WEB-BASED STATISTICS EDUCATION FOR SCHOOLS

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AN INTERACTIVE QUALIFYING PROJECT REPORT SUBMITTED TO THE FACULTY OF WORCESTER POLYTECHNIC INSTITUTE IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF SCIENCE BY:

JAMES E. VAUTIN
NAJMUDDIN J. GUNJA
JOSETTE V. JAECKSCH

ADVISED BY:
PROFESSOR LAURA MENIDES, ADVISOR
PROFESSOR JONATHAN BARNETT, CO-ADVISOR

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WEB-BASED STATISTICS EDUCATION FOR SCHOOLS:
GUIDELINES TO ENHANCE THE AUSTRALIAN BUREAU OF STATISTICS, NATIONAL EDUCATIONAL SERVICES UNIT WEB PAGES

An Interactive Qualifying Project
submitted to Australian Bureau of Statistics, Soo Kong
and to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
Professors Laura Menides and Jonathan Barnett, Advisors
by

James Vautin

Najmuddin Gunja

Josie Jaecksch

Approval:

Laura J. Menides, Advisor

Jonathon Barnett, Co-Advisor

Abstract

The project team, performing at the Australian Bureau of Statistics, National Educational Services Unit in Melbourne (ABS, NESU), created a strategy for the redevelopment and maintenance of the educational portion of the ABS web site. We researched curriculum requirements, student learning styles and other educational web sites; conducted focus groups with teachers and students; and provided a guideline and a model for NESU staff and technical developers to build web pages that are informative, interactive and appealing statistical resources for schools.

Executive Summary

The Problem

Based on a survey of school mathematics co-ordinators, the National Educational Services Unit (NESU) of the Australian Bureau of Statistics (ABS) determined that the educational pages of the ABS web site need content that is more engaging, interactive and geared toward students. Encouraging classroom use of ABS statistics has been an ongoing priority of NESU. In addition, upper ABS management has emphasised promoting statistical studies and other mathematics to students.

The ABS Web Site and NESU Pages

The ABS/NESU web pages house much educational content for teachers and librarians, including lesson plans, activities and data for classroom use. However, student-oriented content is very limited. The web pages are not interactive and do not possess traits such as graphics or sound, that commonly appeal to students.

The Project Overview

The project goals were as follows:

- to explore various web sites and projects with an educational objective;
- to assess web-based activities that would enhance student learning against curriculum outcomes, emphasising statistics and mathematical studies;
- to analyse results of focus groups of students and teachers regarding the web-based activities;

- to develop ideas for new activities that would encourage student learning and interest in mathematics using ABS statistics;
- to create a strategy to position ABS at the forefront of statistical literacy;
- to provide an indicative cost analysis for production and maintenance of the recommended web pages.

Methodology: Background Research

Most of the basis of our final result and development of methodology for this project relied on research. In Worcester, we interviewed educators with relevant backgrounds during which we gained insights on topics from the development of web pages to learning particulars of students.

Methodology: Sample Activities Presented to Focus Groups

Eight web-based activities possessing a sample of traits important to effective education were selected to present to four focus groups. These activities came from web sites with goals similar to our project, including:

- *Interactivate*
  <http://www.shodor.org/interactivate>
- *Java Demos for Probability and Statistics*
  <http://www.math.csusb.edu/faculty/stanton/probstat/index.html>.

The criteria for selecting these activities included interactivity, visual appeal and user friendliness. Activities selected included a circle graph calculator, a probability driven forest fire simulation, and an online quiz.

The sample activities were presented to focus groups, a group of teachers and three groups of students from grades eight to eleven. The responses collected during the focus groups indicated students and teachers preferred the activities that were more interactive, and contained more background information and allowed for more user control. Other comments indicated more colour and sounds were important as well.

ABS Officials' Feedback on Preliminary Recommendations

Preliminary recommendations, based on the focus group results as well as the research conducted in the US were presented in the Australian capital of Canberra to upper level ABS management for feedback on feasibility and the direction to be pursued.

Primary concerns of IT staff were schools' limited accessibility of Java-based activities, compliance with accessibility guidelines for visually impaired users, including the World Wide Web Consortium (W3C) as well as the expected costs and requirements for implementation and maintenance. Further discussion with Canberra officials provided reassurances and solutions to many of these issues. The IT staff also suggested alternate software that would avoid Java usability concerns and comply with the W3C standards.

Other suggestions from ABS staff included providing teacher training for using activities in the classroom, targeting grade levels of developed activities, and raising teacher awareness of the availability of future activities.

Deliverables

The strategy we developed to position ABS at the forefront of statistical literacy has three primary sections:

- Guidelines on future web based activity development including important characteristics, suggested curriculum focuses, and possible data set topics.
- Sample layouts and necessary features of the web pages and interface for students to access the activities and educational material. Included are a written outline and pictorial example.
- Projected costs and requirements for implementation and maintenance of the proposed strategy.

These sections serve as guidelines for NESU staff to work with technical developers in creating and implementing new educational web pages.

Recommended Strategy for ABS

We developed guidelines to make the educational pages more interactive, informative and appealing to students. We recommend that all activities to be developed should possess the following characteristics:

- User interactivity
- Challenging to students
- Complementary to lessons
- Computer exclusivity
- Enhancement by sound
- Colour
- Curriculum focussed

- Activity specific information
- Student-relevant information

Some curriculum-focused activities teachers wanted and we recommend are data collection and representation, Venn diagrams, graphs and smoothing. Data sets for use in the activities should appeal to students, for example sports statistics or current events data.

We recommend that the web pages and interface should consist of a main menu page and three pages for each concept presented in an activity. All of these pages should contain links to other resources and important home pages. Each page should also have supplementary information. The concept-specific pages should include a text-based page, a page for the activity and a separate quiz page.

The projected costs and requirements for our strategy fall into three sections: initial implementation, educational material updates and long-term web page maintenance. Regardless of whether the development is outsourced or kept in house, the quoted initial implementation costs ranged from $AUD 14,000 to $AUD 30,000. We estimate the work hours would total 150 hours for NESU staff and 300 hours for IT development. The educational material, especially the data sets, would need to be updated periodically, and if done in-house, would require minimal effort and costs. Long-term maintenance should also be minimal: approximately three work hours per month to ensure the system is functioning properly.

Conclusion

Our research indicates that an interactive educational web site would promote student interest in and understanding of statistics. The recommendations that we provided will serve as a guide to NESU staff and the IT developers for further development of the NESU web pages into an informative and appealing educational resource for students and teachers.

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1 Introduction

Worcester Polytechnic Institute's theory of project-based education led the project team to work on an Interactive Qualifying Project (IQP) in Melbourne, Australia with the Australian Bureau of Statistics (ABS). The main goal of the IQP is to foster student understanding about the social and ethical issues that exist when dealing with science and technology. While in Melbourne, we recommended strategies to develop the educational portion of the ABS web site into a highly informative, interactive and appealing statistical resource for students grades six and above.

The educational initiative at the ABS is a subsection of its statistical services to the government and community. The Bureau's mission statement is as follows:

> The Australian Bureau of Statistics is Australia's official statistical organization. We assist and encourage informed decision-making, research and discussion within governments and the community, by providing a high quality, objective and responsive national statistical service. (ABS, 2001)

This mission statement reflects an organization that seeks to educate as well as service the needs of a community. Users of ABS statistics can include almost anyone. For this reason, the public must be educated about the statistics available through ABS to increase the usefulness of the organization as a whole.

Since education is such an important aspect of this mission, a separate section of the ABS exists, the National Education Services Unit (NESU). We worked with this section, headed by Assistant Director Soo Kong.

The social benefits of educating students in statistics are numerous. Professionals, including financial advisors, athletes and social scientists, use statistics in some form or another. Yet, many students go through their entire education without any consideration of statistics. Students who have been introduced to concepts of data

collection and presentation are more likely to use these concepts in higher education and choose careers that incorporate statistics later in their lives (McLennan). By educating students in secondary school, the ABS is seeding for the country's future.

This project was designed to execute a variety of functions. Feedback from the 2002 International Conference of Teaching Statistics (ICOTS), in Cape Town suggested that the educational portion of the ABS web site could be made more interesting and appealing to Australian students. This part of the ABS web site is currently geared towards teachers and librarians only, and as a result of our project work, we discovered a new presentation and approach for adding student material. We devised a plan to make the current NESU web site more engaging and interactive, while encouraging interest in ABS statistics. The Victorian mathematics curriculum was used as a guide for development of interactive integration of statistics into classrooms through the NESU's web pages. The World Wide Web Consortium (W3C) accessibility guidelines were also taken into consideration. These guidelines, approved by the Office of Government Online in Australia, ensure that people with disabilities can access government provided online resources. ("Educational web page accessibility for blind and low vision users" 2001)

Our specific tasks for this project which were defined by Iain Sutherland, a staff member of NESU, are the following:

- an exploration of various web packages and presentations;
- an assessment of possible web-based activities to enhance student learning measured against curriculum outcomes and motivational factors for students, emphasis to be given to mathematics subject streams and in particular the study of statistics
- development of new ideas for activities that will fulfil curriculum outcomes and motivate students in using ABS statistics;
- recommendations for a web-based strategy that will position the ABS at the forefront of statistical learning;

- analysis of focus groups conducted with a sample of students and teachers; and
- a cost analysis for production and maintenance of the web pages.

In order to test the effectiveness of current web-based activities, we considered the opinions of many people involved, including those of ABS/NESU employees, teachers, and students. We used opinion based studies in focus groups in order to understand what methods and activities worked best in encouraging students to use and enjoy statistics.

The entity that benefits most directly from our recommendations is the National Educational Services Unit of the ABS. Using our recommendations as a guideline, the NESU will be able to develop a more interactive web site for students, thereby fulfilling one of its main goals.

2 Background and Literature Review

The Australian Bureau of Statistics (ABS) web site is based on the organization's goals. Instead of just housing information about the organization, the web site is aimed at supporting many of the organization's tasks. Through the latest advances in information dissemination, ABS seeks to provide accurate statistics on the government, community, and business, and to enhance this information by educating the public on its use.

Visitors to the web site come from a wide range of backgrounds. Therefore, to be effective, the web site must target a diverse population – from businesses looking for information that may affect their productivity to secondary school students looking for material for their first research paper. This diverse audience is not typical for most web sites; therefore, the ABS web site design must be different in its scope and navigation system from most corporate web sites. By providing a common interface with an appropriate navigation system that redirects people to the portion most applicable to their needs, the web site could be made highly comprehensive. The current navigation system is being revised to provide this direction (Dickinson, telephone conference). The new navigation system will be critical in directing the appropriate traffic – that of students and teachers – to our proposed portion of the web site.

ABS has dedicated a portion of its web site to education to promote the informed decision-making that is part of the mission statement (see section 1). The educational portion of the web site has many features, some intended for particular audiences, and some developed for the general public. The recommended expansion of the ABS web site is more specialized by being an educational resource aimed at an audience of students and teachers for classroom use in grades six and above.

Our recommendations for this expansion of ABS's web site were made with the aim of holding the attention of students. To do this, research was conducted with students of our targeted age groups and with teachers of these grade levels. Focus groups, which allow the subjects to hear and respond to the opinions and thoughts of their counterparts, were used to extract and test this information, and to generate new ideas.

The ideas generated from the focus groups were also incorporated to our recommended strategy to encourage more curiosity in the statistics work that ABS does. One of the most effective teaching elements is to generate interest in the subject, as then students are more likely to learn on their own (Clark, personal interview). Building interest was then an important goal for the project, particularly interest in statistical material in the classroom.

2.1 Victorian Mathematics Curriculum

The Victorian mathematics curriculum was reviewed from the Victorian Curriculum and Assessment Authority web site <http://www.vcaa.vic.edu.au> for different grade levels ranging from six to ten. We gathered data for the different grades from the "Chance and Data" section of the math curriculum and documented the information in a Microsoft Excel spreadsheet (See Appendix B).

2.1.1 Objectives and Focus in grade six

The Chance portion of the Chance and Data section in Grade 6 focuses on simple probability experiments. Students are required to use fractions to assign probabilities and to analyse and predict outcomes for the experiments. The Data portion of the Chance and Data section is divided into several components. The first component deals with collecting, organizing and recording data in a systematic

manner. The second component introduces the students to graphs that include tree diagrams, bar graphs and dot plots. Students are expected to interpret and construct graphs using knowledge of measurement (i.e. areas, scales, lengths etc.). Finally, students are introduced to summary statistics (mean, median, mode and range) and how each method differs from the other (Curriculum and Standards Framework II). See Appendix B for more details on the grade six curriculum.

2.1.2 Objectives and Focus in grades seven and eight

Students in grades seven and eight conduct simple probability experiments involving repeated trials and then analyse the results by assigning probabilities to events. Students are also required to use random number generators to simulate simple situations. The data portion focuses on effective collection and organization of data in order for the students to learn to analyse the data carefully and generate further questions about it. Once data collection has been mastered, students must be able to effectively organize the data in a database and interpret it using summary statistics that they have learned in grade six. Students must also learn to use spreadsheets, statistical software and either a scientific or graphing calculator. For detailed information on the grade seven and eight curriculum, see Appendix B.

2.1.3 Objectives and Focus in grades nine and ten

In grades nine and ten, students analyse published data using long run frequencies. Probability is calculated for compound events. Students learn the difference between mutually exclusive events and mutually inclusive events and are introduced to different terms in probability such as "and", "or" and "not." They must also learn the difference between independent and dependant events and should be

able to infer conditional probabilities in a social framework. Students are required to use graphical methods: graphical calculators, spreadsheets or a statistical software package to represent univariate and bivariate data. Once the data has been collected, students should be able to display the data appropriately using various graphs learned in grade seven and eight. They should also be able to interpret the data using summary statistics (Curriculum and Standards Framework II). For further information on the grade nine and ten curriculum, see Appendix B.

2.2 Student learning styles

In order to select different interactive activities for students, it is important to understand how students think, communicate, and learn. Some students favour particular learning styles over others and it is crucial to identify the different learning styles.

Extensive research has been conducted over the last thirty-five years into student learning styles in mathematics. Different people learn things differently and the origin of such an idea can probably be traced back to the ancient Greek civilization (Wratcher, Morrison, Riley & Scheirton 1997). A learning style can be defined as "personal qualities that influence a student's ability to acquire information, to interact with peers and the teacher, and otherwise participate in learning experiences" (Grasha 1996). A simple multiplication problem can be given to exhibit differences in learning styles. For example, if a student is asked to multiply 34 times 40, depending on his personal preference, he may do it by hand, use a regular calculator or even compute the answer in his mind. Whichever way the student chooses to do the problem, he is utilizing a learning style that is most comfortable to him.

Elizabeth Bogod's article on learning styles and multiple-intelligence identifies three main learning styles that students employ when in a classroom. The first kind is visual. A visual learner is one who learns by watching. According to research conducted at the University of South Dakota, visual learners like to see what they learn. They need to look at their teacher's hand movements and facial expressions in order to understand the material. The second is an auditory learner. These learners require sound in order to comprehend the material. For them, viewing the material is not sufficient to learn it; they often need to speak the material to themselves in order to grasp the essence of the lecture. The third major learning style includes students who learn best by utilizing a hands-on approach. They are called "kinesthetic" or "tactile" learners. Viewing and listening to the material is not enough for them; they need to physically touch what they are learning in order to remember it (U of South Dakota). This background gives us a good indication of what kind of activities would accommodate several of the students' different learning styles.

2.3 Statistics Education

It has been proven that students learn more when they can relate to the information in front of them. When students do work with data that involves things they are interested in, such as sports or data reported in popular press, they are much more intrigued with what they are doing. This is particularly true with the age groups we are working with, and the idea is also supported by the National Center for Teaching Mathematics (NCTM) (Statistical Sampling and Data Collection Activities, 693).

When presented with interactive ways to learn statistical concepts, students are much more likely to succeed than when presented with activities that do not involve simple run of the mill datasets but do include data visualization (DIGstats: Overview).

Two and three dimensional visualization activities that include descriptive and inferential statistical tools are the basis of the DIGstats web site, which is a site that presents statistical information to high school students (See section 2.5 for more information about DIGstats).

Consideration must also be made to the personal motivations of students. Much of what students learn in a topic comes from how they approach it in the first place. When attempting to learn any type of mathematics, students with a personal reason or goal will be much more successful in learning it in the end (Heffernan, personal interview).

2.4 Internet and Educational Applications

Several studies have been conducted on the possible employment of the virtual world in education and learning. Initially, when the Internet was used, it was mostly for courses taught completely online. More often now, the Internet is used to provide enhancement to classes taught on campus (Maddux and Cummings, *Instructional and Cognitive Impacts* 147). Many teachers post homework assignments, set up bulletin boards and display other course-related material on the Internet. This partial integration of the web into curricula serves as a valuable tool, with several different applications possible.

When given the option between strong online presentations of course materials and written texts and syllabi, students prefer web-based presentations (Matthews, *Interactive Learning* 113). The availability, simplicity and multiplicity of the web strongly appeal to both students and teachers. An online application of curriculum also provides a more hands-on environment. By being part of the learning process rather than simply being shown facts and formulas, more information is retained and sought out by students. According to Professor William Clark of WPI, "You have to

do something with the material taught to you in order to learn it. This is interactive learning." John D. Emerson of Middlebury College supports this concept. He states, "The active engagement of new concepts is a key to student success, whereas passive involvement in the learning process at best gives lowered efficiency in learning" (Emerson, *Interactive Learning* 81). Through interactive activities online, the students can obtain applied experiences that may otherwise be awkward, expensive or impractical without the use of a computer. Multiple executions of a certain experiment can be simulated through computer activities, reinforcing learning simply and cheaply. In addition, "a highly interactive and engaging multimedia environment offers the advantages of flexibility that allow students to review a tough concept as much as needed" (Emerson, *Interactive Learning* 83). Another benefit is that when a teacher provides this multimedia environment online, a student is able to access it from any location at any time.

