MEASURING THE IMPACT OF CSIRO'S NON-FORMAL EDUCATION PROGRAMS

An Interactive Qualifying Project Report
completed in
partial fulfilment of the Bachelor of Science degree at
WORCESTER POLYTECHNIC INSTITUTE
by

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5 March 2010

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Keywords:
1. Education
2. Assessment
3. CSIRO

Abstract

We developed and implemented a system to assess the impact of two programs of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) that stimulate Australian students' interest in science. Student questionnaires and teacher interviews before and after the programs and student observations during the programs showed that students were well engaged during the programs but exhibited no long-term, statistically significant changes in interest. Drawing on interviews, observations and questionnaires, we identified several strategies to improve both engagement and long-term impact.

Acknowledgements

There are so many people who have made it possible and even more enjoyable for the four of us to travel 16,000 miles over here to Australia and complete our Interactive Project, that it would take another IQP-length paper in order to extensively outline the due thanks. Therefore, since we all have to go back to take classes this D-term, we would like to thank a few key people.

Firstly, thank you to Holly Ault for presenting the Melbourne Project Centre to us way back in B term of 2008, and giving us some key lessons in Australian culture before our arrival.

We wish to thank Ash Pillai of St. Joseph's College and Andrew Wilkinson of Sandringham College as well as all of the science teachers who allowed us to come into the classroom to survey their students and interview them about the program. Your patience and reception did not go unnoticed. To the CSIRO program presenters, Simon, Cath, Gemma, and Elke – thank you for aiding the process of survey distribution in the classroom.

We want to thank Lyn for organizing our "Fun Fun Night of Fun" which looking back was certainly an understatement as to the amount of fun we had, Ava for bringing us afternoon snacks, Gemma for being awesome, David for being the man, Sean for giving us a free planetarium showing, Simon for his impeccable bowling skills that grabbed the championship win for Kristen's team, and last but certainly not least, Elke for having a crazy collection of wigs and for making our hands famous in the instruction cards (Nicola too). Afternoon tea was always a pleasure with all of you. Thank you all for making us feel at home at the office. (Sorry, if we were too loud – We *are* Americans after all)

A special thanks to Nicola for oh so many things that include but are not limited to introducing us to the city and showing us the ropes, feeding us Australian's finest foods such as apple pie and double cream (even though whipped cream is better) and vegemite (even though not all of us enjoyed it), her impeccable dance skill that we will surely take back to the states, and finally taking us kayaking on the roaring waters of Mt. Martha. Our Australian experience would not have been the same had she not lived in the Milano with us and/or taken us under her wing. Nicola, make sure you call us when you and Luke visit the states!

Also, we would like to thank Mrs. Sharon Davis for providing frequent sustenance at Barbeques and dinner parties. We hope our mothers will be able to live up to her lasagne and sweet plum desert once we get home.

We offer a sincere thanks to Professor Davis ("P-Dubs" as he was referred to whether he knew it or not) for his supervision and direction throughout the last 6 months.

Even when we were in a time crunch in the last 2 weeks, you didn't miss a beat and we appreciated all your thoughtful feedback in making this project a success.

Cath for her endless help and guidance with our project work, giving us the keys to CSIRO Education (literally), getting us internet access, getting us all the way from our apartments to St. Josephs College, and many other instances of "hooking us up."

And finally, a giant twinky thanks to Chris KP for his plethora of ideas, his constant positive attitude in tight times, hours of entertainment, his willingness to chase after terrible footy kicks, Youtube distractions, finding time in his extremely busy schedule to hang out, and of course, "igniting the creative spirit" in all of us. His guidance and insight solidified our project while his comic relief made us look forward to coming to work every morning. Good on ya Chris, and thanks for everything; hopefully we'll get to see one of your shows in the future.

To everyone we mentioned and any we forgot, we ask you to put your hands in one last time to put an exclamation point on this entire experience … "Uhhhah!"

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BD – *Biodiversity and the World Around Us* program

CSIRO – Commonwealth Scientific and Industrial Research Organisation

FF – *Forensic Frenzy* program

IQP – Interactive Qualifying Project

NFE – Non-Formal Education

PR – Pre-Test

P1 – Post-Test 1

P2 – Post-Test 2

SET – Science, Engineering and Technology

STEM – Science, Technology, Engineering and Math

VCE – Victorian Certificate of Education

VELS – Victorian Essential Learning Standards

WPI – Worcester Polytechnic Institute

Executive Summary

"Australia's productivity and success in the highly competitive global market is increasingly reliant on science, engineering and technology (SET) skills. Our abilities in research and development, innovation and discovery are dependent upon the availability of suitably skilled scientists and engineers" (Australian Government Department of Education, 2006). Unfortunately, educational professionals in Australia have noticed that Australian students' interest in science and technology has declined over the past few decades. For example, "30 percent of year 12 students studied physics and 32 percent studied chemistry in 1994. By 2003 this had fallen to 25 percent and 26 percent, respectively" (CSIRO, 2005). This decline is detrimental to Australian society and the future of scientific and technological professions.

The Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia's national science agency, promotes interest and passion in the scientific fields via its non-formal education (NFE) programs. CSIRO's Science Education Centres offer a range of hands-on science programs for students in the classroom and at its own facilities. Two of these programs offered by CSIRO are the *Forensic Frenzy* and *Biodiversity and the World Around Us* programs. They are 90 minute workshops for students from years 5-10 that put students in the role of a forensic scientist or an ecologist.

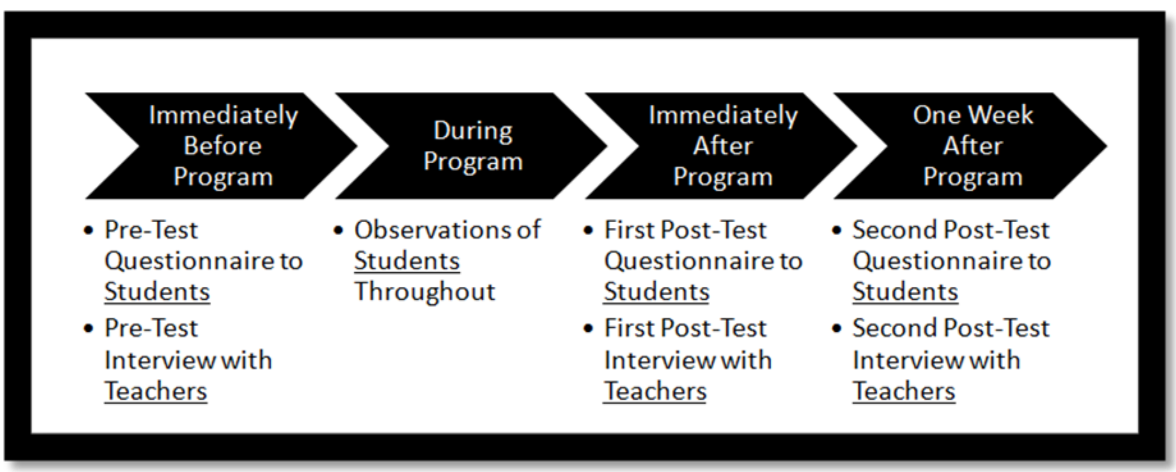
From our experience, students enjoy a break from their daily routine in class to participate in fun and entertaining activities such as field trips and hands-on programs as offered by CSIRO. But are these programs more than just a recess from classroom learning for students? What, if anything, do students take away from it all?

We developed and implemented an in-depth system of assessments to measure the impacts of and recommend improvements for two of CSIRO's NFE programs: *Forensic Frenzy* and *Biodiversity*. A triangulation approach combining questionnaires administered to students, interviews conducted with teachers, and observations of students throughout the program collected the necessary information. Assessments were designed to gather data about seven information targets:

1. Students' feelings, opinions and behaviours toward science
2. Level of interest in science
3. Knowledge about science in general
4. Knowledge about specific topic of the NFE program
5. Reactions to the program
6. Student and teacher demographics
7. Correlation of program to science curriculum or learning unit

The first four targets were meant to track changes in the students due to program participation. The last three characterize background, potentially biased attitudes, and educational setting.

The assessment timeline, which covers from before the program to one week after the program's offering, is shown in the figure below. This first week of assessments serves as the initial stage of a longer-term assessment, running up to one month after the students have experienced the program.



Assessment Administration Timeline

A separate study, conducted by another WPI team, will add a third post-program questionnaire as well as a third post-program interview with teachers approximately one month after the program experience. This added step, which is not shown in the figure, will further refine the understanding of the long-term impact.

Conclusions and Recommendations

Forensic Frenzy proves to better engage students than *Biodiversity*. Therefore, *Biodiversity* should aim to mimic the methods of *Forensic Frenzy*. Specifically, *Biodiversity* may benefit from focusing on a prominent objective throughout the entirety of the program, adapting an analog of *Forensic Frenzy*'s explicit goal, solving a crime, in place of its vaguer goal of studying biodiversity and an endangered species, the bandicoot. Most of the student activities should have an obvious connection to this objective.

A program with a prominent central theme engages student participants more effectively than one whose theme is more abstract, general, or subtle. The information gathered through observations and interviews showed that the students were engaged and enjoying *Forensic Frenzy* during the program, in part because there was a clear objective throughout. Further, a significant 29% of students stated that helping to solve a crime and finding results stood out in their minds a week after the *Forensic Frenzy* program. None of the *Biodiversity* participants mentioned the endangered bandicoot as something that stood out in their minds or something they liked about the program.

Further, observations showed that on average a low percentage of students (28%) take adequate time to read the instructions for activities in both programs. In *Forensic Frenzy,* as students read the instructions, the rate of completion for the activity increased. However, for *Biodiversity,* as students read instructions, the rate of completion decreased. Due to the many variables that could possibly be responsible for this trend, we recommend that further research be conducted to fully understand it.

We recommend that the *Biodiversity* program implements the following to help increase the impact of the program:

- Reiterate an overall explicit objective throughout all of its activities: the bandicoot is on the edge of extinction, and the tests the students will be conducting will identify environmental factors that could affect the bandicoot. Some techniques for emphasizing this explicit central theme include:
    - Use a video or PowerPoint in the introduction of the program to make the bandicoot a more prominent figure in the program narrative and, hence, in the minds of the participants.

- Tweak questions in order to relate the students' findings to the fate of the bandicoot. For example, ask, "How would this change affect the bandicoot?"
- Relate all activities specifically to the fate of the bandicoot.

We also found that knowledge was obtained but not retained by students in the program and their level of interest remained unchanged. We recommend that CSIRO introduce reinforcement activities and encourage their use by classroom teachers at appropriate points in the curriculum before and after the program. The system of student questionnaires showed that students' levels of interest towards science in general did not experience a significant positive or negative change over a period of one week. The questionnaires also showed that students' overall knowledge increased immediately after the program but had subsided one week later.

We recommend that CSIRO implement one or both of the following reinforcement strategies:

- A pre-program worksheet to promote thought and excitement about the program in advance
- A classroom-ready supplemental worksheet or project for teachers to incorporate into their class assignments to reinforce program material

Our analysis of these two programs also produced the following findings and recommendations specific to each program's operations:

- The more popular activities in *Forensic Frenzy* which did not directly support the central theme of solving the crime were found to hinder the functionality of the program when located in close proximity. To address this problem it is advised that stationing these activities near one another should be avoided where possible.
- Participants in *Biodiversity* showed more signs of engagement in the concluding presentation when compared to the general presentation. Again, we suggest a visual aid in the introduction to create a more pronounced concern for the wellbeing of the bandicoot.

In addition to these recommendations, we propose additional studies to further understand and to increase the long-term positive impacts of CSIRO's NFE programs. Most of these use our extensive database of questionnaire results to facilitate following changes in individual (but anonymous) program participants and in specific cohorts (e.g., those with initially low interest in science). Proposed future studies include:

- Develop and implement pre-program and post-program supplementary worksheets for CSIRO's NFE programs and assess the impact of these additional worksheets and activities.
- Measure the effects of various reinforcement strategies such as classroom discussions and homework assignments.
- Measure long-term impacts of CSIRO's NFE programs on primary school students.
- Determine if the presence or absence of the classroom teacher during the program offering significantly affects the long-term impact on the students.

1 Introduction

Science education is recognized as crucial to the growth and development of students (De Laeter & Dekker, 1996). It helps students develop skills, such as making observations and drawing conclusions based on their findings that can transform them into educated citizens. The A*ustralian Education Council* states, “Through science education, all students should develop the confidence, optimism, knowledge, skills and abilities to satisfy their own questions about the workings of the physical, biological, and technological world, and to devise solutions to the problems arising from their own needs and experiences in daily life” (Australian Education Council, Curriculum Corporation (Australia), 1994, p. 4). Thus, a high-quality understanding of the scientific fields and scientific methods can be a significant factor not only for the development of intellectually sophisticated students but also to the growth of productive, erudite citizens.

Despite this importance, interest among Australian students in science and technology has been declining over the past few decades. For example, “30 percent of year 12 students studied physics and 32 percent studied chemistry in 1994. By 2003 this had fallen to 25 percent and 26 percent, respectively” (CSIRO, 2005). Some fear that this loss of interest could affect the technological future of the country as a whole (De Laeter & Dekkers, 1996). A wide array of variables may be contributing to this decline, including infrequent exposure of students to science and a lack of funding for scientific education programs.

“If a greater proportion of upper secondary school students is to be attracted to prepare themselves for scientific and technological careers, then a concerted effort must be made at the State and National levels by the educational authorities, but more particularly by the engineering and scientific professional societies” (De Laeter & Dekkers, 1996). Among major members of the scientific community, the Commonwealth Scientific and Industrial Research Organisation (CSIRO)[1] strives to reverse the declining interest of students in scientific and technological fields. Through the development of non-formal education programs on topics such as biodiversity and forensic science, CSIRO aims to

[1] Abbreviations and their meanings, like this one, can be found in the List of Abbreviations on page xii.

spark curiosity among students and to encourage positive attitudinal and behavioural changes towards science.

Although CSIRO and other science educators have successfully implemented non-formal education programs, challenges remain in assessing the ways in which particular programs actually affect students. CSIRO commissioned this project to improve its offerings by better measuring the long-term impacts of its non-formal educational programs.

Through in-depth research and collaboration with CSIRO's education professionals, our team developed and implemented a system of assessments comprised of visual observations of students, questionnaires administered to students, and interviews with teachers. These allowed the team to assess the successes and failures of CSIRO's *Forensic Frenzy* and *Biodiversity and the World Around Us* programs up to one week after presentation of each program.

The student questionnaires gauged their knowledge and levels of interest towards science and the program topic. Interviews with teachers provided their perspectives on the CSIRO program and on their students' reactions. Observations of the students during the program provided firsthand records of the students' reactions. This triangulation approach enabled us to measure changes in the students as a result of the program, their reactions to the program, and influences from the students' background.

The information gathered through observations and interviews showed that the students were engaged and enjoyed the program experience. Despite that evident engagement, the system of before and after questionnaires showed no significant change or impact as a result of the program up to one week after its offering. However, this information still provides a useful basis for even longer-term evaluation of the programs' impacts. Questionnaire responses and observations have been entered into an extensive database to facilitate following changes in individual (but anonymous) program participants and specific cohorts, e.g., those with initially low interest in science; those studies will be pursued by another research team.

Overall qualitative and quantitative assessment of these results has identified important features and possible attributes. For example, a program with a prominent central theme engages student participants much more effectively than one whose theme is more general or subtle. The variation among schools in the follow-up offerings suggests that CSIRO might augment each of its programs with ready-to-use, program-specific follow-up assignments and projects. These and other findings mark a clear path for CSIRO staff to follow in improving the impact on students of the *Forensic Frenzy* and *Biodiversity* programs.

2 Background

To prepare to address the Commonwealth Scientific and Industrial Research Organisation's need for studying the impact of its non-formal educational programs, this chapter first explains CSIRO's goals and visions. Then it investigates non-formal educational programs, providing answers to such questions as why they are an integral part of educational settings and how these programs relate to and compliment formal classroom learning. Finally, this chapter outlines CSIRO's current assessment processes for its non-formal programs and why further assessment development is necessary.

2.1 The Commonwealth Scientific and Industrial Research Organisation

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is the national science agency within Australia and their departments have been applying non-formal educational learning techniques since 1926. Generally, CSIRO conducts a variety of scientific experiments and research with the goal of benefiting many different facets of Australian industry and society. For example, they study core areas of impact such as energy, climate change, manufacturing, technology, infrastructure and much more to address Australia's major national challenges and opportunities. Through their mission statement they convey their hope that, "by igniting the creative spirit of our people we deliver great science and innovative solutions for industry, society and the environment" (CSIRO, 2005).

2.1.1 CSIRO Education

One way in which CSIRO aims to achieve their goal of igniting the Australian community's spirit is through their nine Science Education Centres in Australia. The focus of these centres is three fold: to make the surrounding community aware of CSIRO's scientific efforts, to educate and stimulate interest in science and its applications, and finally, to encourage students to follow careers in the STEM areas of science, technology, engineering and math (CSIRO, 2005). One way in which they accomplish these goals is by offering and presenting non-formal educational programs to the Australian youth.

2.1.2 CSIRO Programs

To achieve their goals, CSIRO Education attempts to reach out to the community to educate students about science through a variety of hands-on educational programs. These programs are non-formal in nature in that they are organized in a highly adaptable manner outside of the formal classroom learning sphere. Their hope is that this unique approach will in turn inspire the students to become more involved with science.

Of the nine project centres in Australia, we worked with the Victorian Education Centre in Melbourne. They offer many non-formal science education program options to schools. For example, teachers and administrators can choose to book a visit to one of the CSIRO Education offices where science programs, demonstrations, and workshops are held. Another option is for CSIRO staff to travel on-site to the school's facilities where they run hands-on science classes and educational shows on topics ranging from astronomy, robotics, and gene technology to energy and nano-chemistry (CSIRO, 2005).

Two specific examples of CSIRO's programs include *Forensic Frenzy* and *Biodiversity and the World Around Us*. The programs are 90 minute hands-on workshops whose audience is mainly students ages 12 to 15 (CSIRO, 2008). The start of the programs spend approximately 15-20 minutes setting the stage and introducing the students to the subject topic as well. The next 50-60 minutes, students are able to interact with tools and equipment via hands-on activities to complete portions of the program; students are guided through this portion by instruction cards at each station and a student booklet containing information regarding the stations and the program. The final 15-20 minutes is used to wrap up the activities and discuss their relation to the program topic. These interactive science programs cover topics that might not typically be covered in a formal classroom educational environment. CSIRO connects each of its programs to Victorian Essential Learning Standards, or VELS, so that teachers can identify appropriate points in their own teaching that may help to coincide with CSIRO's programs. The VELS are standards which outline what is important for all Victorian students to learn and develop during their time at school. They provide a formal curriculum of state-wide standards which schools use to plan student learning programs, assess student progress and report to parents. (Department of Education and Early Childhood Development, 2009). Teachers are provided with a booklet explaining which areas of the VELS are covered by the program and overview of the information covered in the program. These teacher handouts can be found in Appendix A for *Forensic Frenzy* and Appendix B for *Biodiversity*.

Forensic Frenzy teaches students about different types of forensics and what their applications are, such as forensic accounting, dentistry, pathology, psychology and more. Information about finger printing, fibre analysis, chromatography, blood and DNA analysis as well as other forensic topics are also presented and explained during the program. The program correlates to sections 5 and 6 of the VELS, which require that students use science as a problem-solving tool, engage in hands-on activities, learn the role of the courts and police, and challenge their thinking processes. Such activities are part of the VELS requirements for Discipline Based Learning, Physical, Personal and Social Learning, Interdisciplinary Learning as well as Science Key Learning Areas. By participating in *Forensic Frenzy*, school systems are fulfilling these requirements.

The program informs the students that a man has gone missing a few days earlier and a body has been found. Students are given a student workbook summarizing the details of the crime. A sample student booklet with the information provided to the students can be found in Appendix C. In order to discover who committed the crime, the students must use their knowledge of forensics to analyse the various pieces of evidence presented to them, including a police report from the crime scene and information about the four suspects. The students are directed to various tables in the classroom where activities are set up to display the different pieces of evidence. Each table allows the students to examine evidence through one of the following activity stations.

- Facial Identification
- Ballistics-Type of Firearm
- Ballistics – Greiss Test
- Dental X-Rays
- Is It Blood?
- Fibres on the Body
- Fibres on the Fence
- Oil Stains
- Soil Testing
- Tyre Tracks
- Fingerprints in the Factory
- Fingerprints on the Ransom Note
- Fingerprints on the Gun
- Envelope Ink
- PAID stamp Investigation

The students usually have time to go to most, if not all, of the stations and are encouraged to move freely among the stations, recording their findings in the workbook provided as they go. The discretion given to the students here adheres to the VELS standard that encourages active learning. To conclude the program, the presenter brings the students together and goes through all of the evidence, discussing what each piece proves and how it may help solve the crime.

Biodiversity and the World Around Us is the other program the project team assessed. It is a new program offered by CSIRO and, like *Forensic Frenzy*, *Biodiversity* covers sections 5 and 6 of the VELS. The key concepts covered in the program involve the students finding answers to the following questions:

- What is the environment?
- Why is it important?
- How do scientists monitor the environment?
- What do scientists do with this information?

The students are presented with an endangered species, the Eastern Barred Bandicoot, and the task of examining the living and non-living factors that are impacting the bandicoot's habitat. Following the format of their other NFE programs, *Biodiversity* is divided into activity stations which the students can move among freely. The stations offer tests to monitor the environment, similar to those an ecologist might conduct:

- A World of $C0_2$
- Future Atmosphere
- Microscopic Monitoring
- A Trend in Weather
- Classification Keys
- Soil Texture
- Soil Moisture
- Water pH
- Testing Temperature
- Map That Species!

Questions in the booklet provided to the students (found in Appendix D) probe the larger impacts of the results of each test. To wrap up the program, students are brought together to work as an entire class to create a food web. Each is assigned an organism (bandicoot, frog, mosquito fish, etc.), and they physically connecting the web using a long string. As the food web becomes more populated, it becomes more and more complicated, often tangling students. The tangling is intentional: when one organism pulls on the string, all of the organisms involved in that food chain feel the effects. This experience shows the students that if one species' livelihood is affected by some environmental change, the entire food web is affected, thus stressing the significance of biodiversity.

2.2 Formal and Non-Formal Education Approaches

Formal education is most commonly associated with a classroom environment including a teaching staff and other faculty. In a formal instructional setting, learning is highly structured with a curriculum that must be followed by teachers strictly. By definition, formal learning is "the hierarchically structured, chronologically graded 'education system', running from primary school through the university and including, in addition to general academic studies, a variety of specialised programmes and institutions for full-time technical and professional training" (Smith, 2009).

Because of the nature of classroom instruction, students are often all taught and expected to learn at the same pace, not taking into account the specific needs of each student individually (Merriam, Caffarella, & Baumgartner, 2007). Such classes, which are primarily lecture based, often leave little time for students or teachers to ensure the entire class' understanding of the material (Merriam, Caffarella, & Baumgartner, 2007). Students can become simply passive participants in the lecture. In order to address such shortcomings of formal education, informal and non-formal techniques have been developed to integrate and enhance students' overall experience.

There are two types of learning that happen outside of the classroom setting: informal and non-formal. Although these terms are often used interchangeably, there is an important distinction between the two. Informal learning applies to spontaneous situations that arise in our everyday lives from which we gain knowledge and insight (Eshach, 2006). This type of unstructured learning is distinguished from formal and non-formal learning because of its lack of facilitator or mediator (Eshach, 2006). Non-formal education, while still an out-of-classroom experience, refers to an organized learning environment that tends to value a holistic, creative, and intuitive approach.

Non-formal education (NFE) programs focus heavily on clearly defined purposes and flexibility in organisation and methods: NFE has been described as "any organised educational activity outside the established formal system - whether operating separately or as an important feature of some broader activity - that is intended to serve identifiable learning clienteles and learning objectives" (Smith, 2009). Further, NFE programs are characteristically supportive, structured, prearranged, usually voluntary, typically non-sequential and also non-evaluative (Eshach, 2006). Field trips to science centres, zoos or aquariums, group work, and outreach programs all constitute a non-formal educational setting.

Non-formal education, as opposed to formal classroom learning, is intended to go to greater lengths to create a sense of wonder, awareness, and enthusiasm in students with a non-pressure environment. With NFE, where hands-on activities are integrated into learning environments, students "display interest, enthusiasm, motivation, alertness, and a general openness and eagerness to learn, characteristics that tend to be neglected in school science," where students often feel forced to learn (Ramey-Gassert, 2007). Further, usually the non-evaluative environment of NFE means a non-threatening one in which students feel less pressure and in turn perform better. Eshach points out that this is important especially for girls who sometimes feel intimidated in what is considered a traditionally male-dominated field (science, engineering, and technology) (Eshach, 2006).

Figure 1 compares the three types of education discussed:

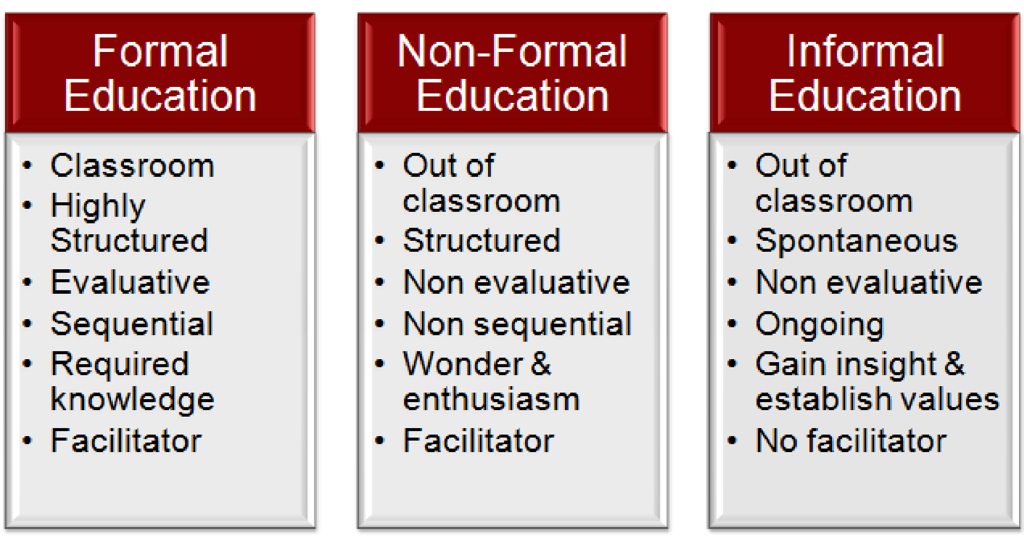


Figure 1: Types of Education

2.3 Assessment

Assessment of NFE is used to evaluate the successes and failures of the program through identifying and recognizing behaviours or abilities that students develop as a result of their experiences during the program (Colardyn & Bjornavold, 2004). The following sections explain why assessment is important to CSIRO, assessment processes now in use, and the current results of such feedback.

2.3.1 CSIRO's Need for Assessment

Assessment is needed in an educational setting for two main purposes: to measure students' knowledge and rate their progress and to measure the impact and success of the program. As a result of assessment, CSIRO can evaluate their programs so they can change and improve their methods of education (Colardyn & Bjornavold, 2004).

To measure the success and impact of their programs, CSIRO needs a form of assessment that measures achievement of the goals and objectives that they have set for the program. The goals are listed below.

- Make the surrounding community aware of CSIRO's scientific efforts
- Educate and stimulate interest in science and its applications
- Encourage students to follow careers in the STEM areas of science, technology, engineering and math

More specifically, as a result of their programs, CSIRO hopes to see a measurable attitudinal and behavioural change in the student.

Currently, CSIRO uses a single questionnaire that is given to teachers to fill out after the program (See Appendix E for the current forms). Chris Krishna-Pillay, CSIRO's Victorian manager, has expressed concern with the lack of "depth" in the content of these assessments, meaning that the information that is gathered with the current assessment tool is shallow in regards to topic coverage and variety. They also do not assess the students in regards to their reactions to the program (only the teachers are questioned) and a follow-up survey of any kind does not exist. Furthermore, without a proper initial assessment to gauge the student's knowledge and interest before the program, how can one properly track any changes? A more complex approach at assessment will allow the project team to measure the attitudinal changes in a student more effectively and in turn, help CSIRO see what aspects of their programs are effective and what aspects need improvement.

2.3.2 CSIRO's Programs: Current Findings

With evidence from CSIRO Education's Victorian Schools Evaluation Database[2], CSIRO managers can claim that the programs have helped create lasting impressions on many schools and many sources of evidence point to this conclusion. First of all, 10% of standard evaluation forms passed out to teachers who attend a CSIRO session (form can be found in Appendix E) are returned showing very positive results. Of the 95 *Forensic Frenzy* evaluation forms returned in the last year, when the booking teacher was asked to give the program an "Overall score for Program out of 10, where 10 is excellent and 0 is unacceptable," the average score was 9.2 out of 10. More specifically, 82.4% of the forms "strongly agreed" that the program was engaging and another 17% "agreed" with this statement. Further, 41.2% "strongly agreed" that the program was likely to encourage students to think about a career in science and 49.0% "agreed" with this statement.

Another reason CSIRO has grounds to believe that their programs are successful is the fact that many of the programs are rebooked each year. Of 842 total bookings from last year, 51.9% of them stated that the reason for booking was because they have seen a program before. The next most significant reason for booking was Internet advertising at 14.6%. This evidence suggests that the programs are viewed positively by teachers. [3]

In order to expand upon the single questionnaire given to teachers for feedback, the project team adds depth and variety to the feedback using a triangulation approach. This approach will include a combination of questionnaires, interviews and observational research. In the following chapter we will explain how these ideas are applied to develop an assessment tool that we use to provide recommendations for improvements and that can be re-used to evaluate CSIRO programs.

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[2] The results presented here were extracted from an internal unpublished database.

[3] Note that there no data is available for *Biodiversity* because it is a brand new program.

3 Research Methodology

To create an effective assessment of CSIRO's non-formal educational (NFE) programs, the project team developed a series of three separate questionnaires for student participants, a semi-structured interview protocol for their teachers and a list of metrics for the observation of students during the programs.

The project team focused on three objectives during the development of the assessment process:

- Identify specific criteria for measuring students' engagement and assessing change in students' knowledge and interest towards science; gather data pertinent to these criteria through the assessment tools.
- Determine, over a one week period, if participation in a CSIRO program changes a student's level of knowledge or interest toward science or the particular topic that is presented in the program.
- Examine which aspects of CSIRO's programs are engaging and pique interest and which areas of the program are less effective in those regards.

The following sections describe how the framework of the assessments was organized and how the assessment tool was used to gather information. The project team's analysis of the data collected provided CSIRO with the following deliverables:

- A useful basis for even longer-term evaluation of the programs' impacts.
- Specific recommendations to improve two of CSIRO's non-formal education programs, *Forensic Frenzy* and *Biodiversity and the World Around Us.*

3.1 Overview of Approach

To evaluate the effectiveness of these NFE programs and their impact on students, the project team triangulated by using three different assessment tools. Research shows that triangulation increases reliability by collecting multiple types of data and cross comparing them and was chosen because "more than one method should be used in the validation process to ensure that the variance reflected that of the trait and not of the method" (Campbell & Fiske as cited by Jick, 1979, p. 602). These three methods were: a pre-post test format of student questionnaires, observations of participants, and teacher interviews.

A pre-post test was administered that included one pre-test and two post-tests. Further post-tests will be administered by another WPI research team to continue this research. While the questionnaires were administered to students, our project team simultaneously interviewed the teachers. During the program the team observed the students' behaviour. Figure 2 shows the chronological administration of the series of assessments.

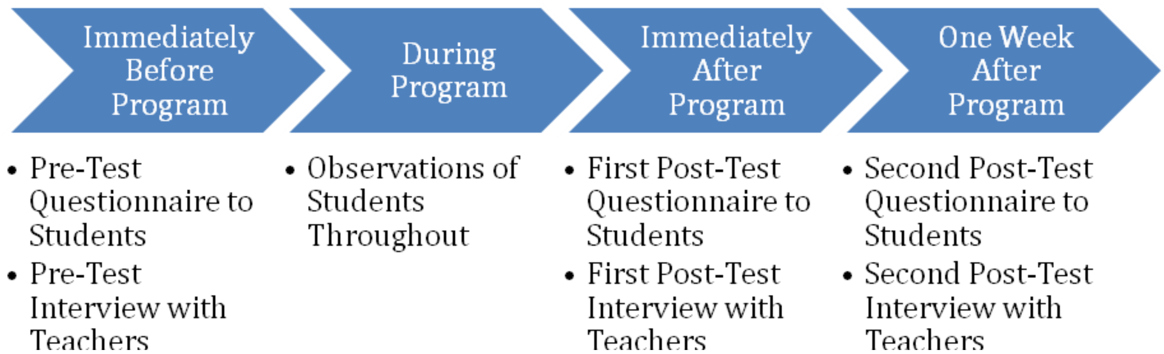


Figure 2: Chronological Administration of Assessments

A full timeline of the work completed throughout the development and implementation of the series of assessments can be found in Appendix F.

3.2 Information Targets

The triangulated assessment process was designed to collect data about the following information targets:

1. Students' feelings, opinions and behaviours toward science
2. Level of interest in science
3. Knowledge about science in general
4. Knowledge about the specific topic of the NFE program
5. Reactions to the program
6. Student and teacher demographics
7. Correlation of program to science curriculum or learning unit

Information targets 1 through 4 were chosen to identify *changes* in students before and after experiencing a CSIRO program. With responses from student questionnaires collected at three different points in time – immediately before the program, immediately after the program, and one week afterwards, the project team could then answer questions such as:

- Did students' opinions of science become more positive?
- Did levels of interest in science increase?
- What did students learn from the program about science in general or the program topic?
- Did students seem to be more aware of science and its roles and applications after experiencing the program?

The fifth information target was aimed at student and teacher reactions to the program, using all three methods of assessment. Gathering this information helped the project team to determine which parts of the programs were engaging and enjoyable and which needed improvement.

The sixth information target, concerning the background of the students and teachers, provided demographic characteristics of our sample population. One use of this information target was in determining the impact that parents have on students' career interests. For example, if the parents of a student worked in a scientific field, would science more likely be involved in that student's future career interests? Would that student exhibit greater interest in or aptitude for science?

The project team used the seventh information target to gather information to determine whether or not the teachers used the material presented in the program to reinforce their science curricula and if so, how they used it. Research suggests that reinforcing program material increases the likelihood of it having a significant long-term impact (Virnoche, 2008).

Each assessment tool gleans data for different information targets as follows: questionnaires gathered information regarding targets 1 through 4 and target 6, observations gathered information about target 5, and interviews collected information regarding all information targets. The breakdown of the questions from questionnaires and interviews into each target can be found in Appendix G and Appendix H respectively.

3.3 Questionnaires

One portion of our triangulation approach for the assessment tool is a system of questionnaires administered to students before and after experiencing one of CSIRO's non-formal education programs. The following explains the generation and administration of the three questionnaires.

3.3.1 Selection of Questions

The content of the questionnaires was designed to address the first four and the sixth information targets. Questions were chosen to distribute throughout the three questionnaires in order to measure a student's position on each of the respective information targets. The project team reviewed past WPI Interactive Qualifying Projects (IQPs), scholarly journals, and held discussions with CSIRO Victoria's Education Managers in order to formulate these questions.

Each questionnaire included program-specific questions relating directly to CSIRO's *Forensic Frenzy* or *Biodiversity* programs as well as general questions that did not relate specifically to the program topic. The only differences between the questionnaires were the several program-specific questions.

Each question was presented in a way that gathered quantitative or qualitative data for analysis. Quantitative assessments gather data to measure the various views and opinions of a chosen sample group to generalize to the entire population (Snap Surveys, 2009). Quantitative data can be compared and interpreted easily on a numerical and statistical level. Multiple choice and 'yes-no' questions collect quantitative data but limit the range of responses that can be delivered. In Teshome's research on attitudes towards informal science and mathematics, Likert-scales and questions requesting respondents to rank agreement with statements on a numerical scale provided quantitative data to support findings of interest and attitudes in students (Teshome, 2001).

In contrast, qualitative assessments ask deeper questions about why subjects feel a certain way, instead of simply what they feel (Market Research World, 2009). Open-ended and fill-in-the-blank questions gather qualitative responses; however, they add complexity to how data can be interpreted. This balance between quantitative and qualitative data ensured that concrete findings from the quantitative data were provided while still discovering deeper thoughts and trends in the teachers' and students' attitudes, opinions and feelings through the qualitative responses.

The wording of the questions was designed to provide reliable data through clear interpretation and vocabulary. Every question was presented in a way that could only be interpreted in the way desired and the phrasing and wording used was focused around the vocabulary of the sample population. All possible discrepancies and misunderstandings were addressed by analysing each question with the help of CSIRO educators as test subjects and adapting the questions based on their responses. This process of testing the questionnaires and fine-tuning the content helped ensure validity in the data collected.

The final pre-test, post-test 1 and post-test 2 questionnaires for *Forensic Frenzy* can be found in Appendix I, Appendix J and Appendix K and *Biodiversity* questionnaires can be found in Appendix L, Appendix M and Appendix N respectively. The table found in Appendix G lists each question throughout the series of assessments sorted by which information target they were designed to gather data about. Information regarding the scholarly source of each question and its location is also found in this table.

3.3.2 Administration of Questionnaires

The three questionnaires were administered over the course of one week. The pre-test (PR) was administered immediately before the program, the first post-test (P1) was administered immediately after the program and the second post-test (P2) was administered one week after the program.

To ensure anonymity, each student was assigned a unique tracking number after the first questionnaires were collected. The project team wrote each student's tracking number in the bottom right hand corner and removed the students' names from the questionnaires. This process permitted tracking individual student responses across the three questionnaires while preserving anonymity. A sample questionnaire packet appears in Appendix I through Appendix N.

When administering the questionnaires, students were encouraged to respond honestly and were informed that their responses were only going to be used to evaluate CSIRO's program and that they would not be graded. This approach was meant to relieve pressure or nervousness while completing the questionnaire in order to collect the most accurate data.

3.4 Observations

To record immediate perceptions of students' attitudes towards CSIRO's NFE programs, the project team used an observational assessment method. "The advantage to observational research is that it provides the observer with a natural, unstructured opportunity to see and understand how people behave and what they do" (Dickman, 2006).

3.4.1 Creation of Observational Checklist

While students participated in CSIRO's hands-on programs, the project team made observations evaluating the students' overall experience during each activity. This provided a firsthand report of how participants verbally and physically react to the program. From these observations, we could evaluate which aspects of the programs were engaging and which were not. This segment of the assessments collected a majority of the information to fulfil the fifth information target of our assessment system, "reactions to the program."

To structure the observations, the project team created a list of behaviours that was used to characterize a student's experience in a CSIRO program. General behavioural categories were derived through review of past IQP reports and consultation with CSIRO officials. Each behaviour was correlated with specific cues or observational signals that demonstrated distinct differences between them. This observational rubric, displayed in Figure 3, along with repeated calibration among the observers, ensured that all observers had similar interpretations of each specific behaviour, thereby minimizing the effects of personal bias.

Behavioral Cues	
Eye Contact (General Presentation)	•Maintain visual eye contact with presenter (M) •Frequent visual eye contact with presenter (F)
Discussion	•Talking to peers about the program/activity at hand (P) •Talking to peers about other topics other than program (O) •Talking to peers, but topic cannot be determined (D) •Asking questions of peers
Concentration	•Putting on blinders to outside stimulus; intently watching •Focused on activity; tuned in; tunnel vision •Watching presenter perform experiments; brows furrowed
Excitement/Enjoyment	•Auditory excitement •Wide eyed •Smiling, laughing •Looks of fascination
Eagerness to Participate	•Moving quickly to activity tables •Answering questions from presenter; hands shot up •Volunteering during presentation •Enthusisam; assertion; pushy
Boredom	•Falling Asleep •Staring at clock •Gazing off the program/activity
Asking Questions	•Raising hand during program to ask insightful questions •During rotation of Activities; approaching instructor •Notes on guidance questions or curiosity questions
Confusion/Frustration	•Quizical looks •Posing confused questions to peers •Audible grunts, angered looks, discouraging looks •Impatience
Physical Distractions	•Phones, cloths, chairs, carpet, schools supplies, etc.
Intended Completion	•Activity completed the way in which the instructions outline
Misuse of Equipment	•Fooling around with equipment •Use outside of instructed steps
Reading Instructions	•Reading the given instructions

Figure 3: Observation Rubric

The system was calibrated through several test runs. All members of the team observed three of CSIRO's onsite programs, *Energy Sources and Uses, Forces and Movement,* and *Toy Science*, using an initial version of the rubric. This experience helped the project team adjust the rubric to reflect the most pronounced visual cues presented by students, as seen in Figure 3.

The test observations of the onsite programs also revealed the importance of viewing each of the particular programs prior to an observational assessment. Our team discovered that having advance knowledge of exactly what a program entails was crucial to making accurate observations. This knowledge permitted close observations without unexpected distractions from the program content. Consequently, the project team observed both *Forensic Frenzy* and *Biodiversity* before gathering data from either of the programs.

3.4.2 Observing Programs

Each of the CSIRO NFE programs was presented in three sections:

1. General introduction of the program given by the presenter to the group as a whole.
2. Hands-on participation in a range of activities by students working in groups of two or three.
3. Wrap-up presentation by the presenter to conclude the session.

During the general introduction, each of the four observers monitored one-quarter of the class, thereby ensuring that every student was being observed. During the hands-on portion, each observer monitored two or three stations at a time, recording the total number of students who participated in the activity and observing their interactions. The final wrap-up presentation was treated in the same way as the introduction with each team member observing one-quarter of the student audience. Figure 4 illustrates this process.

