:

http://www.accessexcellence.org/AE/AEPC/WWC/1991/anatomy.php

Deceptions of the Eyes

Students learn about the tricks their eyes may play on them in terms of complementary colours and optical illusions

Resource:

http://www.netplaces.com/kids-science-experiments/the-human-body/try-this-cyan-black-and-yellow.htm

Invisible Ink

Use lemon juice as invisible ink that is only visible underneath a black light.

Resource:

http://www.sciencekids.co.nz/experiments/invisibleink.html

Planet Cross-section

Students construct a planet cross-section out of clay to better understand geology and the Earth. Students roll a ball of clay with multiple layers of different colours and label the different sections of the Earth.

Resource:

http://web.ics.purdue.edu/~braile/edumod/threedearth/threedearth.htm

Pulse Indicator

Students create their own pulse indicator with only a thumb-tack and matchstick.

Resource:

http://www.sciencefair-projects.org/human-body-projects/pulse-indicator.html

Reaction Times Based on Gender

Determine if boys or girls have a quicker reaction time by having students quickly react and catch a falling meter stick.

Resource:

http://www.selah.k12.wa.us/SOAR/SciProj2000/AshleyD.html

Tasteless Medicine

While plugging or holding their nose, students eat various food items and attempt to guess what the item is based on taste, but it should be quite difficult for the students as the food will taste bland.

Resource:

http://www.netplaces.com/kids-science-experiments/the-human-body/try-this-tasteless-medicine.htm

Tornado in a Bottle

Students make a tornado in a plastic bottle.

Resource:

http://www.sciencekids.co.nz/experiments/makeatornado.html

Red Cabbage Acid and Base Indicator

Use red cabbage to determine whether certain liquids are an acid or a base.

Resource:

http://www.csun.edu/~lav26937/old/coursework/646/assignments/simulated-experiments/graphics/Red%20Cabbage%20Indicator%20lab.pdf

UNIT 4: FIELD TRIPS

Local Beach

Visit a local beach and examine the aquatic life (i.e., crabs, seashells, etc.), collect and analyse water samples (in terms of salt content)

Local Amusement Park

Students measure their pulse before and after riding rollercoasters, or any other more extreme rides. Their measured pulse is a good indicator of their own fear or excitement.

Resource:

http://www.sciencebuddies.org/science-fair-projects/project_ideas/HumBeh_p024.shtml

Royal Botanic Gardens

Plan a day trip over to the Melbourne Royal Botanic Gardens to observe different plants, trees, or wild-life. Or collect and analyse water samples from various ponds and lakes

Resource:

http://www.rbg.vic.gov.au/science

Star Gazing

Students go to an open, quite field and star gaze by eyesight only, and with telescopes if possible.

Resource:

http://www.fourmilab.ch/cgi-bin/Yoursky?z=1&lat=37.8167&ns=South&lon=144.967&ew=East

Sportsworks

Students learn all about the science behind sports in relation to the human body

Resource:

http://museumvictoria.com.au/scienceworks/whatson/current-exhibitions/sportsworks/

Black Holes: Journey into the Unknown

Students explore the world of black holes. How they're made and how their destroyed

Resource:

http://museumvictoria.com.au/planetarium/whatson/black-holes/

Tycho to the Moon

Students watch as "Tycho" travels to the moon and learns all about the phases of the moon and the lunar surface

Resource:

http://museumvictoria.com.au/planetarium/whatson/tycho-moon/

UNIT 5: CAREER EXPLORATION

Local Beach

Visit a local beach and examine the aquatic life (i.e., crabs, seashells, etc.), or collect and analyse water samples (in terms of salt content).

Royal Botanic Gardens

Plan a day trip over to the Melbourne Royal Botanic Gardens to observe different plants, trees, or wild-life. Or collect and analyse water samples from various ponds and lakes???

MORE GENERAL RESOURCES AND WEBSITES:

The following information consists of more general websites which Banksia Gardens can find more resources for expanding the science program framework:

AAAS: Science Net Links
http://sciencenetlinks.com/

CAPSULE: Capstone Unique Learning Experience
http://capsulenu.weebly.com/stem-resources.html

The Coalition for Science After School
http://www.afterschoolscience.org/resources/curricula-activities.php

Experiment-Resources
http://www.experiment-resources.com/kids-science-projects.html

Exploratorium After School Activities
http://www.exploratorium.edu/afterschool/activities/index.php

Exploratorium: The Science Explorer
http://www.exploratorium.edu/science_explorer/

Exploring Nature Educational Resource
http://www.exploringnature.org/db/main_index.php

Primary Resources
http://www.primaryresources.co.uk/science/science.htm

Science Kids: Fun science + technology for kids!
http://www.sciencekids.co.nz/experiments.html

ACTIVITY SPECIFICATIONS TEMPLATE:

More activities can be expanded upon using the following template as a guideline:

Activity Name

Activity Type: *(name of unit: wow factor, competition, workshops/labs, field trips, or career exploration)*
Topic: *(science topic)*
Duration: (*time length)*

Materials:

- Items

Preparation:

4. List of steps to prepare materials ahead of time before activity

Procedure:

9. List of steps to go through when conducting activity with audience

Key Terms and Definitions: *(if applicable)*

Term definition

Takeaway/Discussion:

7. Discussion questions to ask audience

Ways to Expand the Activity:

5.

Career Connection:

Career description which connects to activity

Experiment adapted from:

(*URL of website resource or book reference)*

Definitions adapted from:

(definition resources)