Much anxiety stems from the widespread use of the Internet today. Integrating the web into classrooms creates specific concerns such as student learning styles, accessibility and additional time for the teachers to develop the online tools. First, there are many different learning styles. Teachers cope with these different ways of learning every day. "Web designers can use a variety of ways to accommodate many of these differences" such as using multiple graphics, sound effects and music or interactive controls (Rutkowski). A strong site would appeal to most students in different ways. Another worry is how to reach students with no or very limited web access. They may be denied a very beneficial learning tool and needed assistance. This concern is lessened because most schools now have computers in each classroom or at the least a few available to students in the library. Finally, the substantial time and effort required by a teacher to create and maintain a useful web site or multimedia tool is a large obstacle. If a public or government site is

available with information and activities that a teacher could use or suggest their students access, then this problem is also avoided.

Several varieties of learning tools like tutorials, simulators and calculators are available with numerous applications for different subjects. Particularly for mathematics, online tutorials may be used as reviews for concepts taught in class. Some activities may extend the information presented during lectures, providing more stimulation in the subject area. The variability of the web has proved to offer a strong support as an enhancement to education today.

2.5 Existing Web-based Projects

New applications of the Internet foster the development of learning technologies that are revolutionizing education as we know it. Through our project, we developed a plan to educate students interactively in a way that is most interesting to them. This task required analysis of several technologies and activities found currently on the web.

A technology that we will be taking advantage of is Java. It is currently the most popular method for exhibiting computation-based interactive applications, particularly in areas of science and technology. Java is a universal programming platform developed by Sun Microsystems. Its utilization has cultivated a variety of applications from database management, to mathematical methods displayed on web pages (Java Technology Overview). The numerous statistical Java applets available on the web were used as a basis for presentation and discussion for students and teachers.

Other technologies exist that are more appropriate for presentation rather than interactivity. An example of this is Flash from Macromedia Corporation. Flash is

used in many educational presentations – particularly those that are more animated and entertaining (Macromedia Flash MX Testimonials).

Interactive, on-line education has been studied by many organizations and has resulted in several web sites and projects with a similar focus to that of the NESU's goal for our project. Many teachers and university professors have developed Java applets on a variety of statistical and other mathematical concepts. We looked at several of these sites for ideas on presentation for our own project.

One project called DIGstats <http://www.cvgs.k12.va.us/digstats/>, developed by students at Virginia Tech, was divided into areas of descriptive, inferential and graphical statistics. Each of these areas contained lessons for different topics using simple text and figures. Activities for students to do were also provided; however, these activities were not computer interactive. Instead, data sets were provided in Excel and text formats as well as a set for TI-83 graphing calculators. This was followed by activities and questions based on these data sets.

A site we found to be especially useful was a Portuguese statistics tutorial site called ALEA, an acronym which, in Portuguese, stands for Local Action of Applied Statistics <http://www.ine.pt>. This site was constructed for students to learn statistical concepts by working through a tutorial, reading text and completing exercises. This presentation has very little interaction for the student, the exception being a Trivial Pursuit type game. The game presents a series of multiple-choice questions on a variety of statistics from the Portuguese National Statistics Institute including crime and population figures. The general layout of information was clear and informative as well as colourful and easy to navigate. We considered a similar layout of information and navigation system while focusing more on interactive simulations and demonstrations to teach the concepts.

Another site that we perused through, entitled *Java Demos for Probability and Statistics* <www.math.csusb.edu/faculty/stanton/m262/probstat.html>, had several interactive statistics java applets written by Charles Stanton, a professor at California State University, San Bernardino. These are simple graphs, calculators and simulations based on a few concepts, but have little surrounding information about the topics being covered. The goal on this site was more to provide teachers and students with pre-constructed applets to be used in conjunction with lectures and text books.

A project that provided many useful ideas, as well as some of our sample activities, was developed by Shodor Education Foundation, Inc., and called *Interactivate* <http://www.shodor.org/interactivate>. This site was subdivided into areas designed for different grades of students including third to fifth grade, sixth to eighth and middle school. Each area contained activities for multiple mathematical concepts as well as links to explanations of how to use the activity and more information about the topic to which the activity relates.

2.6 Activity Categories

In the recommendation section, we incorporate activities of different categories defined here:

- Interactive applets – Applets of various technologies that appear within a web page that offer an interactive experience in learning the material. This category includes online quizzes or statistical games like Yahtzee.
- Calculator type applets – Applets that offer the student a functional utility for calculating solutions to problems provided elsewhere. These allow the user to add information into an online database and receive graphs and other data almost instantaneously.

- Simulators and Demonstrators – Applets that demonstrate a particular concept in statistics by offering a visual representation. These types of activities give the user an idea of how a system functions by displaying it in an animated fashion with different selectable data sets.
- Static Objects – Graphs, tables, etc that are used to demonstrate concepts. Most commonly static objects are applied in statistics in conjunction with other material.

2.7 Personal Interviews

On the WPI campus we interviewed several professors with experiences in fields related to our project. Professor Jonathon Barnett specified what our project outcomes should be – a document of various plans for the web site along with cost analyses. With regard to relating to the focus groups, he advised us to be professional with the teachers and a little more casual (but not too casual) with the students.

In our research, we found an article referencing a presentation made by Professor William Clark in 1997 regarding interactive, multimedia teaching tools. We interviewed Professor Clark about it and he offered much of the type of information we sought. He told us more about interactive learning and how students need to be engaged to actually learn the material. Based on the fact that there are several learning styles prevalent in the educational world, he recommended providing several different formats of information and activities on the final site. He also commented on the time required to create high quality multimedia classroom activities. If the initial software is good, it can be updated and used for several years as he has.

Professor Holly Ault, a former IQP advisor at the ABS, gave us useful information on how to relate to the students we would have in the focus groups in

Australia. She said to remember that sixth grade students think in a very different way from tenth grade students and so our questions would have to be phrased accordingly. She also pointed out that the students' analytical skill would not be as strong as the teachers, so extracting opinions from them may be more difficult and this would have to be taken into consideration in our questions as well.

Professor David Brown is a computer science expert at WPI. He regularly teaches a class on Human Computer Interaction, where students study the efficiency and effectiveness of human interaction with computer systems. We contacted Professor Brown in the interest of gaining useful information on our approach to our activities interface, with particular respect to the range of ages in our target audience. He stressed the importance of being familiar with our audience and its preferences. He stated that this information is required before conducting focus groups, to make the sessions more effective. Prototypes will be crucial in presentations to students and teachers, as they will be a basis for discussion in groups. Professor Brown also stressed the importance of games and their influence with this age group, and that we should take advantage of this interest.

2.8 Focus Groups

Using focus groups to gather data has several advantages. According to the American Society of Association Executives web site (http://www.asaenet.org), focus groups are an excellent technique to obtain in-depth detailed data. Due to the relatively small size of the groups, the discussions are usually lively and an eclectic variety of opinions and related ideas can be gathered in a short period of time. Focus groups also help researchers observe interactions between peers and this often provides valuable information on the research topic (Nassar-McMillan and Borders, Use of Focus Groups in Survey Item Development).

However, focus groups are not always easy to conduct. Participants may not be comfortable talking around other people and it is the job of the moderator to induce confidence in his/her group. A successful focus group then depends largely on the proficiency of the moderator.

Large focus groups often create a problem in gathering effective data. To quote Professor Holly Ault during our interview with her, "always make sure that when you conduct focus groups they are not large. In general, the smaller the group, the more likely that it will be helpful. This is so because [in large groups] people start feeding ideas off each other. In a smaller group of about five, each individual can think of his own unique idea."

Another drawback of focus groups is that the opinions expressed by the participants may not be representative of a larger population and so generalizations cannot be made. This limits the degree to which inferential statistics can be performed to analyse responses.

However Nassar-McMillan and Border in their article on focus groups mention that there are no ground rules that need to be followed when conducting focus groups. They could be structured or unstructured depending on the research material that needs to be tested. Further, the focus group could include Power Point presentations, demonstrations and some individual or group activities if researchers believe that it will help further their research.

2.9 Summary

Our goal was to develop recommendations for a proposed educational portion of the Australian Bureau of Statistics web site that educates and generates interest in areas of statistics, and is interactive and educationally stimulating to students of grades six and above. We analysed and researched topics which are pertinent to this

goal, including (but not limited to) Australian curriculum, student learning styles, methods of learning statistics, Internet and traditional methods of learning, existing projects and activities, evaluation methods for web-based activities, personal interviews with faculty and teachers, and background information on conducting focus groups.

3 Methodology

This project consists of several stages of research, evaluation, data collection (through interviews and focus groups), and analysis of the data collected. The final stage is the recommendation of a strategy for the ABS web site complete with a cost analysis (See section 5.3). What follows are the stages of our methodology:

3.1 Research currently available web activities

We started the project by going through different statistics and statistics education web sites and saving important and useful sites in a database for future reference and analysis. This technique was useful as it gave us a flavour of the activities that already existed on the Internet. In the early stages of the project, we browsed through hundreds of web sites in order to collect as much information as possible. The web sites that appeared to have several good activities or one very strong activity were added to our list of bookmarks. As our research progressed, we found more activities that were consistent with the Victorian Statistics Curriculum and added those to the list to consider as well.

3.2 Evaluate Activities

In existing web sites, statistics is presented in several different forms: interactive applets, calculator type applets, simulations and static objects. The activities that we collected were then organized into these respective categories.

We divided the Victorian statistics curriculum into three portions: Grade 6, Grades 7 and 8, and Grades 9 and 10 in order to better understand the differences in statistics levels between grades. (See section 2.1) Using this information, the

different groups of activities were then collected and compared with respect to each grade's curriculum.

3.3 Conduct Interviews

In an effort to see more possibilities for the project, during the first seven weeks in Worcester, we sought knowledge from WPI professors, local public school teachers, and current middle and high school students. Interviewing individuals in a variety of areas was most helpful in shaping the direction of the project. From the wide variety of backgrounds of our interviewees, we gathered several different ideas for improving what we had developed on our own.

3.3.1 With Teachers

The interviews we conducted with teachers from schools in Worcester gave us a better understanding of what some teachers want from web-based activities and how they currently use computers in their classrooms or teaching methods. We asked open-ended questions to get a feel for what most teachers think about the Internet and what they want from interactive sites that could be used in their classrooms. These questions provided new ideas that we could include in our strategy, such as a tracking system the teachers could use to monitor student use of assigned activities (Heffernen, personal interview). We also asked some straightforward questions that provided guidelines to our thinking in how to proceed with sample activity selection.

3.3.2 With Professors

Speaking with several WPI professors on different topics including the thought processes of middle school students, web page presentation, interactive education, and focus group styles has strengthened our recommendation based on the

knowledge and experiences we collected. We compiled professor-specific questions that resulted in the most specialized information that each professor could give us. For example we asked Professor Jonathan Barnett about guidelines on conducting focus groups with teachers as compared to students. We asked Professor David Brown, a Computer Science professor, about web site presentations. We also asked open-ended, general questions that led to other questions we had not considered before the interview; a case in point being the interview with Professor Holly Ault. We asked her about her experiences working with students and she provided much information on differences in ages, including how they could affect cognitive skills and how questions should be phrased to be geared to specific age groups.

3.3.3 With Students

Student interviews, conducted over the internet in the US, provided more information in regards to the direction our web page recommendation should take. Learning firsthand what students like and dislike about learning, about statistics and about interactive Internet activities was invaluable to our approach. Student responses indicated a disregard for statistics as an important category of mathematics. One student asked for examples where statistics were actually used "in the real world" (Jaecksch, personal interview), as she could not think of any everyday applications. Questions requesting simple opinions and a few questions with broader response categories made up the majority of the interviews. We also asked for some preliminary feedback on the sample activities we have already chosen.

3.4 Analyse Interviews

We pieced together the responses from our interviews to develop an initial picture of our recommendations. We considered the preferences of the teachers and

students, in conjunction with current uses and possible future applications of Internet activities to shape our design concept. We looked for trends in answers and applied them to our project accordingly. We considered the advice of the professors for positive directions to follow and pitfalls to avoid with regards to most aspects of our project including: conducting focus groups, activity selection, and the final web site layout. (For further details on these interviews, see section 2.7).

3.5 Select sample activities

Once the various interviews were analysed, the next step was to use the results of the interviews to evaluate a variety of selected web-based activities. Thirteen different sample activities were chosen to go through the evaluation process, where we had determined several characteristics based on our research on online education. To measure the degree to which each of all the collected activities possessed these characteristics, we developed subcategories that were evaluated numerically by comparing each activity to the others. See Appendix G for the specifics of this evaluation. These qualities together with their quantitative subparts are as follows:

1) The activity should be effective, in that it catches the attention of some learning styles from some age groups. Is it:

    Visually stimulating?

    Audibly stimulating?

    Tactilely stimulating?

2) It should be interactive, in the sense that it promotes activity from users which keeps the user attentive to the activity itself.

    How much user input?

    How much user control?

3) It should be educational; the user should actually learn the material associated with the activity.

   How much does the activity explain?

   How much does it demonstrate?

4) The activity must be challenging for students to learn the material better.

   How much previous knowledge is required?

   Is the activity a challenge?

5) It should be colourful.

   How many colours are used?

   How much of each colour?

6) It should correspond to some element in current curriculum.

   How close to a topic in curriculum?

7) It may include an audio component to help the blind and low vision students.

   How much audio?

   How easy to add audio?

   How easy to describe with text?

8) The activity should interest both boys and girls.

   More interesting to one or the other?

9) The activity should be easy to navigate and use.

   How easy to understand?

   How easy to use?

The following is the outline of the evaluation procedure that was followed in selecting the final set of activities that were used in the focus groups:

a) The criteria for what constitutes a good activity were weighted based on importance using scores of one to ten, one being the least important

while ten being the most important. The mean of the three team members' rankings was taken in order to obtain the final weight that each criterion would carry into the evaluation.

b) The sub-categories of each criterion were then weighted with respect to the original scaling of each criterion, obtained in step a. The mean was then taken to determine the value associated with each sub-category of the criterion.

c) Each activity was reviewed and evaluated against the different sub-categories of the different criteria from a scale of one to ten, one being the lowest and ten being the highest.

d) Each number value assigned was then multiplied by its respective weight as determined in step b.

e) Results obtained from step d for each sub-category of the criterion were then added together. The sum was then multiplied by the original weight given to the criterion in step a.

f) All the final results for each criterion of the activity were then added to get the final total score for the activity.

The best eight activities were selected based on two measures. The first was the final score of the activity that it received in the evaluation procedure. The second was based on the type of activity. In order to get useful results, different types of activities were chosen to be presented to the focus groups. The chosen activities included demonstrations, simulations, charts, graphs, quizzes and tables. Refer to appendix G for details on the numerical values assigned to the activities.

3.6 Develop Focus Group Questions

Based on a set of issues provided by the ABS (see Appendix H), the goals of the project and the background from the Worcester interviews, we compiled a preliminary list of questions to ask the two different focus groups. Working with ABS staff members in Melbourne, we deleted, changed and refined these questions into complete and useful sets, one for teachers and one for students.

The questions for the teacher focus group were phrased to open discussion and provide a starting place for the teachers to voice their opinions and preferences. Several questions concentrated on different aspects of similar points. For example, three questions delved into possible applications of web-based activities in teaching. The possible learning value the activity would have for their students was also targeted. Other questions were designed to elicit new ideas from teachers regarding the format of resources ABS could provide. See section 3.7.1 for the list of questions.

The student focus group questions for each activity addressed the following topics: whether or not the chosen activity inspired an interest in statistics; if it also interested them in using more activities like the one currently being demonstrated; if the students feel they learned something from the activity; and finally, if students found it easier to grasp the statistical concept being portrayed using the activity rather than learning it from a textbook. The finalized questions are outlined in section 3.7.2. These were designed to be less open ended than the set for teachers, as students are less likely to voice cognitive opinions in open discussion. (Ault, personal interview)

The depth and variety of the questions ensured the specific information we sought was provided.

3.7 Conduct Focus Groups

The goal of running focus groups with students and teachers is to gain the most useful information from their insights. To do this, we needed to present information to them in a way that most effectively built their opinions of the information. We had to determine what information from them would be most useful, and based on that, develop our presentation to generate appropriate responses.

An important note on the focus groups was our intent – to gain perspectives on the types of activities that could possibly be used in statistics education. For this reason, the demonstration was built around the different **types** of activities available rather than statistics **topics**. The eight activities that were selected for discussion were of a variety of types. Below are screenshots of the activities presented along with the description of the activity.

Circle Graph: This is a **graphing calculator** type activity that allows users to graph data on a circle graph. The users can enter in their own data or use a predefined data set. Percentages of the entered data set are calculated and displayed.