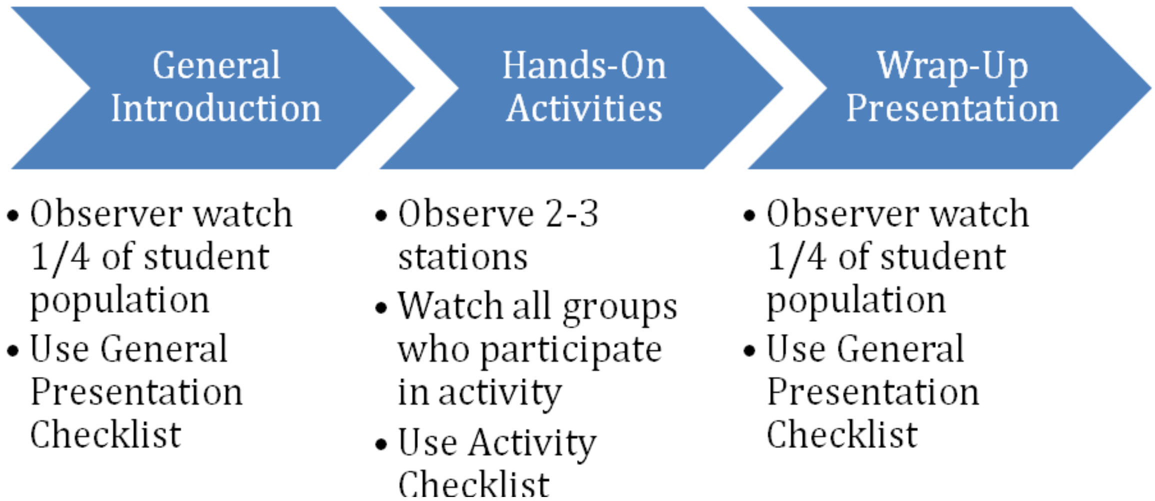


Figure 4: Chronology of a Program Observation

This method was adopted to increase the size of the sample of students being observed. Looking at each activity individually, the observations provide data that demonstrates what activities are successful in engaging students' interest and what activities could use improvements. The section of the observational checklist shown in Figure 5 illustrates the list used to observe one of the hands-on activities. The full observational checklists used can be found in Appendices N and O.

Activity:	Students																													
Program Observations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Discussion (P or O or D)																														
Concentration																														
Enjoyment/Excitement																														
Boredom																														
Eagerness to Participate																														
Asking Questions																														
Confusion/Frustration																														
Physical Distractions																														
Completion																														
Misuse of Equipment																														
Read Instructions																														
Comments:																														

Figure 5: Activity Observational Checklist

3.5 Interviews

The third tool used for the assessments was the teacher interview. With observational research and questionnaires providing the bulk of the quantitative data, the teacher interviews yielded qualitative highlights and contrast. The purpose of this tool was to gain teachers' perspective on how the programs affect the students, and interviews provide an excellent opportunity to explore reactions and attitudes in depth (Dickman, 2006).

Interviews are useful in gathering responses from a person in a manner similar to a questionnaire. Comparable types of questions can be asked, but in an interview, there is a personal interaction between the interviewer and the subject. There is the ability to change or adapt the direction the questions based on how the subject is answering as well as delve deeper and ask follow-up questions. Since there is the connection of conversation between the interviewer and subject, it becomes easier for opinions and feelings to come out during an interview than while filling out a questionnaire (Trochim, Survey Research, 2006).

3.5.1 Developing Questions

Because a pre-post set of questionnaires was administered, the project team applied the same design to the interviews in order to record changes over time. Three interview schedules were formulated with questions adapted from the teacher evaluation forms that CSIRO used in the past to assess their programs (found in Appendix E), past WPI projects involving assessment of non-formal education (Douglas, King & Meleschi, 2001), and discussion with CSIRO Education Manager Chris Krishna-Pillay. The project team decided on a list of questions to ask with follow-up questions for each, referred to as probes. The probes were asked if it seemed appropriate during the interview to construct a methodical line of questioning (Douglas et al. 2001). The questions asked in the interviews were intended to include all of the information targets, with more attention spent on the fifth target, "reactions to the program," and the seventh target, "correlation of program to science curriculum or learning unit" than the others.

The final list of questions that were devised for each of the three interviews involved in the pre-post test format can be found in Appendix Q, Appendix R and Appendix S.

The length of the interviews was a delicate challenge. Ideally, each interview would take as long as needed to produce the most responses for analysis. However, most teachers did not have enough free time before or after the program to permit an extensive interview. The challenge, balancing the depth of the questions with the brief time allotted for each interview, was reduced by having three interviews spread over the span of a week. Each interview protocol was practiced repeatedly with CSIRO Education Managers to be sure that the project team was comfortable conducting them.

3.5.2 Interviewing Teachers

All interviews were recorded. When necessary, interviewers reviewed these recordings to improve the accuracy of their interview notes.

The pre-test interview took place while the students filled out the pre-test questionnaires and was directed at the teacher's background, focusing on their relationship with the students involved in the program as well as their thoughts on the students' current stance on science in general and as an interest.

Post-test interview 1 took place as the students were completing the post-test 1 questionnaire and concentrated on the teachers' immediate reactions to the programs. This established their opinions of how the students enjoyed the program as well as what they personally liked or disliked about the program. The interviewer also asked about the potential for any long-term impacts on the students' interest in science due to the program.

The project team returned to the school for the second post-test interview one week later. This interview followed up on concepts discussed in the pre-test and first post-test interviews to determine if the teacher noticed any changes in the students one week after participation in the program.

3.6 Data Analysis Techniques

Each of the assessment techniques collected two types of data for analysis: quantitative and qualitative. Effective methods for interpretation and analysis of the different types of data were crucial for valid results and conclusions to be drawn.

3.6.1 Quantitative Data

Sampling

An accurate sample of an observed population consists of a size as large as possible, with completely random selection. These sample qualities are to ensure that the statistics derived from the sample will replicate that of the population.

The two programs studied in this report were observed multiple times to accumulate the largest possible sample size. *Forensic Frenzy* was observed five times and *Biodiversity* was observed three times. These programs were presented to classes of roughly 22 students each, providing a final sample size of 179 subjects, 119 for *Forensic Frenzy* and 60 for *Biodiversity*.

Arithmetic Mean

The arithmetic mean, μ, used in the statistical analysis described in this report is an average of the quantitative values accumulated from a sample. It provides a measure of the central tendency of a sample. It can be used for comparison among different samples.

Variance

The variance is the measure of the dispersion which a set of data points lays from the mean value. This is mathematically equivalent to the square of the standard deviation.

Standard Deviation

The standard deviation, σ, is a measure of variability within a set of data about its mean. The standard deviation is equal to the square root of the sum of the variances. Standard deviation can be used to characterize the spread of a set of values around its mean.

Correlation

Correlation is the standardized measurement of association between two random variables, scaled so that it ranges from –1 to 1. This technique was used by the project team to test whether there was a connection between two variables.

Confidence Interval

Confidence interval is the probability that a statement about certain statistical values is true; e.g. a 95% confidence interval indicates a range that one can expect the actual value of the population to fall within 95% of the time. For this research, the project team used a 95% confidence interval.

P Value

The P value is the probability of receiving a result that is far enough from the expected value to be considered statistically significant. The lower the P value, the smaller the chances of receiving a result, assuming the null hypothesis is true.

P Value was used by the project team to analyse statistics that varied significantly from null hypothesis.

Significance Level

Significance level, α, is the level at which the P value must be below to accept the alternate hypothesis and reject the null hypothesis. For all tests conducted in this research, a significance level of 0.05 was selected.

Z-value

The Z-value represents the number of standard deviations a given observation deviates from the mean. Z-values were utilized by the project team in various tests in the analysis of data and the calibration of the observational cue checklist.

2-Proportion-Z-Test

A 2-Proportion Z-test is used to determine if there is a significant difference between two proportions. The returned P Value can be tested against an established level of significance. Validity was ensured by meeting the following conditions:

- Random Sampling
- Responses were independent from one another
- Large sample size

The project team implemented this test in order to test for statistically significant differences between mean values of response received from student questionnaires.

3.6.2 Qualitative Data

Since qualitative data is more complex in nature, its analysis was less formulaic. The qualitative data that needed to be analysed included the responses from the interviews, comments on observations that did not fit into the checklist, and answers to the open response questions from the questionnaires.

The project team followed Seidel's recommendations for analysing qualitative data. The three ongoing and overlapping processes in these recommendations are: noticing, collecting, and thinking (Seidel 1998).

The noticing process involves "making observations, writing field notes, tape recording interviews, gathering documents, etc. When you do this you are producing a record of the things that you have noticed" (Seidel, 1998). This stage of analysis took place during the administration of the assessment when the qualitative responses were collected. The information was then read, and patterns were named, or "coded" to make them easier to organize. Coding is the process of going through each qualitative question generating a general understanding of the possible responses possible, and then categorizing similar responses. This allows the data to be quantified for more reliable analysis to draw conclusions from.

Once patterns have been noticed, they must be sorted into different types, referred to as collecting. Seidel analogises this process with sorting pieces of a puzzle into categories to make it easier to build the puzzle (Seidel, 1998). Using this process, the project team organized the patterns into categories to better track them.

The third process in the analysis is thinking about what was noticed and how it was collected. Seidel returns to the puzzle analogy to explain that once the pieces of the puzzle are organized, it is necessary to figure out how they fit together (Seidel, 1998). In this stage, the project team tracked patterns, similarities, and differences in the data. Thinking about the data caused the group to notice new things, and re-collect them, creating a cyclical process that was continuous throughout the analysis.

4 Data and Analysis

The following chapter presents the relevant data gathered from the system of assessments described in the Research Methodology chapter. These include findings from student questionnaires, student observations, and teacher interviews presented in graphs, charts, and tables.

4.1 Sample Sizes

Figure 6 shows how teachers and students were involved in the program assessment.

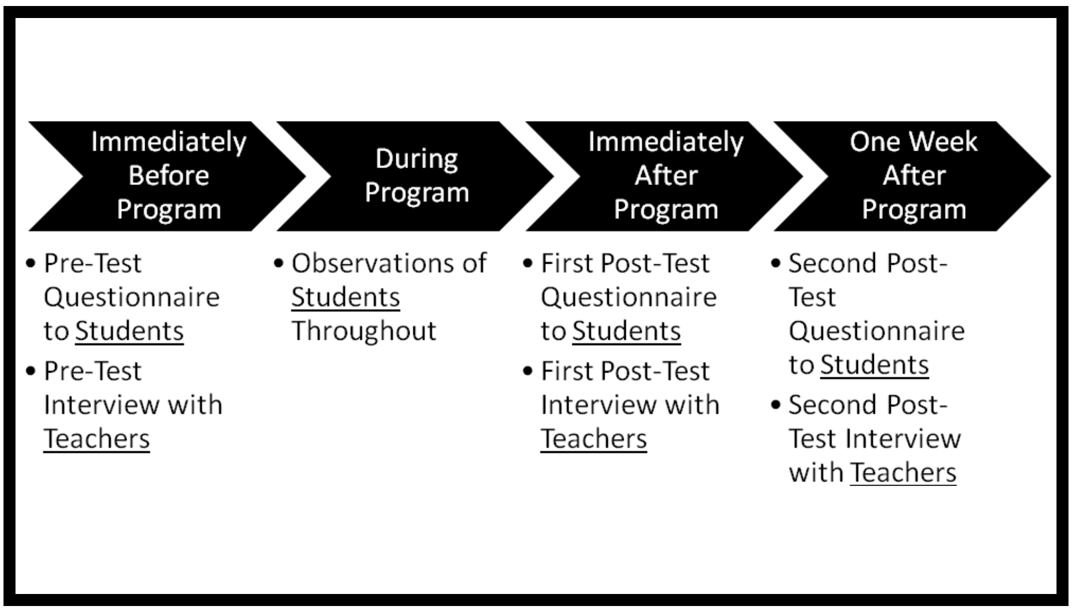


Figure 6: Assessment Administration Timeline

Our assessment protocol also includes further student questionnaires and teacher interviews one month after the program; a second project team will complete those steps.

Table 1 identifies the numbers of students and the names of the teachers who participated in the assessments of the eight program offerings we studied. Table 2 summarizes this data to show the total number of teacher interviews, student observations, and student questionnaires the project team gathered.

We assessed only those program offerings that had been booked with CSIRO at the initiative of the school's staff; none were solicited for the purposes of program assessment. Every student who participated in a program was asked to complete pre-test and post-test questionnaires and all were observed during the session. The teachers who supervised the program were asked to participate in an interview on the day of the program and two post-session interviews.

Table 1: Sample Populations

Session	Date	Program	School	Pre-Test Gender		Post-Test 1 Gender		Post-Test 2 Gender		Year	Teacher Interviewee Pre-Test	Teacher Interviewee Post-Test 1	Teacher Interviewee Post-Test 2
				M	F	M	F	M	F				
Alpha	15/2/2010	*Forensic Frenzy*	St. Josephs College	25	0	26	0	22	0	8	Kamil Gomularz	-	Kamil Gomularz
Beta	15/2/2010	*Forensic Frenzy*	St. Josephs College	18	0	18	0	15	0	8	Jan Van Kruysbergen	Jan Van Kruysbergen	-
Gamma	16/2/2010	*Forensic Frenzy*	St. Josephs College	25	0	25	0	24	0	8	Nick Jones	Nick Jones	Nick Jones
Delta	16/2/2010	*Forensic Frenzy*	St. Josephs College	26	0	27	0	25	0	8	Ashley Humphries	Ashley Humphries	Ashley Humphries
Epsilon	16/2/2010	*Forensic Frenzy*	St. Josephs College	23	0	23	0	13	0	8	Brendan Nichols	Brendan Nichols	Brendan Nichols
Zeta	17/2/2010	*Biodiversity*	Sandringham College	16	0	16	0	9	0	8	Linda Lane	Linda Lane	Michael McGowan
Eta	17/2/2010	*Biodiversity*	Sandringham College	9	14	9	14	9	13	8	Marnie Sparrow	Marnie Sparrow	Marnie Sparrow
Theta	17/2/2010	*Biodiversity*	Sandringham College	10	11	9	11	9	7	8	Dixon	Michael McGowan	Michael McGowan
		Total Number of Students		177		178		146					

Table 2: Summary of Sample Populations

	Forensic Frenzy	***Biodiversity***	**Total**
# of Students Observed	119	59	**178**
# of Students Given a Series of Three Questionnaires	99	47	**146**
# of Interviews Conducted	13	8	**21**

4.2 Variables

The project team identified four variables that may have had an impact on the students' and/or teachers' responses during the assessment process. Figure 7 shows the variables which were identified. To the extent possible, our analysis controlled for these variables.

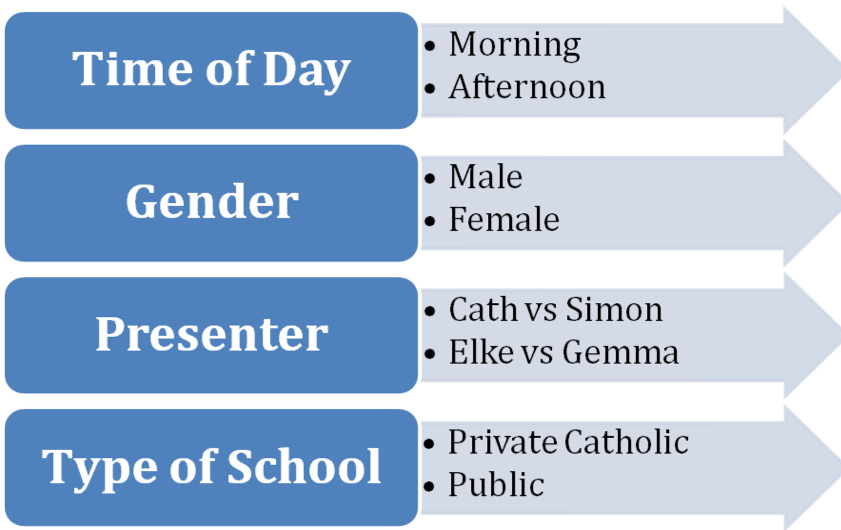


Figure 7: Variables

4.3 Results

4.3.1 Student Questionnaires

The questionnaires collected data from the students for the first six information targets:

1. Students' feelings, opinions and behaviours toward science
2. Level of interest in science
3. Knowledge about science in general
4. Knowledge about the specific topic of the NFE program
5. Reactions to program
6. Student and teacher demographics

Target 6, Student and teacher demographics, was used to help analyse the data from other targets, but no immediate conclusions were drawn from that target itself. The following sections describe the significant data that was gathered from each target.

The table in Appendix G connects each of the questions in the entire series of assessments to the information target to which its responses apply.

Further, all of the answers from the questionnaires were entered in an Access database and used for tasks such as analysing responses of specific sub-populations. We recommend that the following WPI project team who will assess longer-term impact for CSIRO use this Access database to examine these responses for trends and patterns that are either conclusive in themselves or suggestive of actions or inquiries the team should undertake as part of its project. This access database will be given to CSIRO and separately to this follow-up project team.

Target 1: Students' feelings, opinion and behaviour toward science

The following questions were asked in order to gain information about the students' feelings toward science:

Table 3: Target 1 Student Questionnaire Content

Question	(Questionnaire, #)
Is science important? (Rank 'Strongly Agree' to 'Strongly Disagree') Why?	**Post-Test 1-1**
Have you noticed any scientific achievements in the media (newspaper, radio, television, internet) recently? If yes, what?	**Post-Test 1-2**
Have you attended a science event/activity outside of school in the last month? If so, what was it?	**Post-Test 2-4**

Question numbers post-test 1-2 and post-test 2-4 were not used to analyse the students' feelings toward science because the answers proved to be inconclusive.

Figure 8 shows that in general, students agree that science is important. When the students were asked "Is science important?" immediately after having participated in either the *Forensic* or the *Biodiversity* program (on post-test 1), 90.39% of the students agreed or strongly agreed. These numbers will serve as a baseline or control for the follow-up group's research.

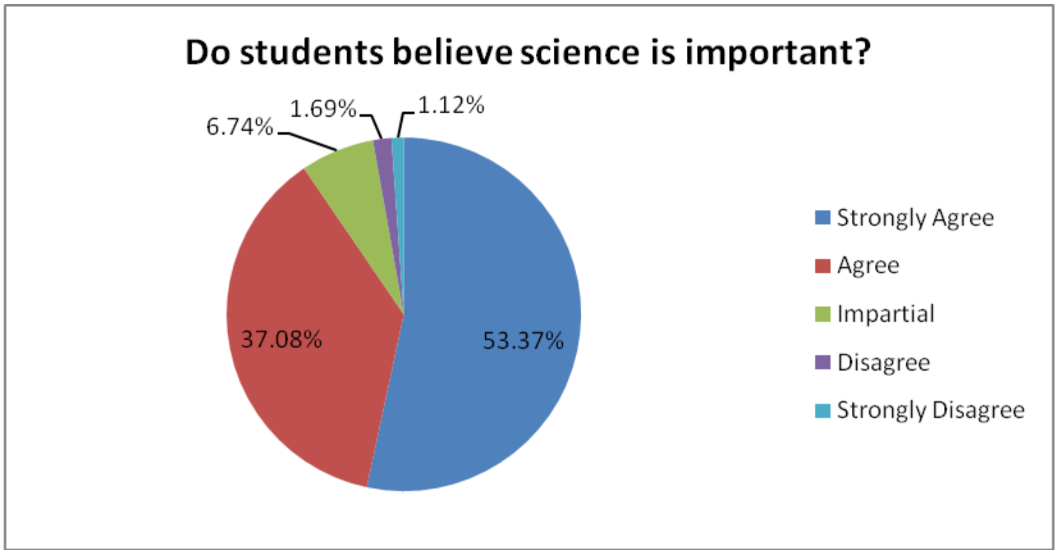


Figure 8: Science Importance in Students' Eyes

Among students whose parents were in the professional fields of science, engineering and/or technology, 87% either strongly agreed or agreed that science is important. Since this fraction is nearly the same as the fraction of the total population holding the same opinion, we conclude that the parents' field of work does not have a significant impact on children's views of science.

Do these same parents' field of work affect their students' career interests? Using Figure 9 to extrapolate, we see that 40% of the students whose parents are in the fields of science/engineering/technology selected science/engineering/technology as a career interest and only 20% of the total number of students chose this as a career interest. Because of this, we conclude that parents' career fields do have an impact on students' career interests.

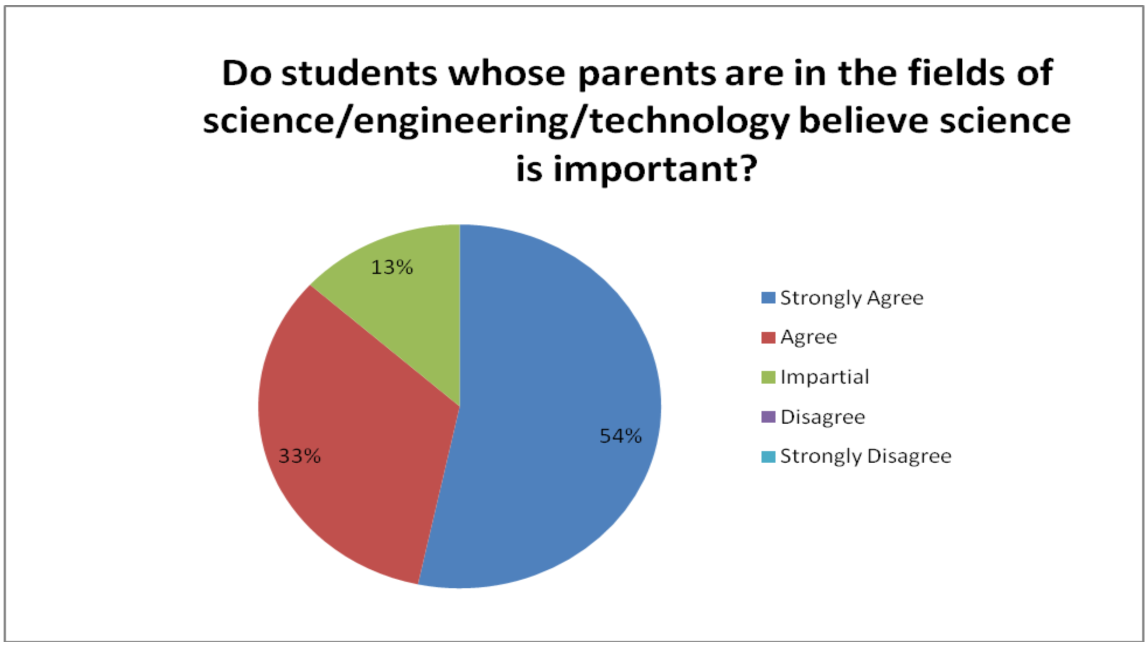


Figure 9: SET Parental Background and Science Importance

Figure 10 shows that there is not a significant difference between how males and females view the importance of science after having seen either the *Biodiversity* or *Forensic Frenzy* programs. The percentages shown represent the percent of students who indicated the respective response when asked the question, "Is science important?" after having participated in the program.

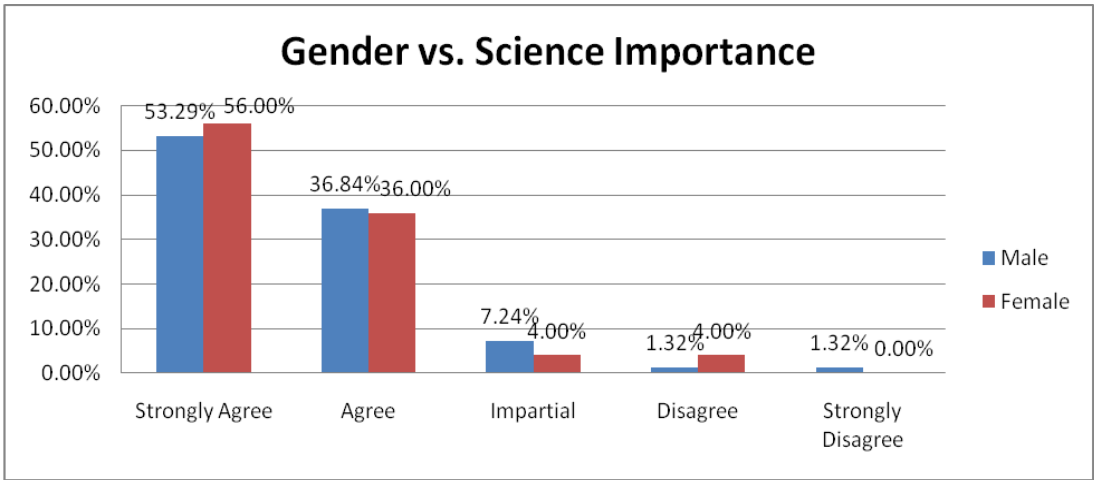


Figure 10: Gender vs. Science Importance

Target 2: Level of interest in science

The following questions were asked in order to gain information about the students' levels of interest in science:

Table 4: Target 2 Student Questionnaire Content

Question		(Questionnaire, #)
Thinking about your knowledge and interest in the subjects listed below, please rate each one on a 7 point scale where "1" means you have a low interest or knowledge, and "7" means you have a high interest or knowledge.	Your interest in science and technology	Pre-Test-4, Post-Test2-2
	Your interest in new technologies	Pre-Test-4, Post-Test2-2
	Your interest in how the items you use in everyday life function/work	Pre-Test-4, Post-Test2-2
What are your current career interests? (Please tick all that apply)		Pre-Test-6
Rate your overall interest in the following science-related materials. Please use a 7 point scale, where 1 means "not at all interested" and 7 means "extremely interested. If you've never heard of it, tick 0.		Post-Test 1-12
Which best describes your interest in science?		Post-Test 2-1
What type of science are you most interested in?		Post-Test 2-3
Do you plan to do VCE? If so, what subjects would you do?		Post-Test 1-6

Students were asked to rate their level of interest in science and technology, new technologies, and in how items they use everyday function/work both before the program and one week after having experienced the program. Students answered on a scale of 1 to 7 where 1 was low interest and 7 was high interest. Figure 11 shows the average response of all students before and after the program. A visible decrease appears in all areas of interest; however, once statistical significance tests were applied (detailed results found in Appendix T), we concluded that the decrease in interest in new technologies and interest in how items function/work was not statistically significant, but that the decrease in interest in science and technology was slightly significant. A 95% confidence interval was used.

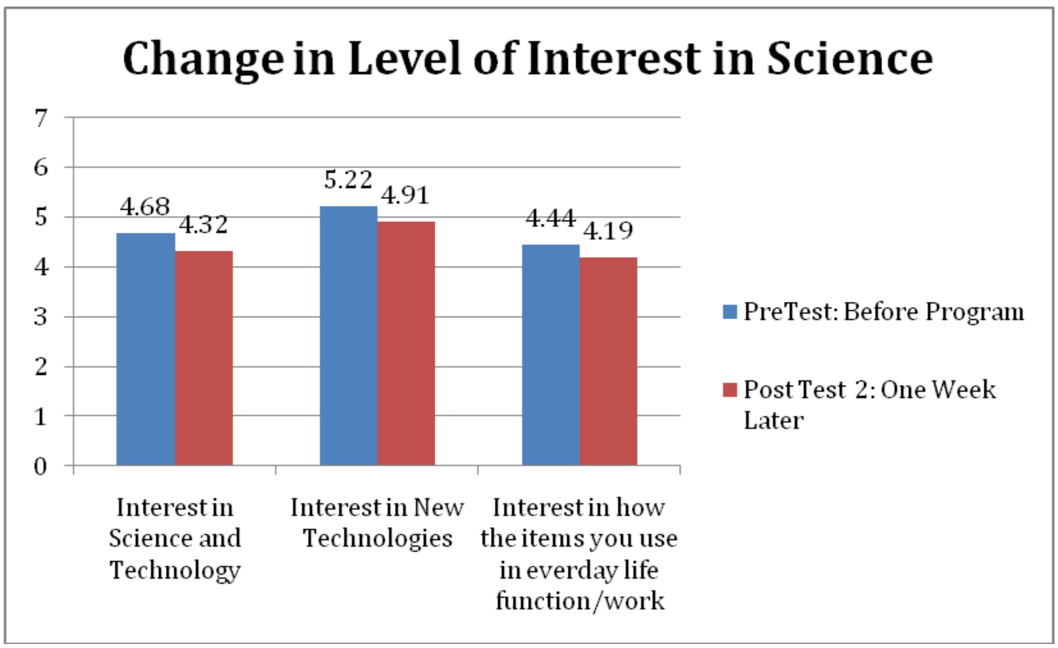


Figure 11: Change in Level of Interest in Science

Students were asked to check off their current career interest and were allowed to check more if applicable. Figure 12 displays the number of students who checked off each respective career field. The number of students that mentioned science/engineering/technology as a current career interest is highlighted. This could be used as a basis to measure over a longer period of time the change in career interest in students.

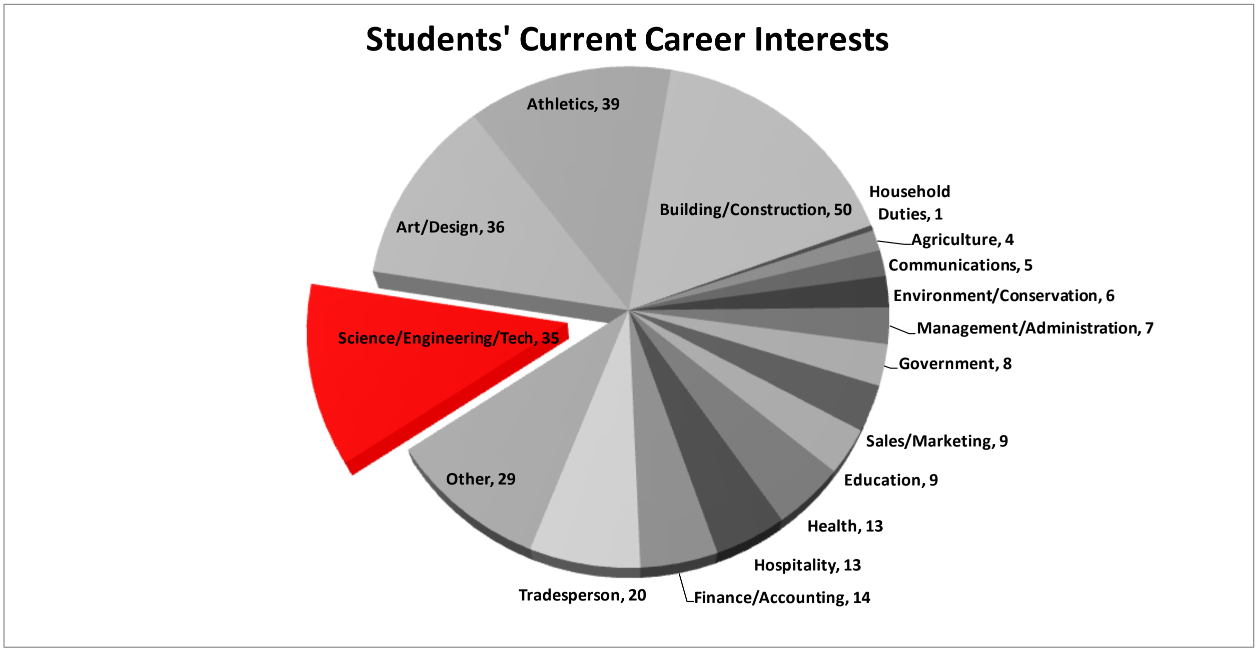


Figure 12: Students' Current Career Interests

Figure 13 shows the average responses of all students when they were asked to rate their overall interest in the displayed science related materials. They were given a 7 point scale where 1 means not interested at all and 7 means they were extremely interested. Students were given the option to tick 0 if they had never heard of the material and these figures were not incorporated into the average. The trend line that can be seen on the graph shows that students enjoy Live Programs and television over online and print science related materials. One can also see that newspapers, *Mythbusters*, and *Scienceworks* are among the best media to capture students' interest in a science-related subject.

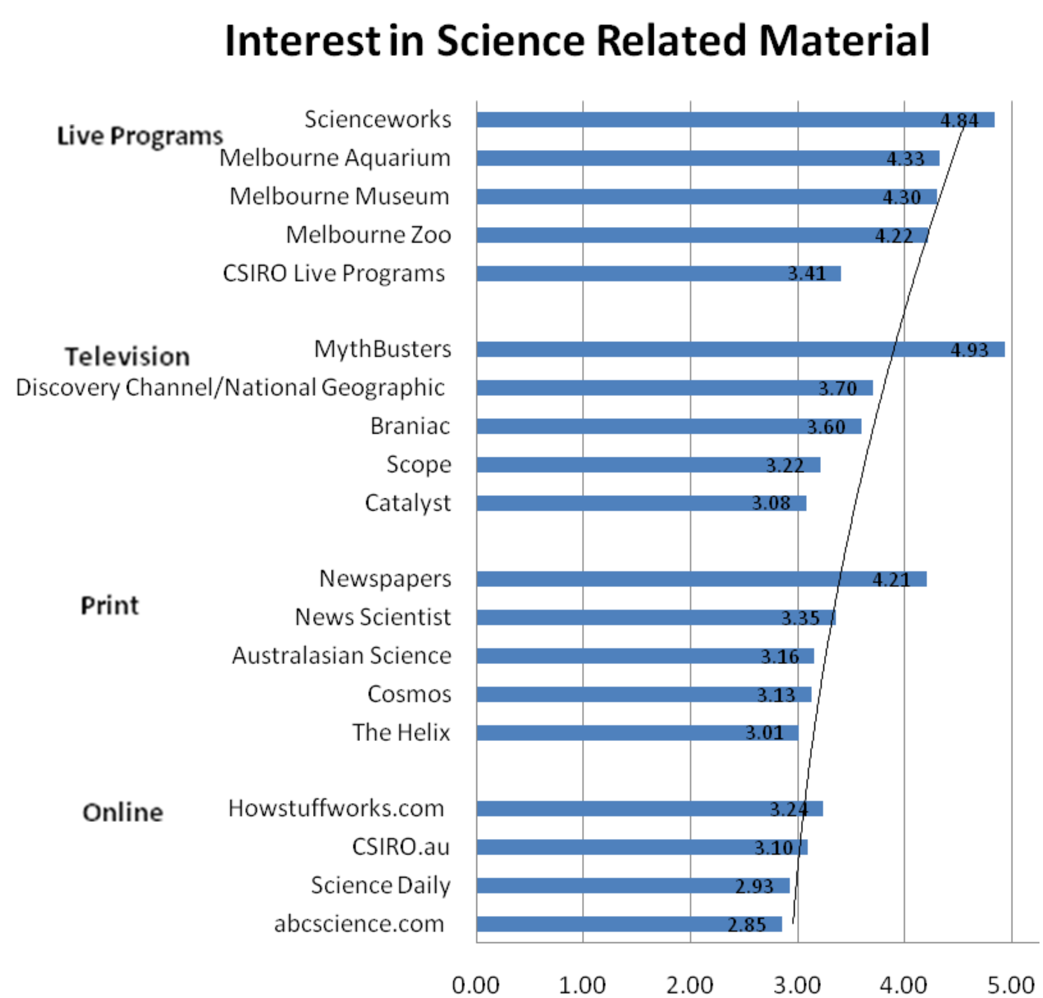


Figure 13: Students' Interest in Science Related Material

Figure 14 summarizes the students' responses to the question "Which best describes your interest in science?" It shows that the majority students are interested in science, but do not all actively seek information about it. All students who experienced either program were surveyed. These numbers will serve as a baseline or control for the follow-up group to compare their findings.

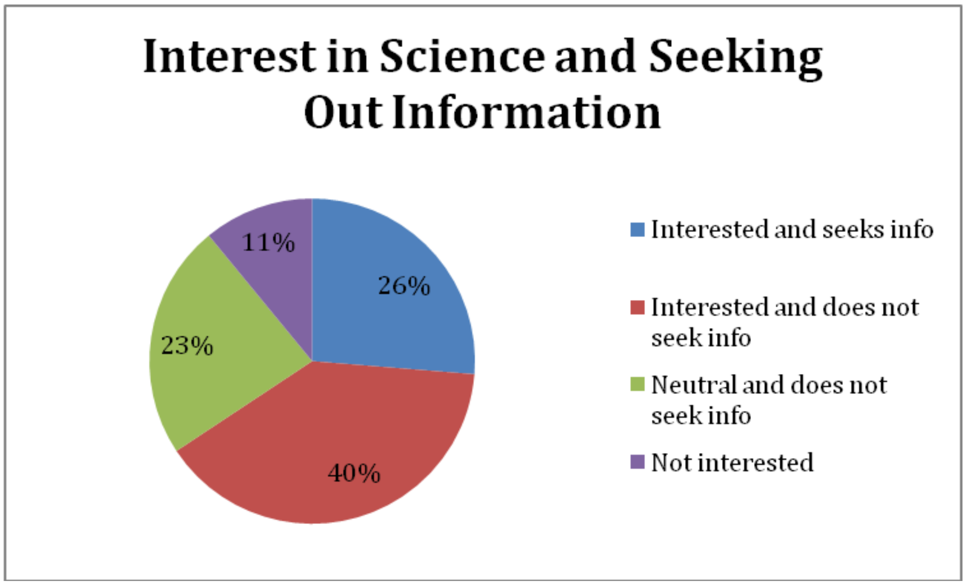


Figure 14: Interest in Science and Seeking Out Information

Post-test 2 asked the students to choose what type of science they were most interested in (students could choose multiple subjects if applicable). Figure 15 shows the number of students' responses total that appeared on all post-test 2 tests collected. Computer science and forensic science were the subjects that students mentioned most frequently as being of interest. These numbers will serve as a baseline or control for the follow-up group to compare their findings.

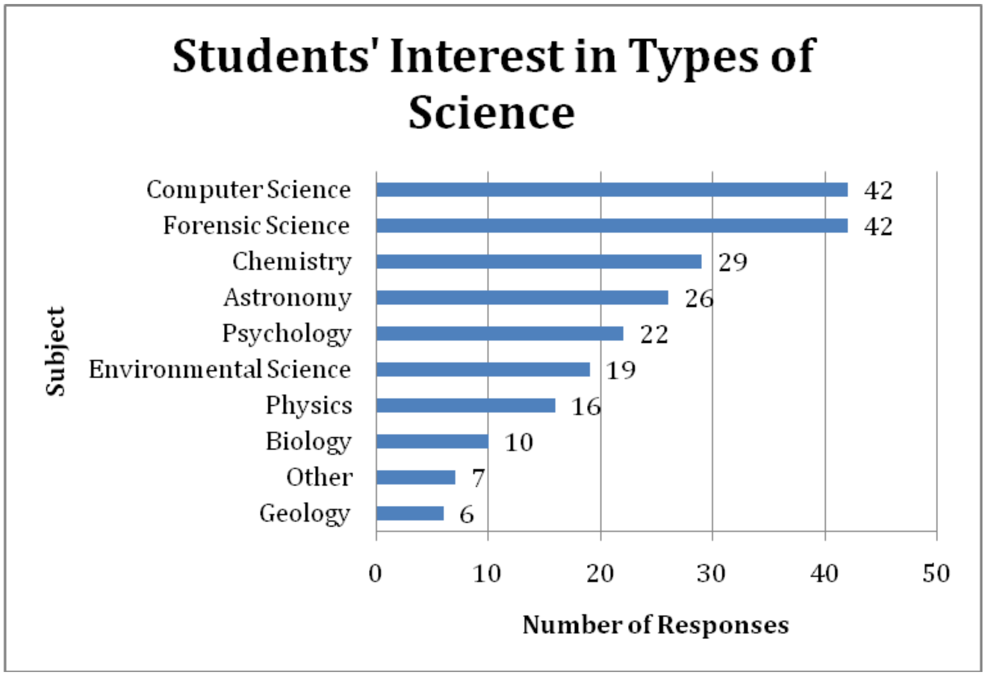


Figure 15: Students' Interest in Types of Science

In post- test 1, students were asked whether or not they plan to do VCE (years 11 and 12 of schooling) and if they do, then what subjects they will study. 102 of 178 students stated that they intended to continue their education with years 11 and 12 (VCE). Of those 102, 25 students (24.5%) expressed interest in studying science during these years. These numbers will serve as a baseline or control for the follow-up group's research.

Target 3: Knowledge about science in general

The questions shown in Table 5 were asked in order to gain information about the students' knowledge about science in general:

Table 5: Target 3 Student Questionnaire Content

Question		(Questionnaire, #)
Thinking about your knowledge and interest in the subjects listed below, please rate each one on a 7 point scale where "1" means you feel you have low interest or knowledge, and "7" means you have a high interest or knowledge.	Your knowledge of science	**Pre-Test-4, Post-Test2-2**
What school subjects are you best at?		**Post-Test 1-8**

Students were asked to rate their knowledge of science between 1 and 7 where 1 means that they have low level of knowledge and 7 means they have a high level of knowledge. Figure 16 shows a slight decrease of 0.21 in students' self-reported average knowledge between the pre-test and post-test; however, a z test, with a 95% confidence interval, has proven that the change is not significant (z test details can be found in Appendix T). Therefore, we can conclude that no significant change in the students' knowledge about science has occurred one week after having experienced the program.

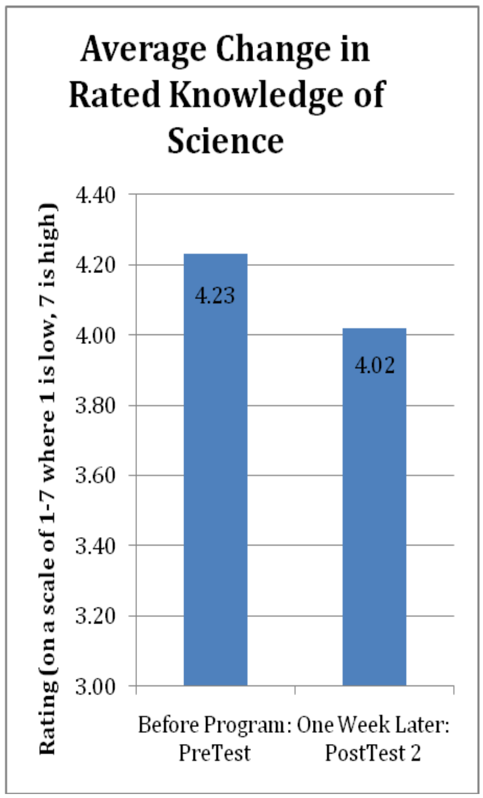


Figure 16: Average Change in Rated Knowledge of Science

Figure 17 summarizes the responses all students from the sample population gave when asked the question “What is your best subject in school?” Students could give more than one subject as the question was open response; therefore the project team calculated the percent of total students who mentioned the respective subject as one of their answers. Of the core subjects, english (29.78%) and mathematics (42.7%) had the highest number of responses, with science being mentioned by many less kids (19.66%). These numbers will serve as a baseline or control for the follow-up group’s research.