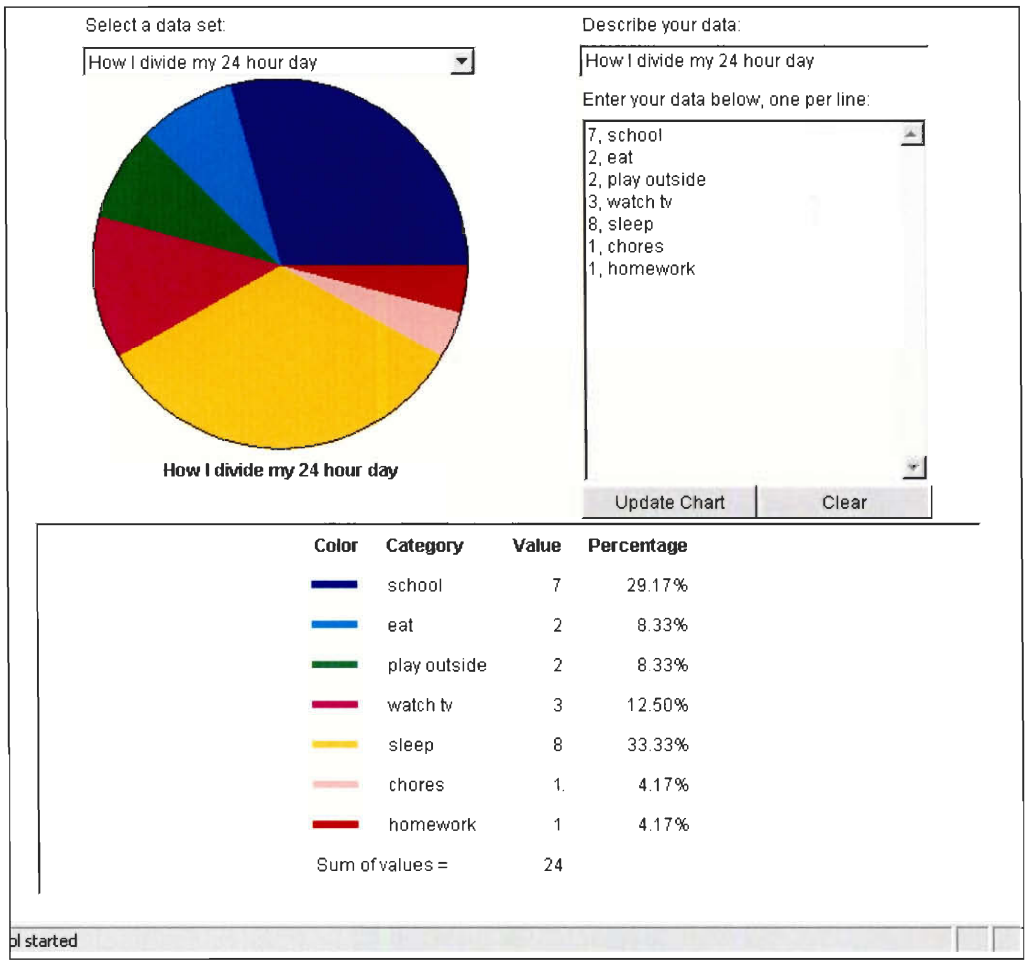


Figure 1: Circle Graph

Histogram: This is a **graphing calculator** type activity where users can construct their own histograms and view frequency data.

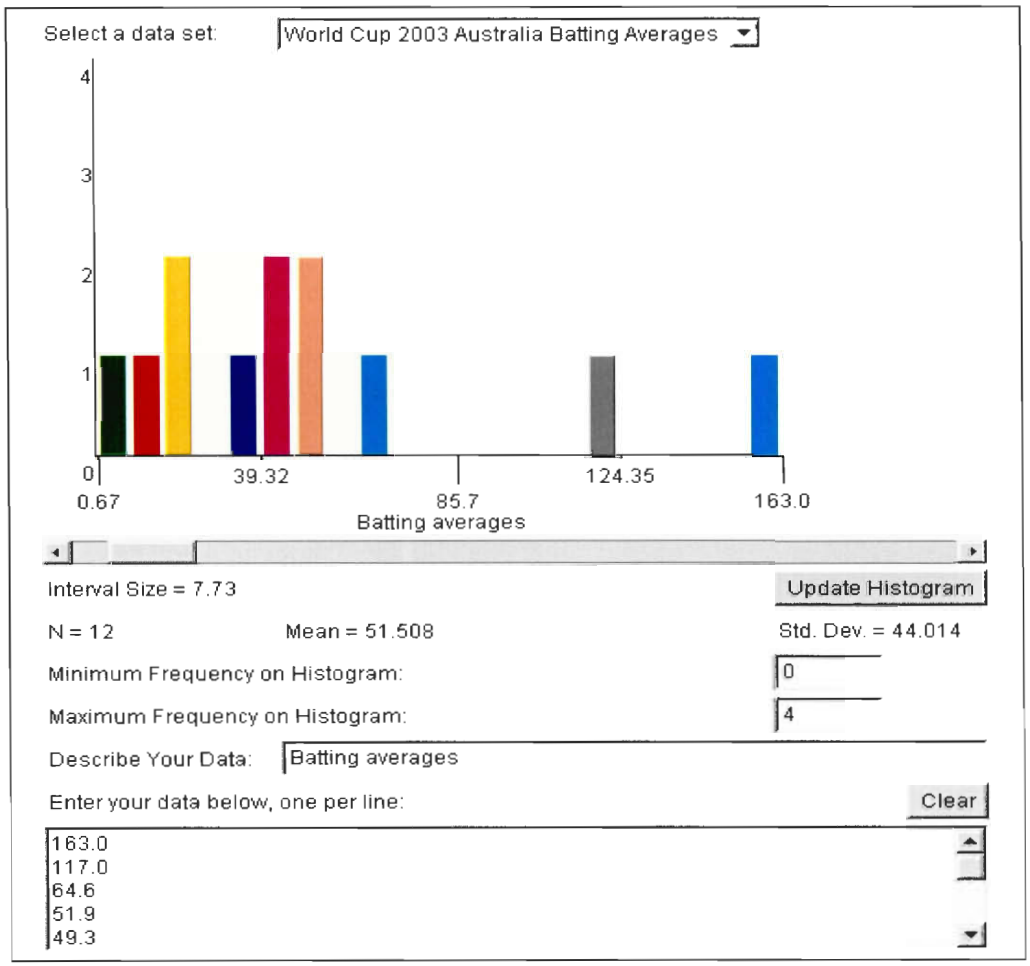


Figure 2: Histogram

Plop It!: This is a **graphing calculator** type activity that ascertains the mean, median and mode of a particular data set using bar graphs.

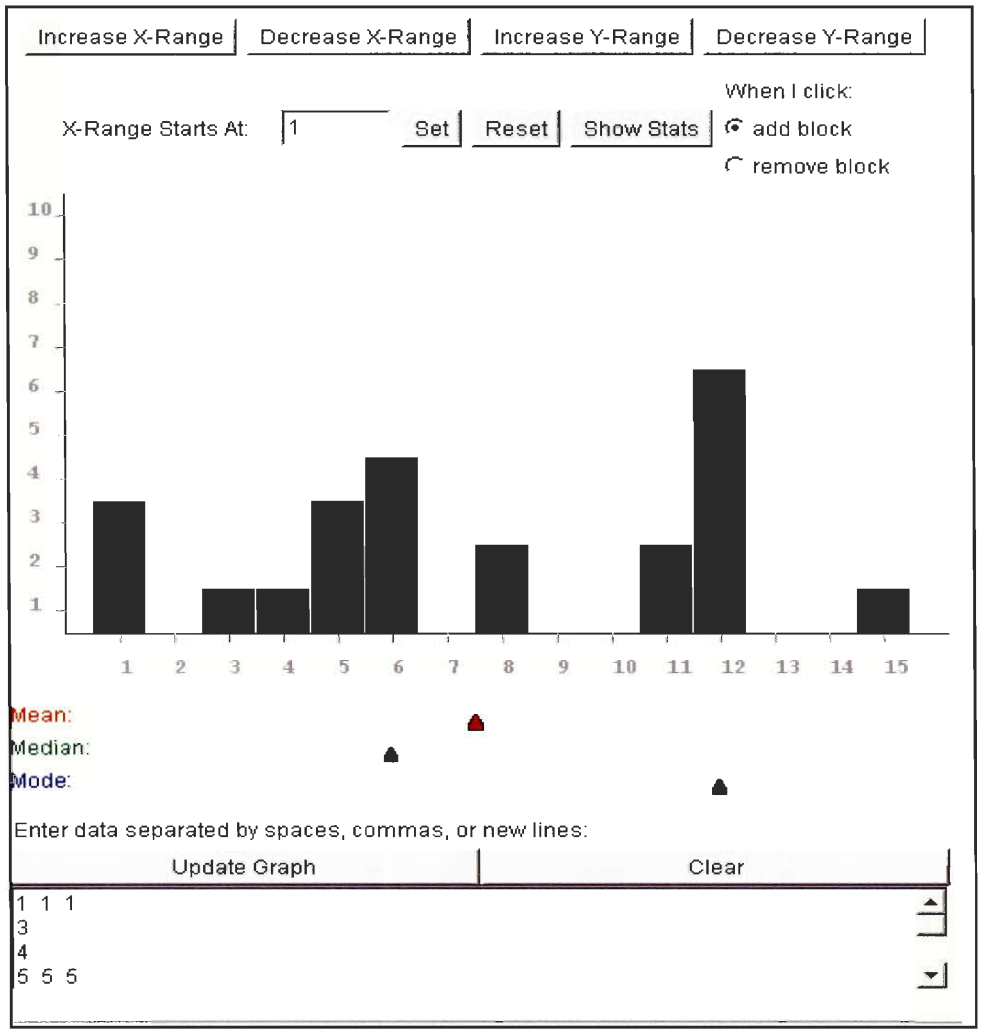


Figure 3: Plop It!

Racing Game: This is a **game simulating** a car race where the results depend on the rolling of a die. An additional feature in the activity, a circle graph of multiple races, reveals to the user the difference between experimental and theoretical probability.

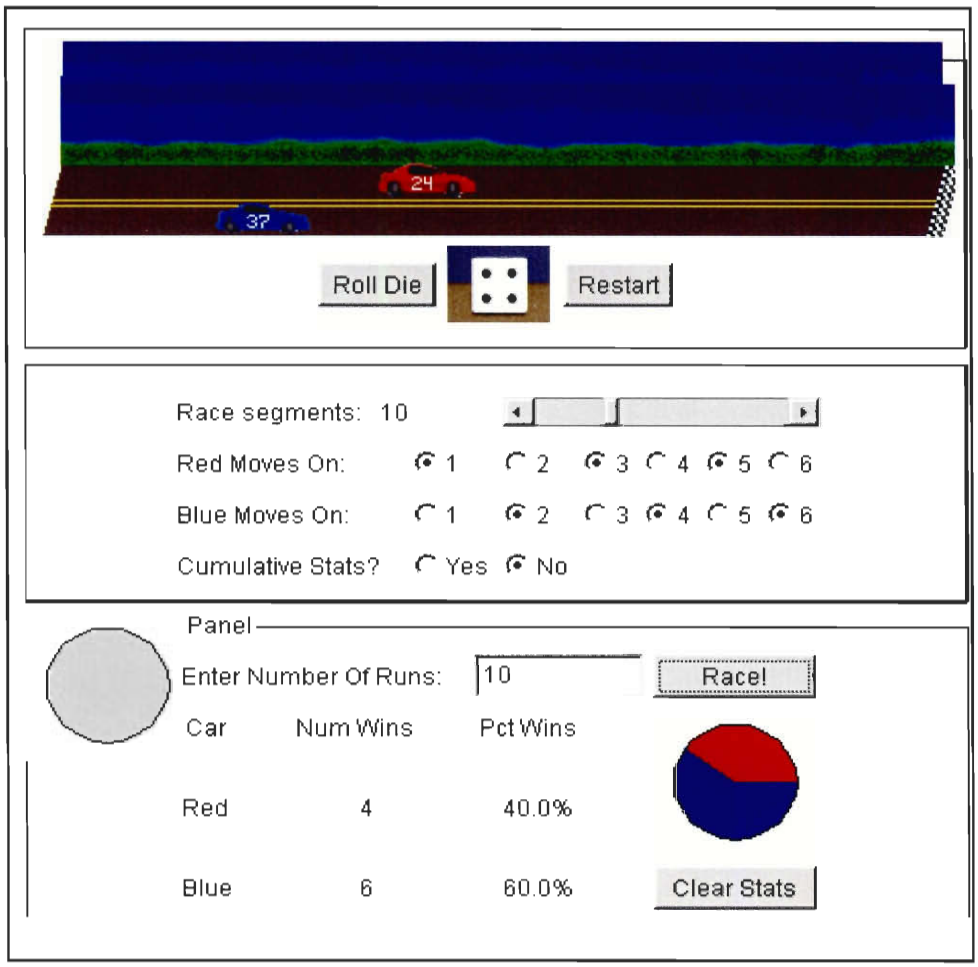


Figure 4: Racing Game

Dice Table: This is a **quiz** activity where users enter answers to several questions based on a probability table. The computer responds with a correct or incorrect message when the answers are submitted

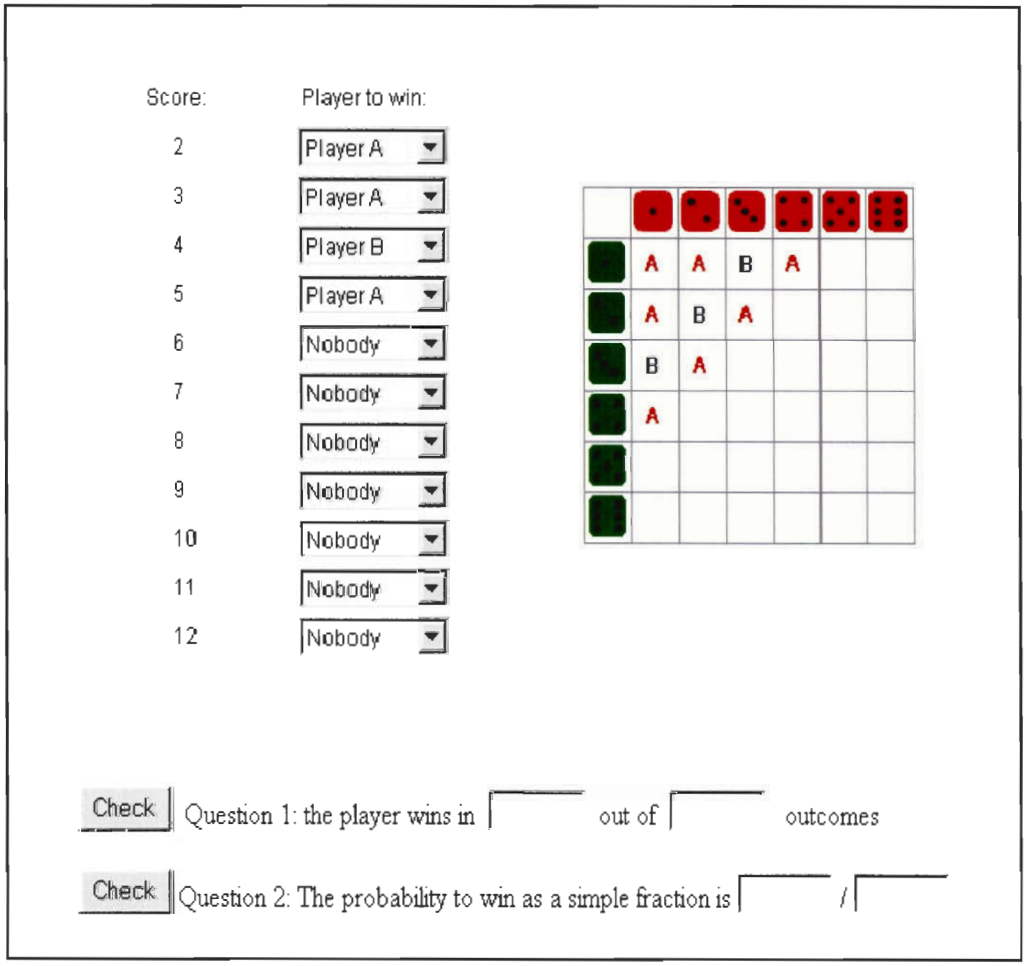


Figure 5: Dice Table

Gambler's Ruin: This simple **graph** activity **simulates** two players gambling. Two graphs show the number of trial runs and the different amounts of money won or lost for each player.

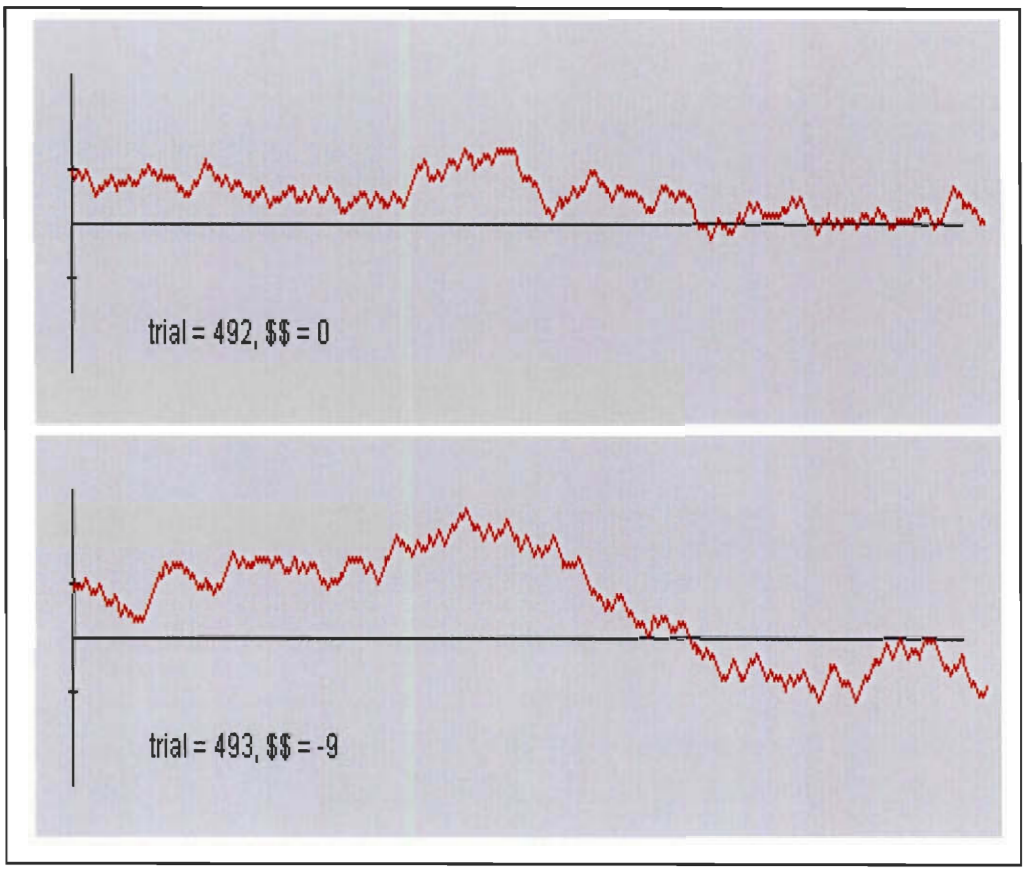


Figure 6: Gambler's Ruin

Fire Simulation: This activity allows the user to **simulate** a forest fire based on entered directional probability.