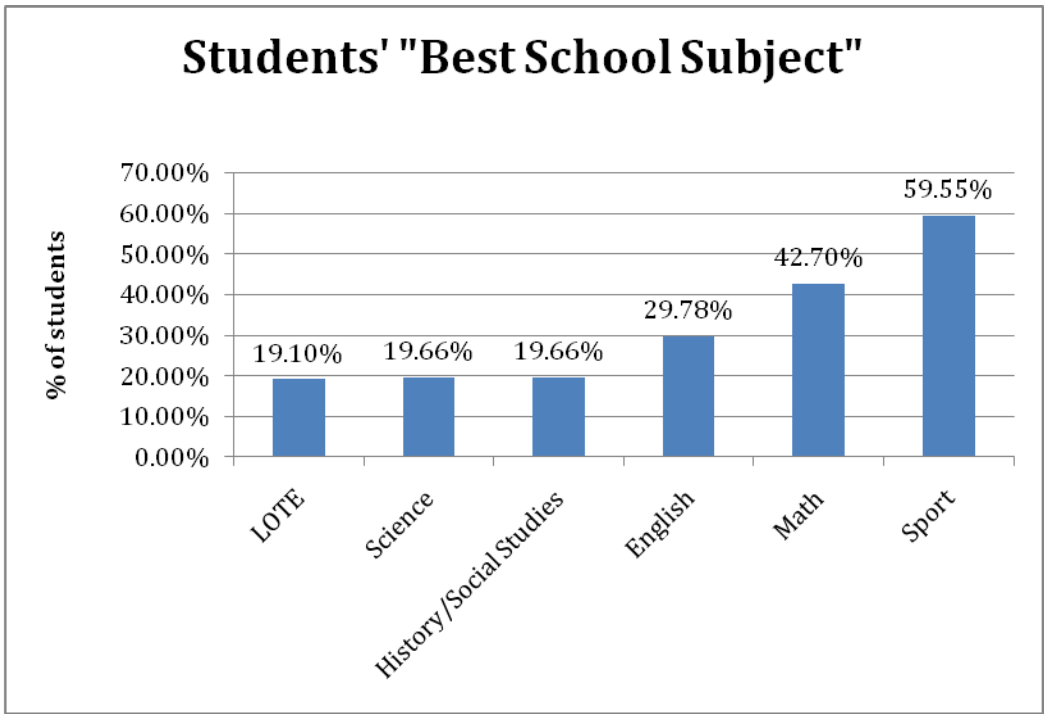


Figure 17: Students' Best School Subjects

Target 4: Knowledge about the specific topic of the NFE program

The following questions were asked in order to gain information about the students' knowledge about the specific topic of the NFE program (*Biodiversity* or *Forensics*):

Table 6: Target 4 Student Questionnaire Content

<table>
<tr><th colspan="2">Questions</th><th>(Questionnaire, #)</th></tr>
<tr><td rowspan="2">Thinking about your knowledge and interest in the subjects listed below, please rate each one on a 7 point scale where "1" means you feel you have low interest or knowledge, and "7" means you have a high interest or knowledge.</td><td>Your knowledge of forensics</td><td>Pre-Test-FF-4
Post-Test 2-FF-2</td></tr>
<tr><td>Your knowledge of the environment/biodiversity</td><td>Pre-Test-BD-4
Post-Test 2-BD-2</td></tr>
<tr><td colspan="2">What does a Forensic Scientist do?</td><td>PreTest-FF-7
Post-Test 1-FF-3</td></tr>
<tr><td colspan="2">Please explain what you think Biodiversity is.</td><td>Pre-Test -BD-7</td></tr>
<tr><td colspan="2">What kinds of crimes do Forensic Scientists help solve?</td><td>Pre-Test -FF-8</td></tr>
<tr><td colspan="2">In your own words, what is the environment?</td><td>Pre-Test -BD-8</td></tr>
<tr><td colspan="2">What are 4 words/phrases that you associate with Forensic Science?</td><td>Pre-Test -FF-9
Post-Test 2-FF-7</td></tr>
<tr><td colspan="2">What are 4 words/phrases that you associate with Biodiversity?</td><td>Pre-Test -BD-9
Post-Test 2-BD-7</td></tr>
<tr><td colspan="2">Why is Biodiversity important?</td><td>Post-Test 1-BD-3</td></tr>
<tr><td colspan="2">Name as many types of science as you can that might be used in Forensics.</td><td>Post-Test 1-FF-4</td></tr>
<tr><td colspan="2">Name 4 tests that you did today.</td><td>Post-Test 1-BD-4</td></tr>
<tr><td colspan="2">What crimes might Forensics be used to solve?</td><td>Post-Test 1-FF-5</td></tr>
<tr><td colspan="2">What is the environment?</td><td>Post-Test 1-FF-5</td></tr>
<tr><td colspan="2">What physical characteristics can be used to identify a suspect?</td><td>Post-Test 2-FF-5</td></tr>
<tr><td colspan="2">What is Biodiversity?</td><td>Post-Test 2-BD-5</td></tr>
<tr><td colspan="2">If you can, please describe one laboratory technique used in Forensic Science.</td><td>Post-Test 2-FF-6</td></tr>
<tr><td colspan="2">If you can, please describe one test a scientist can do to monitor the environment.</td><td>Post-Test 2-BD-6</td></tr>
</table>

Self-Rated Knowledge

Students were asked to rate their knowledge of the specific program topic (either biodiversity or forensics) on a scale of 1 to 7 where 1 means low level of knowledge and 7 means that they believe they have a high level of knowledge. They were asked both before the program and one week after the program. Figure 18 shows that *Biodiversity* participants felt like they had experienced a decrease in knowledge whereas *Forensics* experienced a slight increase. However, z-tests of significance were applied to both changes and neither change represents a statistically significant decrease as shown by the z-test results in Appendix T.

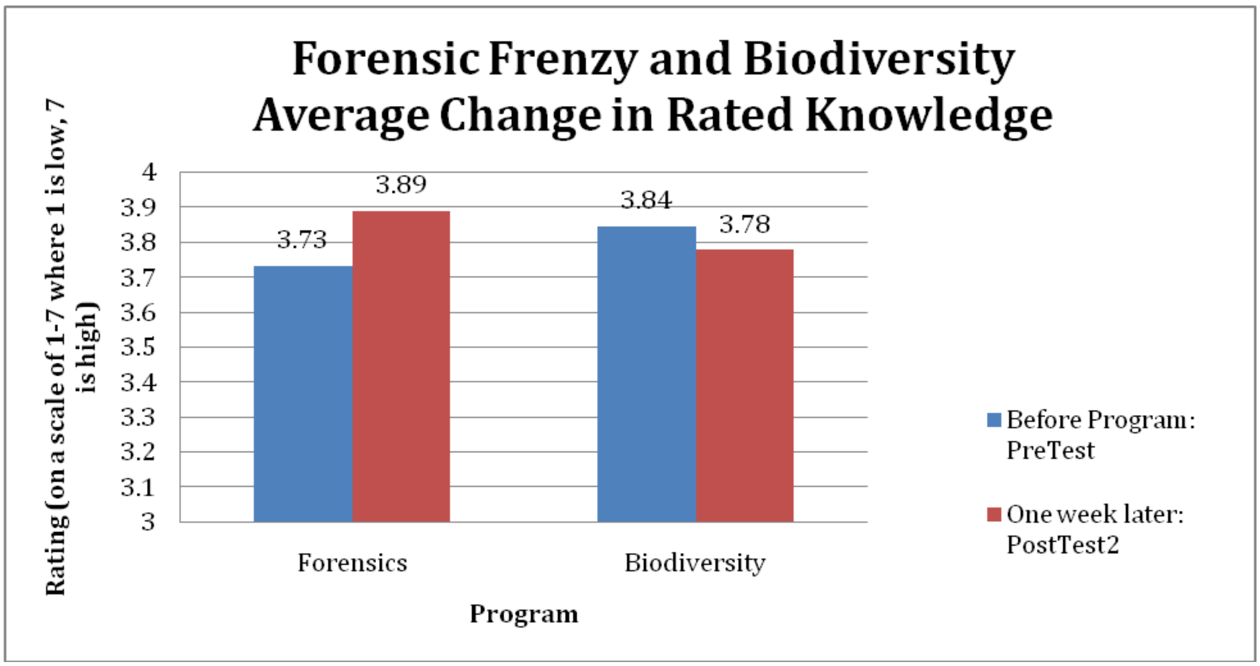


Figure 18: *Forensic Frenzy* and *Biodiversity* Average Change in Rated Knowledge

Knowledge Displayed By Answering Qualitative Questions:

Level of knowledge of biodiversity and forensics was measured using the students' answers to the following questions that appeared on questionnaires:

Biodiversity Pre-Test

- Please explain what you think Biodiversity is.
- In your own words, what is the environment?

Biodiversity Post-Test 1

- Why is Biodiversity important?
- Name 4 tests that you did today.
- What is the environment?

Biodiversity Post-Test 2

- What is Biodiversity?
- If you can, please describe one test a scientist can do to monitor the environment.

Forensic Frenzy Pre-Test

- What is Forensic Science?
- What crimes might Forensics be used to solve?

Forensic Frenzy Post-Test 1

- What do Forensic Scientists do?
- What crimes might Forensics be used to solve?

Forensic Frenzy Post-Test 2

- If you can, please describe one laboratory technique used in Forensic Science.
- What physical characteristics can be used to identify a suspect?

Students' answers to these questions were rated by the project team as either correct or incorrect. All answers that were blank were coded as incorrect for the purposes of this calculation. For each questionnaire, (pre-test, post-test 1 and post-test 2) the percentage of qualitative questions (shown above) rated correct and incorrect was calculated. Figures 19 and 20 show these results for all three questionnaires distributed up to a period of one week after the program.

Qualitative questions which appeared on the questionnaires but were not used in analysis because they were determined to be inconclusive include:

- What are 4 words/phrases that you associate with Biodiversity? (BD-PR and BD-P2)
- What are 4 words/phrases that you associate with Forensic Science? (FF-PR and FF-P2)
- Name as many types of science as you can that might be used in Forensics. (FF-P1)

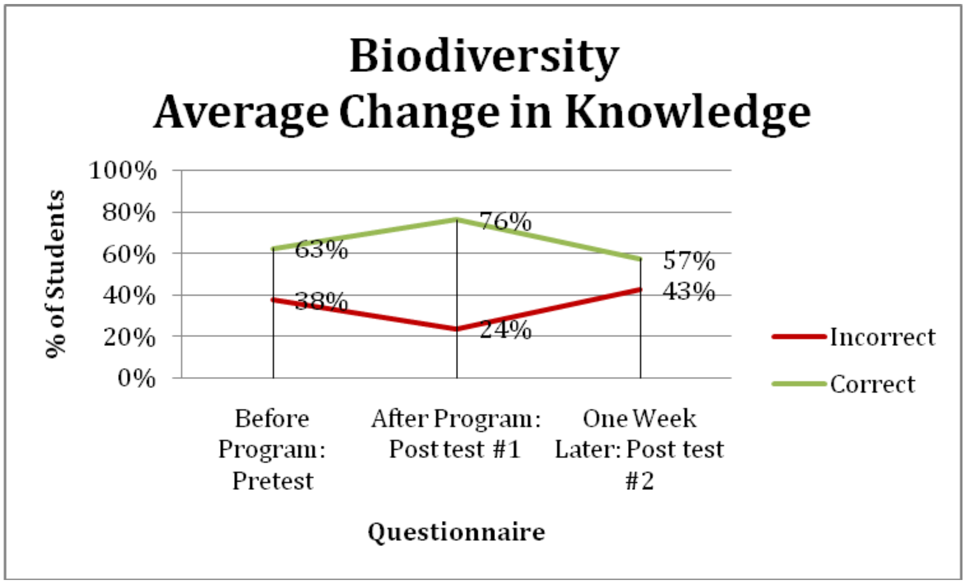


Figure 19: ***Biodiversity's*** **Average Change in Knowledge of Biodiversity/Environment**

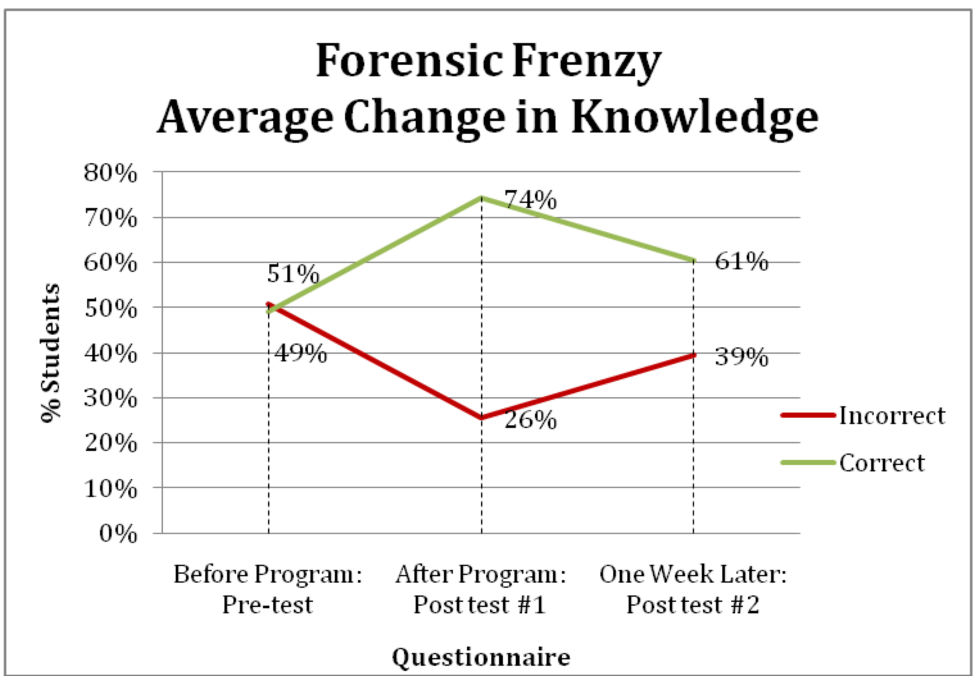


Figure 20: ***Forensic Frenzy*****'s Average Change in Knowledge of Forensics**

In both programs, the graphs show an increase in the percentage of students who answered questions from the pre-test to post-test 1, immediately after the program. These increases show that students learned about biodiversity and forensics from the respective programs. Both graphs also show that from post-test 1 to post-test 2, which was taken one week after the program, there was a decrease in the fraction of students who answered questions correctly and therefore a knowledge decrease. This shows that knowledge was not retained, although it was apparently acquired immediately after the program.

Target 5: Reactions to program

The following questions were asked in order to gain information about the students' reactions to the program:

Table 7: Target 5 Student Questionnaire Content

Question	(Questionnaire, #)
Did you enjoy the CSIRO session on Forensics?	**Post-Test 1-FF-9**
Did you enjoy the CSIRO session on Biodiversity?	**Post-Test 1-BD-9**
What, if anything, did you particularly like about CSIRO's program? Why?	**Post-Test 1-10**
What, if anything, did you particularly dislike about CSIRO's program? Why?	**Post-Test 1-11**
What stands out most in your mind about the *Forensic Frenzy* program?	**Post-Test 2-FF-8**
What stands out most in your mind about the Biodiversity program from last week?	**Post-Test 2-BD-8**

On post-test 1, all students were asked “Did you enjoy the CSIRO session?” and rated it on a scale of loved, liked, impartial, disliked, and strongly disliked. Figure 21 shows that most students liked the program which was positive, but more impressively, no students answered that they disliked or strong disliked the program.

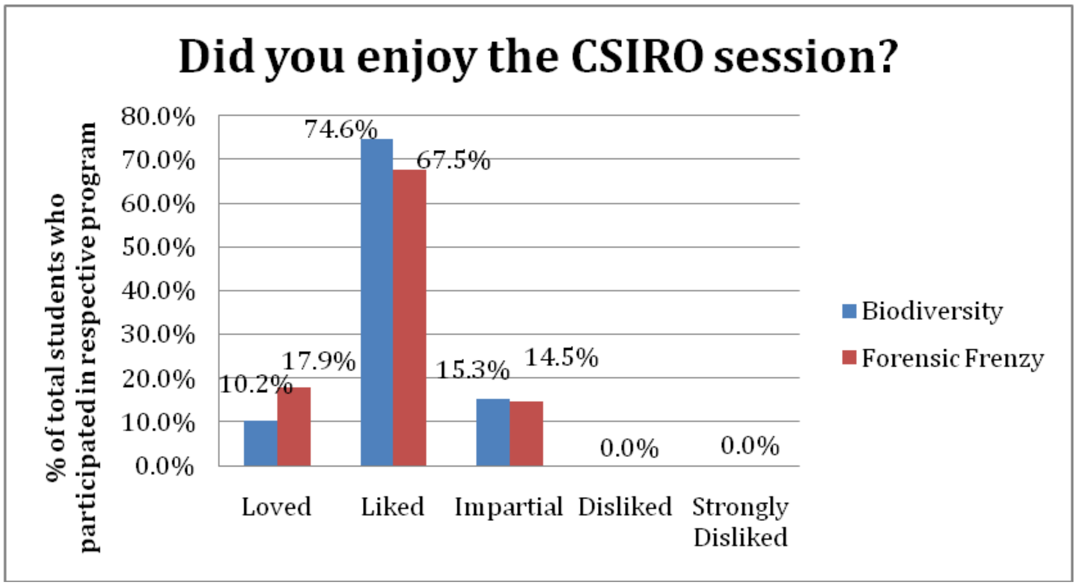


Figure 21: Students' Level of Enjoyment of the Program

On post-test 1, immediately after the program, students were asked to state what they liked and disliked about the program. Questions were coded and answers were grouped accordingly. Table 8 and 9 show results for both *Forensic Frenzy* and *Biodiversity* respectively. The tables also show what stood in their minds after a week later, which was answered on the post-test 2.

Key things to notice in these tables include:

Forensic Frenzy

- **9** students felt that there was not enough time in the program to complete all of the activities.
- **28** Students stated that the aspect of solving a crime, finding results and thinking and analysing evidence to come to a conclusion was what stood out most in their mind after a week.
- Many children liked the activities and “hands-on” nature of the program and even recalled it a week later.
- Fingerprints, Ballistics, Facial Recognition using a Computer, and the “Looking Complete: Facial Reconstruction” activities were generally most memorable both after the program and one week later.

Biodiversity

- Students felt that they learned new things.
- Heat Map, CO2, and Soil activities were most memorable to students according to these answers.

Table 8: *Forensic Frenzy* Student Qualitative Reactions to the Program

Forensic Frenzy					
What Students Disliked		What Students Liked		What Stood Out In Their Minds	
Statement	**Count**	**Statement**	**Count**	**Statement**	**Count**
Talking/explaining too much or boring	10	Interesting, Cool, Enjoyable, Fun	25	Solved Crime, Finding results, thinking and analysing evidence to come to a conclusion	28
Not enough time	9	Hands-On, Interactive	15	Activities/Experiments	15
Surveys	4	"Everything"	15	Fun, Interesting, Cool	12
Too much time/Too many things to do	3	Experiments, Activities, Test Prac	15	Ballistics	11
Other students hogged activities	3	Solving a Crime/Finding evidence	9	Fingerprints	8
Writing	3	Facial Recognition using Computer	7	Hands-On	6
The work	2	Fingerprints	6	Facial Generation/Computer	6
Didn't know who the killer was	2	Skull	5	Murder, Crime	4
Hard/Confusing	1	Equipment	3	Equipment	2
Annoying	1	Ballistics	3	Chromatography	1
Introduction	1	Americans	2	Tyre Tracks	1
Dental X-ray activity	1	Studying Science	2	Playdoh/Skull	1
		Oil	1		

Table 9: *Biodiversity* Students' Qualitative Reactions to the Program

Biodiversity					
What Students' Disliked		What Students' Liked		What Stood Out In Their Minds	
Statement	**Count**	**Statement**	**Count**	**Statement**	**Count**
Soil	5	Learned new things	11	Activities/Experiments	5
Hard/Confusing	4	Got to choose what I wanted to do	8	Heat Map	5
Talking/explaining too much or boring	3	Interesting, Cool, Enjoyable, Fun	6	CO2	5
Not enough time	1	Temperature	5	Soil	5
Everything	1	Everything	3	Simpsons	3
Too much time/Too many things to do	1	Experiments, Activities, Test Prac	2	Temperature Test	3
Microscope	1	Hands-On, Interactive	1	Way organisms live/work together	2
		Soil	1	Interesting	1
		Mac	1	DVD/Video	1
		Nice	1	Food Web	1
		Calm	1	Hands-on, Interactive	1
		Food Web	1		
		CO2	1		

4.3.2 Student Observations

We formally observed the participants in each of the programs in order to address information target 5, reactions to the program. All raw observation data can be found in Appendix U. The graphs shown below relate the visual cues to the specific activities. Positive and negative traits that were above average were accentuated with green and red bars respectively. Cues that were average are shown in blue.

This section provides a side-by-side comparison of all the activities between the two programs. The positive and negative attributes of the activities suggest which activities have the greatest and least impact on participants. Comparable activities are grouped together based on the similarity of the observational cues displayed by students. This grouping facilitates the identification of specific trends that may be associated with the different types of activities.

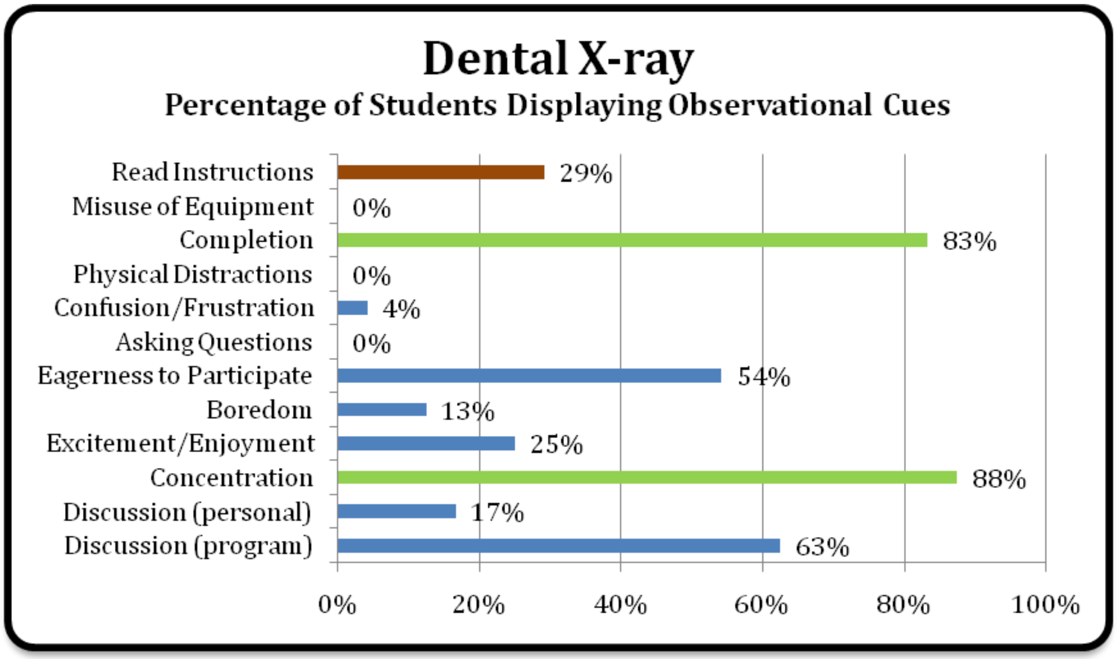


Figure 22: Dental X-Ray Activity

Figure 22, above, displays the percentage of students that reacted to the "Dental X-ray" activity in a specific way. The main points that stand out are that though completion and concentration ranked high for this activity, eagerness to participate was relatively low compared to the other activities. "Dental X-Ray" was also the least visited of all the activities, in 3 different observation sessions only 24 total students visited the activity, showing that it is the least popular of the program.

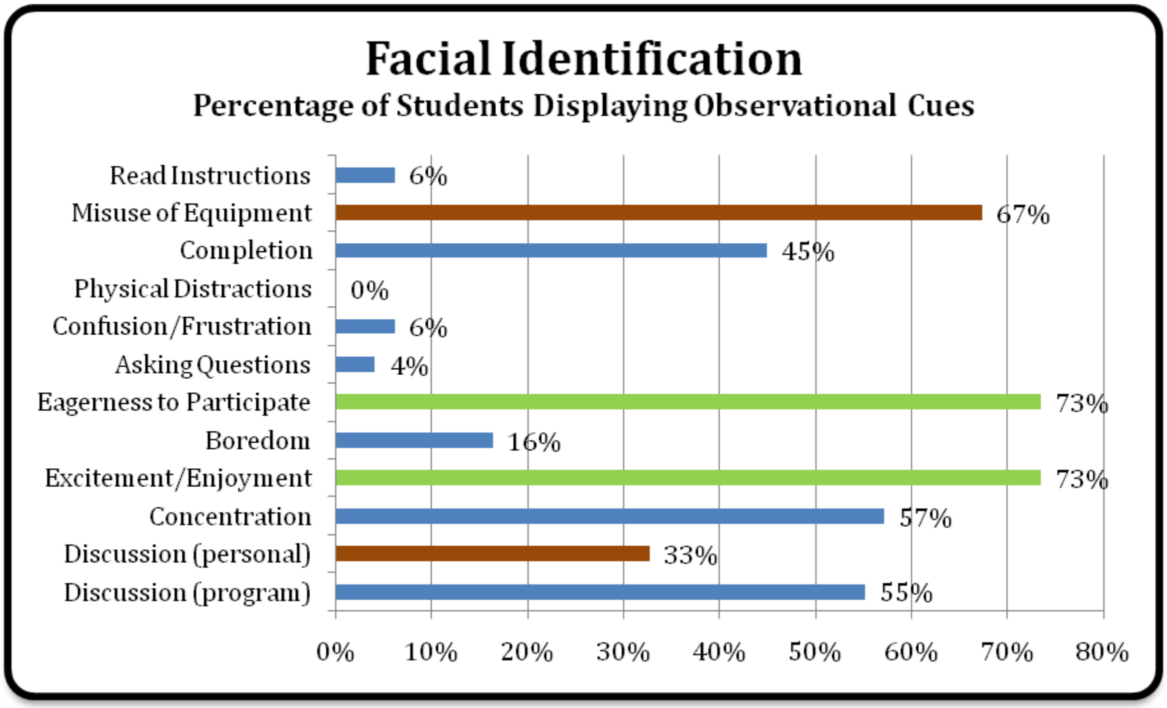


Figure 23: Facial Identification

The summary in Figure 23 of the observations of the "Facial Identification" activity exhibits various behaviours, some constructive, some not. Both eagerness to participate and excitement/enjoyment are ranked the highest of all the *Forensic Frenzy* activities. "Facial Identification", however, also showed the highest misuse of equipment. These qualities allow for the deduction that the "Facial Identification" activity is more a 'playground' for students than an important educational tool. Comparable to "Facial Identification" and "Facial Reconstruction", "Smooth Surfaces" was a highly enjoyable activity that students were exceedingly eager to participate in. These activities were not directly related to helping solve the crime, but rather are present only to give students experience with other forensic science methods. We noticed that this lack of structure often led to kids playing with the equipment rather than conducting the experiment as intended. In contrast to the other "fun" activities, "Smooth Surfaces" had an extremely low percentage of misuse of equipment compared to the "Facial Identification" and "Facial Reconstruction"; 8% compared to 42% and 67%. Figure 24 shows the percentage of observational cues observed in students during three of the programs we referred to as "fun" activities.

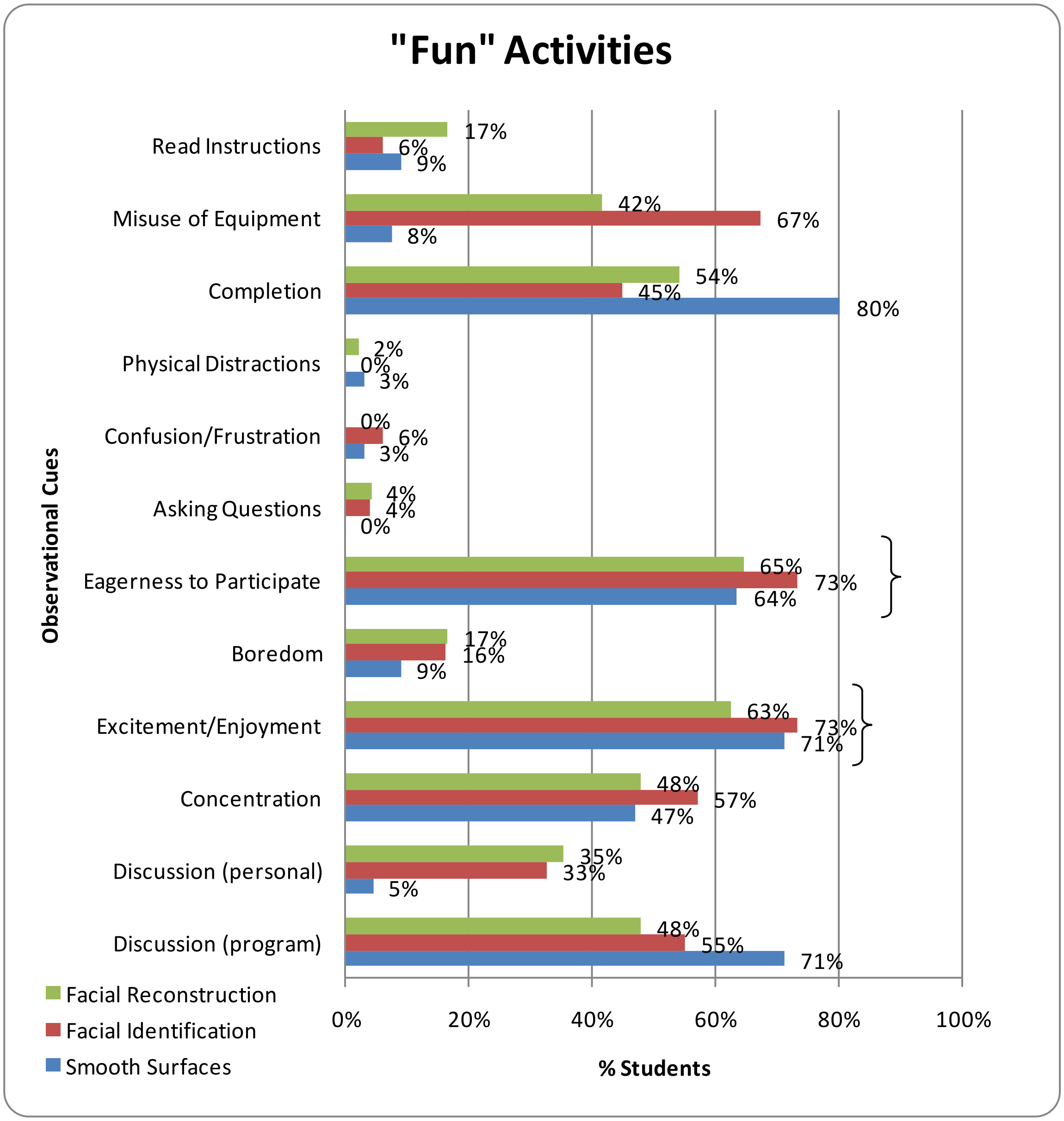


Figure 24: "Fun" Activities: "Smooth Surfaces", "Facial Reconstruction", and "Facial Identification"

Figure 25 shows three of the most engaging activities of the *Forensic Frenzy* program. "Soil Analysis", "Is it blood? Whose blood?" and "Oil Analysis" can be grouped together as activities that promote concentration and extensive program discussion. This collection of activities represents those that students must apply themselves in order to complete. Of all *Forensic Frenzy* activities, this group also showed the highest percentage of instruction card usage. We refer to these activities as "educational" activities.

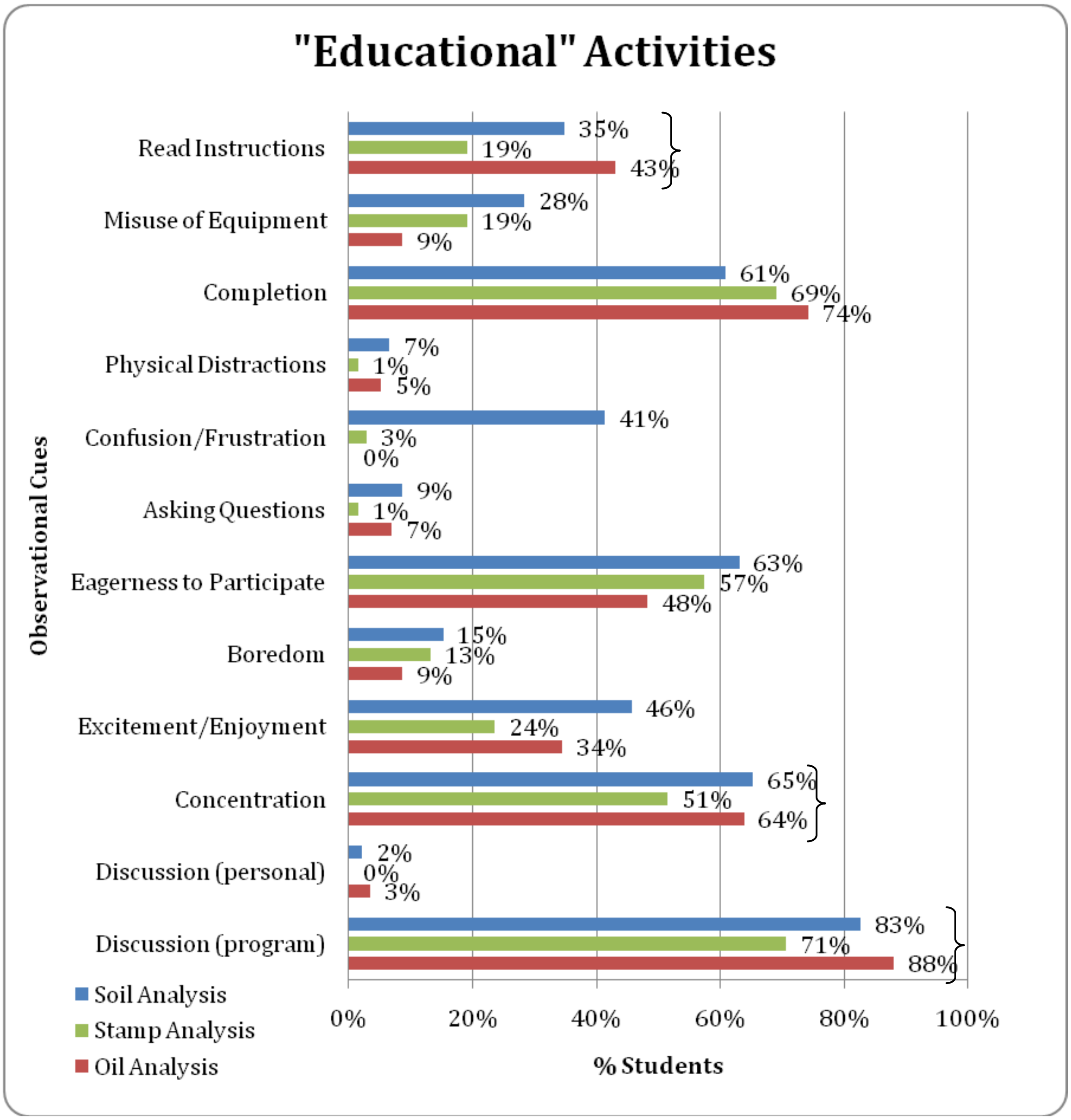


Figure 25: "Educational" Activities: "Soil Analysis", "Is it blood? Whose blood?" and "Oil Analysis"

Figure 26 shows that completion of activities in *Forensic Frenzy* can be directly correlated with whether or not students read the instructions. If students read the cards, the rate of completion increases. In contrast, the observations collected for *Biodiversity* illustrate that students who read the instruction cards are less likely to complete the activity than those who do not.

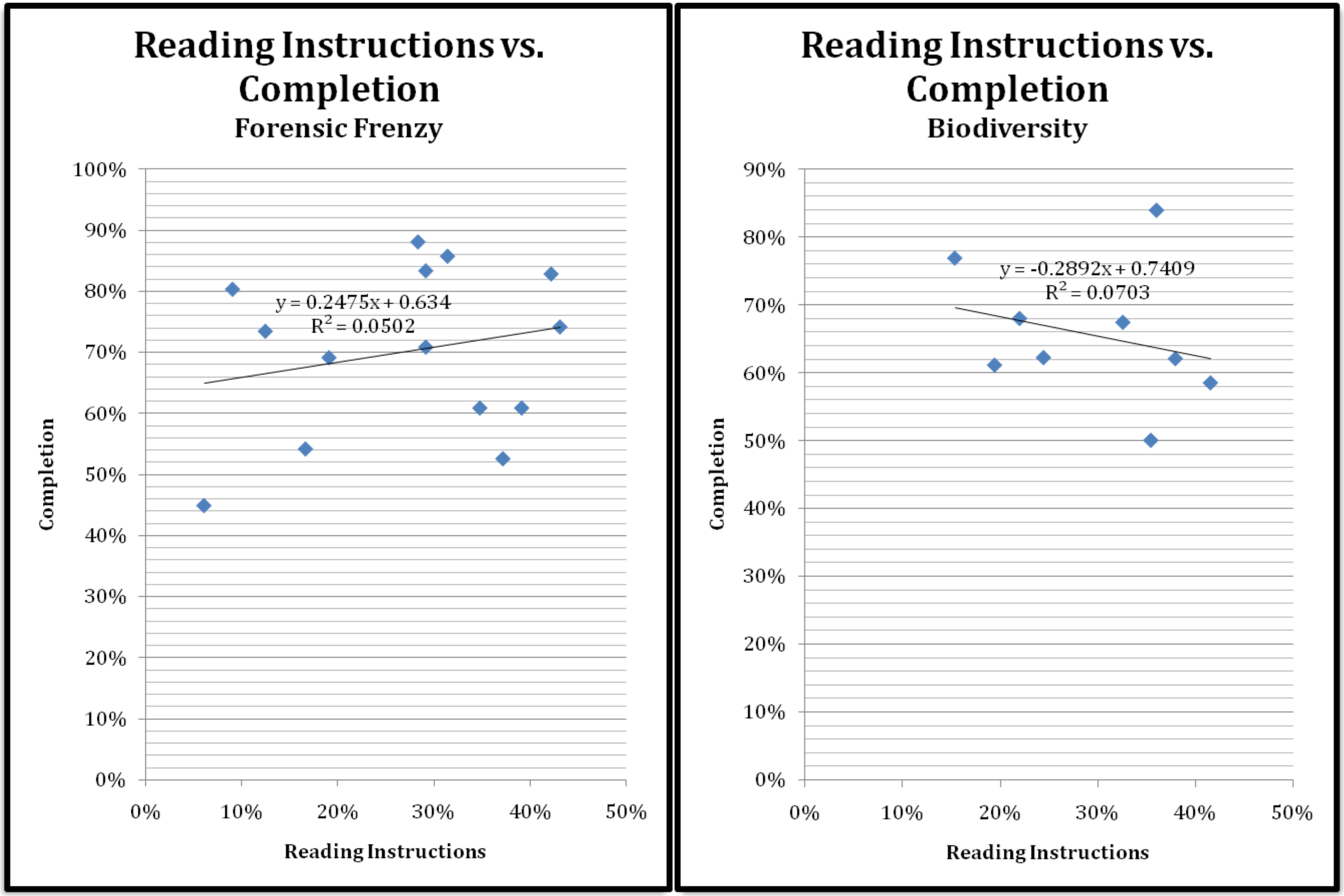
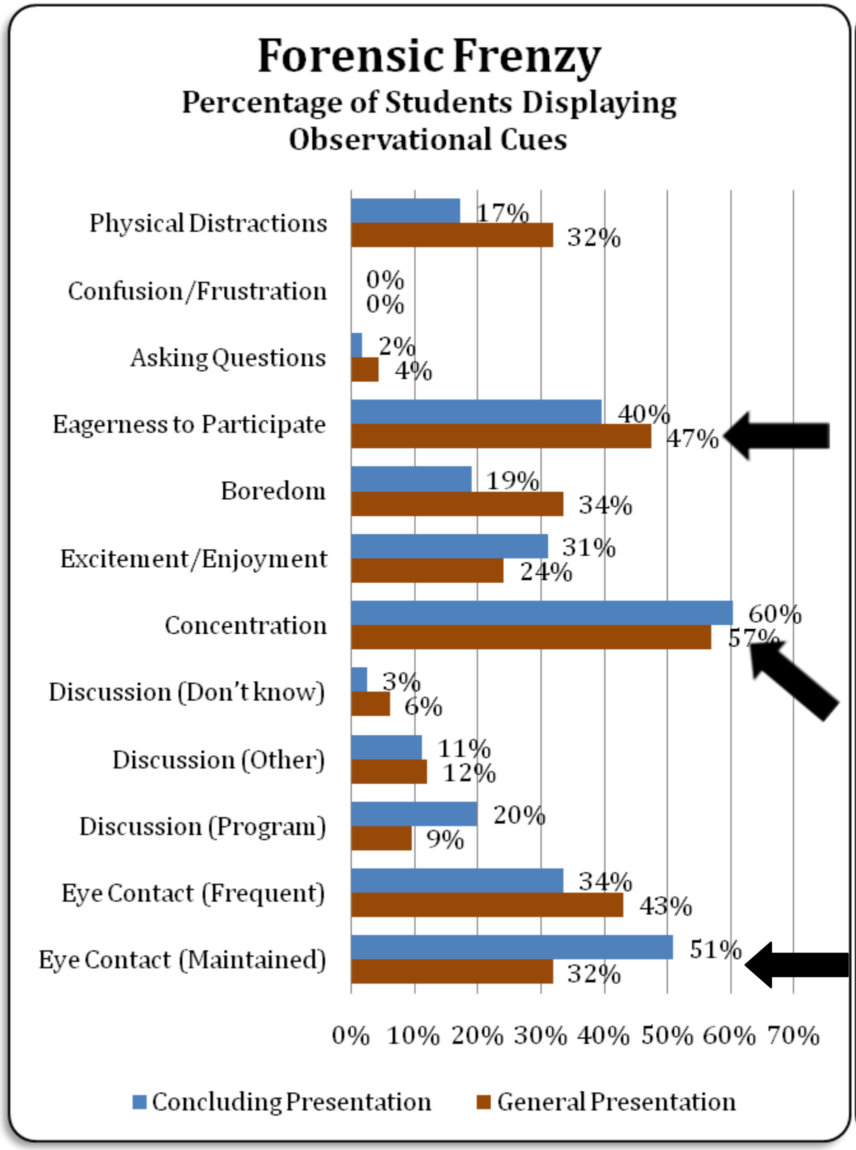


Figure 26: Reading Instructions vs. Completion

Program Comparisons

The timing of these programs and assessments provides a valuable opportunity for comparison between the successes of CSIRO's most popular program, *Forensic Frenzy*, and the first offerings of its newest program, *Biodiversity*. In Figure 27, the main points of interest in this comparison are the presentations and the hands-on activities.