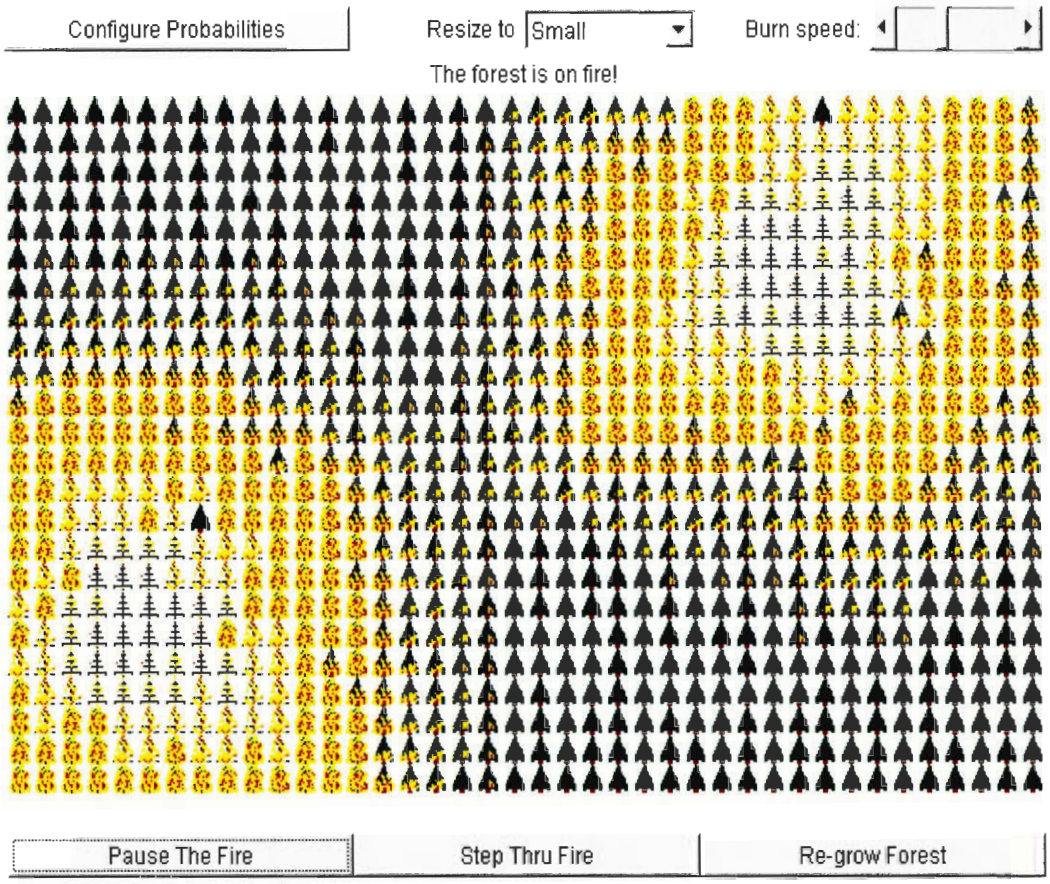


Figure 7: Forest Fire

Dice Rolling Simulation: A **simulation** of a variable number of dice with the sums of the dice faces **graphed** and compared to an ideal normal distribution for the selected number of rolls.

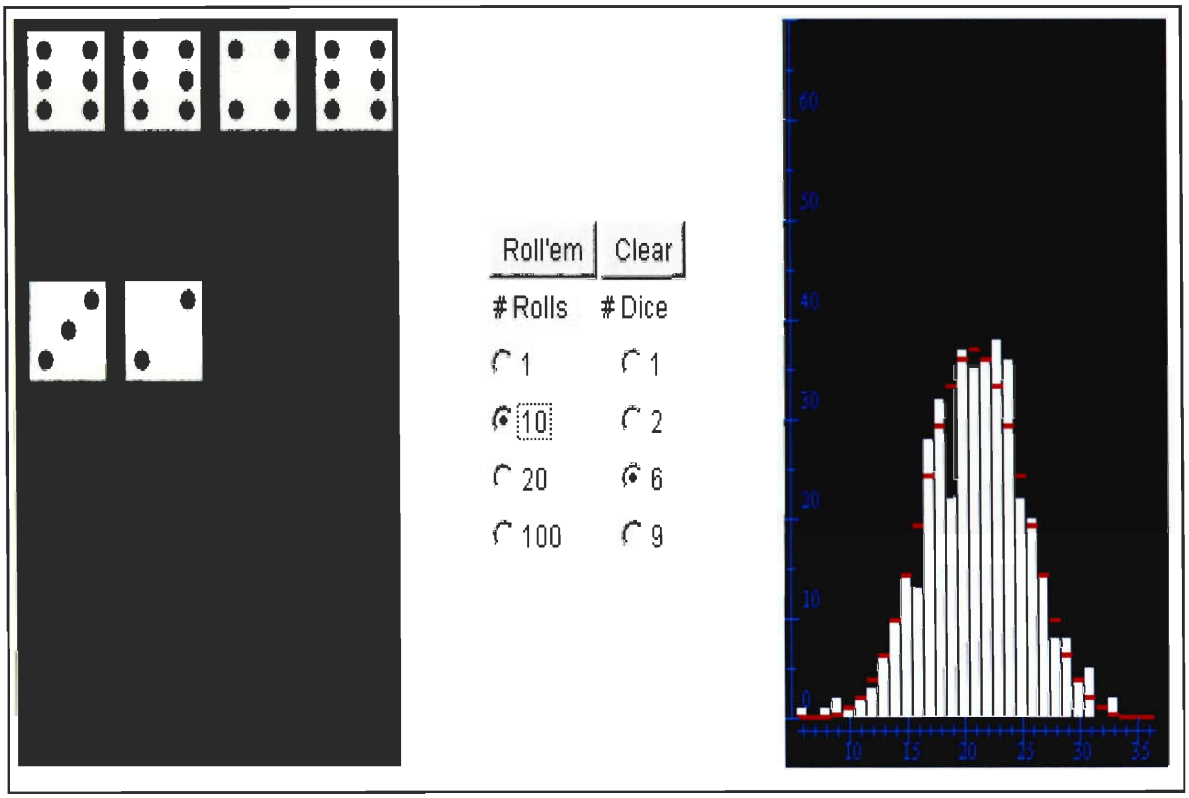


Figure 8: Dice Rolling

Also important to explain was that we were most interested in insights related to the types of activities. Certain pieces of curriculum were represented in some of these activities, and the topics covered generated several responses from the teachers. It was necessary to inform the teachers that the type of feedback we were seeking was not about curriculum.

To display the different activities to the students and teachers, we started with an opening web page with links to the sample activities. Throughout the demonstration, we had the attendees use this main page as an index to select the

activities that were pertinent to the current discussion. The same interface that they worked with was displayed on an overhead in front of them, except the project team, moderating the group, was controlling this interface.

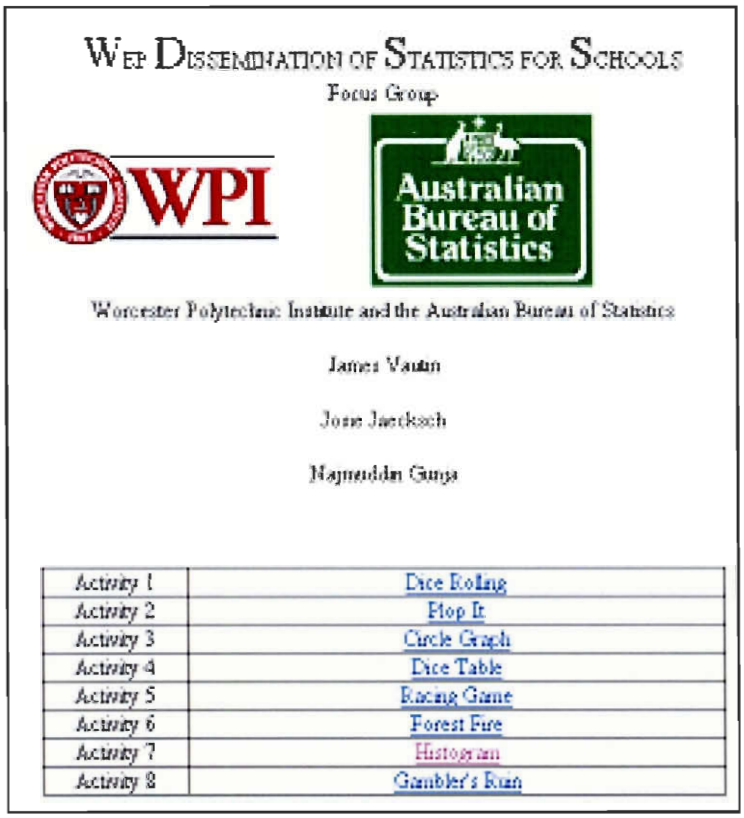


Figure 9: Index

3.7.1 With teachers

On Tuesday, 18 March 2003, we conducted a focus group comprised of nine teachers from Melbourne schools at the ABS office. The teachers were from local Catholic schools, Government schools and private schools. All taught multiple levels ranging from grade six to twelve. These teachers were contacted and paid by the ABS National Education Services Unit to participate in our focus group.

To gather a general idea of current technology use in the class room, we asked a few preliminary questions in a written survey before demonstrating the sample activities we selected. These questions were as follows:

- Have you used a computer to teach maths before? Why/why not?
- Do you use other multimedia equipment to teach maths? (e.g. overheads, video clips, Power Point, graphing calculators)
- Which do you find to be most effective in teaching maths?

We then proceeded to the pilot testing section of the session. Each teacher was invited to explore an activity on an individual computer for a minute or two, and then we asked for reactions based on the following questions:

- Do you think your students could learn from this type of activity?
    - Why/why not?
    - If so, would you use similar activities in your classroom? Why/why not?
- Would you recommend this type of activity for students to look at outside of class time?
    - Why/why not?
- Do you think your students would be interested in this type of activity?
    - Why/why not?
- Would you recommend this type of activity to other maths teachers?
    - Why/why not?
- Have you covered this topic in your class?

After each activity was presented and discussed, we gathered the teachers into a group for more a general discussion. We guided this discussion with these questions:

- Which activities did you find:
    - Easiest to use?
    - Most interesting?
- Which activities do you think would be:
    - Most appealing to your students?
    - Most educational?
    - Difficult to understand?
- In regards to teaching in general, which maths topics would you like to see in these types of activities?
- Which statistics topics do your students have the most trouble learning?
    - Why?
- What statistical resources would you like to see ABS develop to use in the classroom?

These questions were based on preliminary questions we developed in Worcester then refined based on input from ABS staff members. The responses and notes of the discussions were recorded by a WPI team member as well as on a tape recorder to ensure accuracy and completeness. The responses were transcribed and collected into tables for comparison to the student responses and then analysed for trends (See section 4.2).

3.7.2 With students

To conduct focus groups with students, we travelled to the schools of some of the teachers who volunteered their classes to us. We worked with students from three different classes, one class of year eleven students and two classes of year eight

students. We met with diverse groups of students from different socio-economic backgrounds, maths abilities and interests. We first presented to group of seventeen year eleven students (sixteen boys and one girl), at Catholic Regional School, Sydenham, in a computer lab where each student or pair of students had their own computer while the activities were presented on a large screen before the entire class as well. The other two student focus groups were conducted at St Joseph's College, Ferntree Gulley and Forest Hill College, Forest Hill respectively. Nine students were present at St Josephs College, all of whom were boys. The Forest Hill College consisted of nineteen students (eight boys and eleven girls). Due to unavailability of individual computers for the students, we presented all of the activities on a single large screen to the other two classes. As with the teacher focus groups, we asked a few background questions of the students to help open the channels of communication as well as provide some context for their responses to the activities. These preliminary questions were:

- Do you like maths?
- Is it your favourite subject?
- Do you think you are good at maths?
- Do you know what statistics are?
- Do you like doing statistics in maths?

Next, we introduced each activity with instructions and background and gave the students time to explore and react. We then posed the following questions, prompting for some discussion:

- Did you enjoy doing this activity? Why/why not?
- Would you enjoy doing other activities like this one again?
- Do you feel you learned something from this activity? What?

After all of the activities had been presented, we asked for more information from the students in a more informal question and discussion format. We guided this time with these questions:

- Which activities did you like most?
- Would you look for any of these kinds of activities outside of class time?
    - Why/why not?
- What kind of activities would you like to do when learning maths?
- Is it easier to learn from a textbook or from these types of activities? Why?
- Do you think you learned anything today, at all? What?

The students' responses were recorded by a WPI team member and an ABS staff member as well as on a tape recorder, to provide completeness and accuracy. The responses were analysed.

3.8 Analyse Focus Groups

After conducting the focus groups we compiled all of the teacher and student responses into a useful format (See Appendix E). A data table of the replies made it easier to compare responses from each group to the other groups as well as each group's comments about each activity. We looked for significant trends of preferences and opinions about the types of activities we presented as well as recurring comments. The common opinions and statements identified by this analysis became the foundation of our final recommendation to the ABS. Finding a preferred presentation of statistics for both students and teachers was the final goal of the analysis of the focus groups' responses and by combining the various suggestions and ideas, we developed an example and characteristics of such a presentation.

3.9 Research Creation and Maintenance Costs

In order to best generate a cost analysis, a pre-emptive idea of the final project structure was built. This was based on the design of existing web-based projects, considerations of content change as pertinent to Australian schools, and enhancement of many of the sample activities. The structure was then submitted to a number of companies.

The responses were then analysed to see if they were on target with the requirements of the project. Some of the responses required a follow-up, which restated many of the requirements of the project, as well as the strategy involving content development at NESU.

From the responses that were pertinent to these goals, we blended the results of hours and costs together. Some of the companies sent information that had specific hours required to complete specific goal, with information on their billing structure. Others gave less specific estimates.

Relating this information to the resources available at ABS, and with our liaison's input on the billing structure, we applied the number of hours estimated to a fixed billing rate ($AUD60/hour) at ABS to obtain a cost of development in-house.

3.10 Establish Preliminary Recommendations

To ensure our final recommendations would be feasible and supported by upper management, we met at the central office in Canberra on 14 April with ABS officials who were in positions to verify various aspects of our project, point out holes and recommend possible solutions. We solidified our preliminary thinking into an oral presentation format for these officials. For this presentation, we established initial statements the recommended strategy to make the ABS site more interactive and informative, then constructed supporting materials for this strategy including web

page layouts and activity characteristics. We also included preliminary assessments of the requirements for implementation and maintenance of the final pages.

3.11 Present Preliminary Recommendations to Canberra Office

On 14 April, approximately two weeks before the end of the project, we travelled to the Australian capital, Canberra to present our preliminary findings to ABS officials including: Dennis Trewin, Australian Statistician; Siu-Ming Tam, First Assistant Statistician, Information Management Division; Teresa Dickinson, Director of Client Services Division; and Acting Assistant Statistician, Gary Dunnet. We presented our background research, sample activities, focus group results and recommendations regarding activity development, web page layouts and preliminary implementation requirements.

3.12 Discuss Feasibility

Following the presentation, we met with IT staff in Canberra to determine the possibilities of developing and hosting the web pages at ABS. We talked first with Gary Dunnet, Acting Assistant Statistician and Director of Information Technology. We were then referred to Chris Conran, Director of Technical Applications, who answered many of our questions specific to the development of our project, including software capabilities, restrictions and accessibility guidelines.

3.13 Build Recommended Strategies for ABS

Using our analysis of the information derived from our research materials, interviews and focus groups, we compiled a written recommendation of the best course of action to make the ABS pages more interactive, appealing and educational.

We provided specifics on activities including the characteristics that all developed activities should possess, categories of favoured activities, teacher

requested curriculum concepts on which activities can be based, and examples of data sets that would interest students.

Our recommendation to the ABS also contained web site-specific information, which included different methods for keeping the site interesting and educational, such as updating the site to include new data sets periodically. In addition, we suggested the best way to integrate ABS statistical information into the activities and web page layouts. We also included a sample visual of the web site layout. Suggested colours, links and information will also be more easily understood from the visuals than from a written description of the web pages. These sample layouts will be important to the final designers and in keeping the web site visually stimulating to students.

As part of the recommendation, we included an estimate of the costs for the implementation of the basic web site and the projected costs of the type of maintenance and updates we felt would be best. These costs included time to develop and construct the web pages, along with other implementation requirements.

ABS has a strategy for improving the educational section of their web site. The plan we left behind was complete enough to guide the creative-education team and the technology development team through development and implementation. This final compilation was submitted to the NESU team and to our WPI advisors.