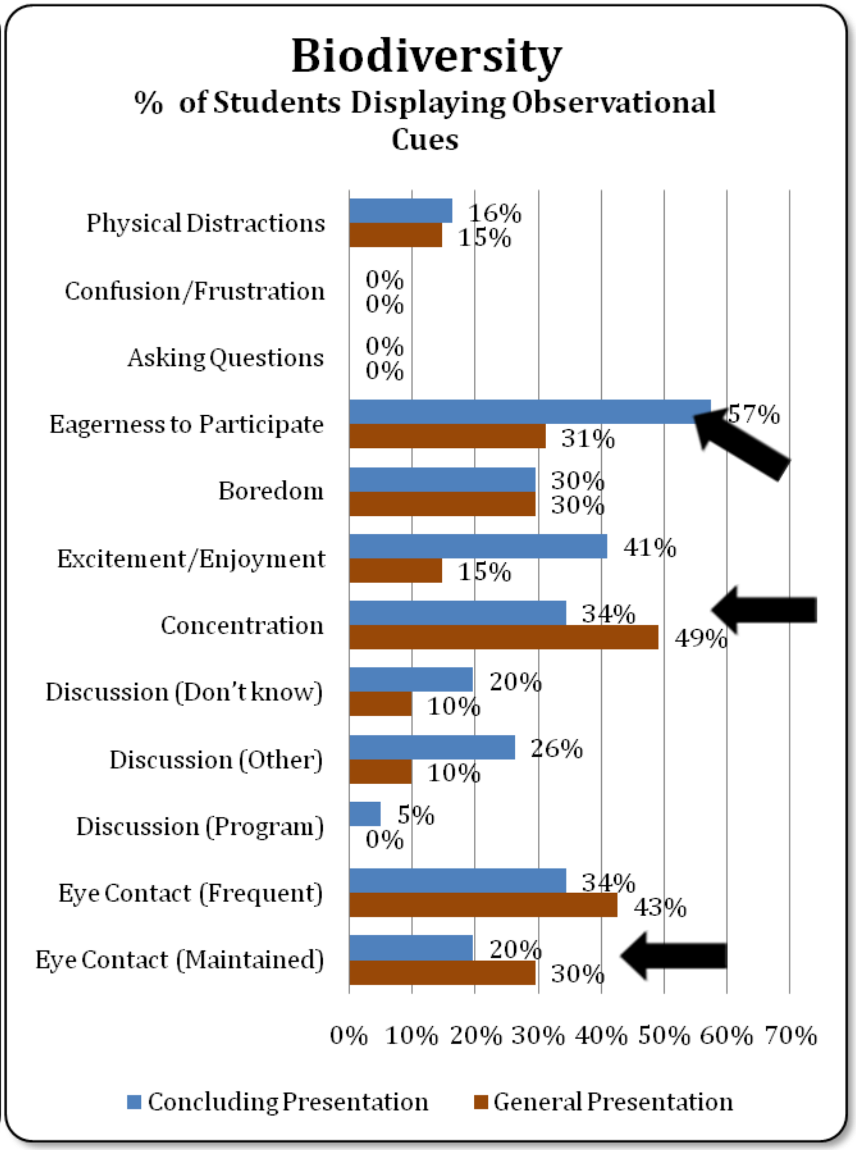


Figure 27: Program Presentation Comparison

Examining the observational data collected during presentations of the two programs reveals the level of engagements of the students when they are not participating in the hands-on activities. The observations of the presentations of both programs show that they generally provide an engaging experience; positive observational traits are maximized and negative ones reduced. *Forensic Frenzy* earned noticeably higher average ratings in observations of positive traits such as maintained eye contact, concentration and eagerness to participate, as identified by the arrows in Figure 27. These results show that the *Forensic Frenzy* program has a presentation method or story that better captures the interest of the students. However, the concluding presentation of *Biodiversity* successfully motivated students' participation in the final activity.

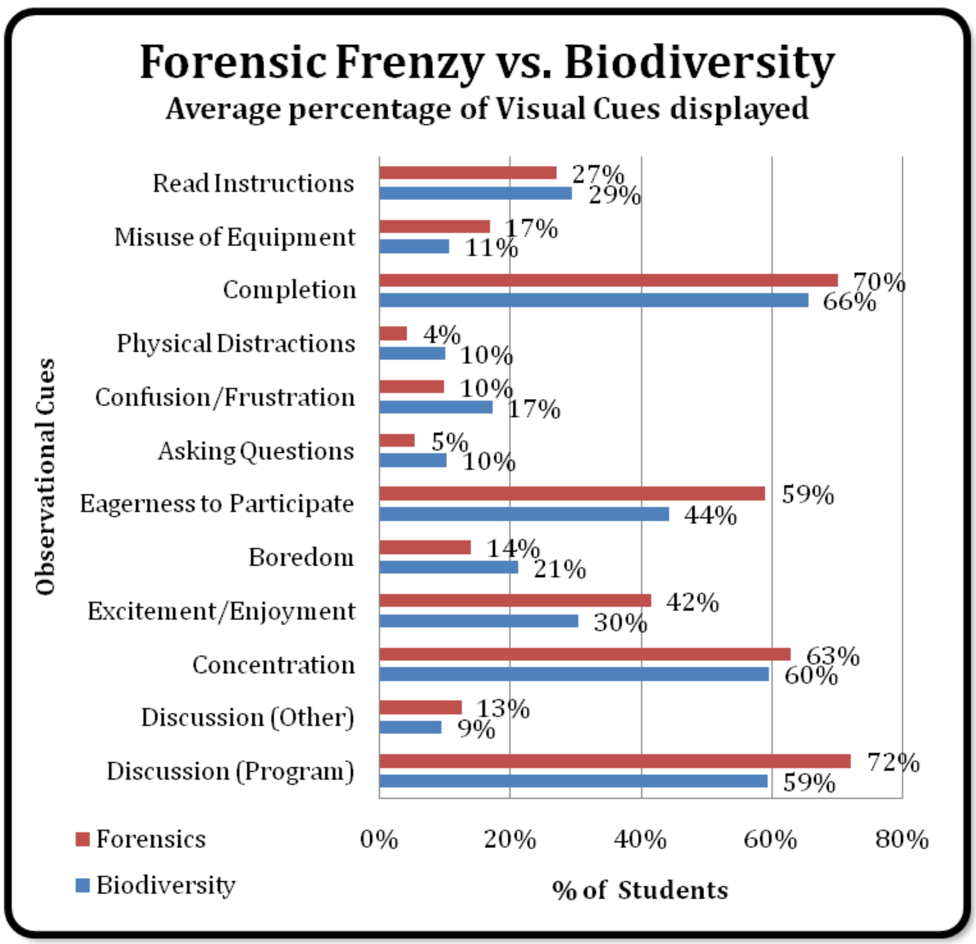


Figure 28: *Forensic Frenzy* vs. *Biodiversity*: Average Trait Comparison

Comparing the programs through the overall observational traits for the activities provides broad insight into the attitudes towards the activities of the program collectively. Figure 28 shows that collectively, the *Forensic Frenzy* activities show a higher concentration of positive traits than those of *Biodiversity*. *Forensic Frenzy* also has a lower percentage of negative traits than *Biodiversity*. "CO_2 Measurement" and "Water pH" are the *Biodiversity* activities that show the most occurrences of negative behaviour (Figure 29).

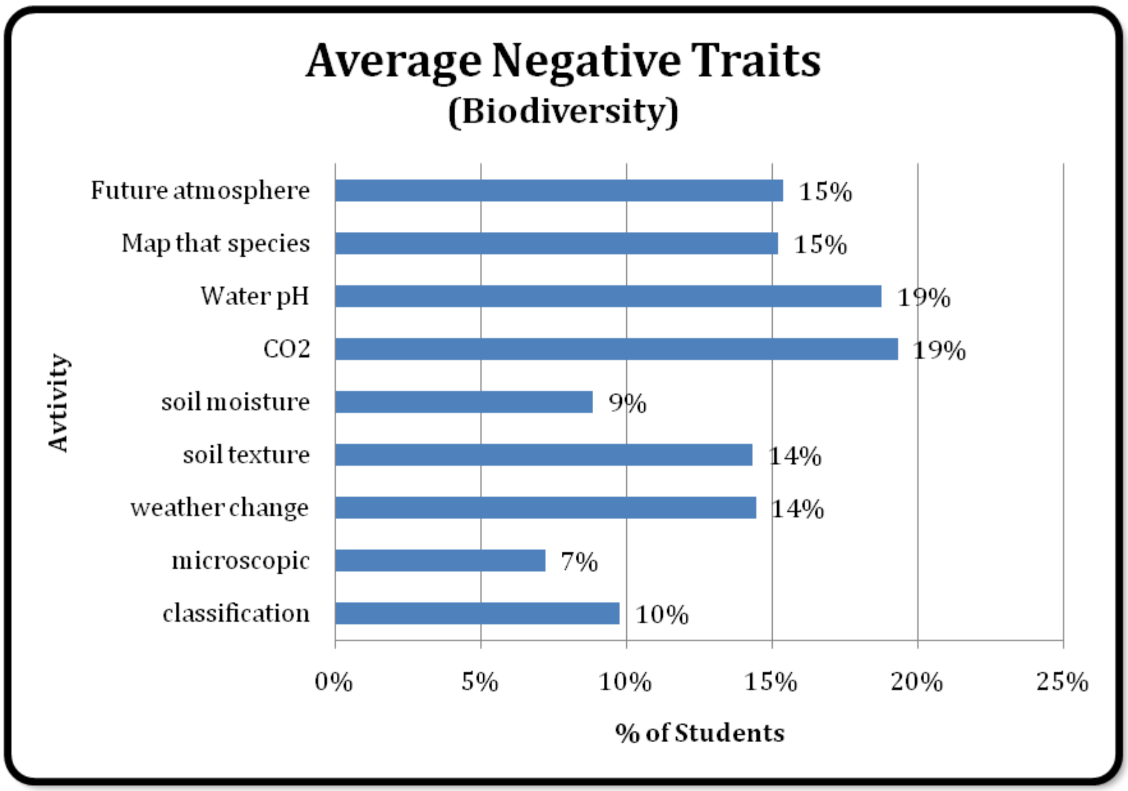


Figure 29: *Biodiversity*: Average Negative Traits

Comparing the opening and closing presentations of the *Biodiversity* program, as shown in Figure 30, reveals that the concluding presentation succeeds in creating an enjoyable environment for students that instigates participation. Parallel with positive aspects of this portion of the program, it can also be noted that during this activity students tend to lose focus. Concentration and eye contact undergo a noticeable decline, and discussion not related to the current activity increases dramatically.

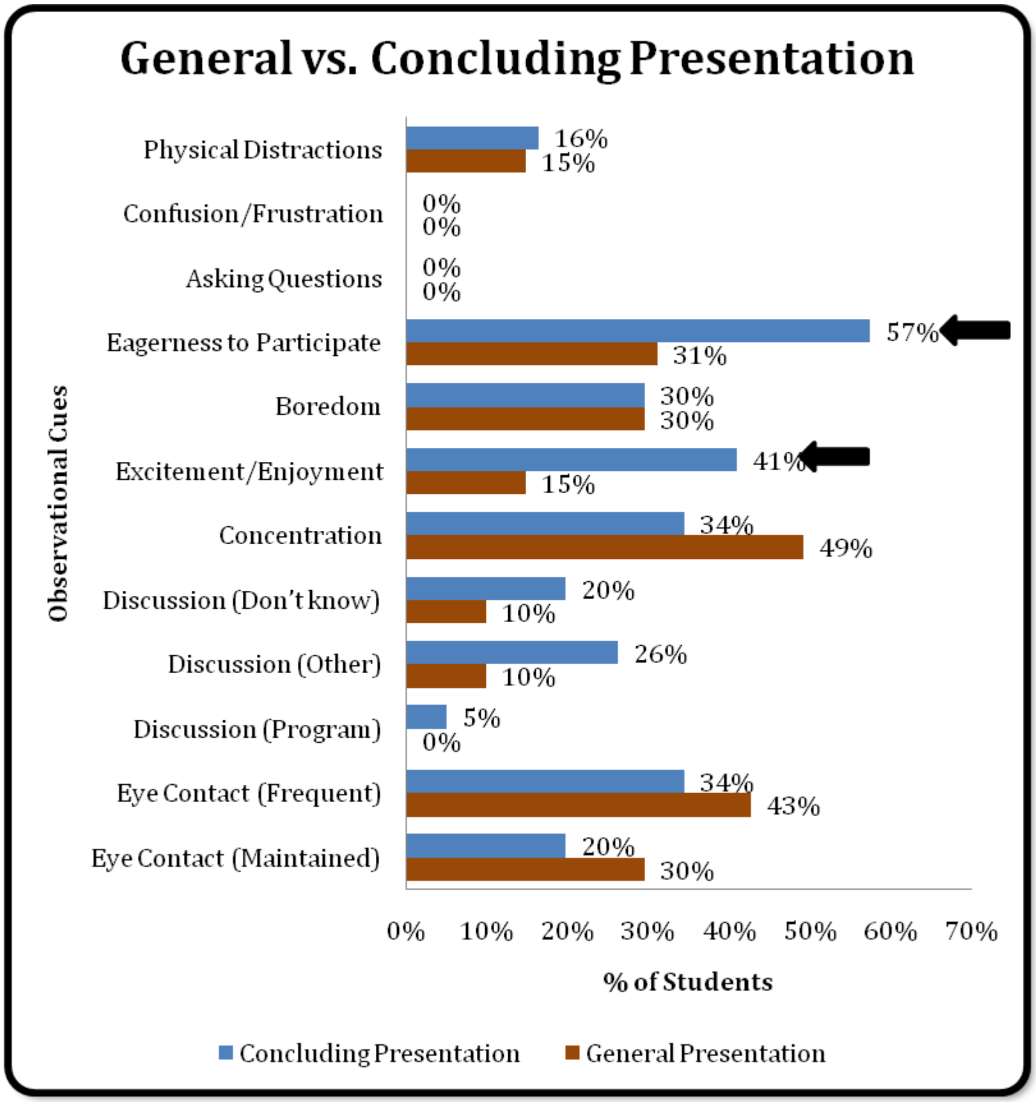


Figure 30: *Biodiversity*: General vs. Concluding Presentation

In addition to a multitude of quantitative data, the project team made written comments to supplement the observational data by allowing the project team to write down anything that they observed that could not be categorized by any of the cues on the observational checklist. All comments and notes are archived in Appendix V by program and activity.

4.3.3 Teacher Interviews

The project team reviewed transcripts of the teacher interviews to notice, collect, and think about trends; the process outlined in Section 3.6.2, Qualitative Data Analysis Techniques. The transcripts of teacher interviews can be seen in Appendix W.

Targets 1 & 2: Students' feelings, opinions and behaviour and level of interest towards science

Of the total of six science teachers interviewed for the two programs, only two had met their students in class in the time between the program and before our second visit. This lack of contact made it difficult for teachers to make an accurate evaluation of changes in the students' interest in and knowledge of the specific program topic and of science in general over the intervening week.

Target 5: Reactions to Program

Of the two teachers who had met their students, one each from *Forensic Frenzy* and *Biodiversity*, both were positive in their reactions to the program and thought it was worth booking. However, when asked, "Did you enjoy the program?" 75% of *Forensic Frenzy* teachers responded with an enthusiastic "yes" while only 33% of *Biodiversity* teachers did. When asked to make suggestions for improvement, teachers were reluctant to suggest any changes. When encouraged to answer, *Forensic Frenzy* teachers would make small changes in the structure of the programs, if at all.

Two of the *Forensic Frenzy* teachers suggested more guidance and structure from the presenters, but acknowledged one of the purposes behind the lack of structure;

> "[I would suggest] more structure, maybe make [the students] move from station to station and be at each for 5 minutes, but then [the presenter] might lose them by forcing them to be at a station they don't want to be at" (B. Nichols, Interview, 16 Feb).

The suggestions from the teachers of *Biodiversity* students focused on improving the structure of the program and on one of the activities itself. One suggestion was made to help keep students focused on completing the activities;

> "I guess [I would improve] the way [the students] record the data. A lot of them just scrunch up their paper when they complete an activity, but maybe they could enter it digitally so they *have* to answer" (M. McGowan, Interview, 17 Feb).

The other suggestion was more geared towards improving one of *Biodiversity's* most important specific activities, the food web activity (referenced in Section 2.1.2). Because this activity can get quite hectic in a small space, one teacher suggested that the activity be brought outdoors when possible.

The most popular activities according to teachers as well as the percentage of teachers who mentioned those activities as being popular can be found in Table 10 below.

Table 10: Most Popular Activities

Forensic Frenzy Activity	% of teachers	*Biodiversity* Activity	% of teachers
Facial ID	75%	**CO2 Monitoring**	100%
Facial Reconstruction	75%	**Soil Testing**	50%
Ballistics	50%	**Classification Keys: Simpsons**	50%

Targets 4 & 7: Knowledge of Specific Program Topic and Correlation to Science Curriculum or Learning Unit

Forensic Frenzy

Classes had just started a unit on forensic science, so all teachers said that the program fit in perfectly with their current learning unit, but because the term had started only one week prior, their knowledge of forensic science was limited. One teacher noticed an objective of the program, but recommended that it be reiterated;

> "The one thing I'd follow up with that was covered [in the program] but could be reinforced would be the difference between a forensic scientist and a forensic police officer." (B. Nichols, Interview, 23 Feb)

He goes on to explain that the students watch the television program "CSI" and it is their impression that it accurately depicts a forensic scientist.

> "If [students] watch it and think that it is what they want to do when they get older, we [as educators] just want to show them that it is not as glamorous as it seems; and that is something I always try to enforce" (B. Nichols, Interview, 23 Feb).

All teachers said that the program would either help them teach science, give them a basis for further study or give them ideas to refer back to when discussing the topic in class. Some teachers already planned class work around the program such as:

- Write a summary of what the students thought actually happened based on the evidence collected during the program.
- A forensic police officer visited a class for the purpose of differentiating between his work and the work of a forensic scientist.

- Develop a workbook with fingerprints and other evidence while writing a research task focused on one area of forensic science and doing a report on what that person or scientist would do, and what their limitations are.

Biodiversity

Classes had just started a unit on Ecology, but students were unaware of what biodiversity really is, and how it fit with what they were doing in class. However, teachers expressed that they would be able to refer back to aspects the *Biodiversity* program in the future, specifically the food web activity.

The students had excursions planned for the week following the program, and teachers expressed that the program would be good preparation.

5 Conclusions and Recommendations

Through the analysis of a multitude of data, the project team noticed several key findings:

- A program with a prominent central theme engages student participants much more effectively than one whose theme is more general or subtle.
- For *Forensic Frenzy,* observations show that as students read the instructions, the rate of completion for the activity increased. However, observations also showed that as students read *Biodiversity*'s instructions, the rate of completion decreased.
- Students obtain knowledge from the programs, but do not retain it; our recommendation is to actively encourage reinforcement.
- There are few but relevant operational changes that can be made in order to increase the impact of the programs.

The following chapter describes each finding and provides recommendations for improvement in each of the areas, as well as suggests ideas for further research.

5.1 Impact through a Central Theme

Forensic Frenzy proves to be more engaging to students than *Biodiversity* and therefore, *Biodiversity* should strive to mimic the methods of *Forensic Frenzy*. *Forensic Frenzy* successfully develops and carries the central theme of solving the murder throughout the program. *Biodiversity* may benefit from having a clear objective or goal throughout the entirety of the program toward which most activities strive.

5.1.1 Findings

Through the analysis of data collected, the project team was able to draw multiple conclusions regarding the impact of each program's central theme.

Interviews conducted with teachers who experienced *Forensic Frenzy* provided evidence that students enjoyed the program. The interviews indicated that students not only enjoyed the program, but it also emphasized the importance of a clear objective throughout the program. When asked if the program captured the interest of the students, one teacher said:

> "I think it was pretty clear that their enthusiasm was pretty high, they were engaged…[and] the fact that they got to do something, that they got to solve a crime was a big part of it" (N. Jones, Interview, 16 Feb, 2010).

Evidence gathered through student questionnaires also backed this finding. When asked one week later, "What stands out most in your mind about the *Forensic Frenzy* program?" a significant 29% of students who responded, identified the central theme of the crime. Responses included helping to solve the crime and finding results by thinking about and analysing the evidence presented to come to a conclusion. This response rate proved to be noticeably higher than responses regarding any other aspect of the program. See Table 8 in Section 4.3.1 for all responses to this question.

Responses to this question from students who expressed a low interest in science by rating their interest as a one, two, or three out of seven also indicated the central theme of solving a crime. 5 of the 17 students (29%) with a low interest in science indicated, one week later, that solving a crime was what stood out in their minds most. This shows that the program is successful in capturing and engaging students including those who claim to have a low interest in science.

Biodiversity does currently attempt to maintain a central theme similar to *Forensic Frenzy* by introducing the endangered eastern barred bandicoot. From students who experienced the *Biodiversity* program, *none* of the responses one week later mention the bandicoot – the central theme of the program – as what stood out in their mind or something that they liked about the program. Table 9 from Section 4.3.1 shows the summary of responses to the program.

Both *Forensic Frenzy* and *Biodiversity* utilize information and instruction cards at each activity. It was found that *Biodiversity* instruction cards deter students from completing activities, while *Forensic Frenzy* instruction cards succeed in influencing completion. The correlation between reading of the instruction cards and completion shows an increase in the rate of completion for *Forensic Frenzy* activities. On the other hand, as the rate of reading the instruction card increases in *Biodiversity*, there is a decrease in the rate of completion. These trends are displayed in Figure 26 in Section 4.3.2.

5.1.2 Recommendation

From our findings, the project team recommends possible ways in which CSIRO can increase the effectiveness of a central theme which could improve the impact of the *Biodiversity* program. Reinforcing the bandicoot problem throughout all stages of the program may increase engagement and improve the experience of participants.

Currently the problem is presented to the students through a short story explaining the bandicoot's current situation during the general introduction to the program. Use of a visual aid beyond the student workbook may improve students' awareness of the central theme. Incorporating a video or PowerPoint in the introduction of the program will help to make the bandicoot a more prominent figure in the program narrative and, hence, in the minds of the participants.

Since the majority of the program focuses on hands-on activities, relating these activities back to the bandicoot specifically would help keep the central theme as a prominent thought as students participate in the activities. For example, during the "Map That Species!" activity, students examine a three-dimensional map illustrating where various species of grass tend to grow. To reference the bandicoot problem, the different species could be replaced with various animals, one being the bandicoot.

Students could also be reminded of the central theme through questions asked in their student workbook or on instruction cards located at each station as they complete the various activities. Questions probe students to relate the findings of the activity to a larger scale on the environment and the world, but none reference back to the impact on the survival of the bandicoot. Changing or adding questions which relate to the bandicoot will promote the overall problem to remain in students' minds as they participate in the program. The current student workbook can be found in Appendix D.

Changing the work booklet and instruction cards will hopefully increase the impact as well as promote completion of activities. With the data collected, the project team is unable to provide sound reasoning for the rate of completion decreasing as a result of reading *Biodiversity* instruction cards. This is concerning and it is recommended that further studies be conducted to determine if the fall of completion is caused directly by the instruction cards or by the activities themselves. Measuring the specific impact of the instruction cards and researching the best format for an effective instruction card could provide more evidence about the correlation of the instruction card to the completion of the activity.

5.2 Impact through Reinforcement

There are no significant changes indicating an impact on the students' interest, knowledge, or opinion up to one week after having participated in either *Forensic Frenzy* or *Biodiversity* programs. The project team recommends that CSIRO offer supplementary ready-to-use program-specific materials for in-class reinforcement of program content. Through background research, the project team found that reinforcement supports long-term impacts (Virnoche, 2008).

5.2.1 Findings

Knowledge: Acquired, but not retained

Although student-rated levels of knowledge in regards to science in general and in regards to the specific program topic did not experience a significant positive or negative change over a period of one week (refer to Figure 16 and 18 in Section 4.3.1), qualitative knowledge questions showed an increase in knowledge immediately after the program and then a decrease after one week, meaning that the same level of knowledge was not retained (refer to Figure 19 and 20 in Section 4.3.1).

Interest: No significant change

Students' rated levels of interest in science in general had not changed significantly, positively or negatively, after one week (refer to Figure 11 in Section 4.3.1). However, teacher interviews observations and questionnaires showed that students were indeed enjoying and engaged in the program. This suggests that students were engaged during the program, but that level of engagement was lost when the program ended.

5.2.2 Recommendations

CSIRO should offer one or a combination of the following:

- A pre-program experience worksheet which will influence thought and excitement about the program before CSIRO even arrives. For *Forensic Frenzy*, one idea would be to send an announcement to the class: "There has been a kidnapping and CSIRO needs your help to help find the culprit"; Then, when CSIRO arrives, make an announcement that a body has been found, and that the classes will be working as forensic scientists to help solve the crime.
- A supplemental worksheet with suggestions for projects to complete after the CSIRO program. In interviews, some teachers alluded to the fact that they would be creating projects and homework on their own, but others did not (refer to appendix W). If CSIRO staff offered their own ideas for follow-up ready-to-use activities, it would give teachers solid material to utilise without having to invent new assignments or spend much time organizing activities.

5.3 Program Operation

Our observations of students throughout the programs lead to the discovery of various critiques that could impact the operation of CSIRO's programs. These findings are program-specific but can be adapted to improve the impact of other programs.

5.3.1 Forensic Frenzy

Conclusion 1:

Through data collected from observations and questionnaires, "Facial Reconstruction," "Smooth Surfaces," and "Facial Identification" were the ranked the most popular activities among students (refer to Figure 24 in Section 4.3.2 to view observational cue statistics and other noted "fun" activities). These activities were found to hinder the functionality of the program when located on tables close to one another. Students often spent long periods of time at these activities (refer to Appendix V for observation comments). These occurrences led to the development of other problems for the workings of the program.

Students who spent too much time at one station lacked adequate time to complete other stations. If they had not completed stations that dealt directly with the crime, students were unable to participate in the concluding presentation where the evidence was all brought together.

Another problem associated with this event is that when a few students take part in an activity for an extended period of time, it leaves little to no time for other students to participate in that particular activity. When asked what they particularly disliked about the program, 9 of 40 (23%) students who answered the question mentioned not having enough time to complete all of the activities (refer to Table 8 in Section 4.3.1).

These "fun" activities were also found to be very distracting to other students. Neighbouring activities often experienced participants being unable to concentrate on the task at hand because of the overwhelming activity at the "fun" stations. This could be credited to the large groups that seemed to congregate around these activities, or the students playing with the equipment to create, what they found to be, comical results that they would show off to their friends. Further, note that the "Facial Identification" activity had the highest observed misuse of equipment percentage of all activities (refer to Figure 24 in Section 4.3.2).

Recommendation:

To address this problem it is advised that stationing these activities near one another should be avoided where possible. This will prevent a certain section of the room from becoming a playground area for students. Positioning these activities near those that are less popular may also influence students to participate in the activities that they would not ordinarily go out of their way to partake in.

Conclusion 2:

The "Dental X-ray" activity did not appeal to very many students. We observed this activity through three program sessions; in total, only 24 students visited the activity. This number immediately stands out when compared to the other activities that on average had an average of around 50 participants. Of those that did partake in the activity very few appeared to be engaged. The level of excitement/enjoyment for this activity was ranked amongst the lowest of all of the activities in the program (refer to Figure 22 in Section

4.3.2). The high completion rate may be misleading; students may be engaged enough to stay around the activity until it is completed. However, the entirety of the activity consists of matching a victim's dental X-rays to only one of two known X-rays.

Recommendation:

In order to increase the challenge and consequent attractiveness of the "Dental X-ray" activity, we recommend adding more X-rays for comparison.

5.3.2 Biodiversity and the World Around Us

Conclusion 1:

In a comparison between the initial and final presentations of the *Biodiversity* program, it is evident that students are not as engaged in the general presentation as in the concluding presentation (refer to Figure 30 in Section 4.3.3). During the introduction of the program and its central topic of the survival of the bandicoot, students were very reluctant to participate; only 31% of students showed any desire of wanting to participate in the presentation. Excitement/enjoyment cues were found in a low percentage of students: 15% (compared to an average of 30%) and boredom was observed in a high number of students: 30% (compared to an average of 23%).

Recommendation:

To deal with this deficiency, it is felt that a visual aid such as a PowerPoint or video may be necessary to increase the excitement towards the program (while also supporting the need for more emphasis on the central theme). Doing so would bring the overall problem to life and create a more pronounced concern for the wellbeing of the bandicoot. An increased excitement at the introduction may help stimulate students throughout the duration of the program.

5.4 Future Research Suggestions

The analysis of our data uncovered many questions that warrant further research:

- Follow up on classes who planned to reinforce material through program-related assignments and projects and those that did not. Explore the possible differences in knowledge retained and in changes in interest or awareness.

- Develop and implement pre and post program supplementary worksheets for CSIRO's NFE programs that may aid in giving teachers a ready-to-use tool to reinforce the material. After they have been implemented, assess their long-term impacts on students in terms of change in interest, knowledge, and attitude.
- Measure long-term impact of CSIRO's NFE programs on primary school students.

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Appendix A: Forensic Frenzy Teacher Notes

CSIRO

Forensic Frenzy

Teacher Booklet (years 7-10)

CSIRO Education, Victoria
Ph: (03) 9252 6387
Web: www.csiro.au/melbcsirosec

cecv catholic education commission of victoria ltd

VICTORIAN INSTITUTE FOR CHEMICAL SCIENCES

State Government Victoria Department of Education and Early Childhood Development

Contents

1. GENERAL INTRODUCTION

Forensics is a field of science dedicated to the methodical gathering and analysis of evidence to establish facts that can be presented in a legal proceeding. Though crime scenes and laboratories are perhaps most often associated with forensics, there is also computer or network forensics, forensic accounting, forensic engineering and forensic psychiatry, among other specialized fields that are today an integral part of forensics. The field of forensics is so vast that it requires specialists or criminalists at every point of investigation, from tyre track analysis, to odontology, to the lands and grooves that make every gun barrel unique. From microscopic evidence and transfer evidence such as fibres and hair, to blood splatter and forensic entomology, there are many fields of specialization within forensic science.

Those who collect forensic evidence must follow strict procedures to protect the evidence from getting contaminated or destroyed, and must preserve the chain of custody. Since science is unbiased and sound, forensics is considered a very critical part of any investigation. Though forensics often deals with circumstantial evidence, it is widely considered as the best and the most compelling evidence available. It has been suggested that the public's awareness of forensic science might be potentially compromising to law enforcement, producing educated criminals who might be more apt to try and effect a clean crime scene. Experts generally tend to believe that it is nearly impossible to avoid leaving behind trace evidence at a crime scene, even when extraordinary efforts are made to the contrary.

This program presents students with a simulated crime and evidence is presented for them to examine in a scientific way. Students are encouraged to formulate their own conclusions based upon the evidence that they have analysed.

2. CURRICULUM LINKS

2.1 The Victorian Essential Learning Standard

This program covers key areas of the following sections of Levels 5 and 6 of the VELS:

2.1.1 Discipline Based Learning

Science

Students will use science as a problem-solving tool and will develop reasoning and critical thinking skills in order to try and solve the crime that they are presented with. Students will collect data systematically, and analyse the collected data. They will link cause and effect to determine the possible sources of trace evidence left at the crime scene.

2.1.2 Physical, Personal and Social Learning

Interpersonal Development

Students work and learn in teams while performing the hands-on activities. They are encouraged to work at sharing tasks with others in their group while performing a range of physical and mental activities of varying lengths and complexity.

Civics and Citizenship

Through the course of discussions held within the program students learn about the role of the courts and police. They consider important principles such as the independence of the judiciary, equality before the law, and the presumption of innocence. Students understand that when Australians travel overseas, the laws of other countries apply to them.

2.1.3 Interdisciplinary Learning

Communication

Students are exposed to a range of aural, written and visual communication skills. They practice their listening skills in both formal and informal learning environments, learn to interpret information from instruction sheets and enjoy the opportunity of questioning speakers to seek clarification of key points.

Thinking Processes

Students participate in a variety of investigations and problem-solving activities that encourage them to experiment with a range of creative solutions. They begin to reflect on the approaches they use to assist them to form their solutions.

Activities in the program encourage students to develop questions and collect data from a range of sources. This data can then be evaluated to determine its validity.

2.2 CSF II Links

This program covers key areas of the following sections of CSF II:

2.2.1 Science Key Learning Area

This program covers each of the physical, chemical and biological science strands of the learning area.

3. CONCEPTS COVERED IN FORENSIC FRENZY

3.1 Types of Forensics

Forensic science is the umbrella term for a collection of scientific procedures that can be employed when it comes to providing evidence that a crime has been committed and also provides ways and means of proving how a crime has been committed. For example:

3.1.1 Computer Forensics

In today's ever changing criminal world the use of computers for fraud and the pursuit of other crimes has increased to dramatic proportions. So much so that specialist departments have been formed to help deal with the problem of computer crime. Computer crime is not only about fraud – online or otherwise – it also encompasses areas such as pornography, child sex abuse and the sale of black market goods online.

3.1.2 Forensic Accounting

A forensic accountant is charged with the task of poring over vast amounts of figures in order to find out where illegal financial practices have taken place and whether or not companies or individuals have been fraudulently treated by someone acting on their behalf.

3.1.3 Forensic Archaeology

Archaeology and anthropology are the study of historic human remains and the objects, buildings and other artefacts associated with them. Forensic archaeologists and anthropologists can apply the same techniques to crime scenes, to get evidence from human remains, as well as from drugs, guns or stolen goods found at crime scenes, whether recent or decades old. A forensic archaeologist's first involvement may be to help the police locate the site where a body and victim's personal items, or stolen goods are buried, through geological and geophysical surveying techniques, as well as using imaging and photography. The forensic archaeologist may also help with the excavation, using similar tools and expertise to those used at an archaeological dig.

3.1.4 Forensic Dentistry

Forensic Dentistry is the area of forensic medicine concerned with the examination of teeth, especially in the cases of victims who cannot be identified by conventional means or when an attacker bites a victim and leaves bite marks behind. A forensic dentist can provide accurate estimates as to the age of a victim, when they died, and can also take DNA samples from the teeth for use in the identification process. As teeth are one of the only things remaining when a body decomposes they are useful for extrapolating DNA samples along with bone marrow and hair.

3.1.5 Forensic Entomology

Entomology is the study of insects, and forensic entomologists use insects to provide more information about crimes. The live and dead insects found at the site of a crime can tell the forensic entomologist many things, including when and where crimes took place, whether the victim had been given drugs, and in murder cases, the time since death, and the length of time the body had been there.

3.1.6 Forensic Graphology

Forensic Graphology is the study of handwriting especially that found in ransom notes, poison pen letters or blackmail demands. As no two individual's handwriting is the same the comparison of handwriting can be used to match with evidence from a suspect. While you cannot tell a person's sex or race from their handwriting it can give interesting clues as to their mental and emotional state.

A Graphologist looks for insights into some of the following: mood, motivation, integrity, intelligence and emotional stability. This may not sound important but you can tell a lot about a person by the way they write - or more importantly - in the words they write. It has become commonplace now for us as individuals to write in the same manner as we speak, using abbreviations, slang and colloquialisms that vary from person to person and indeed place to place. These are important and a Graphologist can make good use of these things during the investigative process. Forensic Graphology can also help provide a usable profile in conjunction with a forensic psychologist that police can use in order to draw up a list of suspects.

3.1.7 Forensic Pathology

Pathology is the study of disease and its causes. Forensic pathology involves discovering the cause of death, especially in cases where it is sudden or the police suspect that it has not occurred by natural causes. A forensic pathologist is a medical doctor trained in pathology.

The first stage is to conduct a post-mortem (also known as an 'autopsy'). This involves first examining the body and looking at its external appearance to help identification and to begin to determine how the person died – for example looking for evidence of blows, looking at the size, shape and location of wounds such as stab wounds or bullet entry points, or looking for signs of asphyxia.

The pathologist will then begin surgical procedures and study the internal organs to see how external injuries connect to internal injuries, for example bruising of the brain following a head injury, or damage to the heart and blood vessels following a stabbing or shooting, and look for evidence of disease as a cause of death, for example heart attack, stroke, aneurysm or infection. The stomach contents may provide clues to the time, circumstances, or cause of death.

The autopsy may also include taking samples that may lead to conviction of a murderer or rapist including taking samples from under fingernails, or samples of semen from vaginal swabs.

3.1.8 Forensic Psychology

Forensic psychology is the forensic study of the mind and the ways in which the mind works, especially in the instances of violent crime. During the course of an investigation a forensic psychologist is charged with the task of uncovering the reasons behind why an individual might carry out such an act.

3.2 Fingerprinting

Fingerprints are the patterns on the inside and the tips of fingers. The ridges of skin, also known as friction ridges, together with the valleys between them form unique patterns on the fingers. Fingerprint analysis is a biometric technique comparing prints from a crime scene with either the prints from a suspect or a database of fingerprints. Uniqueness of prints, and the fact that they do not change during a person's life, form the basis for fingerprint analysis. The uniqueness of the prints is determined by the minute changes in local environment during foetal development; therefore, identical twins undistinguishable by DNA analysis can be differentiated with fingerprint analysis. Although the fingerprint pattern remains the same, growth accounts for an enlargement of the patterns. Additionally, accidents or some diseases may alter fingerprint patterns

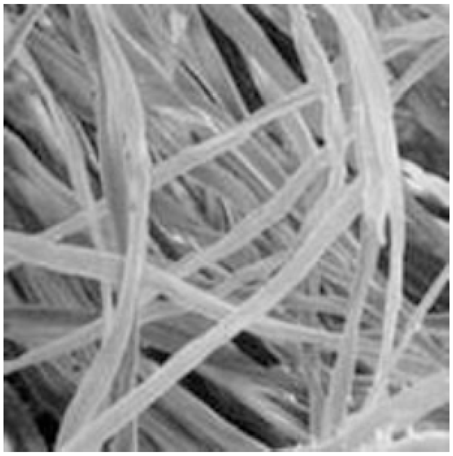
Marcello Malpighi first made notes about the ridges, loops, and spirals of fingerprints in 1686. In 1888 Sir Francis Galton established the first classification system for fingerprints and was the first to assert that no two prints are the same, or that the odds of two prints being identical were about 1 in 64 billion. Sir Edward Henry developed the Henry Classification System in 1901. This system today forms the basis for print recognition in most English speaking countries. This system categorized the ridge patterns into three groups: loops, whorls, and arches.

The presence of pores on the surface of the ridges of the fingers results in the accumulation of perspiration on the fingertips. This moisture remains on the surface of the object a person touches, leaving prints. Depending on the surface touched, prints can be visible to the naked eye (patent) or invisible (latent). Ridges present on the fingers are classified based on the patterns they form. The most important features are ridge endings and bifurcations (separation of a ridge into two). These features are called minutiae and form the basis for further classification and identification. Based on the forms created by the minutiae (loops, whorls, etc.) fingerprints are further sub-classified into many more distinct patterns.

3.3 Fibre Analysis

A fibre is the smallest unit of a textile material that has a length many times greater than its diameter. Fibres can occur naturally as plant and animal fibres or they can be synthetic (man-made). Fibres can be spun with other fibres to form a yarn that can be woven or knitted to form a fabric. The type and length of fibre used, the type of spinning method, and the type of fabric construction all affect the transfer of fibres and the significance of fibre associations.

Analysing fibres is labour intensive, but often proves to be one of the most conclusive forms of forensic detective work. The main reason for this is that we're surrounded by fibres; on our clothes, carpets or fluff gathering in a getaway car. Placing a suspect at the scene of a crime is what it is all about. One of the ways that this can be done is by locating textile fibres similar to those from the victim's clothing or the crime scene on the clothing or person of the suspect or discovering fibre evidence at the crime scene that can somehow be traced back to the suspect.



Fibres are considered a form of trace evidence that can be transferred from the clothing of a suspect to the clothing of a victim during the commission of a crime. Textile fibres can also be transferred from rugs or blankets; between two individuals; between an individual and an object or between two objects.

Whenever a fibre found on the clothing of a victim matches the known fibres of a suspect's clothing, it can be a significant event. Matching dyed synthetic fibres or dyed natural fibres can be very meaningful, whereas the matching of common fibres such as white cotton or blue denim cotton would be less significant. In some situations, however, the presence of white cotton or blue denim cotton may still have some meaning in resolving the truth of an issue. The discovery of cross transfers and multiple fibre transfers between the suspect's clothing and the victim's clothing dramatically increases the likelihood that these two individuals had physical contact.

When a fibre examiner matches a questioned fibre to a known item of clothing, there are only two possible explanations:

- The fibre actually originated from the item of clothing, or
- The fibre did not originate from the item of clothing.

It is argued that the large volume of fabric produced reduces the significance of any fibre association discovered in a criminal case. It can never be stated with certainty that a fibre originated from a particular garment because other garments were likely produced using the same fibre type and colour. The inability to positively associate a fibre with a particular garment to the exclusion of all other garments, however, does not mean that the fibre association is without value.

When one considers the volume of fabric produced in the world each year, the number of garments of a particular colour and fibre type is extremely small. The likelihood of two or more manufacturers duplicating all aspects of the fabric type and colour exactly is extremely remote. The large number of dye types and colours that exist in the world, coupled with the unlimited number of possible dye combinations, makes any fibre association by colour significant. One must also consider the lifespan of a particular fabric: only so much of a given fabric of a particular colour and fibre type is produced, and it will eventually end up being destroyed or dumped in a landfill.

3.4 Chromatography

Chromatography is a method for analysing complex mixtures by separating them into the chemicals from which they are made. The basic principle of chromatography is that different compounds will stick to a solid surface or dissolve in a film of liquid to different degrees. Chromatography is used extensively in forensics, from analysing body fluids for the presence of illicit drugs, to fibre analysis, blood analysis from a crime scene, and at airports to detect residue from explosives.

Ink is a mixture of several dyes and therefore we can separate those colours from one another using chromatography. When ink is exposed to certain solvents the colours dissolve and can be separated out. When we expose a piece of paper with ink on it to a solvent, the ink spreads across the paper when the ink dissolves. This works because molecules in ink and other mixtures have different characteristics (such as size and solubility), and so travel at different speeds when pulled along a piece of paper by a solvent. Different ink pens use different types of ink and this is obvious when you expose the ink to a solvent. A banding pattern of the components of the ink mixture is called a chromatograph.

Many common inks are water soluble and spread apart into the component dyes using water as a solvent. Permanent inks are not water-soluble but are often alcohol-soluble and you can use Isopropyl alcohol as the solvent to create your chromatograph.