4 Data, Results, and Analysis

This section contains the actual data we collected that is pertinent to our project to develop a strategy to make the ABS educational pages more interactive and appealing to students. Included are details about the web-based activities researched, responses from the focus groups conducted, and specifics about the costs for our recommended addition to the ABS web site. Also incorporated in this section is the analysis of the data collected as well as recommendations ABS may decide to implement. These outlines contain the interpretations of teacher and student opinions regarding online activities; the types of activities and the categories of data to be integrated into these activities; suggested schedules for web site maintenance and updates; and the costs in terms of time and money for these different approaches.

4.1 Web-Based Activities

Many examples of statistical activities exist all over the web, such as histograms, pie charts, gambling simulators, distribution simulators, and guessing games. These activities illustrate concepts and allow students to develop estimating skills, practice data reading skills, and develop recognition and understanding of data representations ("Why Activities: Curriculum Context and Resources at Project Interactive"). We used several of these pre-existing activities to test the characteristics and types of activities preferred by students and teachers. All of our sample activities came from *Interactivate* and *Java Demos for Probability and Statistics*. These provided a wide variety of types of activities as well as demonstrated varying degrees of characteristics common to interactive activities.

An important part of the data we gathered was aimed both at representing various concepts as well as capturing various interests of students. Simulations, such

as the dice rolling simulation on Project *Interactive* represent important concepts such as relationships among numbers, number standards, and basic probability. Another simulation, titled "Fire!!," displays important concepts of data analysis and probability, with attention to ideas of chaos and randomness. A slightly more interactive simulation titled "Stock Exchange" introduces the concepts of chance in probability. This activity shows the difference between experimental and theoretical probability. It emphasizes the meanings of operations and how they relate to one another (Curriculum Context and Resources at Project Interactive).

4.2 Focus Groups

The responses we collected during the focus groups conducted with teachers and with students comprise the majority of the data on which our project is based. Divided into three sections corresponding to the way the focus groups were conducted, replies include background information about the teachers and students, answers specific to the various activities, and comparisons of the activities within certain categories. These responses are collected on the following tables mapped out by activity and type of information contained.

4.2.1 Teacher Focus Group

The data collected from the teacher focus group comprised of written answers to a short survey as well as verbal answers. The responses and discussion recorded were activity specific and/or prompted by open-ended questions. The verbal replies were often either a yes or a no with an explanation, suggestion or other comment.

The following is a table of responses to the written survey questions, given to the nine teachers to answer during the course of the focus group. All nine teachers filled out the survey and responded affirmatively to both of the questions. Multiple

examples and explanations were included in most answers. The specific comments and recurrences were as follows:

Table 1: Have you used a computer to teach maths before?

Why/Why not?	Recurrence of the response
For simulations	2
To use Excel	4
To access web sites- data sets	2
For drawing graphs	2
It's easier, provides a different presentation	2
Not often	2
No explanation provided	1

Table 2: Do you use other multimedia equipment to teach maths? [If so, what type?]

Multimedia type	Recurrence of the response
Overheads	3
Video clips	3
PowerPoint	3
Graphing calculators	9 (1 specifically TI-83)

Table 3: Which [equipment] do you find most effective in teaching maths?

Response	Recurrence of the response
Graphing & graphical software	2
Graphing calculators	3 (1 specifically TI-83)
All have their place/equally effective/depends on topic	4

After the written questions, we had the teachers each sit at a computer for a presentation of various activities. The teachers perused each activity, and then we asked them questions about that activity. The following is a synopsis of their responses. A complete table of the teachers' comments can be found in Appendix C.

Activity 1: Dice Rolling Simulation

The teachers reported that they enjoyed this simulation and acknowledged that this type of activity would be educational. However we found that this dice rolling simulation needed some more background information. Some teachers found the

activity difficult to understand, as it did not have an appropriate context. Others commented that two different concepts, normal distribution and sums, were being portrayed in the activity and this was an inappropriate way to teach maths. An additional suggestion made was that the simulation needed more user control.

Activity 2: Plop It

All the teachers appreciated this activity as it allowed them to enter data manually. Further, the teachers agreed that the activity was easy to use, interesting, educational, and would certainly appeal to students. They suggested that this type of activity would be suitable for students in grades 8 and 9 and that they would use the activity in their classrooms.

Activity 3: Circle Graph

The teachers said that they all liked this circle graph activity, even those who were not fond of pie charts in general. They agreed that the activity was easy to use, interesting, had considerable learning value, and would work well for science application. However a few teachers suggested that the students would require some background knowledge on this activity in order to completely understand it.

Activity 4: Dice Table

Teachers believed that this quiz type of activity was educational but only as a tutorial. Some suggested that having a quiz online was unnecessary and it would be easier to have it on paper. Additionally, the quiz questions in this particular activity did not include any open ended questions, which the teachers preferred over direct factual questions.

Activity 5: Gamblers Ruin

Teachers reported that they were not particularly interested in this graph, as they had no user control over the activity. They suggested that if this activity were to be used in the classroom, scales should be placed on the axes and background information should be given about what the students were supposed to learn from the activity.

Activity 6: Racing Game

The teachers stated that they liked this activity and thought that it would be an effective method in teaching students simple probability concepts. Although the teachers commented that the type of activity would appeal to students, they suggested that better graphics with real world events such as actual race car drivers would be required to impress them.

Activity 7: Fire Simulation

The teachers voted this simulation as the best because of its real world representation. They commented that it was an excellent way of teaching students probability and they would certainly use it in the classroom. Further, the activity would definitely appeal to students, and it had excellent user control. Further comments included that the activity was open-ended, enjoyable and interesting.

Activity 8: Histogram

The first comment of the teachers about this activity was that it would be more useful than a graphical calculator. Their reactions suggested that students would like this activity if a few minor changes were made to it. For example, the teachers thought that a little more background information needed to be supplied to students

while doing the activity. Also scales on both axes would help in understanding the activity better. Some teachers suggested that colour should be used appropriately as it influenced how students interpreted results. Currently the colours indicate different data sets as opposed to the single collection that is actually represented.

Our third section of questions called for superlatives for the various activities. The responses to these questions were thus:

Table 4: Which activities did you think were:

Activity	Most educational	Most interesting	Most appealing to students	Easiest to use	Most difficult to use	Activity type
Dice rolling	X				X	Simulation/Graph
Plop it	X	X	X	X		Calc/Graph
Circle graph		X	X	X		Calc/Graph
Dice table						Table/Quiz
Gambler's ruin						Graph/Simulation
Racing game			X			Demo/Game
Fire simulation	X	X	X			Simulation
Histogram						Calc/Graph

Looking at these responses from the teachers, it is clear that the preferred activities were of the simulation and calculator types, where interaction was principal. Plop it! was one of the most popular due to its extensive user control and multiple applications in addition to the interactivity. For each sample activity, someone made the comment that more background about the topic being covered and more directions for the activity were needed. Other frequently occurring suggestions for improvement included combining different types of activities and providing easy-to-implement data sets based on current events.

4.2.2 Student Focus Groups

We asked a collection of background questions in the three student focus groups that we conducted, for a general idea of the type of students with whom we were working. General responses to our preliminary questions were as follows:

Table 5: - Background information on students

Background Q's	Group 1 Responses	Group 2 Responses	Group 3 Responses
Number of Students	17	9	19
Like maths	8 students said yes	1 student said yes	6 students said yes
Math favorite subject	5 students said yes	No student said yes	1 student said yes
Good at maths	5 students said yes	4 students said yes	5 students said yes
What is statistics	5 students responded	3 students responded	2 students responded
	Information gathered from past events,	Sports results	Census
	averages, trends, patterns,	Footy results	How much of something there is
	collection of data which requires processing		
Like statistics	1 student said yes	2 students said yes	2 students said yes
Internet at home	15 students said yes	NA	NA
Heard of ABS	1 student said yes – uncle works at ABS	NA	NA

NA – Not Applicable

The students' comments and replies from the second set of questions, regarding the individual activities, were entered into tables similar to the ones for teacher responses (See Appendix C). A summary of the three focus groups' discussion about each activity is included here:

Activity 1: Dice Rolling Simulation

This activity was well received by students of grades eight and eleven. They liked the idea that the graph could actually move when the dice was rolled and this according to them made the concept to easier to understand. However, some grade 8 students suggested that background information be supplied with the activity to

facilitate concept understanding. Most students also agreed that a little more colour in the activity would make the activity more appealing.

Activity 2: Plop It

Both grade eight and eleven students enjoyed this graphing calculator type activity. The grade eleven students appreciated the educational aspect of the activity, i.e. the mean, median and mode could be calculated at the touch of a button. They also found this activity useful, as it could not be done on a calculator. Grade eight students concentrated more on the colour aspect of the activity. To quote a student, "this activity is so colourful and cute." Some eight graders suggested that sound would enhance the effectiveness of the activity.

Activity 3: Circle Graph

Students of both grades found this activity easy to understand and extremely interesting. The different colours exhibited on the circle graph helped the students grasp the concept easily. Students also liked the idea of being able to enter in their own data sets and manipulate data. For example, one grade eight student divided his twenty-four hour day into three sections, number of hours he spent sleeping, number of hours he spent in school and number of hours he spent studying. He entered in eight hours for each section and plotted the graph. After looking at the graph he was able to infer that since he spent the same amount of time sleeping and in school, it would be more efficient to sleep while he was in school, so that he could spend more time on the Internet! Grade eleven students suggested that the activity should be more user-controlled and contain limitations. For example, a twenty-four hour day data set allowed 26 hours to be plotted in the circle graph.

Empty page

Activity 4: Dice Table

Students of both grade levels did not enjoy this quiz type of activity. They commented that the activity was "excruciatingly boring" and "not interactive." Grade eleven students suggested that the activity could be used as a homework assignment provided that it would require more involvement from the user. Eight graders wanted more colour in the activity and general instructions on how to use the activity.

Activity 5: Gamblers Ruin

This gambling simulation received mixed comments from the two grade levels. Some grade eight students enjoyed the activity because they liked the idea of winning a gambling game. Other who lost while running the simulation, claimed that the lesson they learned from this activity was never to go to casinos! The eleventh grade students suggested that the activity would be more enjoyable if it had more user-control, limitations and instructions on what was happening once the simulation was running.

Activity 6: Racing Game

Both grade levels voted this interactive car racing game as the most enjoyable activity. In general, the students agreed that it was a great combination of fun and maths. Grade eleven students were all able to identify which car would win depending on the assigned probabilities. Grade eight students suggested including real cars and a sound component to the car in order to increase the appeal of the activity

Activity 7: Fire Simulation

The groups of grade eight and eleven students enjoyed this forest fire simulation. Grade eleven students in particular were able to grasp the concept of

directional probability once they had run through the simulation. The grade eight students concentrated more on the aesthetics of the simulation suggesting bigger trees and the addition of fire fighters in order to make the forest fire look real.

Activity 8: Histogram

The different grade levels received this graphing calculator type activity differently. Grade eleven students enjoyed the activity and recommended that it would be a valuable homework tool. They did suggest that the activity needed more user control. Grade eight students, on the other hand, found the activity boring and hard to understand. Although they did like the use of colour in this activity, they found it could not appreciate it as they had not yet learned the concept of a histogram.

In the final section of questioning, we asked more open-ended questions to generate ideas and suggestions from the students. The responses from all three groups are included below:

Table 6: Student Follow-up Questions and Responses

Question	Group 1 Responses	Group 2 Responses	Group 3 Responses
Which were the best activities?	Racing game; Forest fire	Gambling Forest fire Racing game	Forest fire Gambling Racing game
Would you look for any Activities outside of class?	We would not look at this stuff outside class; Needs to be more interesting; Unless it's for homework; Would rather do it FOR homework Than have it calculate answers for homework	Yes, if they're easy to find; Web site is too complicated	Not really; maybe for 2 min Only if they were games; Yahtzee is cool
What kinds of math activities would you like to do to learn maths?	Activities that we can relate to; Ones that we can print out results once completed	Shooting games; More colourful; Interactive	Games, preferably 3D; Dice
Is it easier to learn from a textbook or from these types of activities?	Activities are nice but online activities don't give an answer; Activities should be something you can't do with a calculator	Interactive, because its more fun	Activities are more enjoyable; Don't have to waste time drawing graphs
Did you learn anything today? what?	Mean; Median; Probability	Yes; No; Mode can be anything; May have if there were instructions	Not really; Circle graphs; Percentages; Different ways of showing data

Suggestions	More controls for the activities	Card games	Bright colours
	Yahtzee cooler than dice table	Averages	Lots of colours
	Battleship is a good game	Instruction	More animations
	Age group factors when choosing activities	Shooting games	
		More sound	
		More instructions	
		Have a games icon	

4.3 Outsourcing Cost Analysis Data

ABS has required the services of technology development firms in the past. Information on these projects was collected and examined and is presented in this section.

Table 7: Previous Outsourced Technology Projects at ABS

Title of Project	Type of Project	Cost of Project	Consultancy Selected	Number of Proposals
Census 2001	Web Site	$AUD 181,000	Visual Purple	7
Tale of Two Worlds CD	Educational CD-ROM	$AUD 198,000	SENOJWEB	5

In Table 7, the title of the project is the project name selected by ABS before the project was undertaken. The type of project classifies the project by its use. The cost of the project is an estimate or exact figure extracted from ABS documents on these projects. The consultancy was selected from a successful proposal among other competition. The number of competing firms is listed in the last column, Number of Proposals.

We followed the same model in looking at firms for our cost analysis. We contacted several firms, and based on a preliminary description of our strategy, requested basic cost estimates based on the amount of work required from a firm and how much they charge per hour of labour.

We received estimates, regarding our project, from the following companies:

Table 8: Companies Participating in Cost Estimation

Company Name	Cost Estimation (AUD)	Local Telephone
Senojweb	$AUD 28,000	(03) 9417 3477
Creative Vision	$AUD 51,000	(03) 9629 8850
Zero Gravity Multimedia	$AUD 30,000	(03) 9722 9333
Web Activation	$AUD 14,000	(03) 9654 8266

Multiple correspondences were required to achieve the results as presented. Specifications of the project were sent to each of these companies, but each took their own view on the development process. Many companies considered content building to be part of costs. Clarification was required in many cases to show that much of the content building could be done at ABS-NESU, and then passed on to the developer.

4.4 Feedback on Preliminary Presentation and Proposal

We received useful feedback from staff at ABS after our initial project proposal was available in the office. The feedback covered a wide range of topics, from suggestions on our methods to technical advice and concerns about feasibility.

Teresa Dickinson provided comments on our drafted methodologies that were pertinent to the structure and methods at ABS. She corrected terminology and offered insight that made our presentation and recommendations more attractive to ABS, while at the same time maintaining the requirements set by WPI.

On 11 April, we conducted a presentation at the ABS office in Melbourne, and on 14 April, we conducted the same presentation in Canberra to demonstrate our recommendations to IT staff and upper level management, which included the current CEO of ABS, Dennis Trewin. During the Questions and Comments sessions after these presentations, we received more feedback on issues concerning cost analysis. Questions were asked about work hours and about how prices were related to work hours.

4.5 Feedback on Technology Issues

One of the original concerns of both our project team as well as ABS staff was the technical capabilities required to develop our recommendations. Initially we looked at outsourcing the project, as previous projects, such as the Census 2001 web

site and the Tale of Two Worlds CD were done. Early in the project, however, our liaisons suggested having the technical development of the project done in-house, by application developers that work in ABS.

Along with our initial requests for price quotes to technical development companies, which would be possible candidates for the project to be outsourced, we sent a similar request to Gary Dunnet, who is Director of Dissemination at ABS. Our initial feedback from him by email indicated that he had concerns about viewing of Java-based web pages at schools. After further contact with Gary Dunnet by telephone, we were informed that the project development was possible on-site. His concerns were in relation to the use of firewalls at some schools, and how it is possible for administrators to block Java and other web technologies for security purposes. He also indicated that there would be ways to work around this. (See Appendix D) For more details on the issue, he set us up with a meeting of the director of Technical Applications at ABS, Chris Conran.

Chris Conran was able to give us more information on the possibilities of in-house development. He shared the same concerns as Gary Dunnet regarding accessibility in relation to security systems present at the school, but provided us with more detail on the ability to meet accessibility requirements. The specifics that Chris Conran provided are pertinent to the development process inside ABS, and gave us reassurance that the expertise is available and that the option to keep development of the project internal exists. (See Appendix D)

We found the benefits of keeping the development process inside ABS to be greater than the benefits of outsourcing development of the project. Having developers working within the same organization allows for NESU staff to interact with developers more easily and to achieve goals more quickly.

5 Recommended Strategy for ABS

The Australian Bureau of Statistics (ABS) is the national organization responsible for collecting and providing accurate statistics. The National Educational Services Unit (NESU) is a division devoted to promoting statistics use in schools. ABS, and specifically NESU, has a goal to make the educational pages of the web site more interactive and appealing to students while encouraging more interest in statistics for classroom use and as future careers. Our project provides a strategy to achieve these goals. Specifically it provides recommendations for developing interactive web-based activities and an appropriate interface for these activities. Our recommendations focus on maths and statistics education; however, the strategy could easily be applied to developing activities for other academic subjects.

Our recommendations are based on the responses from teachers and students in Melbourne who participated in our focus group as well as on our research conducted in Worcester. The latter included interviews, articles and textbooks and existing web sites with goals similar to those of our project. We also took into consideration the projected costs and requirements necessary to implement various possible strategies.

Our recommendation for ABS is to add a new portion to the ABS web site under the educational pages for which NESU is responsible. This portion of the web site would house self-contained, lesson-based pages subdivided into a variety of curriculum-focused topics. Each topic would require a textual lesson about the concept, an activity that demonstrates the concept through interactivity, and a quiz or challenge to test the student's mastery of the concept.

5.1 Web Page Content

In order to make the educational web pages more interactive and appealing, activities that teach a variety of curriculum topics should be developed by NESU staff and technical designers. We have provided a framework for all activities to be developed along with suggested curriculum focuses and data topics.

5.1.1 Characteristics

Based on our research into educational web pages we determined that all activities developed for ABS web pages should strive to have the following traits to foster interest, learning and accessibility for students while promoting classroom use by teachers as well.

Activities should be:

- User Interactive

  The user should be able to input data sets into the activity either by hand or by selecting one of several provided data sets. Limitations on how the activity functions, such as the range on a standard deviation graph or the sum of all values entered into a pie chart, should also be able to be controlled by the users through scroll bars or concrete values. User controls should also affect the process or the outcomes of the activity.

  If the student is involved in the functionality of the activity, he/she would be more likely to understand the concepts being presented as well as the parameters. Interactivity promotes interest and learning.

- Challenging

  The activity should provide the student with some challenge that requires thinking, consideration and involvement. An overly easy activity

would simply bore the student. The quiz at the end would provide some of this challenge.

- Complementary to Lessons

  Teachers should be able to use the activity in the classroom as a tool for initially teaching a concept or as a review of concepts previously covered in class.

- Computer Exclusive

  The activity should be something that can **not** be done currently in classrooms using a chalkboard or graphing calculators. This would make the computer a worthwhile tool.

- Enhanced by Sound

  Students are more interested in activities that contain relevant sounds. Auditory effects can also aid visually impaired students and address W3C guidelines.

- Colourful

  An activity that is colourful appeals to students more than a plain black and white activity. However, colour should add to the pages, without being a distraction.

Activities should contain:

- A Curriculum Focus

  The topic covered by an activity should be found within curricula of the states and territories. Teachers can then use the activity in their lessen plans.

- Activity Specific Information

  Each activity should have instructions for use as well as background information about the topic covered by the activity so students know what to do and why.

- Student-relevant Information

  A context for the activity that a student can relate to should be provided for each activity. Students can then relate to the concept and be more interested.

5.1.2 Types of Activities

The responses given during the focus groups that we conducted in Melbourne demonstrate that students and teachers prefer certain types of activities and combinations of types of activities for educational purposes. Graphs that also had a calculator component were very popular. Also preferred were simulations with a corresponding quiz, and demonstrations with a large amount of background information. These preferences were consistent with previous research and the presentations of existing web sites.

5.1.3 Curriculum Topics

The teachers who participated at the focus group suggested that the ABS incorporate certain curriculum topics in the activities. The recommended topics are:

- Graphs
    - Histogram
    - Box Plot
    - Pie Graphs
- Venn Diagrams
- Standard Deviation
- Time Series
- Smoothing
- De-seasonalising data
- Population data
- Data collection
- Data interpretation
- Graphing interpretation

5.1.4 Data Sets Relating to Popular Information

The analysis of the focus groups conducted in Melbourne led to the conclusion that both teachers and students preferred data sets that related to Australian events. Teachers' comments that students would relate more to the activities if they affected their daily lives in some way were confirmed in the student focus groups.

Students in the focus groups payed more attention to data sets concerning sporting events. The histogram contained a data set about Cricket World Cup 2003 batting averages for the Australian Team. When this activity was presented it aroused a stir of interest in students to learn more about the histogram. This confirmed the suggestion by Professor Holly Ault in her interview that Australian students would enjoy sport related activities.

We recommend data sets relating to other current events also be included in the activities. Results from a survey conducted by the NESU in November 2002 suggested that most teachers use statistics from local newspapers. It follows that it would be beneficial to NESU if the web pages provided up-to-date statistics about current events. This would attract more teachers to the web site and ultimately more students. Some possible data sets could include statistics on the Severe Acute

Respiratory Syndrome (SARS) Epidemic or some statistical information about Australian Soldiers sent to Iraq during the 2003 war. Students would be interested to know information about these events and it would ultimately lead to a greater interest in statistics.

Our analysis suggests that students also prefer data sets about themselves. Student heights or student shoe sizes are examples that could also be used by the NESU in order to increase student awareness of statistics.

5.1.5 Concepts displayed in text

Text books are the most common method of providing information for students and are still very effective. Therefore, a text component, describing the concept in words and including any relevant formulas and examples would be a logical inclusion in the proposed web pages. Visual learners as well as hearing impaired students would benefit most from this section. Including an audio component to the text would also aid visually impaired and interest auditory learners.

5.2 Web Pages Design and Maintenance

Based on our analysis of the comments from students, our interview regarding human-computer interaction and existing web sites, it is clear that an appealing, informative and user-friendly interface for students to access the activities is important. With this in mind, we have developed sample layouts with recommended features for the pages to house any developed activities.

5.2.1 Layouts and Features

We developed web page layouts for four different pages: a main menu page, a concept page, an activity page and a quiz page. Each of these pages should contain the following:

- a link back to the ABS home page
- a link back to the main menu page
- the title of the project
- the short description of the project
- an animated conversation box containing page specific information and the source of most audio components.

All project pages should have a similar layout and colour scheme to create unity and assure users that they are still within the project's pages. The animated characters in the conversation box should also be related, as in our sample layout pages where the characters all come from the interactive CD "A Tale of Two Worlds." The CD was developed by the ABS in the year 2000 and students might recognise the characters. Since ABS owns the copy rights for the characters, we recommend using these characters.

5.2.2 Sample Page Layouts

We developed sample page layouts to provide a model for the NESU staff and IT developers to assist them in creating web pages that would interest and appeal to students. The layouts are shown below:

- **Main Menu Sample Layout**

This page should be simple, yet visually appealing. If the students are bored with this page, they would not explore the rest. It should contain a list of descriptive links to the concept pages, links to other current, educational projects and teacher resources. The conversation box on the right of this page should announce newly added material and upcoming material with links to those pages.

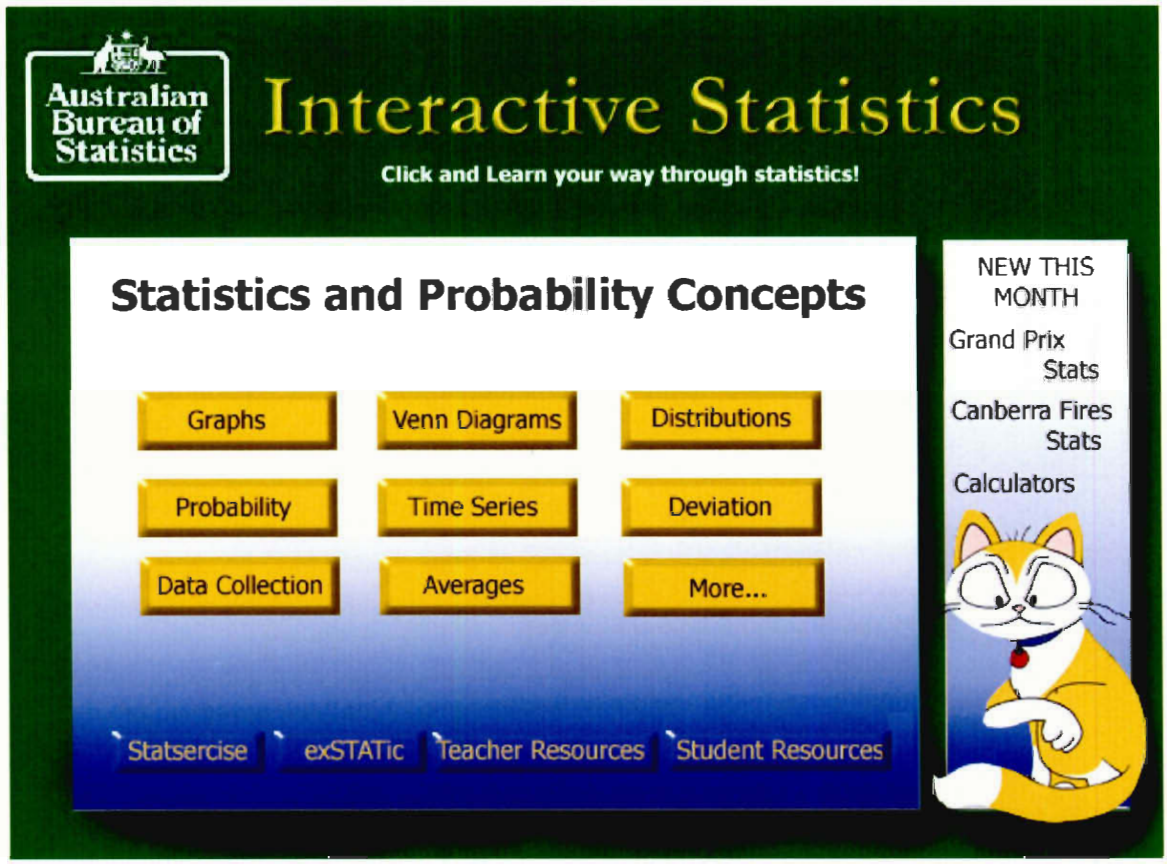


Figure 10: Main Menu Sample Layout

- **Concept Page Sample Layout**

This page should contain the majority of the information on the curriculum focus. A title of the concept should be first, followed by text explaining the concept with definitions, formulas and usage provided in clear language. A scroll bar should be used if necessary. The conversation box should have a link to more information of the topic and possibly an online assistant to answer questions. Tabs with links to the Demo (activity) page and quiz page should also be present.

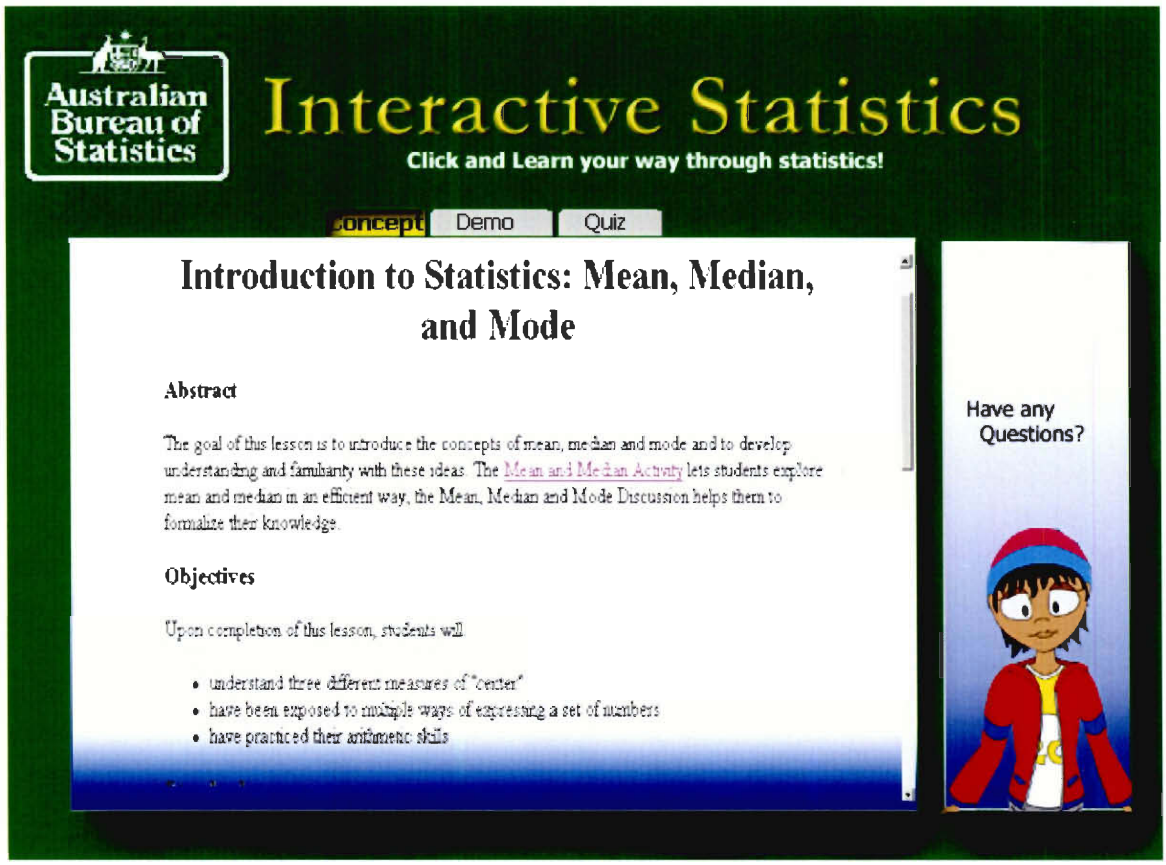


Figure 11: Concept Page Sample Layout

- **Activity Page Sample Layout**

The actual activity should be on this page. A short quiz about the concepts contained should be first, followed by instructions for using the activity, then the activity itself. Links to relevant data sets and the online assistant would be contained in this conversation box. Tabs with links to the concept page and the quiz page should be visible.

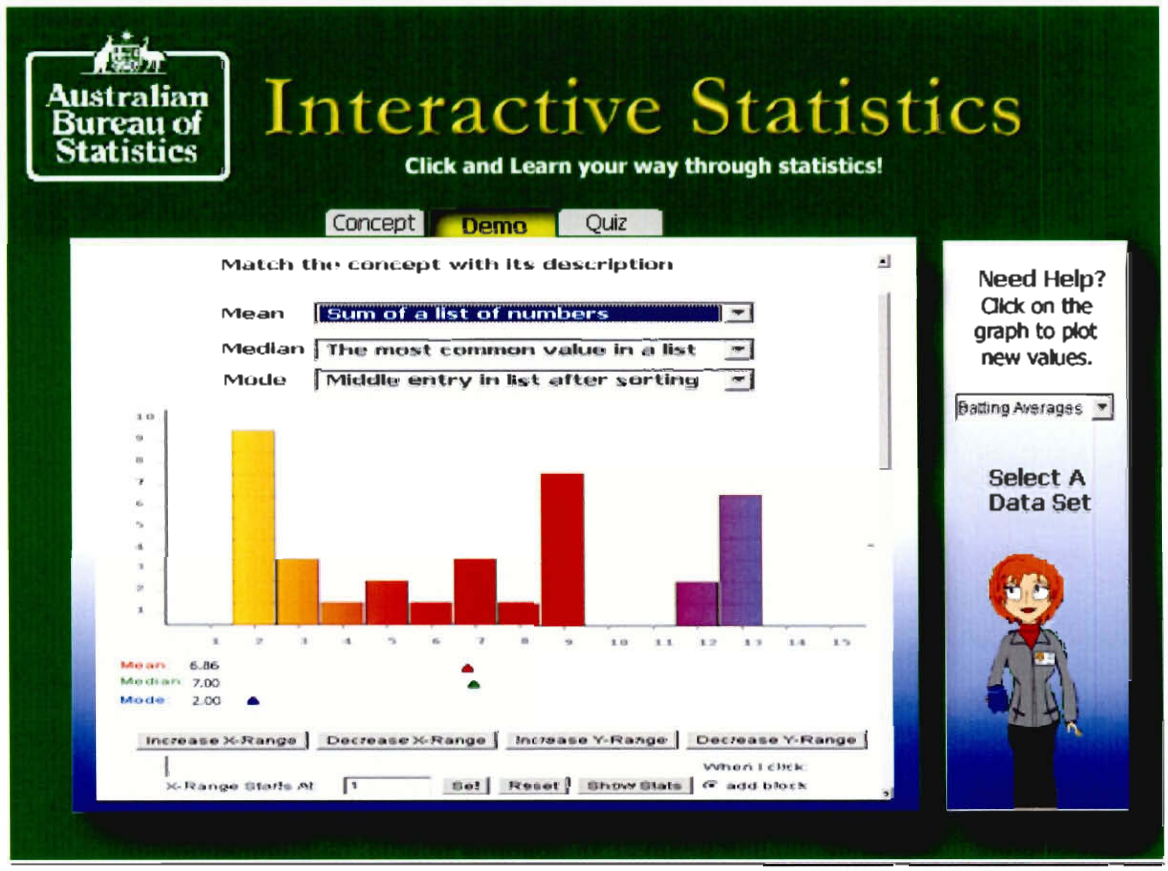


Figure 12: Activity Page Sample Layout

- **Quiz Page Sample Layout**

To test the students understanding of the concept and activity, an online quiz should be located here. Helpful hints and references to information provided on the concept page should be provided in the conversation box. Students should be able to check their answers instantly, with feedback on correctness also provided in the conversation box. Again tabs to the other pages should be visible. A link to the main menu should be provided as well. A section with a greater challenge could also be included.