3.5 Blood and DNA analysis

Blood

We all have slightly less than 5 litres of blood pumping through our bodies. When wounded, bodies leak or spray blood, and the behaviour of blood in flight tends to be unaffected by such things as temperature, humidity, or atmospheric pressure. Blood found at a crime scene may be in the form of fresh liquid, coagulated, dried, or as a small drop or stain, and each form involves a different method of preservation and collection. The analysis of the properties and effects of serums (blood, semen, saliva, sweat, or faecal matter) is called serology.

Blood can tell us a lot of things. It contains DNA, which can be extracted for genetic fingerprinting. The blood type and other physical characteristics can be determined, perhaps the owner suffers from a disorder such as sickle-cell anaemia, which affects blood cell shape. While not in itself sufficient to solve a crime, blood typing can narrow the search and lead to verification of other data. Blood may be attacked by bacteria or insects, helping to reconstruct a time line of events.

Despite how well the crime scene may get cleaned up, even the finest trace of blood can often be detected and further tested. It is often the case that while the perpetrator may scrub down the obvious places, they can still miss between floorboards, under pipes, and inside drains. Merely by pouring water on some tiles at a murder scene and pulling them up wherever the water flowed beneath them, one detective found the only existing trace of the crime--blood. His discovery so surprised the killer, who felt certain he'd done a through job of cleaning up, that he instantly confessed.

When a darkish substance is found at a crime scene, it must first be determined to be blood. There are several tests - presumptive tests used strictly for screening - that will differentiate between blood and other substances, but if other chemicals are present at the scene to which the test chemicals are sensitive, the tests may be vulnerable to corruption. For that reason, these tests are done with great care. A positive result from any of them is an indication to go ahead and use other tests to confirm.

The first test is simply the use of a powerful light moved across every surface of a crime scene. That yields possible traces for visual inspection.

If nothing is seen, but there is reason to suspect blood had been present, a chemical called luminol is sprayed across the scene because it reacts to the haemoglobin in blood by making it luminescent. It only takes about five seconds. The procedure requires that the room be considerably darkened in order to see the faint bluish glow, and the intensity of the glow increases proportionately to the amount of blood present. It works even with old blood or diluted stains, and can illuminate smear marks where blood has been wiped away. However, there is one problem with this test: luminol can destroy the properties of the blood that investigators need for further testing. Its use is limited to proving that blood is present even if not visible.

Other presumptive tests that depend on a colour change involve the following:

- Leucomalachite green (LMG) colour test: This chemical reagent has been around since the early part of the 20th century and undergoes a chemical interaction with blood, yielding a characteristic green colour.

- Tetramethylbenzidine (TMB) colour test: At a crime scene, a CSI technician swabs a suspected bloodstain with a moistened Q-tip and then applies it to a Hemastix strip containing TMB. A Hemastix strip is a dip stick used to test for the presence of blood. If the Hemastix strip turns blue-green, it might be blood.

- Kastle-Meyer colour test: Phenolphthalein is the active chemical reagent in this particular test. When blood, hydrogen peroxide, and phenolphthalein are mixed together, a dark pink colour results. This colour change is due to the haemoglobin (the oxygen-containing molecule within red blood cells) causing a chemical reaction between hydrogen peroxide and phenolphthalein.

Once the presence of blood has been determined, confirmatory tests are carried out. One such test is the Teichmann and Takayama test. This test depends on a chemical reaction between a reagent and haemoglobin. This reaction yields crystals, which then can be seen under a microscope. A considerable benefit of these tests is that they are more effective with aged stains.

DNA

DNA profiling (also called DNA testing, DNA typing, or genetic fingerprinting) is a technique employed by forensic scientists to assist in the identification of individuals on the basis of their respective DNA profiles.

Every single cell in our bodies contains DNA, the genetic material that programs how cells work. 99.9 percent of human DNA is the same in everyone, meaning that only 0.1 percent of our DNA is unique. Each human cell contains three billion DNA base pairs. Our unique DNA, 0.1 percent of 3 billion, amounts to 3 million base pairs. This is more than enough to provide profiles that accurately identify a person. The only exception is identical twins, who share 100 percent identical DNA.

DNA profiling was first described in 1985 by an English geneticist named Alec Jeffreys. Dr. Jeffreys found that certain regions of DNA contained DNA sequences that were repeated over and over again next to each other. He also discovered that the number of repeated sections present in a sample could differ from individual to individual. By developing a technique to examine the length variation of these DNA repeat sequences, Dr. Jeffreys created the ability to perform human identity tests.

These DNA repeat regions became known as VNTRs, which stands for variable number of tandem repeats. The technique used by Dr. Jeffreys to examine the VNTRs was called restriction fragment length polymorphism (RFLP) because it involved the use of a restriction enzyme to cut the regions of DNA surrounding the VNTRs. This RFLP method was first used to help in an English immigration case and shortly thereafter to solve a double homicide case. Since that time, human identity testing using DNA typing methods has been widespread, seeing tremendous growth in the use of DNA evidence in crime scene investigations as well as paternity testing.

To identify individuals, forensic scientists scan 13 DNA regions, or loci, that vary from person to person and use the data to create a DNA profile of that individual (sometimes called a DNA fingerprint). There is an extremely small chance that another person has the same DNA profile for a particular set of 13 regions. A match at all thirteen is rare enough that you a jury can be very confident ("beyond a reasonable doubt") that the right person is accused.

One way to obtain a match is to scan through a DNA database. There are now several DNA databases in existence around the world. Some are private, but most of the largest databases are government controlled. In the United Kingdom, for example, all suspects can be forced to provide a DNA sample. Likewise, all arrestees - regardless of the degree of the charge and the possibility that they may not be convicted - can be compelled to comply. This empowers police officers, rather than judges and juries, to provide the state with intimate evidence that could lead to investigative arrests. In the United States each state legislature independently decides whether DNA can be sampled from arrestees or convicts.

At present the Victoria police may request a sample from a person who is suspected of, charged with or summonsed for an indictable offence, i.e. a serious crime. In addition, police may seek a sample from offenders convicted of certain crimes, whether or not they are currently serving a prison sentence. These include: sexual offences, murder and manslaughter, assault, armed robbery, house- breaking and burglary, hoax crimes and kidnapping.

If a suspect or convicted offender does not consent to provide a sample, the police may apply for a court order to require a sample to be taken and may then obtain a warrant for the arrest of the person to enforce the order. In the case of children aged 10 –17 years, police must apply to the Children's Court for an order to require the child to provide a sample.

Currently in Victoria, if a person offers or volunteers to provide a sample, they can determine the use to which their sample may be put. Volunteers must be asked to specify whether they consent to their profile being used for only a limited purpose or whether they consent to their profile being retained on the database for unlimited use.

The United States maintains the largest DNA database, with the Combined DNA Index System, holding over 5 million records as of 2007. The United Kingdom maintains the National DNA Database (NDNAD), which is of similar size. The size of this database, and its rate of growth, is giving concern to civil liberties groups in the UK, where police have wide-ranging powers to take samples and retain them even in the event of acquittal. The primary concern is privacy. DNA profiles are different from fingerprints, which are useful only for identification. DNA can provide insights into many intimate aspects of people and their families including susceptibility to particular diseases, legitimacy of birth, and perhaps predispositions to certain behaviours and sexual orientation. This information increases the potential for genetic discrimination by government, insurers, employers, schools, banks, and others.

Some advantages of DNA databases include:

- Major crimes often involve people who also have committed other offences. Having DNA banked potentially could make it easier to identify suspects, just as fingerprint databases do.
- Innocent people currently are incarcerated for crimes they did not commit; if DNA samples had been taken at the time of arrest, these individuals could have been proven innocent and thereby avoided incarceration.
- Banking arrestees' DNA instead of banking only that of convicted criminals could result in financial savings in investigation, prosecution, and incarceration.

Some disadvantages include:

- Arrestees often are found innocent of crimes. The retention of innocent people's DNA raises significant ethical and social issues.
- If people's DNA is in police databases, they might be identified as matches or partial matches to DNA found at crime scenes. This occurs even with innocent people, for instance, if an individual had been at a crime scene earlier or had a similar DNA profile to the actual criminal.
- Sensitive genetic information, such as family relationships and disease susceptibility, can be obtained from DNA samples. Police, forensic science services, and researchers

using the database have access to people's DNA without their consent. This can be seen as an intrusion of personal privacy and a violation of civil liberties.

3.6 Soil Analysis

There are thousands of different soil samples around the world, but each has unique qualities that allow forensic analysis to link soil to a crime scene or soil to a suspect. Forensic scientists use soil as evidence in a criminal investigation.

Soil is considered trace evidence. It is made up of disintegrated surface material that can be organic, mineral or synthetic that is found on or near the Earth's surface. Soil can include rocks, minerals, vegetation, animal matter, glass, paint chips, asphalt, brick, and cinders, to name a few. The ratio of the mineral content compared to other matter in the soil can be very site specific. The ratios of mineral, organic and synthetic matter can vary even within a few feet. Sandy soils look, feel and behave quite differently from clay soils or peaty soils. By profiling an array of characteristics of each soil, it is sometimes possible to attribute those characteristics to a specific location. When properly taken soil samples can tell an investigator a lot about where a victim or suspect has been. Analysis of soil samples taken from vehicles can also tell an investigator about where a vehicle has been. Analysis of footwear, clothing and tyres can also place a suspect or victim in a particular location.

Soil samples may be evaluated in several ways:

- A direct comparison of the two samples may be conducted, with investigators looking for aspects such as colour similarities, pH levels and the variety and size of the particles found in the sample. For example, mineral particles will have traces of the rock from which they were derived, such as quartz and limestone, while grains of sand have distinctly different shapes if say, one comes from the ocean and the other from a desert.

- The mineral content can be tested. Some experienced analysts can moisten a sample and feel the soil. Based on feel alone they can tell the ratio of mineral and organic content. Microscopic examination of soil samples will subsequently reveal the type and nature of the mineral, biological and synthetic content of a sample. Electron microscopes can also be used to reveal the crystalline structures of minerals and synthetic material in a sample of soil.

- Another test that is commonly used is the density gradient tube. Two different liquids are added to a glass tube in various ratios. Each ratio represents a different density. The soil sample is poured into the tube. When the various particles reach a level in the liquid where their density is equal to the liquid the particles become suspended. This creates a unique profile of bands in the tube that can be matched to other samples.

3.7 Fluorescent Oils

Motor oil is a lubricant used in internal combustion engines. Most motor oils are made from a petroleum base stock derived from crude oil, with additives to improve certain properties. One of the most important properties of motor oil in maintaining a lubricating film between moving parts is its viscosity. The viscosity of a liquid can be thought of as its "thickness" or a quantity of resistance to flow. The Society of Automotive Engineers (SAE) has established a numerical code system for grading motor oils according to their viscosity.

Fluorescence occurs when a molecule absorbs light energy of one specific wavelength and emits light energy of a longer wavelength. In this case, ultra violet (UV) light is absorbed and visible light (mostly blue) is emitted. Fluorescent compounds such as oil each have a unique colour signature. As most oils contain slightly different grades of oil based upon their viscosity, each type of oil will have a unique glow under the UV light that will enable them to be matched with evidence from a crime scene.

3.8 Ballistics

Forensic ballistics is the science of analysing firearm usage in crimes. The term ballistics refers to the science of the travel of a projectile in flight. The flight path of a bullet includes: travel down the barrel, path through the air and path through a target. Forensic ballistics involves analysis of bullets and bullet impacts to determine the type of bullet used.

Separately from the ballistics information, firearm and tool mark examinations also involve analysing firearm, ammunition, and tool mark evidence in order to establish whether a certain firearm or tool was used in the commission of a crime. Rifling is the process of making grooves in gun barrels that imparts a spin to the projectile for increased accuracy and range. Bullets fired from rifled weapons acquire a distinct signature of grooves, scratches, and indentations that are of value for matching a fired projectile to a firearm. And like fingerprints, no two firearms, even those of the same make and model, will produce the same marks on fired bullets and cartridge cases.

Examiners are often asked to offer conclusions about the origin of spent bullets or cartridge cases. This can sometimes provide a link, connecting evidence found at one scene with evidence found at another, which is very helpful to police and prosecutors in their investigations. A firearms examiner must examine the evidence for a conclusive match, but even a probable match can help police look for additional evidence in areas they would not otherwise have considered.

4. CLASS ACTIVITIES

4.1 Table of Class Activities by Concept

Activity (Page No.)	Types of Forensics	Fingerprinting	Fibre Analysis	Chromatography	Blood & DNA Analysis	Ballistics	Soil Analysis	Fluorescent Oils
Ballistics - who fired a gun (pg. 18)	✓	✓				✓		
Ballistics - type of firearm (pg. 18)					✓	✓		
Fabric on fence (pg. 17)	✓		✓					
Facial reconstruction (pg. 17)	✓							
Fibres on body (pg. 17)	✓		✓					
Fingerprints on factory bench (pg. 17)	✓	✓						
Fingerprints on ransom note (pg. 17)	✓	✓						
Ink from envelope (pg. 17)	✓			✓				
Oil stain (pg. 17)	✓							✓
Paid stamp on ransom note (pg. 17)	✓							
Smooth surfaces (pg. 167	✓	✓						
Soil test from crime scene (pg. 17)	✓						✓	
Stained cloth (pg. 17)	✓				✓			
Tyre tracks (pg. 17)	✓							
Witness ID of suspect (pg. 17)	✓							

4.2 Class Activities in Detail

A crime has been committed and students must analyse various pieces of physical evidence left at the crime scene in order to determine the culprit from amongst four suspects presented to them. Students have been presented with the following information about the crime in the form of a police report and information about the various suspects:

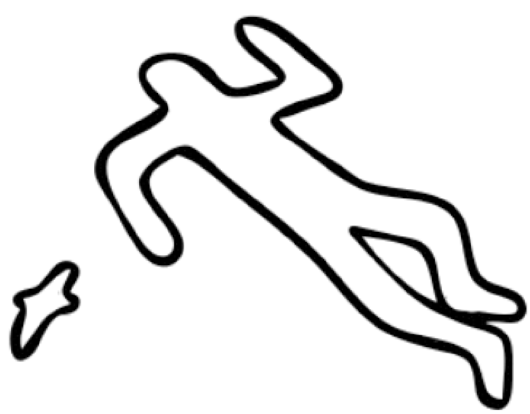
4.2.1 Police Report

The body of a young man has been found in the abandoned paint factory in Bloomsdale. The victim has died from a gunshot wound, and is yet to be positively identified from dental records. Crime scene detectives found the following physical evidence:

1. The shirt worn by the victim at the time of death.
2. Oil sample extracted from the victim's clothing.
3. Cloth fibres found on the victim's clothing.
4. A piece of torn fabric entangled in a barbed wire fence outside the factory.
5. Fingerprints on a bench top in the factory where the victim was found.
6. A footprint found in mud outside the factory.
7. A stained cloth found in an office at the Bloomsdale Research Laboratory.
8. Tyre tracks outside the crime scene.

The body is believed to be that of Nathan Bloom. He and his family are known to police for possession and sale of stolen goods, and for gambling fraud at The Lucky Country Club, a local casino. Their criminal activities have made them local identities in Bloomsdale.

Nathan was abducted for ransom while returning home from a local bar between 12:40 am and 1:00 am ten days ago. A type written note was posted to Mr. & Mrs. Bloom demanding $50,000 in used currency. The ransom note was in an envelope with the address stencilled on the front with black ink.



4.2.2 Police Report … continued

Four suspects have been interviewed. They all deny any knowledge of and involvement with the kidnapping and murder. The suspects are:

Name: Rodney Georgiou

Sex: Male

Age: 25 years

Occupation: Landscape gardener.

Comments: Currently unemployed. Single and lives alone in Bloomsdale. Actively involved in fitness programs. Known to police for break and enter, burglary and possession of stolen goods.


Name: Maria Crossman

Sex: Female

Age: 28 years

Occupation: Cleaner.

Comments: Married and lives with her partner in Bloomsdale. Suspected criminal associate of the Bloom family. Employed as a part time cleaner at the Bloomsdale Research Laboratory.


Name: Eric Smythe

Sex: Male

Age: 31 years

Occupation: Manager.

Comments: Married with two children. Employed at the Lucky Country Club and lives in an apartment at the club. Licensed owner of 2 guns kept at the club for security personnel. No police record.


Name: Tracy Zammitt

Sex: Female

Age: 23 years

Occupation: Laboratory technician.

Comments: Employed at the Bloomsdale Research Laboratory. Experiencing financial difficulties, due to gambling debts. Licensed gun owner and belongs to a sport shooting club.


4.2.3 Evidence Summary

Body identification

- Dental X-rays and DNA patterns on the blood sample indicate that the victim is Nathan Bloom.

FACES computer program

- Georgiou was identified by a witness as the person seen loitering around the Bloom's neighbourhood.

The ransom note

- The stamp impression found on the ransom note was traced to the office of Tracy Zammitt.
- The ink on the ransom note envelope matches ink found at Crossman's house.

Soil testing

- The soil test shows that both Georgiou and Smythe had walked near the crime scene.

Fingerprints

- Crossman's fingerprints were found on a bench top in the factory.
- Both Crossman's and Zammitt's fingerprints were found on the ransom note.

Fabrics and fibres

- Fibres on Nathan's body match those from Crossman's jumper.
- Fabric found on the fence at the factory matched Georgiou's cotton shirt.

Other physical evidence

- Oil stains on Nathan's body matched the oil used in both Crossman's and Smythe's cars.
- The "Hemastix" test confirmed the fabric in the bin in Zammitt's office was stained with blood. DNA analysis showed the blood was from Nathan Bloom.
- The tyre tracks showed that Crossman's car had been at the crime scene.

Ballistics

- Absence of discharge residue suggests gun was fired too far from the victim to be suicide.

- The size of the bullet hole in the victim's shirt suggests that 0.38 ammunition was used.
- Greiss tests show that Smythe and Zammit have all fired guns recently.
- Guns owned by Smythe and Zammitt have the fingerprints of the owner on them, and no-one elses.

4.2.4 Case Brought Before the Court by the Crown Prosecutor

Nathan Bloom and his family have been moderately successful in their criminal activities over the last ten years. They have in the process made enemies and earned the jealousy of like-minded people.

Maria Crossman was guilty of the kidnapping and murder of Nathan Bloom. She did it for her own personal financial gain, and shot Nathan dead in cold blood. It is uncertain whether she ever intended to hand Nathan over in return for the ransom.

Crossman abducted Nathan while he was walking home from a local bar. Nathan knew Crossman and accepted her offer of a lift home. He was held at gunpoint, against his will until his death.

Nathan was shot in the belly at a distance of more than 80 cm with a .38 Smith and Wesson handgun, and the bullet passed through the body. The shooting occurred at an unknown location, and no gun or bullet has been found. Crossman wore gloves during the shooting, so no discharge residue was found on her fingers.

After the shooting, the body was moved to the abandoned factory. A cloth was stained with blood, and this was planted in the office of Tracy Zammitt as part of an attempt to make Tracy a prime suspect in the case. Crossman mistakenly left behind some of her own fingerprints in the factory, and cloth fibres from her clothing were found on the victim's clothing.

Crossman typed the ransom note on Zammitt's typewriter using scrap paper found in her office. The scrap paper carried several clues, including an impression of a paid stamp, which was traced to Zammitt's office, and fingerprints from both Zammitt and Crossman.

Crossman sent the ransom note to the parents of the deceased in an envelope which she addressed using black ink and a stencil. The ink was analysed by police using chromatography, and was matched to a black ink pen found by police at Crossman's home. Crossman hoped to claim the ransom and leave the country before the body was discovered

Georgiou was seen by a witness on the morning of the kidnapping as he was casing the Bloom's neighbourhood. He is a known felon, but it is believed he had no involvement in this case. He had been in the factory, tearing his T-shirt on the barbed wire fence and leaving footprints in the mud. This was unrelated to the crime.

APPENDIX A – USEFUL WEBSITES

Interesting websites that may relate to Forensic Frenzy, and to those interested in Forensic Science in general:

TEACHER RESOURCES

- Cybersleuth. An international school forensics program with a number of Victorian schools involved.

  http://www.kilvington.vic.edu.au/cyber/forensic/index.html

- Yahoo's Forensic Science Index. Quite a good index for more forensic science sites

  http://www.yahoo.com/science/forensics

- Zeno's Forensics Page. Older kids might be interested.

  http://forensic.to/forensic.html

- Crime and Clues. In particular, try clicking on Fingerprint Evidence.

  http://crimeandclues.com/

ACTIVTY SITES FOR KIDS

- MysteryNet kids section. Excellent see-and-solve site for kids

  http://www.MysteryNet.com/thecase/

- FACES website. Download a free demo version of the photofit software used in the Forensic Frenzy

  http://www.iqbiometrix.com

Contact Details

CSIRO Education, Victoria

P.O. Box 56

Highett, 3156

Ph: (03) 9252 6387 or (03) 9252 6410

Email: **education@csiro.au**

Web: **www.csiro.au/melbcsirosec**

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Appendix B: Biodiversity Teacher Notes

Biodiversity and the World Around Us

cecv catholic education commission of victoria ltd

State Government Victoria Department of Education and Early Childhood Development

i

Contents

1. GENERAL INTRODUCTION

Biodiversity and the World Around Us examines the impacts humans have on our environment, and the way scientist collect and use environmental data to monitor these impacts.

In the 90 minute session, students are presented with a hypothetical scenario, based on real case studies. In the fictional town of Peramel exists a nature reserve that provides habitat to the Eastern Barred Bandicoot (*Perameles gunni*). This small population is in decline, and the students are given the task of monitoring the local environment, through a series of hands-on activities, in order to assess the threats impacting on the bandicoot.

The Eastern Barred Bandicoot

The Eastern Barred Bandicoot is a small nocturnal marsupial, native to Australia. This species of bandicoot was once abundant across western Victoria and Tasmania, but is now considered endangered in Victoria, with only around 200 individual animals remaining. In order to ensure the survival of the Eastern Barred Bandicoot, **scientists must study the following factors**:

Diet

Eastern Barred Bandicoots are omnivorous. They eat insects and worms, small frogs, plants and berries.

Predators

Eastern Barred Bandicoots are preyed upon by larger carnivorous animals, such as foxes and cats.

Competitors

Competitors for food include mosquito fish, which eat young aquatic insects, and tadpoles (infant frogs); and large frogs, which insects and smaller frogs.

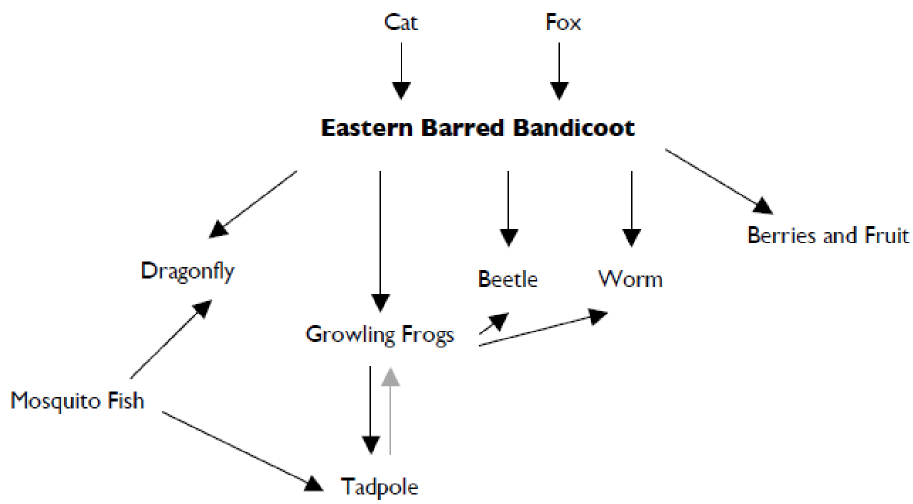
Environmental pressures

Fragmentation occurs when a large habitat is split up into several separate habitats, such as deforestation or clearing land for development. Fragmentation makes it difficult for female bandicoots to move between territories. Frogs are also affected by fragmentation.
Water, soil and atmospheric conditions *indirectly* affect bandicoots by affecting the plants and aquatic species in an area, which the bandicoot feeds off.

Reproduction and lifespan

One female Eastern Barred Bandicoot can produce up to 16 young per year, but many of them do not survive to adulthood. If there is not enough food or water, a female may stop reproducing (such as in drought). Eastern Barred Bandicoots live for 2 – 3 years.

Eastern Barred Bandicoot Foodweb



2. CURRICULUM LINKS

2.1 The Victorian Essential Learning Standard

	Domain & Level	Dimension and Standard
Discipline Based Learning	Science 4	*Science knowledge and understanding* • explain change in terms of cause and effect • apply the terms *relationships*, *models* and *systems* appropriately as ways of representing complex structures • identify and explain the relationships that exist within and between food chains in the environment *Science at work* • analyse a range of science-related local issues and describe the relevance of science to their own and other people's lives • explain how sustainable practices have been developed and/or are applied in their local environment • approach data collection systematically, and analyse data qualitatively in terms of errors of measurement • use a range of simple measuring instruments and materials, and demonstrate understanding of their personal responsibility in using them • use the terms *relationships* and *cause and effect* when discussing and drawing conclusions from the data they collect
	5	*Science Knowledge and understanding* • explain the relationships, past and present, in living and non-living • systems, in particular ecosystems, and human impact on these systems. • analyse what is needed for living things to survive, thrive or adapt • explain how the observed characteristics of living things are used to establish a classification system. *Science at work* • demonstrate safe, technical uses of a range of instruments and chemicals • make systematic observations and interpret recorded data appropriately, according to the aims of the study • demonstrate use of basic sampling procedures and represent relationships in ecosystems graphically • use simulations to predict the effect of changes in an ecosystem. • identify, analyse and ask their own questions in relation to scientific ideas or issues of interest
	6	*Science Knowledge and understanding* • identify and classify the sources of wastes generated, and describe their management, within the community and in industry. • use a specific example to explain the sustainable management of a resource. • explain how the action of micro-organisms can be both beneficial and detrimental to society. *Science at work* • use the relevant science concepts and relationships as one dimension of debating contentious and/or ethically based science-related issues of broad community concern • use chemicals, equipment, electronic components and instruments responsibly and safely • present experimental results using appropriate data presentation formats, and comment on the nature of experimental errors

Physical, Personal and Social Learning	Interpersonal Learning	4	*Working in teams* • work effectively in various teams and take on a variety of roles to complete tasks of varying length and complexity
		5	*Working in teams* • accept responsibility as a team member and support other members to share information, explore the ideas of others, and work cooperatively to achieve a shared purpose within a realistic timeframe
		6	*Working in teams* • work collaboratively, negotiate roles and delegate tasks to complete complex tasks in team
	Personal Learning	4	*Managing personal learning* • persist when experiencing difficulty with learning tasks • seek and use learning support when needed from peers, teachers and other adults • demonstrate a positive attitude to learning within and outside the classroom
		5	*Managing personal learning* • complete competing short, extended and group tasks within set timeframes, prioritising their available time, utilising appropriate resources and demonstrating motivation • demonstrate a positive and structured approach to learning, identifying and using effective strategies that assist with study, both at school and at home
		6	*Managing personal learning* • allocate appropriate time and identify and utilise appropriate resources to manage competing priorities and complete tasks, including learner-directed projects, within set timeframes • take responsibility for their learning environments, both at school and at home, anticipating the consequences of their actions
Interdisciplinary Learning	Communication	4	*Listening, viewing and responding* • ask clarifying questions about ideas and information they listen to and review • develop interpretations of content
		5	*Listening, viewing and responding* • use specialised language and symbols as appropriate to the contexts in which they are working
		6	*Listening, viewing and responding* • use complex verbal and non-verbal cues, subject-specific language, and a wide range of communication forms
	Thinking Processes	4	*Responding, processing and inquiry* • collect relevant information from a range of sources and make judgements about it's worth • distinguish between fact and opinion • use information to develop concepts, solve problems or inform decision making
		5	*Responding, processing and inquiry* • use a range of question types, and locate and select relevant information from varied sources when undertaking investigations • use a range of appropriate strategies of reasoning and analysis to evaluate evidence • use a range of discipline- based methodologies • complete activities focusing on problem solving and decision making which involve an increasing number of variables and solutions
		6	*Responding, processing and inquiry* • process and synthesise complex information and complete activities focusing on problem solving and decision making which involve a wide range and complexity of variables and solutions • employ appropriate methodologies for creating and verifying knowledge in different disciplines.

3. CLASS ACTIVITIES

3.1 Table of Class Activities

Activity (Page No.)	Biotic (living) factors	Abiotic (non-living) factors	Atmospheric change
Microscopic Monitoring (pg. X)	✓		
Classification Key (pg. X)	✓		
Map That Species! (pg. X)	✓		
Testing Temperature		✓	
Water pH (pg. X)		✓	
Soil Texture (pg. X)		✓	
Soil Moisture (pg. X)		✓	
A world of CO2 (pg. X)		✓	✓
Future Air/Atmosphere? (pg. X)		✓	✓
A Trend in the Weather (pg. X)		✓	✓

3.2 Class Activities

3.2.1 Microscopic Monitoring

Scientists often use biological (living) indicators to provide insight into the impact of human activities in the environment. Comparing the diversity and numbers of different populations of microscopic organisms between water samples can tell us a lot about the health of these systems.

Advantages of monitoring microscopic organisms:

- they are affected by physical, chemical and biological conditions, and can therefore represent the overall ecological health
- they are a critical part of the food web
- they cannot easily escape pollution (e.g. like a bird could fly away)
- are abundant and easily sampled

• they respond quickly to a broad range of factors
• are found in all aquatic habitats

Limitations of monitoring microscopic organisms:
• they are unable to indicate the cause of an impact
• they do not respond to all impacts
• this usually does not indicate the presence of disease-causing micro-organisms
• they naturally vary between seasons, preventing seasonal comparisons

3.2.2 Classification Key

Biological classification is the systematic grouping of organisms. Life on earth is typically categorised using the taxonomic ranks – domain, kingdom, phylum, class, order, family, genus and species. This system accounts for all life on earth, breaking it firstly into three domains based on the structure of the organism's cells (Archaea, Bacteria and Eukarya). These are then further split into 5 Kingdoms (Animals, Plants, Fungi, Protists, Archaea and Bacteria). This splitting according to common traits continues down to each individual species.

A classification key is a very useful tool to a field scientist. They are used to identify unknown species using a series of discernable characteristics. Keys can be dichotymous (having only two choices at each branching point), or polytomous (having more than two choices). An example of a dichotymous key can be seen in the image below. Once identified, the location and abundance of the species can be recorded.

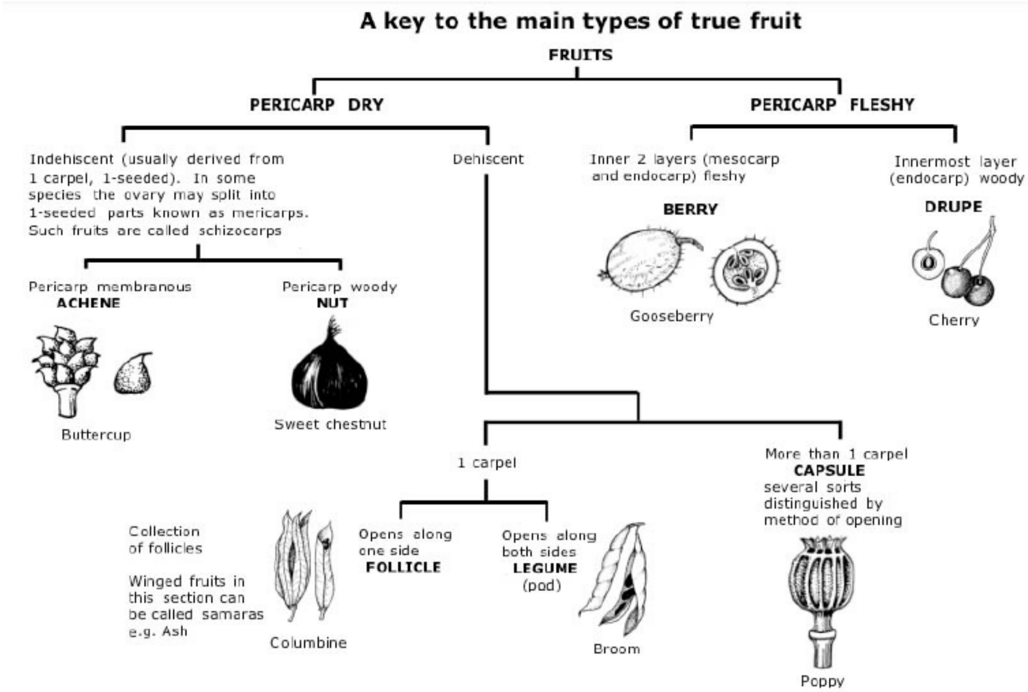


Image courtesy Plant Science Image Database (www.plantscienceimages.org.uk)

3.2.3 Map That Species

Ecologists often make detailed surveys of the different types of plants and animals in an area. Once done, a distribution map like this one, can help them understand what conditions (wet, dry, warm, cold, etc.) each species likes.

In this activity, students examine the distribution of three different grass species on the 3D relief map. From this data, conclusions about the species preferred habitat, and abiotic requirements, can be drawn. For example, the Swamp Wallaby Grass requires wet conditions, and is therefore only found around the creek, and in a noticeable depression where the presence of the swamp grass infers there are wet conditions.

The species shown on the map for this activity where chosen as they illustrate very different survival strategies, and therefore varying success when faced with changing conditions, and human impact.

Swamp Wallaby Grass (*Ampibromus pithogastrus*) is a critically endangered native grass. In 2000, it was estimated that the known Victorian population was only 20 plants, although another significant population has since been found in the Grampians. It is sensitive to physical disturbance, changes in water availability, increased salinity and superphosphates. As seen on the map, the swamp grass exists only in the upstream area of bandicoot habitat, but it fails in the downstream area. It can be seen that this area has been disturbed by the residential developments, and potentially affected by fertilizer run-off from the farm.

Kangaroo Grass (*Themada triandra*) has been observed co-existing with Swamp Wallaby Grass. A native with distribution across Australia, it prefers open areas, such as grasslands and open woodlands. It shows some resistance to disturbance and light grazing. Ryegrass (*Lolium rigidum*) is a declared weed species. It was introduced to Australia from Europe for pastures and lawn. It is highly competitive, and reproduces rapidly in disturbed environments. It's invasive nature results in it being one of the most costly weed species in Australia, as it competes with other crops. In addition, it's pollen is highly allergenic and carries a fungus that can cause "staggers" – a neurological disorder that can cause tremors, lack of co-ordination and spasms in grazing animals.

As it would be practically impossible to make a complete species survey of a given habitat, distribution data is often collected using quadrats. A quadrat is a simple frame, usually square or rectangular, that can be placed at random to isolate a sample. The organisms enclosed within the quadrat can then be identified, counted and recorded. With multiple sampling, the data collected can then be extrapolated over the larger collection area.

3.2.4 Testing Temperature

Temperature can change over a small area of land. Urban areas hold heat due to increased dark, absorbing materials like roads, brick and concrete. Heavily forested areas, however, tend to be cooler, as the evaporation of water from plants keeps temperatures down.

Built up urban areas and cities tend to be warmer than those covered in vegetation. This phenomenon is known as the Urban Heat Island (UHI) effect. There are two contributing factors to this: The increase in dark materials with high heat capacities such as bitumen and concrete, which absorb and retain heat during the day, and release the heat at night: and waste heat generated by energy usage (heaters, air conditioners, combustion engines, etc.). Ways in which UHI can impact the local area include increased severity of heat waves, increased pollution levels, decreased rainfall and increased environmental water temperatures.

In contrast, vegetated areas are kept cool through evapotranspiration – the combined effect of evaporation from the lands surface and transpiration from plants. A simple explanation of this is that water requires energy to move from its liquid form to a gas, and this energy is heat. As heat is used to evaporate the water, evapotranspiration results in an overall cooling affect.

3.2.5 Water pH

pH is a measure of how acidic or alkaline a substance is. Neutral substances, like pure water, are considered to have a pH of 6.5 – 7.5. Values above 7.5 are alkaline or basic, while values below 6.5 are acidic.

The pH scale relates to the concentration of dissolved hydrogen ions (the H in pH) in a solution. The scale is negative logarithmic, which means that a low pH has a high hydrogen concentration, and vice versa. A change in ph of one numerical value indicates a 10 fold change in hydrogen ions. For example, pH 6 has 10 times more hydrogen than pH 7, but pH 5 has 100 times more than pH7.

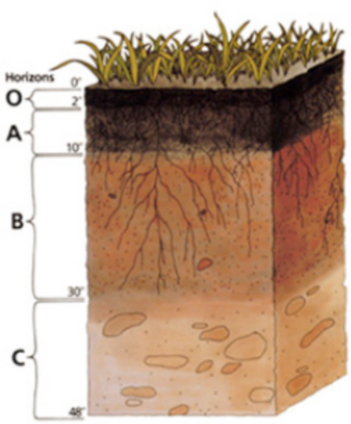
Healthy stream water should have a pH of 5.5 – 7.5. It is normal for the water to be slightly acidic due to the breakdown of organic matter in the surrounding environment. As water filters through the soil, tannins, among other compounds, are dissolved. This produces tannic acid, thus lowering the pH.

When a water body contains excess nutrients, often as a result of fertiliser run-off, algae and other plants can flourish. This is known as eutrophication. The increase in pH is due to a number of factors. The increase in plant matter consumes hydrogen (H+) ions through photosynthesis. Photosynthesis also requires CO2, and when plants are using CO2 at a rate greater than the rate of CO2 diffusion into the water, dissolved carbonates will be consumed instead. These carbonates would otherwise decrease acidity, for example in the form of carbonic acid.

Eutrophication poses a problem for water bodies. Along with increases in pH, oxygen content becomes depleted as the water becomes choked with decomposing plant matter. As the nutrient level increases, fewer organisms can cope with the changes, leading to a loss of biodiversity. At extreme levels, "lake death" can occur, where no conditions are such that no living organisms can inhabit the water body.

3.2.6 Soil Texture

Soil type is an important factor in any ecosystem. It determines the type of plants, and therefore the type of animals, that can live there. Clay soils hold water well, sandy soils drain quickly, while soils with lots of broken down plant matter (loams) indicate a healthy, nutrient rich ecosystem.



Assessment of soil texture is a valuable tool to the field scientist. A scientist with skills in texture assessment can quickly get a picture of the overall of the ecosystem, and any problems it may be experiencing due to runoff, erosion, loss of vegetation etc.

Generally, a soil scientist will assess the texture of not just the top layer of soil, but each subsequent layer underneath. This is known as the soil profile, and may contain layers (horizons) of soil. For example, a profile may have a top layer of loam, with increasing clay underneath, and seams of sand or stone at different depths. The scientist would also perform other tests, for example pH, moisture content, presence or absence of calcium carbonate (lime) and record the depth of each horizon.

Image: Example of soil profile, with horizons labelled. Courtesy USDA.

3.2.7 Soil Moisture

Soil moisture is a measure of how much water is in a soil. If a soil is moist, plants have better access to water. There are big differences in soil moisture between ecosystem types – some plants are adapted to low moisture (deserts) while some need lots of water (rain forest).

The water holding capacity of soil is a crucial determining factor to the type of ecosystem an area can support. Generally speaking, soils with a mixture of particle sizes (eg. clays, sands, silts) have a higher water holding capacity than those of uniform particle size. This is because mixed soils contain pores that can hold water due to surface tension, the "pull" between water molecules.

In addition, added organic matter helps hold water in soils. Organic matter is broken down plant and animal matter that has been decomposed through the action of bacteria, micro organisms and fungi to form humus. Humus is high in carbon, so therefore soils with a high organic content are effective carbon sinks too.

Maintaining constant water availability is crucial to sustain ecosystem health. Changes in hydrology (availability and movement of water) can detrimentally, and possibly permanently affect the nature of an ecosystem. These changes can be seen in the samples given to the students. The soil sample taken from the forested, undisturbed site contained 17% moisture, whilst the soil taken from the disturbed, cleared land near the housing development contained only 5%, despite both samples being collected at the same time, shortly after a rain event.

3.2.8 A world of CO_2

Carbon dioxide is a very important gas on Earth. It absorbs the heat from the sun during the day, and releases at night. If we didn't have this CO_2 "blanket", Earth would be much colder than it is today, with average temperature of -25 degrees!

However, too much CO_2 released from burning fuel (wood, petrol, gas etc) can increase the temperature on earth. Other greenhouse gases are also on the rise. The earth has warmed several degrees in the last few decades.

Carbon dioxide is all around us. The balance in concentrations of CO_2 and other greenhouse gases is in fact one of the reasons life on earth is possible. The greenhouse gases (carbon dioxide, water vapour, methane etc.) in our atmosphere absorb infrared (heat) radiation, and re-emit it, resulting in direct warming of the earths surface and atmosphere. This insulates the earth, minimising diurnal (day and night) differences in temperatures.

In this activity, students use CO_2 meters to directly measure the concentration of carbon dioxide in the classroom, outdoors and from their breath. They observe clear differences (2-4 fold) between indoor and outdoor These differences can be later explained when they test their breath, which can be up at a 30 fold increase on the ambient air.

All animals require oxygen to undertake cellular respiration – the process by which glucose and oxygen produces carbon dioxide, water, energy and heat, according to the equation below:

$$\text{glucose} + \text{oxygen} = \text{carbon dioxide} + \text{water} + \text{heat} + \text{ATP (energy)}$$

This carbon dioxide is then breathed out, resulting in the high reading the students obtained. This expired CO_2 primarily accounts for the increased levels inside compared to outside, although contributions from other sources also contribute to a lesser degree

3.2.9 Future Air/Future Atmosphere

Carbon dioxide is a naturally occurring gas. It is released when carbon rich, organic matter is "broken down" in the presence of oxygen. This can happen through decomposition, where organisms consume the matter, releasing CO_2 through respiration, or combustion.

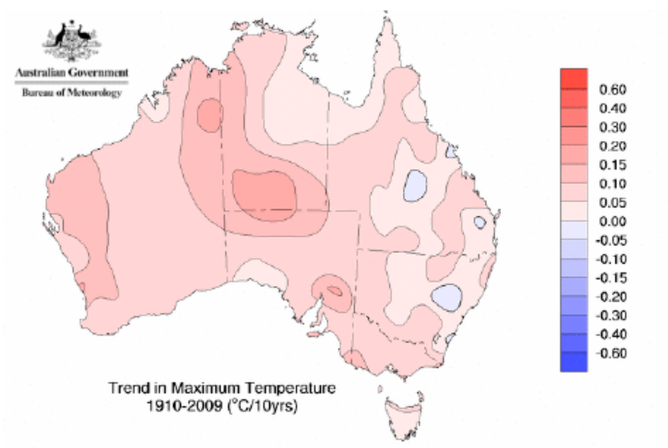
The contribution of humans to these processes has been on the increase. Our use of fossil fuels is a primary contribution, but our impact through changing land use is also profound. Carbon can be stored in organic matter, both in vegetation and soils. Land clearing and agriculture releases this carbon store, most of which is converted to CO_2 or methane, another greenhouse gas.