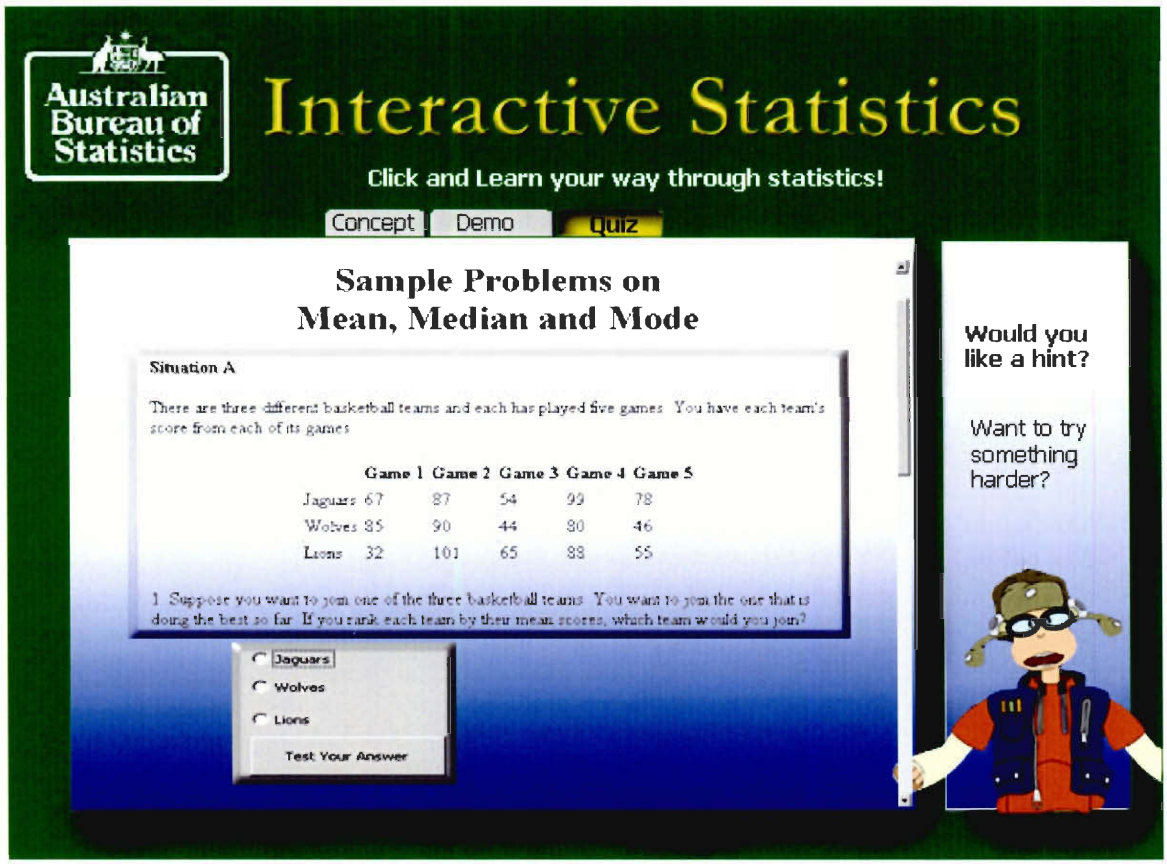


Figure 13: Quiz Page Sample Layout

5.2.3 Web Pages Maintenance

In order to keep the ABS web site on the forefront of statistical learning, updates must be made to renew the interest of students and keep them actively involved in the web pages.

Data sets, such as those available in graphing activities, must be updated and maintained regularly to reflect popular information. The system should allow for updates at any given time, to take advantage of opportunities where new data can be used as a medium to attract visitors. The information should also be maintained on a periodical basis, at least once a semester, to allow for teachers to have fresh information when they return to the site as their curriculum proceeds.

5.3 Web Page Development

The financial, staffing, and support requirements to build the ABS web site have been divided into three major categories: Initial Development requirements are the resources that would be necessary for the development and implementation of the web site; Educational Material Update requirements are resources that would allow the site to stay up-to-date and hold the interest of the audience; and Long Term Maintenance refers to the resources required to keep the site running over a long period of time.

5.3.1 Initial Development Costs

Many considerations in determining the requirements of the initial development depend on where the development would occur. For reasons discussed in section 4.5, a system that is developed within ABS is favourable. In talking with the appropriate IT staff, we found that the project can be developed within ABS; however, outsourcing options should still be considered.

Initial Development resources are made up of three parts:

- Costs of development
- Work hours required by ABS staff
- New system resources

The cost of development outside the organisation was generated through analysis of responses from technology development companies that specialize in this field. The most reasonable offer from one of these companies was as low as $AUD14,000 for initial development. Other offers ranged up to $AUD30,000.

Costs of development of an outsourced project can be used as a basis for determining costs of development within ABS. However, a project developed within ABS can be billed interdepartmentally. For the ABS, this is a more cost effective method, as no money leaves the organization. As explained below, prices of development on-site were generated by the hours estimated by outsourcing companies and the billing rate at ABS IT level-2 development work (ITO2). ABS ITO2 at the present time of recommendation is $AUD60 per hour of work. At this rate, we estimated the cost of development from the IT department to be $AUD19,000.

Because the cost of this project by technology development companies is based on estimates, the results varied. All of the estimates included a breakdown of the costs, including the number of hours assigned to any given task, and the price per hour of each task. From this information, we were able to compare costs and generate our own estimates of hours required for the development phase.

It was estimated that the project would require approximately 300 hours of site development. Of this, about 100 hours would be dedicated to graphical design, character design, and site layout. The remaining 200 hours would be required for technical development, which includes coding, debugging, and optimisations.

5.3.2 Initial Development Strategy

If our recommendations for new interactive web pages are to be implemented, there are two development phases of the production for which costs can be projected. The first of these phases is the in-house development of content by the National Education Services Unit (NESU). The second phase is the technical development either by ABS IT staff or outsourced to a consultancy firm in the field of web development.

The first phase, in NESU, would be development focused on educational and content creation. Using the educational resources and staff available at ABS, including on-site teachers and education professionals, much of the content and general site objectives can be built without much additional resource allocation or spending. Based on our recommendations, the educators and professionals at NESU could build a complete project specification.

In the second phase, with the appropriate curriculum and other content objectives prepared by the NESU, the technical and functional content would be created. This would be done by the technical developers, either out-sourced or done on-site by ABS technical applications developers.

5.3.3 Educational Material Updates

A web site with a foundation of a backend database would allow NESU staff to maintain part of the site without any interaction from IT staff. Data sets and teaching documents could be updated through such a database. If the system were to be integrated with Lotus Notes, this would allow for NESU staff to update pages in the same fashion that they update any other document they work with. The ability to perform many of these functions requires that the system be on-site. Running a

system off-site would allow for less direct control from NESU staff, and could require assistance from IT staff in processes such as updating teaching content.

An educational material updating system should be designed so that minimal effort is required to use it. If this system is streamlined, it would benefit the site by allowing for the most up-to-date data sets, which would aid in maintaining the interest of the students, and also allow for the most effective up-to-date teaching content.

5.3.4 Long Term Maintenance

Any web system is susceptible to issues that require maintenance on a technical level. For a system that allows for dynamic content through material updates, this is especially the case. Issues such as user traffic, system upgrades, and security all play a factor in long term maintenance.

The requirements of a system that is hosted external to ABS are similar to those of a system hosted in-house; however, there is no present infrastructure that would allow the site to be hosted externally. One person would have to be appointed responsible for the maintenance and upkeep of the site. This would require possible external contracts and more resources. In any case, if the system should run off site, it should require no more than three hours per month in maintenance. This is dependant on the educational material update system which would be directly under the control of the NESU staff.

A site housed at ABS has the advantage of a supporting infrastructure. The site would be on a system that is already maintained by ABS staff members, who work closely with the IT staff that developed it. This would create a much more seamless operation of the system.

6 Conclusions and General Recommendations

We provided the ABS/NESU with a strategy to develop the educational portion of the ABS web site into a highly informative, interactive and appealing statistical resource for students grades six and above. We also provided model web pages and guidelines for statistics activities for schools. The interactive web site we recommend leads to an increase in student interest, through their involvement in the activity, as well as improves student learning, thereby fulfilling major goals of the NESU.

During this project, we recognised opportunities for future projects and developed suggestions for expansions of this project. These topics would require further research into feasibility and suitability.

6.1 To ABS

Based on our experiences and observations, we believe the following areas may be further researched, revised or developed:

Activity Development Partnership with *Interactivate Team*

The Project Interactivate Manager, Bethany Hudnutt suggested a possible partnership with ABS to develop their currently available activities further to benefit both organisations. For details, see Appendix I.

New system for web page design

IT staff could create more diverse templates for different types of web pages to be available for general use by ABS staff. These templates could include more

options for text, pictures, animations, etc. Submitted web pages could become more interesting, and still provide the IT staff with needed information.

Better NESU home-page

The educational home-page is mostly text based, fairly crowded and difficult to navigate. Design a home page for NESU resources that is colourful, informative and provides links to more specialized sections for teachers or students before listing all the resources available. Currently, the extent of this site is limited by requirements of the entire ABS web site, which might not necessarily reflect on the goals of NESU's web pages. Perhaps special considerations could be made to reflect the specialized area of education pages.

Better navigation system

Include more home pages with outlines and overviews of information available by following links in order to aid users to navigate the entire ABS web site.

Student login

Adding a student login option for the interactive section will allow students to track their progress and permit customisation of colours, titles, and data sets. This would permit personalisation and incline students to visit the web site more often.

Teacher login

If teachers were able to login and track their students' progress as well as add classroom specific information they would be more likely to use the educational pages as a teaching tool. This could be accomplished by using a database backend that allows teachers to create virtual classrooms with virtual student rosters. When using

the activities, the students would select their name and virtual classroom upon entry of the site. This information would be held as the student's activity is tracked and recorded. Teachers, acting as the administrators of the virtual classrooms, could then check the progress of their students.

6.2 To WPI

Development of activities and pages as a Major Qualifying Project (MQP)

The activities and web pages we have recommended would require many work hours as well as money to develop. The actual building of the pages could very easily become an MQP. All development would conform to the W3C standards, as well as the standards developed in the 2001 ABS IQP regarding web sites for visually impaired students and the guidelines developed in this IQP. Professor Matthew Ward would be a logical advisor for an Australian based, computer science project.

Smart tutorial

To extend the concept of interactive education, a smart tutorial that responds to a student's learning style and ability would be a very useful MQP. Professor Neil Heffernen discussed the possibilities of such a study with us during our interview with him.

7 Bibliography

Abbey, Beverly, ed. *Instructional and Cognitive Impacts of Web-Based Education.* Hershey: Idea, 2000.

American Society of Association Executives. 2003. 19 Feb. 2003. <http://www.asaenet.org>

Ault, Holly. Personal interview. 12 Feb. 2003.

Australian Bureau of Statistics. 20 Jan. 2003. Australian Bureau of Statistics. 8 Jan. 2003. <http://www.abs.gov.au>

Barnett, Jonathan. Personal interview. 10 Feb. 2003.

Berg, Bruce Lawrence. *Qualitative Research Methods for the Social Sciences.* Long Beach: Allyn & Bacon, 2000.

Brown, David. Personal interview. 13 Feb. 2003.

Brown, David G., ed. "Interactive Learning: Vignettes from America's Most Wired Campuses." Bolton: Anker, 2000.

Carr, Joseph J. *A Crash Course in Statistics: An Innovative Book/Multimedia Approach to Collecting, Organizing and Analysing Data.* San Diego: HighText Publications, 1994.

Clark, William. Personal interview. 12 Feb. 2003.

Clark, W. M., "Using Multimedia and Cooperative Learning In and Out of Class", Proceedings Frontiers In Education Conference, Pittsburgh, PA , November, 1997.

Curriculum and Standards Framework II. 2002. Victorian Curriculum and Assessment Authority. 15 Jan. 2003. <http://www.vcaa.vic.edu.au/csfcd/home.htm>

Dickinson, Teresa. Telephone conference. 7 April 2003.

DIG Stats. 1999. Central Virginia Governor's School for Science and Technology. 17 Jan. 2003 <http://www.cvgs.k12.va.us/digstats/>

Dunn, R. and K. Dunn. "Teaching students through their individual learning styles: A practical approach." Englewood Cliffs, NJ: Prentice Hall, 1978.

Dunn, R., K. Dunn. and G. E. Price. "Productivity Environ-mental Preference Survey." Obtainable from Price Systems, Box 1818, Lawrence, KS 66044, 1990.

Emerson, John D. "Student-Centered Learning of Statistics Using Multimedia." Brown.

Global Change: A New Web-Based Curriculum for Multi-Disciplinary Science Education. Satellite Videoconference. WPI Advanced Distance Learning Network, 1998.

Gluck, Kevin A., Marsha C. Lovett, John R. Anderson, and Valerie Shute. "The Curriculum and the Interface: A Componential Analysis of the Learning Curve." <http://act.psy.cmu.edu/ftp/models/freq-dist/freq-dist.html>.

Graham, Alan. *Statistics.* Illinois: NTC Publishing Group, 1994.

Grasha, A. F. *Teaching with Style*. Pittsburgh: Alliance, 1996.

Hakim, Sara. Internet interview. 20 Jan. 2003.

Index of stat~100/java. U. of Illinois at Urbana-Champaign. June 2002. <http://www.stat.uiuc.edu/~stat100/java/>

Jaecksch, Shauna. Internet interview. 22 Jan 2003.

Java Technologies Overview. 2003. Sun Microsystems, 19 Feb. 2003. <http://wwws.sun.com/software/java/overview.html>

Macromedia Flash MX Testimonials. 2003. Macromedia Corporation, 19 Feb. 2003. <http://www.macromedia.com/software/flash/reviews>

Maddux, Cleborne D., and Rhoda Cummings. "Developing Web Pages as Supplements to Traditional Courses." Abbey.

Maxwell, Joseph A. *Qualitative Research Design: An Interactive Approach.* Thousand Oaks: Sage, 1996.

McLeannan, W. *Statistics – A Powerful Edge. Second Edition.* Canberra. Australian Bureau of Statistics. 1998.

Nassar-McMillan and Borders. "Use of Focus Groups in Survey Item Development" <http://www.nova.edu/ssss/QR/QR7-1/nassar.html>

"Now, That's edutainment." Article on INE, Portugal's Statistics office in a FAX received at ABS on 21 Mar. 2003.

Perkins, David N., Judah L. Schwartz, Mary Maxwell West, and Martha Stone Wiske, ed. *Software Goes to School: Teaching for Understanding with New Technologies.* New York: Oxford, 1995.

Rutkowski, Kathy. "Designing Effective EduWebs- Defining Effectiveness" <www.netteach.com>

Siegrist, Kyle and Dawn Duehring. "Buffon's Coin Experiment." July 2002. U. of Alabama at Huntsville. <http://www.math.uah.edu/psol/applets/BuffonCoin Experiment.html>

Siegrist, Kyle and Dawn Duehring. Proportion Estimate Experiment. July 2002. U. of Alabama at Huntsville. <http://www.math.uah.edu/psol/applets /BuffonCoinExperiment.html>

Stanton, Charles. "Java Demos for Probability and Statistics." Feb 2003. California State U. at San Bernardino. <http://www.math.csusb.edu/faculty/stanton/probstat/index.html>

Sutherland, Iain. "Outputs." Jan 2003. <http://www.wpi.edu/~jbarnett/oz03>

"Tools for an Interactive Learning Environment (TILE)." 11 Mar. 1998. U of California at Berkeley. 18 Jan. 2003 <http://stat-www.berkeley.edu/users/nolan/TILE/>

"Web sites Useful to Teachers of Statistics." 2002. American Statistical Association. 12 Jan. 2003. <http://www.amstat.org/education/web4teachers.html>

"Why Activities: Curriculum Context and Resources at Project Interactive." 2003. The Shodor Education Foundation, Inc. 19 Feb. 2003.<http://www.shodor.org/interactivate/>

Wratcher, M.A. Morrison, E.E., Riley, V.L. & Scheirton, L.S. "Curriculum and program planning: A study guide for the core seminar. Programs for higher education." Ft. Lauderdale: 1997. Nova Southeastern University.

Appendix A - Description of Organization

Australian Bureau of Statistics (ABS)

The following is some background information on the Australian Bureau of Statistics and the National Education Services Unit as mentioned in the Australian Bureau of Statistics Corporate Plan.

RELEVANCE

Our efforts are directed to the best interest of the Australian community. To aid this, the ABS should ensure that data needed for policy and research purposes is available when required. Good statistical planning, which requires a keen understanding of the current and future needs of users, is essential. We also recognise that, in order to be relevant to informed decision making, debate, and discussions, our statistics must be timely and relatable to other data. To support this, they will be placed in an appropriate statistical framework. We should also provide analyses and explanations to help the interpretation of our statistics.