In this activity, students compare and record the changes in temperature over the duration of the session in four chambers. Two chambers contain ambient air, whilst two have added carbon dioxide. One of each of these chambers has a white background, while the other two have black. This allows students to explore not only the effect of increased CO_2 in our atmosphere, but also the affect of albedo, or the reflectivity of surfaces. If the energy that reaches earth from the sun, some 30% is reflected directly into back into space. White surfaces (cloud, ice, snow) reflect this radiation, whilst dark surfaces (ocean, rock, bare earth) will absorb this as heat energy. This sets up what is known as a positive feedback loop, where an increase in temperature (possibly due to increased CO_2), results in melting of the ice and snow. This results in more dark surfaces being exposed, which increases the area of heat absorption. This increases the temperature which may again result in loss of white surfaces, and so on.

3.2.10 A Trend in the Weather

Scientists studying natural systems use data collected over a long period of time. This data can then be used to observe trends – how conditions are changing over time.

Trend maps graphically display change over time. For this activity, daily maximum temperature has been chosen, as this is often the one most associated with when we think of fluctuations in temperature. The maps show change over a given period of time as a function of average maximum temperature at the start of the time period.



For example, the map to the left indicates that since 1910, the maximum daily temperatures have increased on average 0.05 - 0.10 degrees Celsius each decade. Or 0.5 to 1 degree over the 100 year period.

When comparing this to the map for the period 1970-2009, it becomes apparent that much of the change in temperature in the last 100 years has, in fact, occurred in the last 30 years. This indicates a non-linear increase in temperatures, or that the rate of temperature increase has risen sharply in more recent years.

Contact Details

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Important Disclaimer

Your CSIRO

Australia is founding its future on science and innovation. Its national science agency, CSIRO, is a powerhouse of ideas, technologies and skills for building prosperity, growth, health and sustainability. It serves governments, industries, business and communities across the nation.

Appendix C: Forensic Frenzy Student Booklet

Forensic Frenzy

Student Booklet (Year 7- 10)

CSIRO Education, Victoria
Ph: (03) 9252 6387
Web: www.csiro.au/melbcsirosec

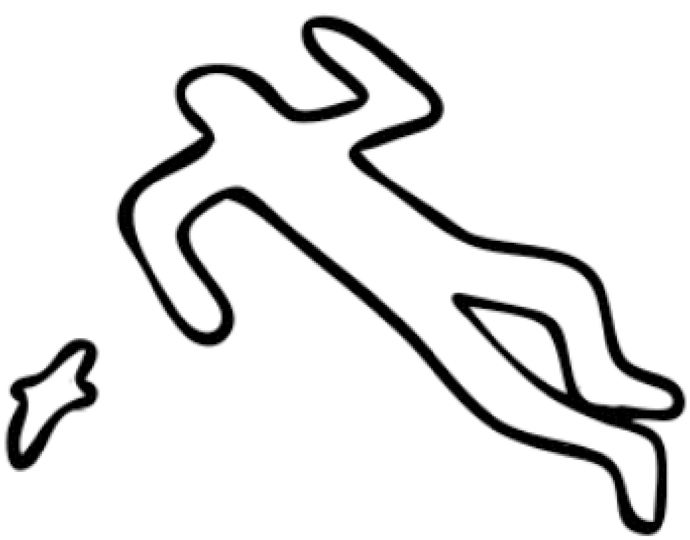
Police Report

The body of a young man has been found in the abandoned paint factory in Bloomsdale. The victim has died from a gunshot wound, and is yet to be positively identified from dental records. Crime scene detectives found the following physical evidence:

- The shirt worn by the victim at the time of death.
- Oil sample extracted from the victim's clothing.
- Cloth fibres found on the victim's clothing.
- A piece of torn fabric entangled in a barbed wire fence outside the factory.
- Fingerprints on a bench top in the factory where the victim was found.
- A footprint found in mud outside the factory.
- A stained cloth found in an office at the Bloomsdale Research Laboratory.
- Tyre tracks outside the crime scene.

The body is believed to be that of Nathan Bloom. He and his family are known to police for possession and sale of stolen goods, and for gambling fraud at The Lucky Country Club, a local casino. Their criminal activities have made them local identities in Bloomsdale.

Nathan was abducted for ransom while returning home from a local bar between 12:40 am and 1:00 am ten days ago. A type written note was posted to Mr. & Mrs. Bloom demanding $500,000 in used currency. The ransom note was in an envelope with the address stencilled on the front with black ink.



Police Report ... continued

Four suspects have been interviewed. They all deny any knowledge of and involvement with the kidnapping and murder.

The suspects are:

Name: Rodney Georgiou
Sex: Male
Age: 25 years
Occupation: Landscape gardener.
Comments: Currently unemployed. Single and lives alone in Bloomsdale. Actively involved in fitness programs. Known to police for break and enter, burglary and possession of stolen goods.

Name: Maria Crossman
Sex: Female
Age: 28 years
Occupation: Cleaner.
Comments: Married and lives with her partner in Bloomsdale. Suspected criminal associate of the Bloom family. Employed as a part time cleaner at the Bloomsdale Research Laboratory.

Name: Eric Smythe
Sex: Male
Age: 31 years
Occupation: Manager.
Comments: Married with two children. Employed at the Lucky Country Club and lives in an apartment at the club. Licensed owner of 2 guns kept at the club for security personnel. No police record.

Name: Tracy Zammitt
Sex: Female
Age: 23 years
Occupation: Laboratory technician.
Comments: Employed at the Bloomsdale Research Laboratory. Experiencing financial difficulties, due to gambling debts. Licensed gun owner and belongs to a sport shooting club.

Investigation Findings

Record your findings from each of the pieces of evidence in the appropriate place in the table below. It is very important to be clear about your results. If you are at all unsure, then you should repeat the test or write 'inconclusive' next to it. **DO NOT GUESS!** It is possible to get more than one match.

Evidence	Observations	Conclusions
Facial Identification	*Neighbour constructed photofit of man loitering near Blooms' house. Photofit identified as Georgiou*	*Georgiou was man seen loitering near Blooms' house before kidnapping*
Ballistics – type of firearm used		
Ballistics – Greiss Test		
Fingerprints on the gun		
Dental X-rays		
Is it blood? Whose blood?		
Fibres on the body		
Fabric on the fence		
Oil stains		
Soil testing		
Tyre tracks		
Fingerprints at the factory		
Fingerprints on the ransom note		
Envelope ink		
PAID stamp		

Evidence Summary

Record a summary of all of the evidence gathered in the table below:

Crossman	Georgiou	Smythe	Zammitt	Victim
				Ballistics

Report to the Commissioner of Investigations

Write your own version of events, describing what you think may have happened based upon the evidence that you have collected.

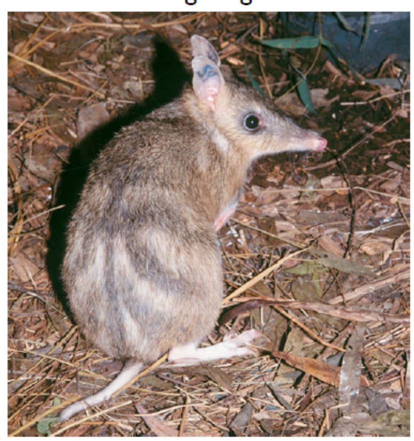
Appendix D: Biodiversity Student Booklet

Biodiversity and the World Around Us

Student Booklet

Biodiversity at Risk!

Peramel is an outer suburb of Melbourne, located approximately 5 kilometres from the bay. It is home to Bandy Park, a nature reserve. The Bandy Park Nature Group have noticed a recent drop in the number of sightings of the Eastern Barred Bandicoot a small population of which lives in the park. Peramel is experiencing a housing boom, with many new residences being built in the area. The Bandy Park Nature Group has asked us to examine the area, and assess any risks to the Bandicoot population.



Bandicoots are small, rabbit sized marsupials. They are ground dwelling and eat mostly insects, with some berries and fruit. Of the 11 species of Bandicoots found in Australia, three are now extinct. The Eastern Barred Bandicoot, along with two others, is now on the Endangered list.

Your task today is to examine the living (biotic) and non-living (abiotic) factors that are impacting in the bandicoot's habitat, before it is too late! Complete the activities, and answer the questions below to discover more!

<u>A World of CO_2</u>

1. Record the readings from the CO_2 meter below;

   Classroom;___________ppm Outside:___________ppm Breath:____________ppm

2. Was there a difference between inside and outside? Can you say why?

____

____

Future Atmosphere?

1. Do you think the extra CO_2 in the enhanced jars are making a difference to the temperature? How?

____

____

2. If polar ice sheets and snow (white surfaces) melt to expose ocean and land (dark surfaces), do you think global temperatures would increase or decrease? Why?

____

3. What do you think could happen on Earth if the carbon dioxide level in our air increased?

____

____

Microscopic Monitoring

1. Watching the DVD, fill in the table below:

Samples	**Number of Different Species**	**Total numbers (tick box)**		
		1-10	11-50	50+
A – Creek (upstream)				
B – Farm Dam				
C – Creek (downstream)				

1. Which sample do you consider to be the "healthiest"? Why?

____

____

A Trend in the Weather

1. What do the differences in colours between the first map (1910-2009) and the last map (1970-2009) tell us?

____

2. If the temperature was rising at the same rate, all the maps would look the same. Is this the case? Do you think the temperature increase is:

☐ Speading up? ☐ Slowing down? ☐ Staying constant?

Classification Keys

1. Were there any characters that were difficult to classify? Why?

____
____

2. How would a classification key be useful to a scientist in the field?

____
____

Soil Texture

1. Which sample was the most "loamy" (contained the most broken down plant matter)?

____

2. Look at the map to see where the soil samples were taken. How does their location help explain their texture?

____
____
____

Soil Moisture

1. Complete the table below;

	Wet Weight (g)		Dry Weight (g)		Wet weight (g)			Moisture
Sample 1	50	–		÷	50	X 100	=	%
Sample 2	50	–		÷	50	X 100	=	%

2. Why is soil moisture important?

____
____
____

Water pH

Sample 1 pH ______________ Sample 2 pH_______________

1. When green algae grows in water, it increases pH, making the water alkaline. Which of the samples shows evidence of an algal bloom?

   ____

2. When excess nutrients (eg. from fertilisers) wash into the water, the water becomes **eutrophied**, and algae can grow. Where do you think this fertiliser may have come from (look at the map).

Testing Temperature

1. Record the following;

   Maximum temperature:_________°C. Where?____________________________

   Minimum temperature:_________°C. Where?_____________________________

   Average temperature (approximately):_________ °C.

2. Why do you think these areas had different temperatures?

   ____
   ____
   ____

Map That Species!

1. What sort of conditions does the Swamp Grass (blue) need? How do you know?

   ____

2. Does the Kangaroo Grass (yellow) prefer open areas, or those covered with trees?

   ____

3. The Rye Grass (red) is a weed species because it can quickly infest and dominate native vegetation. Can you see this happening on the map? Where?

   ____

Appendix E: CSIRO Current Teacher Evaluation Forms

I

PROGRAM EVALUATION

CSIRO

Your comments are valued and will help us continue to develop programs that are relevant to the needs of teachers. Your assistance by filling in this evaluation is greatly appreciated.

SCHOOL NAME: ______________________________ POSTCODE: __________

TEACHER'S NAME (optional): ______________________________

EMAIL (optional): ______________________________

YEAR LEVEL (please circle): P 1 2 3 4 5 6 7 8 9 10 11 12

PROGRAM: ______________________________

DATE OF PROGRAM: ______________ NAME OF PRESENTER: ______________

	strongly agree	agree	neutral	disagree	strongly disagree
1. The program was engaging					
2. The program was educational					
3. The program encouraged student participation					
4. The program related well to the curriculum/learning unit					
5. The program is likely to encourage students to think about a career in science					
6. The program helped students understand the value of scientific research					
7. The program format, activities were appropriate for this age group					
8. The program support materials were useful (if applicable)					
9. The program is likely to have a lasting positive impact on the students					
10. Program cost was appropriate					
11. I would use this program again					
12. This program was easy to book (booking teacher only)					
13. This program was easy to host (travelling programs) (booking teacher only)					

14. Overall score for Program out of 10; 10 = excellent, 5 = average, 0 = unacceptable ___ /10

15. What were the best features of the program?

____

____

16. What features could have been improved?

____

____

17. Do you have any additional comments or suggestions for new program topics?

____

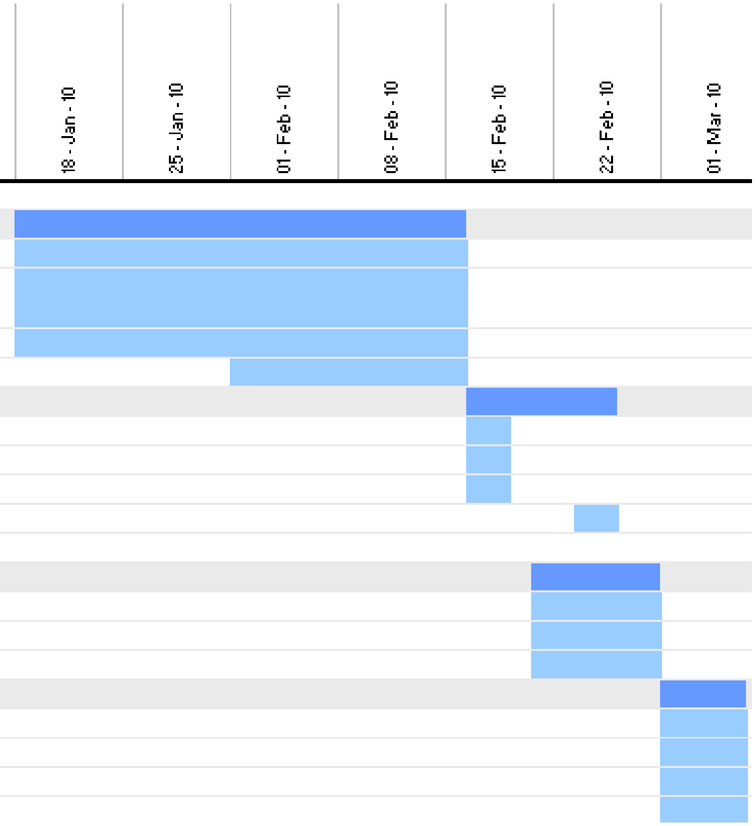
____

____

Please fax or mail to:
The Manager
CSIRO Education, Victoria
PO Box 56 Highett Vic 3190
Fax: (03) 9252 6256

Appendix F: Work Schedule

WBS	Tasks	Task Lead	Start	End	Duration (Days)	% Complete	Working Days	Days Complete	Days Remaining
1	**Prepare for**	CSIRO-C10 team	11-Jan-10	16-Feb-10	36	100%	27	36	0
1.2	Formualte Questionnaire		11-Jan-10	16-Feb-10	36	100%	27	36	0
1.3	Checklist for Observational Research		11-Jan-10	16-Feb-10	36	100%	27	36	0
1.4	Determine Interview Questions		11-Jan-10	16-Feb-10	36	100%	27	36	0
1.1	Schedule School Visits		1-Feb-10	16-Feb-10	15	100%	12	15	0
2	**Conduct Assessments**	CSIRO-C10 Team	16-Feb-10	25-Feb-10	9	100%	8	9	0
2.1	Pre-test, Interview 1		16-Feb-10	18-Feb-10	2	100%	3	2	0
2.2	Post-test 1, Interview 2		16-Feb-10	18-Feb-10	2	100%	3	2	0
2.3	Observations		16-Feb-10	18-Feb-10	2	100%	3	2	0
2.5	Post-Test 2, Interview 3		23-Feb-10	25-Feb-10	2	100%	3	2	0
2.6	Post-Test 3		16-Mar-10	18-Mar-10	2	100%	3	2	0
3	**Data Analysis**	CSIRO-C10 Team	19-Feb-10	1-Mar-10	10	100%	7	10	0
3.1	Questionnaires		19-Feb-10	1-Mar-10	10	100%	7	10	0
3.2	Observations		19-Feb-10	1-Mar-10	10	100%	7	10	0
3.3	Interviews		19-Feb-10	1-Mar-10	10	100%	7	10	0
4	**Deliverables**	CSIRO-C10 Team	1-Mar-10	5-Mar-10	4	100%	5	4	0
4.1	Evaluation of Assessment		1-Mar-10	5-Mar-10	4	100%	5	4	0
4.2	Evaluation of CSIRO		1-Mar-10	5-Mar-10	4	100%	5	4	0
4.3	Guidelines for NFE Programs		1-Mar-10	5-Mar-10	4	100%	5	4	0
4.4	Presentation of Results		1-Mar-10	5-Mar-10	4	100%	5	4	0



Appendix G: Questionnaire Questions Sorted by Information Target

The identification number representing the location of each question consists of three portions. For example PR-FF-3 is the third question on the pre-test for Forensic Frenzy. The following table explains the identification numbers in depth.

Questionnaire	Program	Question Number
PR = Pre-test	FF = Forensic Frenzy	Assigned number for each question on specific questionnaire
P1 = Post-Test 1	BD = Biodiversity	
P2 = Post-Test 2		

Question		Source	#
1. Students' feelings, opinions and behaviour toward science			
Is science important? (Rank 'Strongly Agree' to 'Strongly Disagree') Why?			**P1-1**
Have you noticed any scientific achievements in the media (newspaper, radio, television, internet) recently? If yes, what?			**P1-2**
Have you attended a science event/activity outside of school in the last month? If so, what was it?			**P2-4**
2. Level of interest			
Thinking about your knowledge and interest in the subjects listed below, please rate each one on a 7 point scale where "1" means you have a low interest or knowledge, and "7" means you have a high interest or knowledge.	Your interest in science and technology	Chris Krishna-Pillay	**PR-4, P2-2**
	Your interest in new technologies	National Science Week	**PR-4, P2-2**
	Your interest in how the items you use in everyday life function/work	Chris Krishna-Pillay	**PR-4, P2-2**
What are your current career interests? (Please tick all that apply)		National Science Week	**PR-6**
Rate your overall interest in the following science-related materials. Please use a 7 point scale, where 1 means "not at all interested" and 7 means "extremely interested. If you've never heard of it, tick 0.		Chris Krishna-Pillay	**P1-12**
Which best describes your interest in science?		National Science Week	**P2-1**
What type of science are you most interested in?		Chris Krishna-Pillay	**P2-3**
Do you plan to do VCE? If so, what subjects would you do?		Chris Krishna-Pillay	**P1-6**

3. Knowledge about science in general			
Thinking about your knowledge and interest in the subjects listed below, please rate each one on a 7 point scale where "1" means you feel you have low interest or knowledge, and "7" means you have a high interest or knowledge.	Your knowledge of science	National Science Week	**PR-4, P2-2**
What school subjects are you best at?		Chris Krishna-Pillay	**P1-8**
4. Knowledge about specific topic of the NFE program			
Thinking about your knowledge and interest in the subjects listed below, please rate each one on a 7 point scale where "1" means you feel you have low interest or knowledge, and "7" means you have a high interest or knowledge.	Your knowledge of forensics	Past IQP: CSIRO 08	**PR-FF-4, FF-P2-2**
	Your knowledge of the environment/biodiversity	CSIRO's Biodiversity	**PR-BD-4, BD-P2-2**
What does a Forensic Scientist do?		CSIRO's Forensic Frenzy	**PR-FF-7, P1-FF-3**
Please explain what you think Biodiversity is.		CSIRO's Biodiversity	**PR-BD-7**
What kinds of crimes do Forensic Scientists help solve?		CSIRO's Forensic Frenzy	**PR-FF-8**
In your own words, what is the environment?		CSIRO's Biodiversity	**PR-BD-8**
What are 4 words/phrases that you associate with Forensic Science?		CSIRO's Forensic Frenzy	**PR-FF-9, P2-FF-7**
What are 4 words/phrases that you associate with Biodiversity?		CSIRO's Biodiversity	**PR-BD-9, P2-BD-7**
Why is Biodiversity important?		CSIRO's Biodiversity	**P1-BD-3**
Name as many types of science as you can that might be used in Forensics.		CSIRO's Forensic Frenzy	**P1-FF-4**
Name 4 tests that you did today.		CSIRO's Biodiversity	**P1-BD-4**
What crimes might Forensics be used to solve?		CSIRO's Forensic Frenzy	**P1-FF-5**
What is the environment?		CSIRO's Biodiversity	**P1-FF-5**
What physical characteristics can be used to identify a suspect?		CSIRO's Forensic Frenzy	**P2-FF-5**
What is Biodiversity?		CSIRO's Biodiversity	**P2-BD-5**
If you can, please describe one laboratory technique used in Forensic Science.		CSIRO's Forensic Frenzy	**P2-FF-6**
If you can, please describe one test a scientist can do to monitor the environment.		CSIRO's Biodiversity	**P2-BD-6**

5. Reactions to the program		
Did you enjoy the CSIRO session on Forensics?		**P1-FF-9**
Did you enjoy the CSIRO session on Biodiversity?		**P1-BD-9**
What, if anything, did you particularly like about CSIRO's program? Why?	CSIRO's Past Program Assessments	**P1-10**
What, if anything, did you particularly dislike about CSIRO's program? Why?	CSIRO's Past Program Assessments	**P1-11**
What stands out most in your mind about the Forensic Frenzy program?	CSIRO's Past Program Assessments	**P2-FF-8**
What stands out most in your mind about the Biodiversity program from last week?		**P2-BD-8**
6. Subject and teacher demographics		
Date of Birth: _ _ / _ _ / _ _ _ _	Demographics	**PR-1**
Gender: Male ___ Female ___	Demographics	**PR-2**
Is English your first language? Yes ___ No ___ If not, what is?	Chris Krishna-Pillay	**PR-3**
Which best describes the field in which your parents work? Tick all that apply.	National Science Week	**PR-5**
What subjects are you currently studying? (including electives)	Chris Krishna-Pillay	**P1-7**

Appendix H: Interview Questions Sorted By Information Target

The identification number representing the location of each question from the teacher interviews consists of two portions. For example, P2I-3 is the third question asked during post-interview 2. The following table explains the identification numbers in depth.

Interview	Question Number
PRI = Pre-Interview	Assigned number for each question asked during specific interview
P1I = Post-Interview 1	
P2I = Post-Interview 2	

This table illustrates all interview questions, the percentage of responses received as well as which information target each question collects information about.

Interview Questions	Percent of Response			Info. Target
Pre-Test Interview	**FF**	**BD**	**All**	
Are you a science teacher?				6
No	25%	67%	38%	
Are you familiar with these kids in the classroom? How do they normally behave?				6
Generally Good	100%	50%	67%	
Mixed, good & bad	0%	50%	33%	
Yes	80%	33%	63%	
How do you expect this program to fit with what you are currently covering in class?				7
Current unit is directly related to subject	100%	0%	80%	
Preparation for another unit	0%	100%	20%	
Describe your students and their demeanor when teaching science related subjects. Why do think this is?				1,2
Engaged with hands-on activities	75%	0%	60%	
Generally interested in science	25%	100%	40%	
What topics in your science curriculum have you noticed are most engaging to the students? Why?				1,2
Anything hands-on or interactive	75%	0%	60%	
Chemistry	0%	100%	20%	
Program Topic (Forensic science or Biodiversity)	25%	0%	20%	
Is there a technology curriculum? What about that do students get enthused about?				7
Yes	50%	0%	40%	
No	25%	0%	20%	
Integrated with regular curriculum	25%	100%	40%	
Do you plan to assess the students on this material covered (through reports, projects, tests, observations during the program, etc)? Do you plan to assess on the day of the session?				5
Yes: Homework/Test	25%	0%		
Yes: Project	25%	100%		
Yes: Plan to do a discussion	25%	0%		
No	25%	0%		

Post-Test Interview 1	FF	BD	Overall	Target
Did you enjoy the program?				5
Enthusiastic yes	75%	33%	57%	
Yes	25%	67%	43%	
How well did the program compliment the current science curriculum/or specific learning unit related to this program?				5
Very well	100%	50%	80%	
Well	0%	50%	20%	
Were the activities appropriate for the age group? Were the activities appropriate for your students specifically?				5
Yes	100%	100%	100%	
Would you say this program captured the interest of the students?				5
Did the concept capture them?				5
Yes	100%	0%	57%	
They struggled with the concept	0%	100%	43%	
Did the hands-on doing engage them?				5
Yes	100%	100%	100%	
What were the most engaging parts of the program?				5
See Table 10				
What could be improved?				5
Don't want to change, but if I had to, improve structure	75%	0%	43%	
Activity details	0%	67%	29%	
Nothing	25%	33%	29%	
What changes did you see during the program? How did behaviour change from regular classroom settings?				1,2
More engaged	100%	33%	67%	
No change	0%	67%	33%	
Is the program likely to have a lasting positive impact on the students?				1,2
Yes, it's possible	100%	67%	86%	
Yes if reinforced	0%	33%	14%	
Do you think the students approach to science will improve as a result of the program?				1,2
Yes	33%	50%	40%	
Hopefully	67%	0%	40%	
Time will tell	0%	50%	20%	
Will this program be advantageous to helping you teach them about science?				7
Yes	50%	0%	33%	
Yes, Will give the teacher ideas/references	50%	100%	67%	
Do you expect the programs will affect students' future to be involved with science? VCE? University? Career?				1,2
Gives them more guidance, shows them options in the real world	50%	33%	43%	
No	0%	33%	14%	
Not career, but future study, yes	25%	0%	14%	
Time will tell	25%	0%	14%	
Yes if the student is already interested in science	0%	33%	14%	

Post-Test Interview 2	FF	BD	Overall	Target
Did you have a post-program discussion with the students? Was it spontaneous or planned?				7
Yes	50%	0%	33%	
Not yet, haven't had class since	50%	100%	67%	
Have you noticed any changes in the students towards science and technology since the CSIRO program?				1,2,3
Yes - they're less behaved during bookwork than before	50%	0%	33%	
Not yet	0%	100%	33%	
Too early to tell	50%	0%	33%	
Have there been unprompted questions or comments from students?				1,2
No	50%	100%	67%	
Yes	50%	0%	33%	
What types have they come up with?				1,2
Who is guilty?	50%	0%	50%	
General questions about Forensics	50%		50%	
General questions about Biodiversity		0%	0%	
Have you been surprised?				1,2
Yes	50%	0%	50%	
No				
Do you think the program may have had an effect on students' futures? Would they want be involved with science? VCE? University? Career?				1,2
Yes	0%	100%	33%	
No	50%	0%	33%	
Too early to tell	50%	0%	33%	
Was the program worth doing? (effort, cost, arrangements, planning, etc)				5
Enthusiastic Yes	100%	0%	50%	
Yes	0%	100%	50%	
Is there anything that you feel CSIRO could change to make the program have more value?				5
Reinforce difference between forensic science and forensic police	50%			
No	50%			
Make bandicoot more apparent using visuals (PowerPoint, video)	0%	50%		
Follow up to make sure they did the activities and did them right.	0%	50%		

Appendix I: Forensic Frenzy Pre-Test Questionnaire

Name:

Forensic Frenzy

CSIRO

1. **Date of Birth: _ _ / _ _ / _ _ _ _**

2. **Gender: Male ___ Female ___**

3. **Is English your first language? Yes ___ No ___**
   If not, what is? ______________

4. **Thinking about your knowledge and interest in the subjects listed below, please rate each one on a 7 point scale where "1" means you have a <u>low interest or knowledge,</u> and "7" means you have a <u>high interest or knowledge</u>.**

   1 (the lowest) <------ 4(moderate) ------> 7 (the highest)

	1	2	3	4	5	6	7
Your knowledge of science							
Your knowledge of forensics							
Your interest in science and technology							
Your interest in new technologies							
Your interest in how the items you use in everyday life function/work							

5. **Which best describes the field in which your parents work? Tick all that apply.**

   - o Management
   - o Government
   - o Environment
   - o Agriculture
   - o Science/Engineering
   - o Construction
   - o Finance/Accounting
   - o Communications
   - o Tradesperson
   - o Hospitality
   - o Health
   - o Education
   - o Sales
   - o Art
   - o Athletics
   - o Household Duties
   - o Other:____________

6. **What are your current career interests? (Please tick all that apply)**

   - o Management
   - o Government
   - o Environment
   - o Agriculture
   - o Science/Engineering
   - o Construction
   - o Finance/Accounting
   - o Communications
   - o Tradesperson
   - o Hospitality
   - o Health
   - o Education
   - o Sales
   - o Art
   - o Athletics
   - o Household Duties
   - o Other:____________

7. **What does a Forensic Scientist do?**

   ____

   ____

8. **What kinds of crimes do Forensic Scientists help solve?**

   ____

   ____

9. **What are 4 words/phrases that you associate with Forensic Science?**

   1. ____________________________ **3.** ____________________________
   2. ____________________________ **4.** ____________________________

P R	

Appendix J: Forensic Frenzy Post-Test Questionnaire One

Name:

Forensic Frenzy

CSIRO

1. **Is science important?**
   - o Strongly Agree
   - o Agree
   - o Impartial
   - o Disagree
   - o Strongly Disagree

   Why? ______________________________

   ____

2. **Have you noticed any scientific achievements in the media (newspaper, radio, television, internet) recently?**

   Yes No

   If yes, what? ______________________________

3. **What do Forensic scientists do?**

   ____

   ____

4. **Name as many types of science as you can that might be used in Forensics.**

   ____

   ____

5. **What crimes might Forensics be used to solve?**

   ____

   ____

6. **Do you plan to do VCE? If so, what subjects would you do?**

   ____

   ____

7. **What subjects are you currently studying? (including electives)**

   ____

   ____

8. **What school subjects are you best at? (circle)**

   English Mathematics
   Social Studies Science
   Art Sport
   LOTE History
   Physical Education Other: __________

9. **Did you enjoy the CSIRO session on Forensics?**
   - o Loved
   - o Liked
   - o Impartial
   - o Disliked
   - o Strongly Disliked

10. **What, if anything, did you particularly like about CSIRO's program? Why?**

    ____

    ____

11. **What, if anything, did you particularly dislike about CSIRO's program? Why?**

    ____

    ____

12. **Rate your overall interest in the following science-related materials. Please use a 7 point scale, where 1 means "<u>not at all interested</u>" and 7 means "<u>extremely interested</u>". If you've never heard of it, tick 0.**

    (1) Not at all interested← →(7) Extremely Interested

Television:	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Online:**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Discovery Channel/National Geographic									ABC Science								
MythBusters									CSIRO.au								
Braniac									Howstuffworks.com								
Catalyst									Science Daily								
Scope																	
Print:	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Live:**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Newspapers									CSIRO Live Programs								
News Scientist									Melbourne Zoo								
Cosmos									Melbourne Aquarium								
The Helix									Melbourne Museum								
Australasian Science									Scienceworks								

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Appendix K: Forensic Frenzy Post-Test Questionnaire Two

Name:

Forensic Frenzy

CSIRO

1. **Which best describes your interest in science?**

   - I am interested and I seek information about science
   - I am interested but do not seek information about science
   - I am neutral and do not seek information about science
   - I am not interested in science

2. **Thinking about your knowledge and interest in the subjects listed below, please rate each one on a 7 point scale where "1" means you have a <u>low interest or knowledge</u>, and "7" means you have a <u>high interest or knowledge</u>.**

1 (the lowest) <------ 4(moderate) ------> 7 (the highest)

	1	2	3	4	5	6	7
Your knowledge of science							
Your knowledge of forensics							
Your interest in science and technology							
Your interest in new technologies							
Your interest in how the items you use in everyday life function/work							

3. **What type of science are you most interested in?**

   - Physics
   - Chemistry
   - Biology
   - Astronomy
   - Geology
   - Psychology
   - Environmental Science
   - Forensic Science
   - Computer Science
   - Other:___________

4. **Have you attended a science event/activity outside of school in the last month? If so, what was it?**

   - **Yes** ___________________________
   - **No**

5. **What physical characteristics can be used to identify a suspect?**

____

____

6. **If you can, please describe one laboratory technique used in Forensic Science.**

____

____

7. **What are 4 words/phrases that you associate with Forensic Science?**

1. ___________ **3.** ___________

2. ___________ **4.** ___________

8. **What stands out most in your mind about the Forensic Frenzy program?**

____

____

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Appendix L: Biodiversity Pre-Test Questionnaire

Name:

Biodiversity

CSIRO

1. **Date of Birth: _ _ / _ _ / _ _ _ _**

2. **Gender: Male ___ Female ___**

3. **Is English your first language? Yes ___ No ___**
   If not, what is? _____________

4. **Thinking about your knowledge and interest in the subjects listed below, please rate each one on a 7 point scale where "1" means you have a low interest or knowledge, and "7" means you have a high interest or knowledge.**

1 (the lowest) <------ 4(moderate) ------> 7 (the highest)

	1	2	3	4	5	6	7
Your knowledge of science							
Your knowledge of the environment/biodiversity							
Your interest in science and technology							
Your interest in new technologies							
Your interest in how the items you use in everyday life function/work							

5. **Which best describes the field in which your parents work? Tick all that apply.**

- o Management
- o Government
- o Environment
- o Agriculture
- o Science/Engineering
- o Construction
- o Finance/Accounting
- o Communications
- o Tradesperson
- o Hospitality
- o Health
- o Education
- o Sales
- o Art
- o Athletics
- o Household Duties
- o Other:___________

6. **What are your current career interests? (Please tick all that apply)**

- o Management
- o Government
- o Environment
- o Agriculture
- o Science/Engineering
- o Construction
- o Finance/Accounting
- o Communications
- o Tradesperson
- o Hospitality
- o Health
- o Education
- o Sales
- o Art
- o Athletics
- o Household Duties
- o Other:___________

7. **Please explain what you think Biodiversity is.**

____

____

8. **In your own words, what is the environment?**

____

____

9. **What are 4 words/phrases that you associate with Biodiversity?**

1. ________________________ **3.** ________________________

2. ________________________ **4.** ________________________

P R	

Appendix M: Biodiversity Post-Test Questionnaire One

Name:

Biodiversity

CSIRO

1. **Is science important?**
   - Strongly Agree
   - Agree
   - Impartial
   - Disagree
   - Strongly Disagree

   Why?________________________________

2. **Have you noticed any scientific achievements in the media (newspaper, radio, television, internet) recently?**

   Yes No

   If yes, what?____________________________

3. **Why is Biodiversity important?**

4. **Name 4 tests that you did today.**

5. **What is the environment?**

6. **Do you plan to do VCE? If so, what subjects would you do?**

7. **What subjects are you currently studying? (including electives)**

8. **What school subjects are you best at? (circle)**

   English Mathematics
   Social Studies Science
   Art Sport
   LOTE History
   Physical Education Other: __________

9. **Did you enjoy the CSIRO session on Biodiversity?**
   - Loved
   - Liked
   - Impartial
   - Disliked
   - Strongly Disliked

10. **What, if anything, did you particularly like about CSIRO's program? Why?**

11. **What, if anything, did you particularly dislike about CSIRO's program? Why?**

12. **Rate your overall interest in the following science-related materials. Please use a 7 point scale, where 1 means "<u>not at all interested</u>" and 7 means "<u>extremely interested</u>". If you've never heard of it, tick 0.**

(1) Not at all interested← →(7) Extremely Interested

Television:	0	1	2	3	4	5	6	7	**Online:**	0	1	2	3	4	5	6	7
Discovery Channel/National Geographic									ABC Science								
MythBusters									CSIRO.au								
Braniac									Howstuffworks.com								
Catalyst									Science Daily								
Scope																	
Print:	0	1	2	3	4	5	6	7	**Live:**	0	1	2	3	4	5	6	7
Newspapers									CSIRO Live Programs								
News Scientist									Melbourne Zoo								
Cosmos									Melbourne Aquarium								
The Helix									Melbourne Museum								
Australasian Science									Scienceworks								

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Appendix N: Biodiversity Post-Test Questionnaire Two

Name:

Biodiversity CSIRO

1. **Which best describes your interest in science?**

   - I am interested and I seek information about science
   - I am interested but do not seek information about science
   - I am neutral and do not seek information about science
   - I am not interested in science

2. **Thinking about your knowledge and interest in the subjects listed below, please rate each one on a 7 point scale where "1" means you have a low interest or knowledge, and "7" means you have a high interest or knowledge.**

   1 (the lowest) <------ 4(moderate) ------> 7 (the highest)

	1	2	3	4	5	6	7
Your knowledge of science							
Your knowledge of the environment/biodiversity							
Your interest in science and technology							
Your interest in new technologies							
Your interest in how the items you use in everyday life function/work							

3. **What type of science are you most interested in?**

   - Physics
   - Chemistry
   - Biology
   - Astronomy
   - Geology
   - Psychology
   - Environmental Science
   - Forensic Science
   - Computer Science
   - Other:____________

4. **Have you attended a science event/activity outside of school in the last month? If so, what was it?**

   - **Yes** ______________________________
   - **No**

5. **What is Biodiversity?**

   ____

   ____

6. **If you can, please describe one test a scientist can do to monitor the environment.**

   ____

   ____

7. **What are 4 words/phrases that you associate with Biodiversity?**

   1. ____________ **3.** ____________
   2. ____________ **4.** ____________

8. **What stands out most in your mind about the Biodiversity program from last week?**

   ____

   ____

P 2

Appendix O: General Presentation Observational Checklist

Observational Checklist **Program Name:** **Date:**

General Presentation	Students																													
Program Observations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Eye Contact (M or F)																														
Discussion (P or O or D)																														
Concentration																														
Enjoyment/Excitement																														
Boredom																														
Eagerness to Participate																														
Asking Questions																														
Confusion/Frustration																														
Physical Distractions																														

Comments:

Appendix P: Activity Specific Observational Checklist

Activity:	Students																													
Program Observations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Discussion (P or O or D)																														
Concentration																														
Enjoyment/Excitement																														
Boredom																														
Eagerness to Participate																														
Asking Questions																														
Confusion/Frustration																														
Physical Distractions																														
Completion																														
Misuse of Equipment																														
Read Instructions																														

Comments:

Appendix Q: Pre-Test Interview

School Location: ______________________________ Teacher Name: ______________________
Date of Interview: _____________________________ Interviewer: _________________________

Pre Test

- Are you a science teacher?
  - Yes
    - How do you expect this program to fit with what you are currently covering in class?
    - Describe your students and their demeanor when teaching science related subjects. Why do think this is?
    - What topics in your science curriculum have you noticed are most engaging to the students? Why?
    - Is there a technology curriculum? What about that do students get enthused about?
  - No
    - What is your teaching background?
    - Are you familiar with these kids in the classroom? How do they normally behave?
- At university, what are your areas of specialty within your teaching?
- Do you plan to assess the students on this material covered (through reports, projects, tests, observations during the program, etc)? Do you plan to assess on the day of the session?

Appendix R: Post-Test Interview One

School Location: ____________________________ Teacher Name: _____________________
Date of Interview: ___________________________ Interviewer: _______________________

Post Test 1

- Did you enjoy the program? How well did the program compliment the current science curriculum/or specific learning unit related to this program?
- Were the activities appropriate for the age group? Were the activities appropriate for your students specifically?
- Would you say this program captured the interest of the students?
    - Did the concept capture them?
    - Did the hands on 'doing' engage them?
    - Did the program keep and maintain their interest?
- What were the most engaging portions of the program?
- What could be improved?
- What changes did you see during the program? How did behavior change from regular classroom settings?
- Is the program likely to have a lasting positive impact on the students?
- Do you think the students approach to science will improve as a result of the program? Will this program be advantageous to helping you teach them about science?
- If question seems pertinent during specific interview: Do you expect the programs will affect students' future to be involved with science? VCE? University? Career?

Appendix S: Post-Test Interview Two

School Location: ____________________________ Teacher Name: _____________________
Date of Interview: ___________________________ Interviewer: _______________________

Post Test 2

- Did you have a post-program discussion with the students? Was it spontaneous or planned? How did it go? (Go more in depth if discussion sounded good)

- Have you noticed any changes in the students towards science and technology since the CSIRO program? What evidence tells you this?

- Do you expect the programs will affect students' future to be involved with science? VCE? University? Career?

- Have there been unprompted questions or comments from students? Did you observe/experience these during class or outside of class time? (while walking to class in the halls, etc) What types have they come up with? Have you been surprised?

- What changes do you see as students change from subject to subject? (If they don't actually know, ask what they might imagine the change to be)

- Have the students shown any change in attitude towards careers in science?

- Is there anything that you feel CSIRO could change to make the program have more value? To students? To you?

- Was the program worth doing? (effort, cost, arrangements and planning, etc)

Appendix T: Significance Tests

Significance Tests with 95% confidence levels		
z-Test: Two Sample for Means		
Interest in Science and Technology		
	Variable 1	*Variable 2*
Mean	4.683615819	4.321917808
Known Variance	1.82	2.12
Observations	177	146
Hypothesized Mean Difference	0	
z	2.296644195	
P(Z<=z) one-tail	0.010819538	
z Critical one-tail	1.644853627	
P(Z<=z) two-tail	0.021639075	
z Critical two-tail	1.959963985	
z-Test: Two Sample for Means		
Interest in New Technologies		
	Variable 1	*Variable 2*
Mean	5.215909091	4.909722222
Known Variance	1.93	2.26
Observations	176	144
Hypothesized Mean Difference	0	
z	1.875225971	
P(Z<=z) one-tail	0.030380821	
z Critical one-tail	1.644853627	
P(Z<=z) two-tail	0.060761643	
z Critical two-tail	1.959963985	

z-Test: Two Sample for Means		
Interest in how the items you use in everyday life function/work		
	Variable 1	*Variable 2*
Mean	4.440677966	4.191780822
Known Variance	2.38	2.6
Observations	177	146
Hypothesized Mean Difference	0	
z	1.407872449	
P(Z<=z) one-tail	0.079584421	
z Critical one-tail	1.644853627	
P(Z<=z) two-tail	0.159168843	
z Critical two-tail	1.959963985	
z-Test: Two Sample for Means		
Average Change in Rated Knowledge of Science		
	Variable 1	*Variable 2*
Mean	4.225988701	4.020689655
Known Variance	1.14	1.38
Observations	177	145
Hypothesized Mean Difference	0	
z	1.625170001	
P(Z<=z) one-tail	0.05206317	
z Critical one-tail	1.644853627	
P(Z<=z) two-tail	0.104126341	
z Critical two-tail	1.959963985	

z-Test: Two Sample for Means		
FF - Average Change in Rated Knowledge		
	Variable 1	*Variable 2*
Mean	3.811966	3.888888889
Known Variance	1.31	1.32
Observations	117	99
Hypothesized Mean Difference	0	
z	-.491144	
P(Z<=z) one-tail	0.311662	
z Critical one-tail	1.644854	
P(Z<=z) two-tail	0.623325	
z Critical two-tail	1.959964	
z-Test: Two Sample for Means		
BD - Average Change in Rated Knowledge		
	Variable 1	*Variable 2*
Mean	3.948275862	3.777777778
Known Variance	1.35	2.27
Observations	58	45
Hypothesized Mean Difference	0	
z	0.627951262	
P(Z<=z) one-tail	0.265017934	
z Critical one-tail	1.644853627	
P(Z<=z) two-tail	0.530035868	
z Critical two-tail	1.959963985	

Appendix U: Raw Observation Data

The observational data collected was compiled into the following spreadsheet. The table is organized by the dates and times of each session as well as the activities that each program is broken down into. Each activity consists of its own table spanning two pages, horizontally. Each table if titled with the name of the activity that it applies to.

Biodiversity		**Session #**						
General Presentation	**# Students**	**17-2-10 8:55am**	**17-2-10 11:15am**	**17-2-10 1:30pm**				
Program Observations	**61**	**16**	**23**	**22**	**Total**	**Mean**	**Median**	**St Dev**
Eye Contact (Maintained)	61	5	5	8	18	6.00	5.00	1.73
Eye Contact (Frequent)	61	6	12	8	26	8.67	8.00	3.06
Discussion (Program)	61	0	0	0	0	0.00	0.00	0.00
Discussion (Other)	61	1	4	1	6	2.00	1.00	1.73
Discussion (Don't know)	61	2	0	4	6	2.00	2.00	2.00
Concentration	61	7	12	11	30	10.00	11.00	2.65
Excitement/Enjoyment	61	1	5	3	9	3.00	3.00	2.00
Boredom	61	8	6	4	18	6.00	6.00	2.00
Eagerness to Participate	61	6	7	6	19	6.33	6.00	0.58
Asking Questions	61	0	0	0	0	0.00	0.00	0.00
Confusion/Frustration	61	0	0	0	0	0.00	0.00	0.00
Physical Distractions	61	5	3	1	9	3.00	3.00	2.00
Classification Keys	**# Students**	**17-2-10 8:55am**	**17-2-10 11:15am**	**17-2-10 1:30pm**				
Program Observations	**45**	**11**	**20**	**14**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	45	7	16	11	34	11.33	11.00	4.51
Discussion (personal)	45	0	0	1	1	0.33	0.00	0.58
Concentration	45	3	16	8	27	9.00	8.00	6.56
Excitement/Enjoyment	45	6	12	10	28	9.33	10.00	3.06
Boredom	45	1	0	3	4	1.33	1.00	1.53
Eagerness to Participate	45	6	8	7	21	7.00	7.00	1.00
Asking Questions	45	1	2	0	3	1.00	1.00	1.00
Confusion/Frustration	45	5	1	0	6	2.00	1.00	2.65
Physical Distractions	45	2	3	0	5	1.67	2.00	1.53
Completion	45	8	12	8	28	9.33	8.00	2.31
Misuse of Equipment	45	1	0	5	6	2.00	1.00	2.65
Read Instructions	45	0	11	0	11	3.67	0.00	6.35

Biodiversity					
General Presentation	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	Total %	
Program Observations	% of Class				Confidence
Eye Contact (Maintained)	31%	22%	36%	30%	0.43
Eye Contact (Frequent)	38%	52%	36%	43%	0.77
Discussion (Program)	0%	0%	0%	0%	
Discussion (Other)	6%	17%	5%	10%	0.43
Discussion (Don't know)	13%	0%	18%	10%	0.50
Concentration	44%	52%	50%	49%	0.66
Excitement/Enjoyment	6%	22%	14%	15%	0.50
Boredom	50%	26%	18%	30%	0.50
Eagerness to Participate	38%	30%	27%	31%	0.14
Asking Questions	0%	0%	0%	0%	
Confusion/Frustration	0%	0%	0%	0%	
Physical Distractions	31%	13%	5%	15%	0.50

Classification Keys	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	Total %	
Program Observations	% of Class				Confidence
Discussion (program)	64%	80%	79%	76%	1.32
Discussion (personal)	0%	0%	7%	2%	0.17
Concentration	27%	80%	57%	60%	1.92
Excitement/Enjoyment	55%	60%	71%	62%	0.89
Boredom	9%	0%	21%	9%	0.45
Eagerness to Participate	55%	40%	50%	47%	0.29
Asking Questions	9%	10%	0%	7%	0.29
Confusion/Frustration	45%	5%	0%	13%	0.77
Physical Distractions	18%	15%	0%	11%	0.45
Completion	73%	60%	57%	62%	0.67
Misuse of Equipment	9%	0%	36%	13%	0.77
Read Instructions	0%	55%	0%	24%	1.86

Microscopic Monitoring	# Students	17-2-10 8:55am	17-2-10 11:15am	17-2-10 1:30pm				
Program Observations	**50**	**16**	**18**	**16**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	50	15	16	13	44	14.67	15.00	1.53
Discussion (personal)	50	0	0	3	3	1.00	0.00	1.73
Concentration	50	12	16	14	42	14.00	14.00	2.00
Excitement/Enjoyment	50	9	12	4	25	8.33	9.00	4.04
Boredom	50	4	0	2	6	2.00	2.00	2.00
Eagerness to Participate	50	12	8	1	21	7.00	8.00	5.57
Asking Questions	50	1	2	3	6	2.00	2.00	1.00
Confusion/Frustration	50	2	1	3	6	2.00	2.00	1.00
Physical Distractions	50	0	3	0	3	1.00	0.00	1.73
Completion	50	14	12	16	42	14.00	14.00	2.00
Misuse of Equipment	50	0	0	0	0	0.00	0.00	0.00
Read Instructions	50	4	11	3	18	6.00	4.00	4.36

A Trend in the Weather	# Students	17-2-10 8:55am	17-2-10 11:15am	17-2-10 1:30pm				
Program Observations	**36**	**9**	**16**	**11**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	36	7	10	8	25	8.33	8.00	1.53
Discussion (personal)	36	0	2	3	5	1.67	2.00	1.53
Concentration	36	4	11	4	19	6.33	4.00	4.04
Excitement/Enjoyment	36	2	0	2	4	1.33	2.00	1.15
Boredom	36	3	4	6	13	4.33	4.00	1.53
Eagerness to Participate	36	4	2	2	8	2.67	2.00	1.15
Asking Questions	36	0	0	0	0	0.00	0.00	0.00
Confusion/Frustration	36	0	2	0	2	0.67	0.00	1.15
Physical Distractions	36	0	3	3	6	2.00	3.00	1.73
Completion	36	8	8	6	22	7.33	8.00	1.15
Misuse of Equipment	36	0	0	0	0	0.00	0.00	0.00
Read Instructions	36	0	6	1	7	2.33	1.00	3.21

Microscopic Monitoring	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	Total %	
Program Observations	**% of Class**				**Confidence**
Discussion (program)	94%	89%	81%	88%	0.42
Discussion (personal)	0%	0%	19%	6%	0.48
Concentration	75%	89%	88%	84%	0.55
Excitement/Enjoyment	56%	67%	25%	50%	1.12
Boredom	25%	0%	13%	12%	0.55
Eagerness to Participate	75%	44%	6%	42%	1.54
Asking Questions	6%	11%	19%	12%	0.28
Confusion/Frustration	13%	6%	19%	12%	0.28
Physical Distractions	0%	17%	0%	6%	0.48
Completion	88%	67%	100%	84%	0.55
Misuse of Equipment	0%	0%	0%	0%	
Read Instructions	25%	61%	19%	36%	1.21

A Trend in the Weather	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	Total %	
Program Observations	**% of Class**				**Confidence**
Discussion (program)	78%	63%	73%	69%	0.50
Discussion (personal)	0%	13%	27%	14%	0.50
Concentration	44%	69%	36%	53%	1.32
Excitement/Enjoyment	22%	0%	18%	11%	0.38
Boredom	33%	25%	55%	36%	0.50
Eagerness to Participate	44%	13%	18%	22%	0.38
Asking Questions	0%	0%	0%	0%	
Confusion/Frustration	0%	13%	0%	6%	0.38
Physical Distractions	0%	19%	27%	17%	0.57
Completion	89%	50%	55%	61%	0.38
Misuse of Equipment	0%	0%	0%	0%	
Read Instructions	0%	38%	9%	19%	1.05

Soil Texture	# Students	17-2-10 8:55am	17-2-10 11:15am	17-2-10 1:30pm				
Program Observations	**53**	**14**	**20**	**19**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	53	10	16	15	41	13.67	15.00	3.21
Discussion (personal)	53	1	2	1	4	1.33	1.00	0.58
Concentration	53	10	5	13	28	9.33	10.00	4.04
Excitement/Enjoyment	53	8	13	9	30	10.00	9.00	2.65
Boredom	53	0	2	5	7	2.33	2.00	2.52
Eagerness to Participate	53	7	12	13	32	10.67	12.00	3.21
Asking Questions	53	0	2	3	5	1.67	2.00	1.53
Confusion/Frustration	53	0	9	2	11	3.67	2.00	4.73
Physical Distractions	53	3	0	4	7	2.33	3.00	2.08
Completion	53	4	14	13	31	10.33	13.00	5.51
Misuse of Equipment	53	2	4	3	9	3.00	3.00	1.00
Read Instructions	53	7	5	10	22	7.33	7.00	2.52

Soil Moisture	# Students	17-2-10 8:55am	17-2-10 11:15am	17-2-10 1:30pm				
Program Observations	**43**	**13**	**21**	**9**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	43	7	15	6	28	9.33	7.00	4.93
Discussion (personal)	43	0	0	0	0	0.00	0.00	0.00
Concentration	43	8	13	7	28	9.33	8.00	3.21
Excitement/Enjoyment	43	0	0	3	3	1.00	0.00	1.73
Boredom	43	5	5	2	12	4.00	5.00	1.73
Eagerness to Participate	43	2	11	6	19	6.33	6.00	4.51
Asking Questions	43	0	2	0	2	0.67	0.00	1.15
Confusion/Frustration	43	1	1	2	4	1.33	1.00	0.58
Physical Distractions	43	0	1	0	1	0.33	0.00	0.58
Completion	43	7	15	7	29	9.67	7.00	4.62
Misuse of Equipment	43	2	0	0	2	0.67	0.00	1.15
Read Instructions	43	2	12	0	14	4.67	2.00	6.43

Soil Texture	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	Total %	
Program Observations	**% of Class**				**Confidence**
Discussion (program)	71%	80%	79%	77%	0.87
Discussion (personal)	7%	10%	5%	8%	0.16
Concentration	71%	25%	68%	53%	1.09
Excitement/Enjoyment	57%	65%	47%	57%	0.71
Boredom	0%	10%	26%	13%	0.68
Eagerness to Participate	50%	60%	68%	60%	0.87
Asking Questions	0%	10%	16%	9%	0.41
Confusion/Frustration	0%	45%	11%	21%	1.27
Physical Distractions	21%	0%	21%	13%	0.56
Completion	29%	70%	68%	58%	1.48
Misuse of Equipment	14%	20%	16%	17%	0.27
Read Instructions	50%	25%	53%	42%	0.68

Soil Moisture	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	Total %	
Program Observations	**% of Class**				**Confidence**
Discussion (program)	54%	71%	67%	65%	1.47
Discussion (personal)	0%	0%	0%	0%	
Concentration	62%	62%	78%	65%	0.96
Excitement/Enjoyment	0%	0%	33%	7%	0.52
Boredom	38%	24%	22%	28%	0.52
Eagerness to Participate	15%	52%	67%	44%	1.35
Asking Questions	0%	10%	0%	5%	0.35
Confusion/Frustration	8%	5%	22%	9%	0.17
Physical Distractions	0%	5%	0%	2%	0.17
Completion	54%	71%	78%	67%	1.38
Misuse of Equipment	15%	0%	0%	5%	0.35
Read Instructions	15%	57%	0%	33%	1.92

A World of CO_2	# Students	17-2-10 8:55am	17-2-10 11:15am	17-2-10 1:30pm				
Program Observations	**29**	**7**	**11**	**11**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	29	3	7	5	15	5.00	5.00	2.00
Discussion (personal)	29	4	0	0	4	1.33	0.00	2.31
Concentration	29	2	6	4	12	4.00	4.00	2.00
Excitement/Enjoyment	29	2	3	3	8	2.67	3.00	0.58
Boredom	29	2	2	3	7	2.33	2.00	0.58
Eagerness to Participate	29	2	4	4	10	3.33	4.00	1.15
Asking Questions	29	1	3	0	4	1.33	1.00	1.53
Confusion/Frustration	29	0	2	4	6	2.00	2.00	2.00
Physical Distractions	29	3	0	1	4	1.33	1.00	1.53
Completion	29	4	9	5	18	6.00	5.00	2.65
Misuse of Equipment	29	4	0	3	7	2.33	3.00	2.08
Read Instructions	29	4	5	2	11	3.67	4.00	1.53

Water pH	# Students	17-2-10 8:55am	17-2-10 11:15am	17-2-10 1:30pm				
Program Observations	**48**	**14**	**17**	**17**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	48	12	13	11	36	12.00	12.00	1.00
Discussion (personal)	48	0	4	2	6	2.00	2.00	2.00
Concentration	48	10	7	10	27	9.00	10.00	1.73
Excitement/Enjoyment	48	3	2	3	8	2.67	3.00	0.58
Boredom	48	5	6	1	12	4.00	5.00	2.65
Eagerness to Participate	48	4	5	9	18	6.00	5.00	2.65
Asking Questions	48	2	2	2	6	2.00	2.00	0.00
Confusion/Frustration	48	2	5	7	14	4.67	5.00	2.52
Physical Distractions	48	4	1	6	11	3.67	4.00	2.52
Completion	48	8	5	11	24	8.00	8.00	3.00
Misuse of Equipment	48	0	0	2	2	0.67	0.00	1.15
Read Instructions	48	6	2	9	17	5.67	6.00	3.51

A World of CO_2	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	Total %	
Program Observations	**% of Class**				**Confidence**
Discussion (program)	43%	64%	45%	52%	0.73
Discussion (personal)	57%	0%	0%	14%	0.84
Concentration	29%	55%	36%	41%	0.73
Excitement/Enjoyment	29%	27%	27%	28%	0.21
Boredom	29%	18%	27%	24%	0.21
Eagerness to Participate	29%	36%	36%	34%	0.42
Asking Questions	14%	27%	0%	14%	0.56
Confusion/Frustration	0%	18%	36%	21%	0.73
Physical Distractions	43%	0%	9%	14%	0.56
Completion	57%	82%	45%	62%	0.96
Misuse of Equipment	57%	0%	27%	24%	0.76
Read Instructions	57%	45%	18%	38%	0.56

Water pH	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	Total %	
Program Observations	**% of Class**				**Confidence**
Discussion (program)	86%	76%	65%	75%	0.28
Discussion (personal)	0%	24%	12%	13%	0.57
Concentration	71%	41%	59%	56%	0.49
Excitement/Enjoyment	21%	12%	18%	17%	0.16
Boredom	36%	35%	6%	25%	0.75
Eagerness to Participate	29%	29%	53%	38%	0.75
Asking Questions	14%	12%	12%	13%	
Confusion/Frustration	14%	29%	41%	29%	0.71
Physical Distractions	29%	6%	35%	23%	0.71
Completion	57%	29%	65%	50%	0.85
Misuse of Equipment	0%	0%	12%	4%	0.33
Read Instructions	43%	12%	53%	35%	0.99

Map that Species!	# Students	17-2-10 8:55am	17-2-10 11:15am	17-2-10 1:30pm				
Program Observations	**50**	**14**	**17**	**19**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	50	8	15	16	39	13.00	15.00	4.36
Discussion (personal)	50	4	2	2	8	2.67	2.00	1.15
Concentration	50	8	15	7	30	10.00	8.00	4.36
Excitement/Enjoyment	50	3	11	6	20	6.67	6.00	4.04
Boredom	50	1	1	4	6	2.00	1.00	1.73
Eagerness to Participate	50	10	14	12	36	12.00	12.00	2.00
Asking Questions	50	0	1	4	5	1.67	1.00	2.08
Confusion/Frustration	50	3	0	5	8	2.67	3.00	2.52
Physical Distractions	50	0	1	1	2	0.67	1.00	0.58
Completion	50	5	14	15	34	11.33	14.00	5.51
Misuse of Equipment	50	7	6	1	14	4.67	6.00	3.21
Read Instructions	50	9	0	2	11	3.67	2.00	4.73

Future Atmosphere	# Students	17-2-10 8:55am	17-2-10 11:15am	17-2-10 1:30pm				
Program Observations	**39**	**8**	**13**	**18**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	39	6	10	12	28	9.33	10.00	3.06
Discussion (personal)	39	1	1	3	5	1.67	1.00	1.15
Concentration	39	3	11	11	25	8.33	11.00	4.62
Excitement/Enjoyment	39	0	0	1	1	0.33	0.00	0.58
Boredom	39	1	3	8	12	4.00	3.00	3.61
Eagerness to Participate	39	3	0	12	15	5.00	3.00	6.24
Asking Questions	39	1	4	4	9	3.00	4.00	1.73
Confusion/Frustration	39	2	2	7	11	3.67	2.00	2.89
Physical Distractions	39	0	0	0	0	0.00	0.00	0.00
Completion	39	3	13	14	30	10.00	13.00	6.08
Misuse of Equipment	39	2	0	0	2	0.67	0.00	1.15
Read Instructions	39	0	3	3	6	2.00	3.00	1.73

Map that Species!	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	Total %	
Program Observations	**% of Class**				**Confidence**
Discussion (program)	57%	88%	84%	78%	1.21
Discussion (personal)	29%	12%	11%	16%	0.32
Concentration	57%	88%	37%	60%	1.21
Excitement/Enjoyment	21%	65%	32%	40%	1.12
Boredom	7%	6%	21%	12%	0.48
Eagerness to Participate	71%	82%	63%	72%	0.55
Asking Questions	0%	6%	21%	10%	0.58
Confusion/Frustration	21%	0%	26%	16%	0.70
Physical Distractions	0%	6%	5%	4%	0.16
Completion	36%	82%	79%	68%	1.53
Misuse of Equipment	50%	35%	5%	28%	0.89
Read Instructions	64%	0%	11%	22%	1.31

Future Atmosphere	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	Total %	
Program Observations	**% of Class**				**Confidence**
Discussion (program)	75%	77%	67%	72%	0.96
Discussion (personal)	13%	8%	17%	13%	0.36
Concentration	38%	85%	61%	64%	1.45
Excitement/Enjoyment	0%	0%	6%	3%	0.18
Boredom	13%	23%	44%	31%	1.13
Eagerness to Participate	38%	0%	67%	38%	1.96
Asking Questions	13%	31%	22%	23%	0.54
Confusion/Frustration	25%	15%	39%	28%	0.91
Physical Distractions	0%	0%	0%	0%	
Completion	38%	100%	78%	77%	1.91
Misuse of Equipment	25%	0%	0%	5%	0.36
Read Instructions	0%	23%	17%	15%	0.54

Concluding Presentation	# Students	17-2-10 8:55am	17-2-10 11:15am	17-2-10 1:30pm				
Program Observations	**61**	**16**	**23**	**22**	**Total**	**Mean**	**Median**	**St Dev**
Eye Contact (Maintained)	61	3	5	4	12	4.00	4.00	1.00
Eye Contact (Frequent)	61	7	7	7	21	7.00	7.00	0.00
Discussion (Program)	61	3	0	0	3	1.00	0.00	1.73
Discussion (Other)	61	3	8	5	16	5.33	5.00	2.52
Discussion (Don't know)	61	6	2	4	12			
Concentration	61	3	12	6	21	7.00	6.00	4.58
Excitement/Enjoyment	61	8	8	9	25	8.33	8.00	0.58
Boredom	61	6	7	5	18	6.00	6.00	1.00
Eagerness to Participate	61	10	14	11	35	11.67	11.00	2.08
Asking Questions	61	0	0	0	0	0.00	0.00	0.00
Confusion/Frustration	61	0	0	0	0	0.00	0.00	0.00
Physical Distractions	61	2	6	2	10	3.33	2.00	2.31

Concluding Presentation	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	Total %	
Program Observations	**% of Class**				**Confidence**
Eye Contact (Maintained)	19%	22%	18%	20%	0.25
Eye Contact (Frequent)	44%	30%	32%	34%	
Discussion (Program)	19%	0%	0%	5%	0.43
Discussion (Other)	19%	35%	23%	26%	0.63
Discussion (Don't know)	38%	9%	18%	20%	
Concentration	19%	52%	27%	34%	1.15
Excitement/Enjoyment	50%	35%	41%	41%	0.14
Boredom	38%	30%	23%	30%	0.25
Eagerness to Participate	63%	61%	50%	57%	0.52
Asking Questions	0%	0%	0%	0%	
Confusion/Frustration	0%	0%	0%	0%	
Physical Distractions	13%	26%	9%	16%	0.58

Forensic Frenzy

General Presentation	# Students	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm				
		Session #								
Program Observations	**116**	**23**	**18**	**25**	**27**	**23**	**Total**	**Mean**	**Median**	**St Dev**
Eye Contact (Maintained)	116	6	4	8	11	8	37	7.40	8.00	2.61
Eye Contact (Frequent)	116	10	6	12	11	11	50	10.00	11.00	2.35
Discussion (Program)	116	7	2	2	0	0	11	2.20	2.00	2.86
Discussion (Other)	116	6	0	4	4	0	14	2.80	4.00	2.68
Discussion (Don't know)	116	0	0	4	0	3	7	1.40	0.00	1.95
Concentration	116	16	12	12	15	11	66	13.20	12.00	2.17
Excitement/Enjoyment	116	3	6	8	5	6	28	5.60	6.00	1.82
Boredom	116	10	4	8	11	6	39	7.80	8.00	2.86
Eagerness to Participate	116	14	10	10	10	11	55	11.00	10.00	1.73
Asking Questions	116	0	0	1	0	4	5	1.00	0.00	1.73
Confusion/Frustration	116	0	0	0	0	0	0	0.00	0.00	0.00
Physical Distractions	116	10	6	7	7	7	37	7.40	7.00	1.52

Oil Analysis	# Students	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm				
Program Observations	**58**	**20**	**11**	**13**	**0**	**14**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	58	19	8	13		11	51	12.75	12.00	4.65
Discussion (personal)	58	0	2	0		0	2	0.50	0.00	1.00
Concentration	58	12	11	7		7	37	9.25	9.00	2.63
Excitement/Enjoyment	58	9	3	4		4	20	5.00	4.00	2.71
Boredom	58	1	0	1		3	5	1.25	1.00	1.26
Eagerness to Participate	58	13	6	7		2	28	7.00	6.50	4.55
Asking Questions	58	2	0	2		0	4	1.00	1.00	1.15
Confusion/Frustration	58	0	0	0		0	0	0.00	0.00	0.00
Physical Distractions	58	0	1	0		2	3	0.75	0.50	0.96
Completion	58	18	11	9		5	43	10.75	10.00	5.44
Misuse of Equipment	58	2	0	3		0	5	1.25	1.00	1.50
Read Instructions	58	14	4	0		7	25	6.25	5.50	5.91

Forensic Frenzy	**Session #**						
General Presentation	**15-2-10 11:15am**	**15-2-10 1:45pm**	**16-2-10 9:00am**	**16-2-10 11:15am**	**16-2-10 1:45pm**	**Total %**	
Program Observations	**% of Class**						**Confidence**
Eye Contact (Maintained)	26%	22%	32%	41%	35%	32%	0.47
Eye Contact (Frequent)	43%	33%	48%	41%	48%	43%	0.43
Discussion (Program)	30%	11%	8%	0%	0%	9%	0.52
Discussion (Other)	26%	0%	16%	15%	0%	12%	0.49
Discussion (Don't know)	0%	0%	16%	0%	13%	6%	0.35
Concentration	70%	67%	48%	56%	48%	57%	0.39
Excitement/Enjoyment	13%	33%	32%	19%	26%	24%	0.33
Boredom	43%	22%	32%	41%	26%	34%	0.52
Eagerness to Participate	61%	56%	40%	37%	48%	47%	0.32
Asking Questions	0%	0%	4%	0%	17%	4%	0.32
Confusion/Frustration	0%	0%	0%	0%	0%	0%	
Physical Distractions	43%	33%	28%	26%	30%	32%	0.28

Oil Analysis	**15-2-10 11:15am**	**15-2-10 1:45pm**	**16-2-10 9:00am**	**16-2-10 11:15am**	**16-2-10 1:45pm**	**Total %**	
Program Observations	**% of Class**						**Confidence**
Discussion (program)	95%	73%	100%		79%	88%	1.20
Discussion (personal)	0%	18%	0%		0%	3%	0.26
Concentration	60%	100%	54%		50%	64%	0.68
Excitement/Enjoyment	45%	27%	31%		29%	34%	0.70
Boredom	5%	0%	8%		21%	9%	0.32
Eagerness to Participate	65%	55%	54%		14%	48%	1.17
Asking Questions	10%	0%	15%		0%	7%	0.30
Confusion/Frustration	0%	0%	0%		0%	0%	
Physical Distractions	0%	9%	0%		14%	5%	0.25
Completion	90%	100%	69%		36%	74%	1.40
Misuse of Equipment	10%	0%	23%		0%	9%	0.39
Read Instructions	70%	36%	0%		50%	43%	1.52

Stamp Analysis	# Students	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm				
Program Observations	**68**	**21**	**16**	**20**	**0**	**11**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	68	15	11	19		3	48	12.00	13.00	6.83
Discussion (personal)	68	0	0	0		0	0	0.00	0.00	0.00
Concentration	68	9	10	11		5	35	8.75	9.50	2.63
Excitement/Enjoyment	68	4	3	6		3	16	4.00	3.50	1.41
Boredom	68	4	2	1		2	9	2.25	2.00	1.26
Eagerness to Participate	68	12	6	16		5	39	9.75	9.00	5.19
Asking Questions	68	1	0	0		0	1	0.25	0.00	0.50
Confusion/Frustration	68	0	0	2		0	2	0.50	0.00	1.00
Physical Distractions	68	0	1	0		0	1	0.25	0.00	0.50
Completion	68	14	12	16		5	47	11.75	13.00	4.79
Misuse of Equipment	68	2	4	3		4	13	3.25	3.50	0.96
Read Instructions	68	7	4	2		0	13	3.25	3.00	2.99

Soil Analysis	# Students	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm				
Program Observations	**46**	**12**	**16**	**12**	**0**	**6**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	46	11	12	12		3	38	9.50	11.50	4.36
Discussion (personal)	46	1	0	0		0	1	0.25	0.00	0.50
Concentration	46	10	13	3		4	30	7.50	7.00	4.80
Excitement/Enjoyment	46	6	9	3		3	21	5.25	4.50	2.87
Boredom	46	1	5	1		0	7	1.75	1.00	2.22
Eagerness to Participate	46	11	10	7		1	29	7.25	8.50	4.50
Asking Questions	46	0	2	2		0	4	1.00	1.00	1.15
Confusion/Frustration	46	5	2	10		2	19	4.75	3.50	3.77
Physical Distractions	46	0	3	0		0	3	0.75	0.00	1.50
Completion	46	12	13	0		3	28	7.00	7.50	6.48
Misuse of Equipment	46	0	2	8		3	13	3.25	2.50	3.40
Read Instructions	46	6	4	4		2	16	4.00	4.00	1.63

Stamp Analysis	**15-2-10 11:15am**	**15-2-10 1:45pm**	**16-2-10 9:00am**	**16-2-10 11:15am**	**16-2-10 1:45pm**	**Total %**	
Program Observations			**% of Class**				**Confidence**
Discussion (program)	71%	69%	95%		27%	71%	1.62
Discussion (personal)	0%	0%	0%		0%	0%	
Concentration	43%	63%	55%		45%	51%	0.63
Excitement/Enjoyment	19%	19%	30%		27%	24%	0.34
Boredom	19%	13%	5%		18%	13%	0.30
Eagerness to Participate	57%	38%	80%		45%	57%	1.23
Asking Questions	5%	0%	0%		0%	1%	0.12
Confusion/Frustration	0%	0%	10%		0%	3%	0.24
Physical Distractions	0%	6%	0%		0%	1%	0.12
Completion	67%	75%	80%		45%	69%	1.14
Misuse of Equipment	10%	25%	15%		36%	19%	0.23
Read Instructions	33%	25%	10%		0%	19%	0.71

Soil Analysis	**15-2-10 11:15am**	**15-2-10 1:45pm**	**16-2-10 9:00am**	**16-2-10 11:15am**	**16-2-10 1:45pm**	**Total %**	
Program Observations			**% of Class**				**Confidence**
Discussion (program)	92%	75%	100%		50%	83%	1.26
Discussion (personal)	8%	0%	0%		0%	2%	0.14
Concentration	83%	81%	25%		67%	65%	1.39
Excitement/Enjoyment	50%	56%	25%		50%	46%	0.83
Boredom	8%	31%	8%		0%	15%	0.64
Eagerness to Participate	92%	63%	58%		17%	63%	1.30
Asking Questions	0%	13%	17%		0%	9%	0.33
Confusion/Frustration	42%	13%	83%		33%	41%	1.09
Physical Distractions	0%	19%	0%		0%	7%	0.43
Completion	100%	81%	0%		50%	61%	1.87
Misuse of Equipment	0%	13%	67%		50%	28%	0.98
Read Instructions	50%	25%	33%		33%	35%	0.47

Dental X-Ray	# Students	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm				
Program Observations	**24**	**0**	**10**	**0**	**7**	**7**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	24		5		5	5	15	5.00	5.00	0.00
Discussion (personal)	24		4		0	0	4	1.33	0.00	2.31
Concentration	24		8		6	7	21	7.00	7.00	1.00
Excitement/Enjoyment	24		3		1	2	6	2.00	2.00	1.00
Boredom	24		0		2	1	3	1.00	1.00	1.00
Eagerness to Participate	24		7		5	1	13	4.33	5.00	3.06
Asking Questions	24		0		0	0	0	0.00	0.00	0.00
Confusion/Frustration	24		1		0	0	1	0.33	0.00	0.58
Physical Distractions	24		0		0	0	0	0.00	0.00	0.00
Completion	24		9		5	6	20	6.67	6.00	2.08
Misuse of Equipment	24		0		0	0	0	0.00	0.00	0.00
Read Instructions	24		2		5	0	7	2.33	2.00	2.52

Tire Tracks	# Students	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm				
Program Observations	**67**	**24**	**0**	**22**	**0**	**21**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	67	16		19		16	51	17.00	16.00	1.73
Discussion (personal)	67	5		0		3	8	2.67	3.00	2.52
Concentration	67	11		16		9	36	12.00	11.00	3.61
Excitement/Enjoyment	67	7		12		11	30	10.00	11.00	2.65
Boredom	67	5		4		1	10	3.33	4.00	2.08
Eagerness to Participate	67	16		10		18	44	14.67	16.00	4.16
Asking Questions	67	2		0		2	4	1.33	2.00	1.15
Confusion/Frustration	67	5		0		0	5	1.67	0.00	2.89
Physical Distractions	67	0		2		5	7	2.33	2.00	2.52
Completion	67	20		18		21	59	19.67	20.00	1.53
Misuse of Equipment	67	0		1		2	3	1.00	1.00	1.00
Read Instructions	67	2		12		5	19	6.33	5.00	5.13

Dental X-Ray	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm	Total %	
Program Observations			% of Class				**Confidence**
Discussion (program)		50%		71%	71%	63%	
Discussion (personal)		40%		0%	0%	17%	0.92
Concentration		80%		86%	100%	88%	0.40
Excitement/Enjoyment		30%		14%	29%	25%	0.40
Boredom		0%		29%	14%	13%	0.40
Eagerness to Participate		70%		71%	14%	54%	1.22
Asking Questions		0%		0%	0%	0%	
Confusion/Frustration		10%		0%	0%	4%	0.23
Physical Distractions		0%		0%	0%	0%	
Completion		90%		71%	86%	83%	0.83
Misuse of Equipment		0%		0%	0%	0%	
Read Instructions		20%		71%	0%	29%	1.01

Tire Tracks	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm	Total %	
Program Observations			% of Class				**Confidence**
Discussion (program)	67%		86%		76%	76%	0.41
Discussion (personal)	21%		0%		14%	12%	0.60
Concentration	46%		73%		43%	54%	0.86
Excitement/Enjoyment	29%		55%		52%	45%	0.63
Boredom	21%		18%		5%	15%	0.50
Eagerness to Participate	67%		45%		86%	66%	1.00
Asking Questions	8%		0%		10%	6%	0.28
Confusion/Frustration	21%		0%		0%	7%	0.69
Physical Distractions	0%		9%		24%	10%	0.60
Completion	83%		82%		100%	88%	0.37
Misuse of Equipment	0%		5%		10%	4%	0.24
Read Instructions	8%		55%		24%	28%	1.23

Is it blood? Whose blood?	# Students	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm				
Program Observations	**64**	**26**	**0**	**19**	**0**	**19**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	64	20		16		16	52	17.33	16.00	2.31
Discussion (personal)	64	4		0		3	7	2.33	3.00	2.08
Concentration	64	17		15		9	41	13.67	15.00	4.16
Excitement/Enjoyment	64	14		10		9	33	11.00	10.00	2.65
Boredom	64	3		1		2	6	2.00	2.00	1.00
Eagerness to Participate	64	14		6		18	38	12.67	14.00	6.11
Asking Questions	64	0		3		1	4	1.33	1.00	1.53
Confusion/Frustration	64	10		1		0	11	3.67	1.00	5.51
Physical Distractions	64	0		0		3	3	1.00	0.00	1.73
Completion	64	17		16		20	53	17.67	17.00	2.08
Misuse of Equipment	64	3		1		1	5	1.67	1.00	1.15
Read Instructions	64	8		7		12	27	9.00	8.00	2.65

Ransom Note Fingerprints	# Students	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm				
Program Observations	**48**	**10**	**8**	**16**	**14**	**0**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	48	8	7	11	12		38	9.50	9.50	2.38
Discussion (personal)	48	0	1	1	2		4	1.00	1.00	0.82
Concentration	48	8	6	6	12		32	8.00	7.00	2.83
Excitement/Enjoyment	48	2	2	4	10		18	4.50	3.00	3.79
Boredom	48	3	0	3	3		9	2.25	3.00	1.50
Eagerness to Participate	48	5	5	11	7		28	7.00	6.00	2.83
Asking Questions	48	0	0	2	0		2	0.50	0.00	1.00
Confusion/Frustration	48	0	0	0	6		6	1.50	0.00	3.00
Physical Distractions	48	0	0	0	1		1	0.25	0.00	0.50
Completion	48	9	5	10	10		34	8.50	9.50	2.38
Misuse of Equipment	48	0	1	2	0		3	0.75	0.50	0.96
Read Instructions	48	4	0	4	6		14	3.50	4.00	2.52

Is it blood? Whose blood?	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm	Total %	
Program Observations			**% of Class**				**Confidence**
Discussion (program)	77%		84%		84%	81%	0.57
Discussion (personal)	15%		0%		16%	11%	0.51
Concentration	65%		79%		47%	64%	1.02
Excitement/Enjoyment	54%		53%		47%	52%	0.65
Boredom	12%		5%		11%	9%	0.24
Eagerness to Participate	54%		32%		95%	59%	1.50
Asking Questions	0%		16%		5%	6%	0.37
Confusion/Frustration	38%		5%		0%	17%	1.35
Physical Distractions	0%		0%		16%	5%	0.42
Completion	65%		84%		105%	83%	0.51
Misuse of Equipment	12%		5%		5%	8%	0.28
Read Instructions	31%		37%		63%	42%	0.65

Ransom Note Fingerprints	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm	Total %	
Program Observations			**% of Class**				**Confidence**
Discussion (program)	80%	88%	69%	86%		79%	0.67
Discussion (personal)	0%	13%	6%	14%		8%	0.23
Concentration	80%	75%	38%	86%		67%	0.80
Excitement/Enjoyment	20%	25%	25%	71%		38%	1.07
Boredom	30%	0%	19%	21%		19%	0.42
Eagerness to Participate	50%	63%	69%	50%		58%	0.80
Asking Questions	0%	0%	13%	0%		4%	0.28
Confusion/Frustration	0%	0%	0%	43%		13%	0.85
Physical Distractions	0%	0%	0%	7%		2%	0.14
Completion	90%	63%	63%	71%		71%	0.67
Misuse of Equipment	0%	13%	13%	0%		6%	0.27
Read Instructions	40%	0%	25%	43%		29%	0.71

Factory Bench Fingerprints	**# Students**	**15-2-10 11:15am**	**15-2-10 1:45pm**	**16-2-10 9:00am**	**16-2-10 11:15am**	**16-2-10 1:45pm**				
Program Observations	**64**	**23**	**8**	**19**	**14**	**0**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	64	19	7	10	11		47	11.75	10.50	5.12
Discussion (personal)	64	2	1	3	0		6	1.50	1.50	1.29
Concentration	64	17	6	4	7		34	8.50	6.50	5.80
Excitement/Enjoyment	64	6	2	7	3		18	4.50	4.50	2.38
Boredom	64	4	0	1	6		11	2.75	2.50	2.75
Eagerness to Participate	64	4	5	12	5		26	6.50	5.00	3.70
Asking Questions	64	1	0	0	0		1	0.25	0.00	0.50
Confusion/Frustration	64	0	0	0	0		0	0.00	0.00	0.00
Physical Distractions	64	1	0	0	1		2	0.50	0.50	0.58
Completion	64	18	5	13	11		47	11.75	12.00	5.38
Misuse of Equipment	64	4	1	5	1		11	2.75	2.50	2.06
Read Instructions	64	4	0	1	3		8	2.00	2.00	1.83

Own Fingerprints	**# Students**	**15-2-10 11:15am**	**15-2-10 1:45pm**	**16-2-10 9:00am**	**16-2-10 11:15am**	**16-2-10 1:45pm**				
Program Observations	**66**	**17**	**8**	**22**	**19**	**0**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	66	14	8	12	13		47	11.75	12.50	2.63
Discussion (personal)	66	0	0	3	0		3	0.75	0.00	1.50
Concentration	66	9	5	5	12		31	7.75	7.00	3.40
Excitement/Enjoyment	66	14	7	13	13		47	11.75	13.00	3.20
Boredom	66	0	0	3	3		6	1.50	1.50	1.73
Eagerness to Participate	66	11	5	13	13		42	10.50	12.00	3.79
Asking Questions	66	0	0	0	0		0	0.00	0.00	0.00
Confusion/Frustration	66	0	0	0	2		2	0.50	0.00	1.00
Physical Distractions	66	0	2	0	0		2	0.50	0.00	1.00
Completion	66	16	5	15	17		53	13.25	15.50	5.56
Misuse of Equipment	66	2	0	1	2		5	1.25	1.50	0.96
Read Instructions	66	2	1	2	1		6	1.50	1.50	0.58

Factory Bench Fingerprints	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm	Total %	
Program Observations	% of Class						**Confidence**
Discussion (program)	83%	88%	53%	79%		73%	1.26
Discussion (personal)	9%	13%	16%	0%		9%	0.32
Concentration	74%	75%	21%	50%		53%	1.42
Excitement/Enjoyment	26%	25%	37%	21%		28%	0.58
Boredom	17%	0%	5%	43%		17%	0.67
Eagerness to Participate	17%	63%	63%	36%		41%	0.91
Asking Questions	4%	0%	0%	0%		2%	0.12
Confusion/Frustration	0%	0%	0%	0%		0%	
Physical Distractions	4%	0%	0%	7%		3%	0.14
Completion	78%	63%	68%	79%		73%	1.32
Misuse of Equipment	17%	13%	26%	7%		17%	0.51
Read Instructions	17%	0%	5%	21%		13%	0.45

Own Fingerprints	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm	Total %	
Program Observations	% of Class						**Confidence**
Discussion (program)	82%	100%	55%	68%		71%	0.63
Discussion (personal)	0%	0%	14%	0%		5%	0.36
Concentration	53%	63%	23%	63%		47%	0.82
Excitement/Enjoyment	82%	88%	59%	68%		71%	0.77
Boredom	0%	0%	14%	16%		9%	0.42
Eagerness to Participate	65%	63%	59%	68%		64%	0.91
Asking Questions	0%	0%	0%	0%		0%	
Confusion/Frustration	0%	0%	0%	11%		3%	0.24
Physical Distractions	0%	25%	0%	0%		3%	0.24
Completion	94%	63%	68%	89%		80%	1.34
Misuse of Equipment	12%	0%	5%	11%		8%	0.23
Read Instructions	12%	13%	9%	5%		9%	0.14

Ballistics	# Students	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm				
Program Observations	**78**	**13**	**16**	**9**	**19**	**21**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	78	9	15	9	17	17	67	13.40	15.00	4.10
Discussion (personal)	78	4	0	0	2	0	6	1.20	0.00	1.79
Concentration	78	7	14	5	12	17	55	11.00	12.00	4.95
Excitement/Enjoyment	78	4	3	9	9	6	31	6.20	6.00	2.77
Boredom	78	3	4	1	0	3	11	2.20	3.00	1.64
Eagerness to Participate	78	3	4	7	16	8	38	7.60	7.00	5.13
Asking Questions	78	0	1	2	3	0	6	1.20	1.00	1.30
Confusion/Frustration	78	2	1	0	5	0	8	1.60	1.00	2.07
Physical Distractions	78	2	1	1	3	0	7	1.40	1.00	1.14
Completion	78	8	12	3	3	15	41	8.20	8.00	5.36
Misuse of Equipment	78	2	1	2	0	1	6	1.20	1.00	0.84
Read Instructions	78	2	6	3	5	13	29	5.80	5.00	4.32

Facial Identification	# Students	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm				
Program Observations	**49**	**0**	**11**	**12**	**11**	**15**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	49		5	10	5	7	27	6.75	6.00	2.36
Discussion (personal)	49		6	2	0	8	16	4.00	4.00	3.65
Concentration	49		3	8	11	6	28	7.00	7.00	3.37
Excitement/Enjoyment	49		9	11	8	8	36	9.00	8.50	1.41
Boredom	49		1	1	3	3	8	2.00	2.00	1.15
Eagerness to Participate	49		10	11	8	7	36	9.00	9.00	1.83
Asking Questions	49		2	0	0	0	2	0.50	0.00	1.00
Confusion/Frustration	49		0	0	3	0	3	0.75	0.00	1.50
Physical Distractions	49		0	0	0	0	0	0.00	0.00	0.00
Completion	49		7	12	3	0	22	5.50	5.00	5.20
Misuse of Equipment	49		9	3	6	15	33	8.25	7.50	5.12
Read Instructions	49		2	0	0	1	3	0.75	0.50	0.96

Ballistics	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm	Total %	
Program Observations			**% of Class**				**Confidence**
Discussion (program)	69%	94%	100%	89%	81%	86%	0.91
Discussion (personal)	31%	0%	0%	11%	0%	8%	0.40
Concentration	54%	88%	56%	63%	81%	71%	1.10
Excitement/Enjoyment	31%	19%	100%	47%	29%	40%	0.62
Boredom	23%	25%	11%	0%	14%	14%	0.36
Eagerness to Participate	23%	25%	78%	84%	38%	49%	1.14
Asking Questions	0%	6%	22%	16%	0%	8%	0.29
Confusion/Frustration	15%	6%	0%	26%	0%	10%	0.46
Physical Distractions	15%	6%	11%	16%	0%	9%	0.25
Completion	62%	75%	33%	16%	71%	53%	1.19
Misuse of Equipment	15%	6%	22%	0%	5%	8%	0.19
Read Instructions	15%	38%	33%	26%	62%	37%	0.96

Facial Identification	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm	Total %	
Program Observations			**% of Class**				**Confidence**
Discussion (program)		45%	83%	45%	47%	55%	0.66
Discussion (personal)		55%	17%	0%	53%	33%	1.02
Concentration		27%	67%	100%	40%	57%	0.94
Excitement/Enjoyment		82%	92%	73%	53%	73%	0.40
Boredom		9%	8%	27%	20%	16%	0.32
Eagerness to Participate		91%	92%	73%	47%	73%	0.51
Asking Questions		18%	0%	0%	0%	4%	0.28
Confusion/Frustration		0%	0%	27%	0%	6%	0.42
Physical Distractions		0%	0%	0%	0%	0%	
Completion		64%	100%	27%	0%	45%	1.45
Misuse of Equipment		82%	25%	55%	100%	67%	1.43
Read Instructions		18%	0%	0%	7%	6%	0.27

Envelope Ink	**# Students**	**15-2-10 11:15am**	**15-2-10 1:45pm**	**16-2-10 9:00am**	**16-2-10 11:15am**	**16-2-10 1:45pm**				
Program Observations	**35**	**0**	**12**	**11**	**0**	**12**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	35		8	11		8	27	9.00	8.00	1.73
Discussion (personal)	35		2	0		4	6	2.00	2.00	2.00
Concentration	35		10	11		9	30	10.00	10.00	1.00
Excitement/Enjoyment	35		4	2		4	10	3.33	4.00	1.15
Boredom	35		4	1		1	6	2.00	1.00	1.73
Eagerness to Participate	35		7	4		9	20	6.67	7.00	2.52
Asking Questions	35		0	5		2	7	2.33	2.00	2.52
Confusion/Frustration	35		0	3		2	5	1.67	2.00	1.53
Physical Distractions	35		0	0		0	0	0.00	0.00	0.00
Completion	35		10	11		9	30	10.00	10.00	1.00
Misuse of Equipment	35		0	3		3	6	2.00	3.00	1.73
Read Instructions	35		3	4		4	11	3.67	4.00	0.58

Looking Complete: Facial Reconstruction	**# Students**	**15-2-10 11:15am**	**15-2-10 1:45pm**	**16-2-10 9:00am**	**16-2-10 11:15am**	**16-2-10 1:45pm**				
Program Observations	**48**	**0**	**17**	**9**	**12**	**10**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	48		8	6	5	4	23	5.75	5.50	1.71
Discussion (personal)	48		6	3	2	6	17	4.25	4.50	2.06
Concentration	48		8	5	6	4	23	5.75	5.50	1.71
Excitement/Enjoyment	48		14	8	4	4	30	7.50	6.00	4.73
Boredom	48		2	1	5	0	8	2.00	1.50	2.16
Eagerness to Participate	48		14	6	5	6	31	7.75	6.00	4.19
Asking Questions	48		0	1	1	0	2	0.50	0.50	0.58
Confusion/Frustration	48		0	0	0	0	0	0.00	0.00	0.00
Physical Distractions	48		1	0	0	0	1	0.25	0.00	0.50
Completion	48		16	8	1	1	26	6.50	4.50	7.14
Misuse of Equipment	48		8	2	4	6	20	5.00	5.00	2.58
Read Instructions	48		2	3	0	3	8	2.00	2.50	1.41

Envelope Ink	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm	Total %	
Program Observations			**% of Class**				**Confidence**
Discussion (program)		67%	100%		67%	77%	0.57
Discussion (personal)		17%	0%		33%	17%	0.66
Concentration		83%	100%		75%	86%	0.33
Excitement/Enjoyment		33%	18%		33%	29%	0.38
Boredom		33%	9%		8%	17%	0.57
Eagerness to Participate		58%	36%		75%	57%	0.83
Asking Questions		0%	45%		17%	20%	0.83
Confusion/Frustration		0%	27%		17%	14%	0.51
Physical Distractions		0%	0%		0%	0%	
Completion		83%	100%		75%	86%	0.33
Misuse of Equipment		0%	27%		25%	17%	0.57
Read Instructions		25%	36%		33%	31%	0.19

"Looking Complete: Facial Reconstruction"	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm	Total %	
Program Observations			**% of Class**				**Confidence**
Discussion (program)		47%	67%	42%	40%	48%	0.48
Discussion (personal)		35%	33%	17%	60%	35%	0.58
Concentration		47%	56%	50%	40%	48%	0.48
Excitement/Enjoyment		82%	89%	33%	40%	63%	1.34
Boredom		12%	11%	42%	0%	17%	0.61
Eagerness to Participate		82%	67%	42%	60%	65%	1.19
Asking Questions		0%	11%	8%	0%	4%	0.16
Confusion/Frustration		0%	0%	0%	0%	0%	
Physical Distractions		6%	0%	0%	0%	2%	0.14
Completion		94%	89%	8%	10%	54%	2.02
Misuse of Equipment		47%	22%	33%	60%	42%	0.73
Read Instructions		12%	33%	0%	30%	17%	0.40

Fibres on the Body/ Fabric on the Fence	# Students	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm				
Program Observations	**46**	**0**	**13**	**0**	**22**	**11**	**Total**	**Mean**	**Median**	**St Dev**
Discussion (program)	46		11		11	5	27	9.00	11.00	3.46
Discussion (personal)	46		1		0	6	7	2.33	1.00	3.21
Concentration	46		9		16	6	31	10.33	9.00	5.13
Excitement/Enjoyment	46		1		3	3	7	2.33	3.00	1.15
Boredom	46		1		4	1	6	2.00	1.00	1.73
Eagerness to Participate	46		9		20	4	33	11.00	9.00	8.19
Asking Questions	46		2		0	0	2	0.67	0.00	1.15
Confusion/Frustration	46		5		2	2	9	3.00	2.00	1.73
Physical Distractions	46		2		0	3	5	1.67	2.00	1.53
Completion	46		6		14	8	28	9.33	8.00	4.16
Misuse of Equipment	46		1		0	0	1	0.33	0.00	0.58
Read Instructions	46		5		8	5	18	6.00	5.00	1.73

Concluding Presentation	# Students	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm				
Program Observations	**116**	**23**	**18**	**25**	**27**	**23**	**Total**	**Mean**	**Median**	**St Dev**
Eye Contact (Maintained)	116	11	9	13	14	12	59	11.80	12.00	1.92
Eye Contact (Frequent)	116	8	3	10	9	9	39	7.80	9.00	2.77
Discussion (Program)	116	9	3	6	2	3	23	4.60	3.00	2.88
Discussion (Other)	116	7	3	0	2	1	13	2.60	2.00	2.70
Discussion (Don't know)	116	0	0	2	0	1	3	0.60	0.00	0.89
Concentration	116	8	9	23	14	16	70	14.00	14.00	6.04
Excitement/Enjoyment	116	8	7	9	5	7	36	7.20	7.00	1.48
Boredom	116	4	6	2	6	4	22	4.40	4.00	1.67
Eagerness to Participate	116	13	10	3	12	8	46	9.20	10.00	3.96
Asking Questions	116	0	0	1	1	0	2	0.40	0.00	0.55
Confusion/Frustration	116	0	0	0	0	0	0	0.00	0.00	0.00
Physical Distractions	116	7	7	0	5	1	20	4.00	5.00	3.32

Fibres on the Body/ Fabric on the Fence	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm	Total %	
Program Observations			% of Class				**Confidence**
Discussion (program)		85%		50%	45%	59%	1.00
Discussion (personal)		8%		0%	55%	15%	0.93
Concentration		69%		73%	55%	67%	1.48
Excitement/Enjoyment		8%		14%	27%	15%	0.33
Boredom		8%		18%	9%	13%	0.50
Eagerness to Participate		69%		91%	36%	72%	2.37
Asking Questions		15%		0%	0%	4%	0.33
Confusion/Frustration		38%		9%	18%	20%	0.50
Physical Distractions		15%		0%	27%	11%	0.44
Completion		46%		64%	73%	61%	1.20
Misuse of Equipment		8%		0%	0%	2%	0.17
Read Instructions		38%		36%	45%	39%	0.50

Concluding Presentation	15-2-10 11:15am	15-2-10 1:45pm	16-2-10 9:00am	16-2-10 11:15am	16-2-10 1:45pm	Total %	
Program Observations			% of Class				**Confidence**
Eye Contact (Maintained)	48%	50%	52%	52%	52%	51%	0.35
Eye Contact (Frequent)	35%	17%	40%	33%	39%	34%	0.50
Discussion (Program)	39%	17%	24%	7%	13%	20%	0.52
Discussion (Other)	30%	17%	0%	7%	4%	11%	0.49
Discussion (Don't know)	0%	0%	8%	0%	4%	3%	0.16
Concentration	35%	50%	92%	52%	70%	60%	1.10
Excitement/Enjoyment	35%	39%	36%	19%	30%	31%	0.27
Boredom	17%	33%	8%	22%	17%	19%	0.30
Eagerness to Participate	57%	56%	12%	44%	35%	40%	0.72
Asking Questions	0%	0%	4%	4%	0%	2%	0.10
Confusion/Frustration	0%	0%	0%	0%	0%	0%	
Physical Distractions	30%	39%	0%	19%	4%	17%	0.60

Appendix V: Comments from Observations

The following is a documentation of the qualitative notes made during observations of CSIRO programs. These notes were made to supplement the observational data by allowing the project team to write down anything that they observed that could not be categorized into any of the cues on the observational checklist. Notes are comprised of comments made from all four observers and organized by program and activity.

Forensic Frenzy

General Presentation – Beginning

- Reading and underlining from Student Booklet
- Trying to wipe off stamps that they had given themselves earlier during Paid stamp activity
- Two were talking about each other once, but then talked about program
- Physical distractions were doodling on papers
- One kid answered almost every question
- One bored kid was actually asleep
- One kid doodling
- Students distracted by playing with pens & pencils
- Towards the end student concentration/eye contact deteriorate
- Doodling on activity sheet
- Playing with rubber band and paper
- Drawing on desk with pen

Oil Stains

- Distracted by another kid
- Kid wanted to do oil test, but his partner made him do another
- Always asking "is it the one that's brightest?"
- One left and went to stamps
- Got distracted by another station

PAID stamp

- Going back and forth between this station and oil, distracted by other kids
- Stamping arms
- Just stamping everywhere, stamping each other

Soil Testing

- Substance runoff
- One kid did the experiment while the other looked around at other activities
- One kid talked about Facebook to another group
- One kid wasn't participating until prompted by his partner
- Two kids watched while other group completed, then went
- Kids were distracted by observer
- Accidentally used too much soil almost every time
- Confusion due to not following instructions & not getting answer
- Too much dirt
- Did it wrong first, then tried again correctly
- One group did it for 20 minutes

Ballistics

- Two kids spent a lot of time discussing both parts of activities at once
- Kids would work on both at once
- One kid was bored and distracting the other two
- Kid grabbed a ruler to measure hole sizes, spent a lot of time looking at hole sizes, didn't read any instructions, just knew what to do
- One kid was bored
- Lots of discussion about whether to use the front or back to determine what gun was used
- Discussed both program and something else, maybe a movie?
- Distracted by observer
- Some kids stayed when time was up to finish figuring it out
- Spent so much time here
- Greiss test question – what is it?
- Grabbed magnifying glass and fooled around with it
- No one looked at greiss test
- Just looked at bullet holes, no analysis

Tyre Tracks

- None

Is it blood? Whose blood? – Is it blood?

- Commonly read instructions halfway through when unsure what to do
- Getting distracted by facial reconstruction, one kid finished
- Dumped too many samples by accident
- Kids thought DNA & is it blood? Whose blood? were linked
- Kids doing DNA & this one simultaneously
- Last group didn't want to stop when presenter said it was over

Fingerprints – Ransom Note

- First group very thorough
- 3 participants: 5 seconds at each station
- One kid specifically said "I'm never becoming a scientist EVER!"
- Got distracted by Skull activity

Fingerprints – Factory Bench

- Finished quickly
- Left without making conclusion
- Did bench/note together

Own Fingerprints

- Not for use in helping to solve the crime

Fibres on the Body/Fabric on the Fence

- Confusion from not reading instructions
- After realizing they did it wrong they figured out what to do on their own and took the time to redo
- Student distracted by observer
- "What are we supposed to do?" "I don't know" then don't read directions
- Only concentrating while using scope
- Problem: one group member uses scope

Dental X-Ray

- Maybe more X-rays, more possibilities = more interesting?

Facial Identification

- Completion turns to play
- Two came back and stayed well over half of the entire time
- Trying to make other faces
- Should have a limit or a goal, then leave
- Evidence column should match title and information card
- Fooling around with hair and accessories
- Spent a long time doing it, one group wanted to do it, couldn't, then got bored and left
- Misuse through looking at picture whole time or just making a weird face

Looking Complete: Facial Reconstruction

- Lots of fooling around
- Maybe don't put on same table as Facial Identification
- Like to play with dough
- Didn't know it wasn't helping solve the crime
- Usually would not reconstruct, kids just play
- Made a huge nose
- Talked about each other's names & then about activity
- One stayed behind to complete while other two went to do something else; he spent a lot of time, very, very detailed, but didn't do many other activities
- Takes too long to do it right, and only one person can really do it at a time
- Lots thought that the skull looked like Michael Jackson
- Last two students spent extensive time (around 15 minutes), then eventually got on task and completed intended activity

Envelope Ink: Chromatography

- Did not read instructions – submerged paper – confused
- 4 Students submerged paper
- Student was bored and walked away when other two messed up and had to redo experiment
- Name of activity on instructions vs. student workbook don't match up

General Presentation – End

- One kid told two others to be quiet when they were talking during presentation
- Physical distractions were doodles
- Writing on himself, stabbing between fingers with pen
- Never could ID the witness whose face was already identified in directions
- Clearly did not read it
- Again did not read instructions
- Could not answer who's office the cloth was on
- Not a lot of kids went to dental station
- Playing with paper

<u>Biodiversity</u>

General Presentation – Beginning

- None

Classification Keys – Simpsons

- Kids enjoy playing with Simpsons toys
- Simpsons may be too distracting
- Students distract those who are participating
- Too in depth
- Had to tell other group to leave so they could finish
- Just asking each other "who is this character?" for all figures
- Distracted by other kids
- Distracted by other activity
- Writing all over the board
- One kid left to help a CO2 group then came back

Microscopic Monitoring

- Visible excitement
- Students rushed to try and do at the end
- Discussed & deliberated a lot
- Good activity
- Poking each other
- Distracted by other activity
- Three kids who read instructions were walked through it by presenter

A Trend in the Weather

- Thinks he knows without doing it
- Finished quickly
- Distracted by Simpsons
- Confused by maps
- Had to stop
- Sometimes did not finish
- Walked away

Soil Texture

- Just felt one dirt sample, didn't put water in it
- Students distracted by other group
- Kids don't want to play with dirt
- Just Made and played with dirt balls
- Got distracted by lab equipment (not program related equipment)
- "I don't want to do this, it's stupid"
- Can't get soil to ribbon
- Need a picture of the map for second question

Soil Moisture

- Students didn't do it right until presenter helped them
- One kid did all the work, while other two watched, then copied answers
- Copied answers
- One student completed, other two copied answers

A World of CO2

- One group disappeared for extended time
- One kid pretended it was a remote control gun
- When outside, students went off track without supervision
- Confused and walked away
- Get bored/confused inside but excited when outside and see changes
- Hard to observe full activity due to following kids outside and changing their behaviour

Water pH

- Didn't know what to label
- Distracted by other students and other activities

Map that Species/Testing Temperature

- Think they need to take temperature directly on dots
- Group of students return in order to complete map after originally only finishing testing map
- Got confused and left
- "Which way does the laser come out?"
- Students think dots correspond with temperature

Future Atmosphere

- Students press stop on the stopwatch when they approach the station when stopwatch is supposed to run continuously throughout the program

General Presentation – End

- Lots of talking and fooling around during the food web
- Not getting the point, they didn't care
- At start of web only 3 eager to participate, by the end all were jumping at every animal and volunteering
- One kid was asleep for most of ending presentation
- During food web – students volunteering before animal is even announced

Appendix W: Teacher Interview Transcripts

The following represents all of the interviews that were conducted during the project team's assessment.

Forensic Frenzy

Ashley Humphrey PR Interview

Q: Are you a science teacher?
A: Yes

Q: How do you expect this program to fit with what you are currently covering in class?
A: Just going to follow on the unit we've been doing with Forensics.

Q: Describe your students and their demeanour when teaching science related subjects. Why do think this is?
A: Reserved, it's the start of the year. Finding their feet, will be more boisterous in the end.

Q: In your past experience teaching science, would you say these guys are more enthusiastic with science or less?
A: They sort of approach it with trepidation, but they're generally pretty open to anything that we do in here.

Q: What topics in your science curriculum have you noticed are most engaging to the students? Why?
A: Anything practical. They like to get their hands dirty.

Q: Is there a technology curriculum? What about that do students get enthused about?
A: Yes.

Q: Do you plan to assess the students on this material covered (through reports, projects, tests, observations during the program, etc)? Do you plan to assess on the day of the session?
A: There will be parts of it in a test, we'll discuss it at the end, but some of the things in here we've covered already, so it'll be a follow-up. Announced to the class that homework will be based on the program: Write a report about who you thought committed the crime and how.

Ashley Humphrey P1 Interview

Q: Did you enjoy the program?
A: Yeah, I loved it.

Q: How well did the program compliment the current science curriculum/or specific learning unit related to this program?
A: Perfect, fits in perfectly with our forensic unit.

Q: Were the activities appropriate for the age group? Were the activities appropriate for your students specifically?
A: All the tests are quite understandable, makes them read.

Q: Would you say this program captured the interest of the students?
A: Yeah, everyone involved.

Q: Did the hands on 'doing' engage them?
A: Yeah.

Q: What were the most engaging portions of the program?
A: When they can see the tests working.

Q: What could be improved?
A: (Pressed for an answer) Just a bit more time doing, less time explaining maybe.

Q: What changes did you see during the program? How did behaviour change from regular classroom settings?
A: Pretty good, regular. A bit more engaged in this than in regular science class because they have more to do.

Q: Is the program likely to have a lasting positive impact on the students?
A: It'll help them remember forensics.

Q: Do you think the students approach to science will improve as a result of the program?
A: I hope so.

Q: Will this program be advantageous to helping you teach them about science?
A: Again, it gives me something to discuss. We will be discussing.

Q: Do you expect the programs will affect students' future to be involved with science? VCE? University? Career?
A: I think it gives them an option, puts it in their mind. It's just good for them to know what's out there.

Ashley Humphrey P2 Interview

Was planning to do a discussion the day we came for an interview. Hadn't had students in class since the program took place, so couldn't answer any questions.

Brendan Nichols PR Interview

Q: Are you a science teacher?
A: Yes.

Q: How do you expect this program to fit with what you are currently covering in class?
A: Really well, we're doing forensic science for three weeks, they know we've played with some of these techniques and ideas, and there are some that we haven't and won't in the classroom.

Q: Describe your students and their demeanour when teaching science related subjects. Why do think this is?
A: When we're doing theory classes they're very good, quiet, and they get on with their work. Prac classes they get really excited but they listen to the instructions so they're a good group, this bunch.

Q: What topics in your science curriculum have you noticed are most engaging to the students? Why?
A: The ones they don't enjoy are the physics with the sound and light, usually its more theory based stuff where the experiments aren't really exciting, or they'll do the experiment, and there'll be a chemical reaction, and there will be a one degree difference, and to them, they just don't care.

Q: Is there a technology curriculum? What about that do students get enthused about?
A: We've added it in science a bit; we're adapting Formula 1 in schools. Using ICT to come up with an outcome.

Q: Do you plan to assess the students on this material covered (through reports, projects, tests, observations during the program, etc)? Do you plan to assess on the day of the session?
A: Yeah, they have a workbook from the work we've gone through which is pretty basic with fingerprints, they also do a research task looking at one area of forensic science and doing a report on what that person or scientist would do, and what their limitations are, so they don't go watch CSI and think they can go around shooting people. Sort of just make sure they can understand that everything they see isn't how it seems.

Brendan Nichols P1 Interview

Q: Did you enjoy the program?
A: Yeah it was great.

How well did the program compliment the current science curriculum/or specific learning unit related to this program?
A: Yeah, it was good, perfect. Fit in perfectly with what we're doing.

Q: Were the activities appropriate for the age group? Were the activities appropriate for your students specifically?
A: Yes, they enjoyed it and I think it was at their level.

Q: Did the concept capture them?
A: Yes.

Q: Did the hands on 'doing' engage them?
A: Yeah, we like to do as much "prac" as we can.

Q: What were the most engaging portions of the program?
A: The oil tests, the soil tests, making the face, the fingerprints is what they enjoyed the most. And the guns in the corner.

Q: What could be improved?
A: (pressed for answer) More structure, maybe make them move from station to station and be at each for say 5 minutes, but then you might lose them forcing them to be at a station they don't want to do. But maybe a little more structure.

Q: What changes did you see during the program? How did behaviour change from regular classroom settings?
A: I think because of the nature of the program they were talking a lot more and they were working together, I noticed they all trying to figure out who did what. They were sort of trying to think ahead to who might have done it.

Q: Is the program likely to have a lasting positive impact on the students?
A: Yeah, they'll be all trying to work out who did it.

Q: Do you think the students approach to science will improve as a result of the program?
A: Yeah, I think anything hands-on gets their attention and interest in science.

Q: Will this program be advantageous to helping you teach them about science?
A: It will be, because I'll be able to come back to this and it's good because it's got their attention because they want to know what's happened, so certainly they'll be a lot more engaged when talking about this subject because rather than reading about it they've got an activity in mind where they've got a worksheet, and using the information they'll be able to make a best guess as to who has done it.

Q: If question seems pertinent during specific interview: Do you expect the programs will affect students' future to be involved with science? VCE? University? Career?
A: I hope so; again presenting the real world to the kids can only be a good thing. One of the videos we show them is about what forensic scientists actually do and so now that they do it, it's good for them to make those distinctions as well.

Brendan Nichols P2 Interview

Q: Did you have a post-program discussion with the students? Was it spontaneous or planned?
A: No, it's going to happen tomorrow. We had one class; I have a mate who is a police officer who works at the crime desk so he came in and spoke to the kids about what he does with fingerprints and DNA and followed up with some of the stuff that CSIRO did in their program.

Q: Have there been unprompted questions or comments from students?
A: Not yet, no.

Q: Was the program worth doing?
A: Yes, it was great. A lot of those activities are things we try to do but we can't fit them all in. So any time the kids can move around to say eight or nine different activities that's great.

Q: Is there anything that you feel CSIRO could change to make the program have more value?
A: The one thing I'll follow up with that was covered but could be reinforced would be the difference between a forensic scientist and a forensic police officer. The kids watch CSI and see Horatio runs around with a gun, collects all the evidence, does all the tests himself, and goes out and shoots someone dead. It's no big deal, but if kids look at it and think that's what they want to do when they get older, just want to show them that it's not as glamorous as it seems, and that's something I always try to enforce. It's similar to when kids come into science in year 7 they think its all lighting bunsen burners and blowing stuff up. That's their idea of science. So we try to keep them interested but get rid of the misinterpretations.

Jan Van Kruysbergen PR Interview

Q: Are you a science teacher?
A: I am, not practicing at the moment.

Q: How do you expect this program to fit with what the students are currently covering in class?
A: I would think that it will do 2 things probably: Explain a little about the methodology of science, it will also explain how science can be relevant in the real world. As far as skills are concerned, I would imagine that it aims to develop some scientific skills.

Q: Are you familiar with these kids in the classroom? How do they normally behave?
A: (Not his students) I wouldn't be surprised if you find that the students here are, on a scale of 1 to 10, at about an 8 or 9 in terms of behaviour. As far as their interest or attitude on science, it really depends on the teachers.

Jan Van Kruysbergen P1 Interview

Q: Did you enjoy the program?
A: Yes.

Q: Were the activities appropriate for the age group? Were the activities appropriate for these students specifically?
A: I think it's good.

Q: Would you say this program captured the interest of the students?
A: Yes.

Q: Did the concept capture them?
A: Yes, I think because they can relate it to a real story, its closely connected so it makes it very suitable at this age.

Q: Did the hands on 'doing' engage them?
A: Yes, it's very important.

Q: What were the most engaging portions of the program?
A: They enjoyed playing with the laptop, but I don't know if that was the most constructive one, but it was the most engaging.

Q: What could be improved?
A: (pressed) Slightly more active assistance from the instructor for the students doing the activities. I think it's a good idea to go from group to group to ask 'how's it going' It did happen, but I think it could be improved, more actively. It's really difficult to give attention to all of them, and some of them don't need any guidance. It would be better for the administrator to go from group to group to see if everyone was on the right track.

Q: Is the program likely to have a lasting positive impact on the students?
A: Yes, it's impossible to tell. The smallest things, at the right time, it's all about timing. For some, it might be the right time.

Q: Will this program be advantageous to helping you teach them about science.
A: I think this is the way science should be taught at this level.

Q: Do you expect the programs will affect students' future to be involved with science? VCE? University? Career?
A: Yes, it's impossible to tell. The smallest things, at the right time, it's all about timing. For some, it might be the right time.

More thoughts on the program:
I think in the future they could hook this up with an English project, where you ask them to write an essay about a scenario of what happened. I think it hits the spot, definitely for this age group.
And you guys (the observers) normally aren't here, usually it's just the one presenter, and in some schools it's just the presenter without an extra teacher so it's hard to keep an eye on behaviour as well as scientific progress, so if there is some external supervision, I think it is a good idea, because there is a bit more space to make sure they are all on track.

Kamil Gomularz PR Interview

Q: Are you a science teacher?
A: Yes.

Q: How do you expect this program to fit with what you are currently covering in class?
A: We're doing a Forensic Science Unit at the moment.

Q: Describe your students and their demeanour when teaching science related subjects. Why do think this is?
A: I think they're generally okay, generally interested, I've only had them for a couple of weeks now, I'm trying to think of the lessons we've had, we've done some videos and practical stuff. Only had them for a few weeks.

Q: What topics in your science curriculum have you noticed are most engaging to the students? Why?
A: Anything that's hands-on, the more hands on the better, they don't like bookwork.

Q: Is there a technology curriculum? What about that do students get enthused about?
A: No, we're trying to produce it; we do have what's called "systems & tech."

Q: Do you plan to assess the students on this material covered (through reports, projects, tests, observations during the program, etc)? Do you plan to assess on the day of the session?
A: I don't know what we're going to do. I haven't heard that we're going to assess them. No official plans, no plans to officially assess them.

Kamil Gomularz P2 Interview

Q: Did you have a post-program discussion with the students?
A: Briefly, they all wanted to know who had done it, I didn't know if it was the same as in years past, so I didn't tell them. I thought it was important that they know, because they wanted to know, but I didn't want to guess and tell them the wrong answer.

Q: Have you noticed any changes in the students towards science and technology since the CSIRO program?
A: I'd have to take a look at my planner to find out what we've done, but it depends on what we're doing and what time of day. Bookwork, they're a bit more restless and chatty, but we did a hands-on activity the other day and they really enjoyed it, probably because it was hands-on.

Q: Have there been unprompted questions or comments from students?
A: They've been asking me who had done it. I didn't prompt anymore questions because I thought it would take place at the end of the program.

Q: Do you think the program may have had an effect on students' futures? Would they want be involved with science? VCE? University? Career?
A: Not really, it depends on what time of day and what they're doing in class I'd say.

Nick Jones PR Interview

Q: Are you a science teacher?
A: Yes.

Q: How do you expect this program to fit with what you are currently covering in class?
A: Currently doing Forensic Science, so I suppose it'll give the kids a bit of a practical aspect by doing some of the tests that a Forensic Scientist might do.

Q: Describe your students and their demeanour when teaching science related subjects. Why do think this is?
A: They have an expectation that it'll be practically based at least two sessions we do a week are very hands-on, and they like to see science in action.

Q: What topics in your science curriculum have you noticed are most engaging to the students? Why?
A: Certainly forensic science is one of them, anything, even Chemistry, when they do chemistry pracs. Why? **From the shows on TV, anything to do with crime.**

Q: Is there a technology curriculum? What about that do students get enthused about?
A: We sort of integrate technology as much as we can into the subjects.

Q: Do you plan to assess the students on this material covered (through reports, projects, tests, observations during the program, etc)? Do you plan to assess on the day of the session?
A: Not particularly for this session itself, but some of the stuff we're doing in forensic science is assessable, but this is just to aid them. Yeah, we'll do a discussion.

Nick Jones P1 Interview

Q: Did you enjoy the program?
A: Absolutely, it was great, yes.

Q: How well did the program compliment the current science curriculum/or specific learning unit related to this program?
A: Really well, it basically developed what we spoke about on different tests that forensic scientists do.

Q: Were the activities appropriate for the age group? Were the activities appropriate for your students specifically?
A: Yes.

Q: Would you say this program captured the interest of the students?
A: I think it was pretty clear that their enthusiasm was pretty high, they were engaged.

Q: Did the concept capture them?
A: Yeah, definitely.
Q: Did the hands on 'doing' engage them?
A: Yeah, the fact that they got to do something; that they got to solve a crime was a big part of it.

Q: What were the most engaging portions of the program?
A: The facial identification system and the ballistics were pretty interesting. The use of technology is interesting to kids, and for ballistics, they haven't really been exposed to guns, except for on TV, so this is their chance to be a forensic scientist.

Q: What could be improved?
A: Nothing really, ideally, we'd have more time, if we could do multiple visits and multiple sessions.

Q: What changes did you see during the program? How did behaviour change from regular classroom settings?
A: Yeah, their behaviour was better, even more so. They're generally well behaved, their enthusiasm was much better today.

Q: Is the program likely to have a lasting positive impact on the students?
A: I think it's something they'll remember from school. How much they get out of it in terms of content, that's still up in the air, but in terms of experience, I think they'll remember it.

Q: Do you think the students approach to science will improve as a result of the program?
A: I hope so, it's one of the reasons we do this, and we get CSIRO in to try to build that long-lasting appreciation for science.

Q: Will this program be advantageous to helping you teach them about science?
A: It's always advantageous to see other people doing their thing, other teachers do their thing.

Q: If question seems pertinent during specific interview: Do you expect the programs will affect students' future to be involved with science? VCE? University? Career?
A: As far as a career, maybe that's a bit too far off. But for future study, I think it'll definitely have an impact on them for sure.

Nick Jones P2 Interview

Q: Did you have a post-program discussion with the students?
A: Yes, the kids were interested to see who had committed the crime, so we went over that. It went well. Thought they did a great job.

Q: Have you noticed any changes in the students towards science and technology since the CSIRO program?
A: Difficult to say, we've only just started the year. I suppose we'd have to measure that over a longer time. In terms recognizing it and understanding it, I suppose they're still quite fresh. Maybe in a few months time.

Q: Have there been unprompted questions or comments from students?
A: Yeah, certainly. Definitely wanting to find out more about different fields of forensic science. That was one of the tasks they've spent quite a bit of time on. It asked them to research a particular type of forensic science, so they'd be asking about the field they'd chosen.

Q: Did you observe/experience these during class or outside of class time? (While walking to class in the halls, etc)
A: In class.

Q: What types have they come up with? Have you been surprised?
A: I was surprised in a sense about the level of interest they had and the depth of the research they had done. Particularly when they got interested in a particular area, they did their own research and through that they developed quite a good understanding.

Q: Do you think the program may have had an effect on students' futures? Would they want be involved with science? VCE? University? Career?
A: Hard to tell, really hard to tell. As far is stirring a level of interest, that's all that we can really ask for, and to develop an interest and appreciation of science.

Q: Was the program worth doing? (Effort, cost, arrangements and planning, etc)
A: Yes absolutely, I've done it before and I think it's great.

Q: Is there anything that you feel CSIRO could change to make the program have more value?
A: Not really, one of its real strengths and one of the things I enjoy most about it is that there are a lot of hands-on activities that the kids get to do. If they didn't have that, then that's something they would need to do, but I'm exceptionally happy with the way it runs.

<u>Biodiversity</u>

Dixon PR Interview

Q: Are you a science teacher?
A: No.

Q: Is there a technology curriculum? What about that do students get enthused about?
A: Yes, there is. They usually get enthusiastic about games and mostly creative stuff as well.

Q: What is your teaching background?
A: Maths and IT.

Q: Are you familiar with these kids in the classroom? How do they normally behave?
A: They're pretty mixed, some really good girls and conscientious boys but there are some that set the others off as well, sometimes because the boys can't do the work so they act up.

Q: Do you know if their science teacher is planning to assess the students on the material covered (through reports, projects, tests, observations during the program, etc)?
A: No.

Linda Lane PR Interview

Q: Are you a science teacher?
A: No.

Q: What is your teaching background?
A: English/History.

Q: Are you familiar with these kids in the classroom? How do they normally behave?
A: Generally quite good, there are a few that are a bit silly.

Q: At university, what are your areas of specialty within your teaching?
A: English and history.

Q: Do you know if the science teacher plans to assess the students on the material covered (through reports, projects, tests, observations during the program, etc)? Do you plan to assess on the day of the session?
A: No, I'm just supervising.

Linda Lane P1 Interview

Q: Did you enjoy the program?
A: Yes.

Q: Were the activities appropriate for the age group? Were the activities appropriate for your students specifically?
A: Yes.

Q: Would you say this program captured the interest of the students?
A: Yeah, I noticed they were all quite engaged in the activities.

Q: What were the most engaging portions of the program?
A: They seemed to be interested in all of them.

Q: What could be improved?
A: Nothing.

Q: What changes did you see during the program? How did behaviour change from regular classroom settings?
Q: I think their concentration just lasted slightly longer. The boys who normally get bored only got bored towards the end because I think it was just the hands-on and the fact they had to record data.

Q: Is the program likely to have a lasting positive impact on the students?
A: That's a hard one, not the program itself, but I think science in general.

Q: If question seems pertinent during specific interview: Do you expect the programs will affect students' future to be involved with science? VCE? University? Career?
A: No, I don't think it will.

Marnie Sparrow PR Interview
Q: Are you a science teacher?
A: Yes.

Q: How do you expect this program to fit with what you are currently covering in class?
A: We're doing ecology at the moment, so I'm hoping it'll talk about how humans interact with ecosystems and how we can be more sustainable and the impact we have on biodiversity.

Q: Describe your students and their demeanour when teaching science related subjects. Why do think this is?
A: This particular group in general is really interested, they love doing practicals, they're quite thoughtful in their approach to science, and they're a group you can talk to about issues related to science.

Q: What topics in your science curriculum have you noticed are most engaging to the students? Why?
A: They like chemistry the best at this level because it is very hands-on.

Q: Is there a technology curriculum? What about that do students get enthused about?
A: Yeah, we try to implement technology into our science curriculum; we have a tight budget so we do the best we can.

Q: Do you plan to assess the students on this material covered (through reports, projects, tests, observations during the program, etc)? Do you plan to assess on the day of the session?
A: Yes, they're doing a folio or a sketchbook assignment where they do reflections on things like today's class, and it depends on what I enjoy about today's program, I might implement some of the ideas into it.

Marnie Sparrow P1 Interview

Q: Did you enjoy the program?
A: Yeah, I thought it was really good, I thought there were enough activities; it was really interesting.

Q: How well did the program compliment the current science curriculum/or specific learning unit related to this program?
A: I thought it was really good to have a look at some of the equipment that an environmental scientist uses. Also the interactive food-web we did at the end was really great, we haven't done food webs yet, so it'll be good to refer back to when we start to do food webs.

Q: Were the activities appropriate for the age group? Were the activities appropriate for your students specifically?
A: Yeah I do.

Q: Would you say this program captured the interest of the students?
A: Most of their interest throughout, there was a few kids of course that were disinterested or got bored with the activities, but the majority definitely.

Q: Did the concept capture them?
A: I think they still need to do some work on what biodiversity is, I don't think they understand the definition, but they understand its importance.

Q: Did the hands on 'doing' engage them?
A: Yeah, definitely.

Q: What were the most engaging portions of the program?
A: I think probably actually getting to do the activities was the most engaging for them because, like I said, they're quite a hands-on group. I think the temperature measurement, the CO2 measurement and the soil. For the temperature and CO2 I think it was because they got to use the hand-held equipment, they had to read it themselves and the soil because they had an opportunity to get their hands dirty.

Q: What could be improved?
A: Possibly doing the interactive food-web outside because they sort of got cramped. I think that's it.

Q: What changes did you see during the program? How did behaviour change from regular classroom settings?
A: Not a lot of change, I think they were pretty much themselves. Maybe because there were more adults around guiding them instead of just me, they were a little bit more focused.

Q: Is the program likely to have a lasting positive impact on the students?
A: Yeah, I hope so, as long as I follow it up in class it will, as long as there's a follow-up.

Q: Do you think the students approach to science will improve as a result of the program?
A: I think some of them will have a better idea about what environmental science is about.

Q: Will this program be advantageous to helping you teach them about science?
A: Yes, definitely, it's given me some ideas and some things to refer back to, so when we're talking about it later in the topic I'll be able to say "remember when you looked at the temperature monitoring? Remember when you looked at pH?"

Q: If question seems pertinent during specific interview: Do you expect the programs will affect students' future to be involved with science? VCE? University? Career?
A: For some of them if they've got an interest in environmental science it would help them see what kind of work they'd be doing out in the field, but the majority probably not, I think it would have to be a student that already has an interest in it.

Marnie Sparrow P2 Interview

Q: Did you have a post-program discussion with the students?
A: That was our plan for today, talk about Biodiversity to make sure they understand the concept. I don't think that everyone got it; they enjoyed doing it but I don't think they got it.

Q: If you were given a worksheet, would you be more willing to reinforce program material?
A: Yeah, for sure, that would be great.

Q: Have you noticed any changes in the students towards science and technology since the CSIRO program?
A: A couple of them have said they enjoy working with the equipment, but we haven't had another class since then, so not really, not yet.

Q: Do you think the program may have had an effect on students' futures? Would they want be involved with science? VCE? University? Career?
A: Yeah, I think it's given them a better idea of what kind of work an environmental scientist would do.

Q: Was the program worth doing? (effort, cost, arrangements and planning, etc)
A: For us it was great because it was free, but I think having to pay it first term wouldn't work because we already have got an excursion planned. I would probably slot them in at the end of the year, ideally if we had to pay for it, so we'd be able to let the parents know. It's worth the cost but I'd do it at the end of the year.

Q: Is there anything that you feel CSIRO could change to make the program have more value?
A: I said to Elke that it would be great to have a video or some pictures on a PowerPoint of the bandicoot to make it a little more visual, but other than that, the worksheet to keep the kids connected with the packet they're looking at. Also when they were doing the food web I thought it was a bit chaotic doing it in their seats so I thought they could do it outside if possible.

Mike McGowan P1 Interview

Q: (He came in half-way through the program) Are you their science teacher?
A: Yes I am.

Q: Did you enjoy the program?
A: Yeah.

Q: How well did the program compliment the current science curriculum/or specific learning unit related to this program?
A: Very well, because they're doing a unit on ecology, and they're doing an excursion next week to Rickers point so this is good background for that.

Q: Were the activities appropriate for the age group? Were the activities appropriate for your students specifically?
A: Yeah it was fine.

Q: Would you say this program captured the interest of the students?
A: It's hard because I only saw half of it, but yeah the majority of it.

Q: Did the concept capture them?
A: I think they struggled a bit with the concept of biodiversity. Just linking the word with the meaning is a little difficult for them to understand. I think they understand what biodiversity is.

Q: What were the most engaging portions of the program?
A: I think they liked the CO2 meter the most because they got to walk around and see the numbers change. Classification they seem to enjoy.

Q: What could be improved?
A: I guess the way they record the data. A lot of them just scrunch up their paper when they complete this or they complete that, but maybe they could sort of enter it digitally so they have to answer.

Q: What changes did you see during the program? How did behaviour change from regular classroom settings?
A: No, they were good, there's not much difference; they were probably a bit more respectful because they didn't know you. Compared to theory, yes, prac work they like as well.

Q: Is the program likely to have a lasting positive impact on the students?
A: I think the more exposed they get to programs like this the better.

Q: Do you think the students approach to science will improve as a result of the program?
A: Time will tell, it's hard to say.

Q: Will this program be advantageous to helping you teach them about science?
A: Yes, definitely, it's given me some ideas and some things to refer back to, so when we're talking about it later in the topic I'll be able to say "remember when you looked at the temperature monitoring? Remember when you looked at pH?"

Q: If question seems pertinent during specific interview: Do you expect the programs will affect students' future to be involved with science? VCE? University? Career?
A: Yeah, it gives them a bit more guidance.

Mike McGowan P2 Interview

Q: Did you have a post-program discussion with the students?
A: No, I plan to. We're going to do stuff with food webs.

Q: Would you use a supplemental worksheet if CSIRO gave one?
A: Definitely. Yeah.

Q: Have there been unprompted questions or comments from students?
A: Haven't seen them or talked to them yet, no.

Q: Do you think the program may have had an effect on students' futures? Would they want be involved with science? VCE? University? Career?
A: Um, I think some would, yeah. If they were interested in certain areas of science, like in terms of the environment, yeah.

Q: Was the program worth doing? (effort, cost, arrangements and planning, etc)
A: Look, in preparation for going to their Ricker Point excursion in terms of looking at an ecosystem, a whole day of activities is good preparation for them before they actually go.

Q: Is there anything that you feel CSIRO could change to make the program have more value? To students? To you?
A: I only saw the first part of it, but I guess following up with a worksheet to see what the kids have done, because some of them only did five of the experiments, missed a couple here and there. Just making sure they did all of them and understood the purpose of each one.