OBJECTIVES

1. An expanded and improved national statistical service

2. An ABS statistical service that is timely, relevant, responsive, and respected for its integrity and quality

3. Informed and increased use of statistics

4. An active contributor to international statistical activities that is important to Australia or our region

5. An organisation that encourages learning, innovation, performance and excellence in all it does

6. The trust and cooperation of our providers

7. Strong recognition and support for the ABS amongst decision makers and the community

STRATEGIES

1. An expanded and improved national statistical service

2. An ABS statistical service that is timely, relevant, responsive, and respected for its integrity and quality

3. Informed and increased use of statistics

4. An active contributor to international statistical activities that are important to Australia or our region

5. An organisation that encourages learning, innovation, performance and excellence in all it does

6. The trust and cooperation of our providers

7. Strong recognition and support for the ABS amongst decision makers and the community

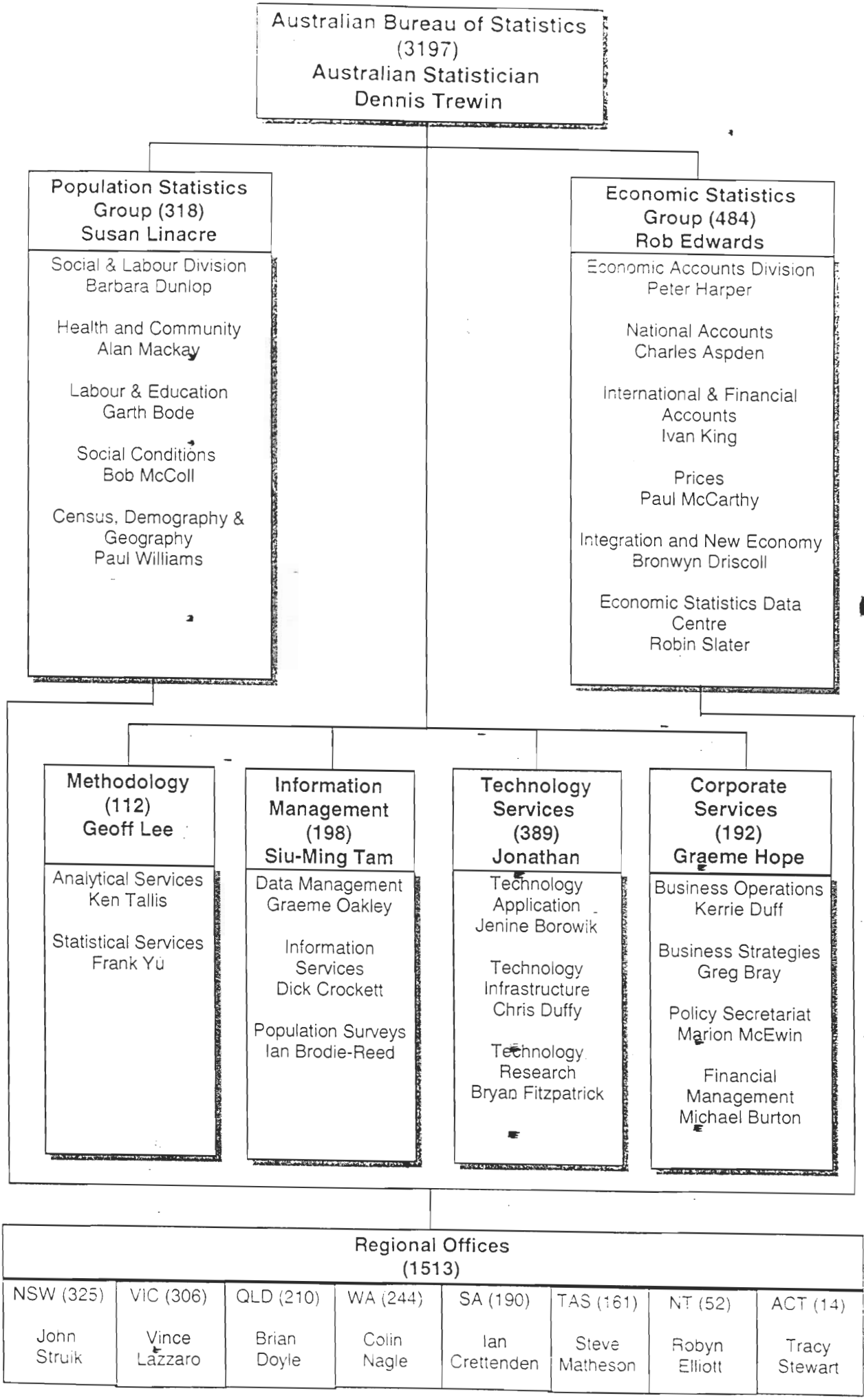
The National Education Services Unit (NESU)

The following is the background and role of the NESU as mentioned in the Australian Bureau of Statistics corporate plan:

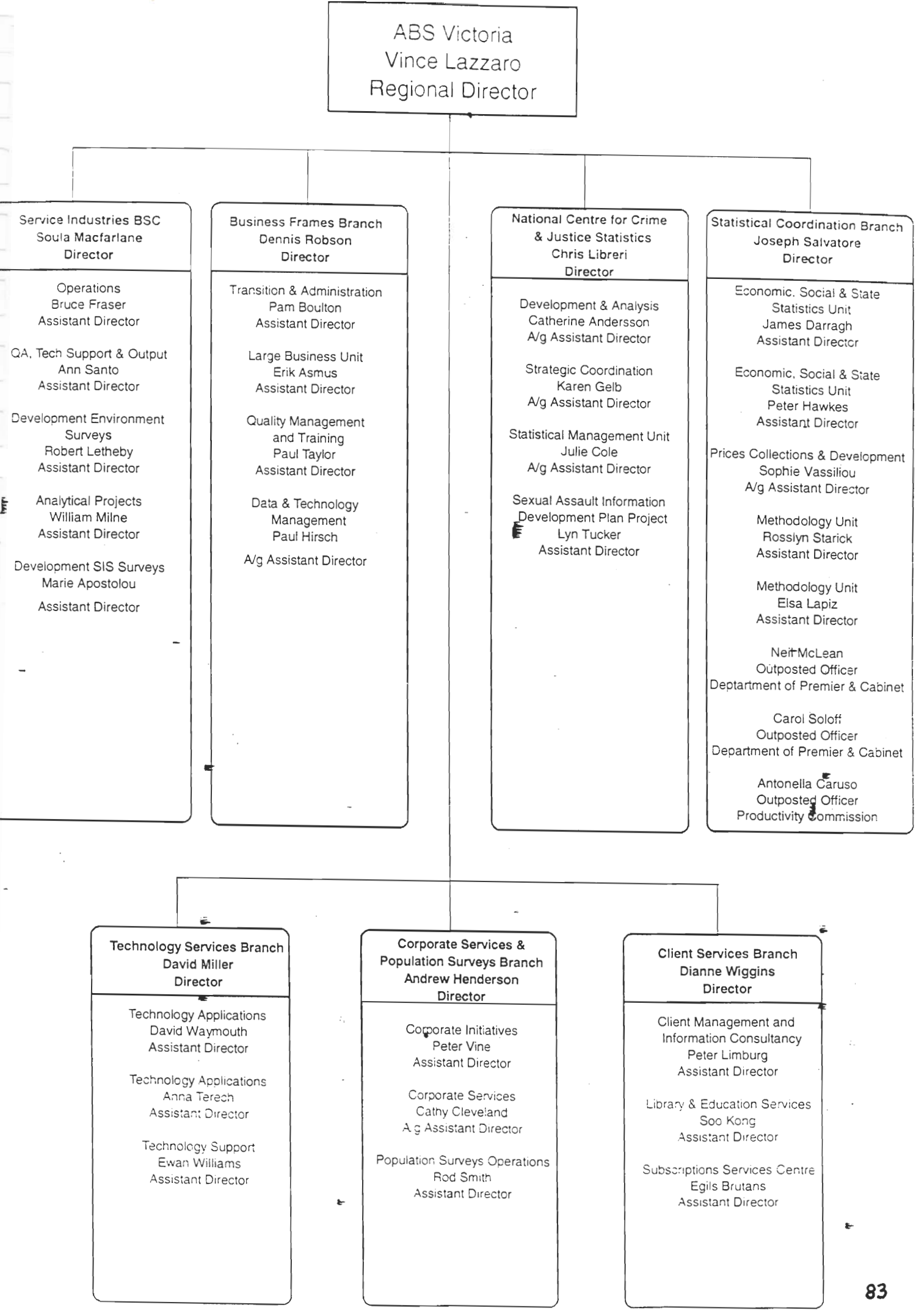
1. The Education Services Unit was first established in the ABS Victorian Office in 1990 as part of the National Client Services Program Account Management project (541). It has received ongoing funding of $100k per annum from project 541 and over the years has supplemented this allocation through S31 claims (traditionally for a further $100k per annum) from the sale of ABS publications. This funding arrangement has facilitated a consistent staffing complement of an EL1 Manager, and an APS5 and APS3 support. In addition to this, the Unit has also been successful in attracting funding from different Subject Matter Areas each year, to cover the placement of a TRIP resource (Teacher Release to Industry Program) to develop specific learning materials around ABS statistics as well as the development of special products, e.g. A Tale of Two Worlds.

2. The key role of the Unit to date has been to promote greater access, understanding, and use of ABS statistics by teachers, school librarians and students. This role has been predominantly aligned with the ABS Corporate Objective number 3: "Informed and increased use of statistics". In pursuing this objective, the Unit has also contributed significantly towards the achievement of another two corporate objectives - that of building strong recognition and support for the ABS in the community and the delivery of a timely, relevant and responsive statistical service (as evidenced by the success of new products specifically developed for the sector).

3. More recently, the Australian Statistician has raised the possibility of expanding ABS objectives in the education sector, to consider ways we might develop students' interest in statistics and data, to potentially increase the number of students choosing statistics as a career. This new direction will impact on the NESU work program, emphasising a more direct involvement by students, not only with ABS statistical outputs, but also statistical processes and their mathematical application. Introducing students to the power of statistics in an engaging and interactive way, will require broader collaboration with both internal and external stakeholders; some additional resources; and supplementary skills within the Unit. These have been outlined below in an attempt to identify what might be able to achieve in the next three financial years and what this might cost.



Staff numbers as at 30 June 2002


ABS Victoria
Vince Lazzaro
Regional Director
Service Industries BSC
Soula Macfarlane
Director
Operations
Bruce Fraser
Assistant Director
QA, Tech Support & Output
Ann Santo
Assistant Director
Development Environment Surveys
Robert Letheby
Assistant Director
Analytical Projects
William Milne
Assistant Director
Development SIS Surveys
Marie Apostolou
Assistant Director
Business Frames Branch
Dennis Robson
Director
Transition & Administration
Pam Boulton
Assistant Director
Large Business Unit
Erik Asmus
Assistant Director
Quality Management and Training
Paul Taylor
Assistant Director
Data & Technology Management
Paul Hirsch
A/g Assistant Director
National Centre for Crime & Justice Statistics
Chris Libreri
Director
Development & Analysis
Catherine Andersson
A/g Assistant Director
Strategic Coordination
Karen Gelb
A/g Assistant Director
Statistical Management Unit
Julie Cole
A/g Assistant Director
Sexual Assault Information Development Plan Project
Lyn Tucker
Assistant Director
Statistical Coordination Branch
Joseph Salvatore
Director
Economic, Social & State Statistics Unit
James Darragh
Assistant Director
Economic, Social & State Statistics Unit
Peter Hawkes
Assistant Director
Prices Collections & Development
Sophie Vassiliou
A/g Assistant Director
Methodology Unit
Rosslyn Starick
Assistant Director
Methodology Unit
Elsa Lapiz
Assistant Director
Neil McLean
Outposted Officer
Deptartment of Premier & Cabinet
Carol Soloff
Outposted Officer
Department of Premier & Cabinet
Antonella Caruso
Outposted Officer
Productivity Commission
Technology Services Branch
David Miller
Director
Technology Applications
David Waymouth
Assistant Director
Technology Applications
Anna Terech
Assistant Director
Technology Support
Ewan Williams
Assistant Director
Corporate Services & Population Surveys Branch
Andrew Henderson
Director
Corporate Initiatives
Peter Vine
Assistant Director
Corporate Services
Cathy Cleveland
A/g Assistant Director
Population Surveys Operations
Rod Smith
Assistant Director
Client Services Branch
Dianne Wiggins
Director
Client Management and Information Consultancy
Peter Limburg
Assistant Director
Library & Education Services
Soo Kong
Assistant Director
Subscriptions Services Centre
Egils Brutans
Assistant Director

Appendix B - Victorian Curriculum

The following is a synopsis of the Chance and Data section of the Victorian mathematics curriculum for grades six to ten taken from the Victorian Curriculum and Assessment Authority web site <http://www.vcaa.vic.edu.au>

	Topics	Focus and Outcomes
Grade 6		
	Chance	Analyse outcomes from simple experiments with dice and spinners and order them from least likely to most likely. Design a simple random device to produce a specified order of probability. Use and interpret numerical statements on a numerical scale from 0 to 1. Use and interpret common probability statements like "fifty-fifty chance". Make statements about chance and appreciate the concepts of fair and unfair.
	Data collection	Collect data of interest and pose questions and make predictions about them, suggest what data to collect to estimate numbers or population values etc. Prepare a short questionnaire of a few questions to enable data collection
	Summarizing data	Student should be able to collect discrete data in a table, present continuous data in a table and enter simple information into a class Database with predefined fields
	Tree diagram, bar graph, pictograph, line graph, dot plot and pie graph	Students should be able to construct these graphs where the frequency axis may be scaled with multiples. Bar graphs of grouped continuous data where groups are treated as categories. Students should also be able to choose which graphical display to use in different situations
	Mean, median, mode and range	Students should be able to find the lowest and highest data of a set, the middle score by ordering a data set, and calculate the mean and mode.
	Interpret data	Students should be able to interpret information from arrow, tree and Venn diagrams or Karnaugh maps, interpret scales on graphs, compare summary statistics (e.g. mean heights of boys & girls) and extract information from a database (e.g. a population database)
	Compare data	Determine which data is useful and which is not and extract and discuss information from newspapers, magazines and text books

	Topics	Focus and Outcomes
Grade 7-8		
	Chance	Analyse experiments to determine the probability of experiments (use fractions and decimals to assign probabilities) Carry out experiments to determine probability using long-run relative frequency. Design a specified random device to obtain desired probability and use a random device to simulate a simple situation
	Pose questions and collect data	Students should be able to plan and conduct a survey to obtain categorical data (e.g. survey of eye colour to estimate proportion of people with brown eyes) and ordinal data (e.g. asking students to rate a movie from a scale of very good to very bad). They should also know how to distinguish between discrete and continuous data. Finally students should collect data in their area of interests and use the organized data to pose questions
	Summary and presentation of data	Students should be able to organize measurements in tables with provided class intervals, enter and manipulate data in a spread-sheet and design a simple database to collect data. They should also be able to present univariate data in line plots with various scales such as multiples and decimal fraction, construct stem plots, histograms to group and display univariate data. Students should also use technology to graphically display the data (e.g. Spreadsheets or calculators)
	Mean, mode, mode and Range	Students should be able to obtain the data from an ordered stem plot and use a graphical calculator or a statistical software to provide summary statistics
	Interpretation of data	Students should be able to interpret information in stem plots and box plots. They should be able to extract and comment on information contained in a variety of graphs, tables and databases and interpret simple time series data (e.g. comment on a plot of monthly max temperatures of an unspecified place) They should also be able to explain the process of data collection and evaluate obtained results. Further, students should be able to explain orally the meaning of mean, median, mode and range and interpret different uses of the term "average". Also they should be able to compare two data sets using mean, median and range.
	Inferences of data	Students should be able to draw inferences from collected data, prepared databases and from trends based on graphs of simple time series data
	Predictions	Should be able to make predictions based on samples and estimate a proportion using a sample value obtained from an experiment or a survey

	Topics	Focus and Outcomes
Grade 9-10		
	Chance	Estimate probabilities using published data on long run frequencies. Use a random number generator or a computer package to simulate a simple situation. Determine probabilities in situations involving mutually exclusive and complementary events. Interpret "and", "or" and "not" when used in events. Assign probabilities to compound events by the use of a variety of representations of sample spaces (e.g. Venn Diagrams, tree diagrams). Assign and interpret probabilities given as odds (e.g. 2 against 1). Identify incidents of subjective probability (e.g. bookmaker) and justify estimates made in situations
	Pose questions	Design questionnaires and undertake trials to see whether the questions served the purpose. Plan an experiment to compare 2 groups on the same variable. Know the difference between a sample and the population from which it is drawn and appreciate the importance of randomisation to obtain a fair sample.
	Collect Data	Collect and receive bivariate data (e.g. height and arm-span) and time series data (e.g. max daily temperatures). Identify variables that help answer questions and set up fields for developing a simple database based on previously defined variables.
	Summarizing data	Students should be able to organize raw data and examine it for errors and inconsistencies, plan class intervals for continuous data using an appropriate number of intervals for the purpose. They should also experiment with different class intervals for histograms of the same set and plan and use a spreadsheet to organize raw data

	Presenting Data	Students should be able to construct a box plot using the median, quartiles and lowest and highest values. They should also be able to display 2 sets of univariate data using double column bar graphs, back-to-back stem plots and comparative box plots. Further they should use technology (graphical calc or a statistics package) to provide graphical displays of data Students should be able to use technology to provide summary statistics like range, etc from the data. They should also use fractions and percentages to describe the variability. Students should also be able to identify outliers in a data set and calculate the interquartile range as a measure of the spread. They should also be able to represent bivariate data in a scatter plot and find a line of good fit by eye when relevant. Students must also be able to represent time series using line graphs and use a software or calculator to produce a scatter plot or a time series plot.
	Interpretation	Students should be able to explain orally the meaning of summary statistics, tables and graphs as found in newspapers and magazines. Students should also be able to interpret data from prepared databases including those not requiring the logical connectors 'and', 'or' and 'not'. They should also explain how the design of questions may influence a responders answer. The students should evaluate the results from a trial questionnaire to refine the questions to be asked when the real sample is taken. Reports on the similarities and differences between 2 data sets and informal statements between bivariate variables suggested by a scatter plot must be made. Finally a prediction for the best line of fit must be made

Appendix C- Transcribed Interviews

Personal Interview with Professor Holly Ault
Date: February, 2003

Interviewer: Josette Jeacksch
Note taker: Najmuddin Gunja

JJ: You advised the last ABS project. Can you tell us about experience working with ABS team?

HA: Well Soo Kong is very enthusiastic and outgoing, always looking for opportunities to get students involved. The staff showed the students the local culture and they even took the students to Phillip Island for a weekend!

JJ: Did you assist the previous group with creating their interview questions? If so, what advice did you give them that might be helpful to us?

HA: Well last year we worked with blind and low vision students and since I have previous experience working with the disabled I was able to help them with framing their interview questions.

JJ: You deal with a lot of people everyday, so we were wondering if you could provide some insight or recommendation on working with focus groups comprised of teachers and focus groups comprised of students.

HA: Well last year, my students did not conduct focus groups. What are the grades you will be focusing on in your project?

JJ: Grades 6-10

HA: Ok, well the first thing you must realize is that grade 6 students and grade 10 students are very different, with respect to maturity levels. You must get the younger kids focused on questions as their attention spans will be short. Oh and always make sure that when you conduct focus groups they are not large. The smaller the group, the more successful will be the focus group. This is so because people started feeding ideas off each other. In a small group, each individual can think of his own unique idea. Another thing you must remember is to try and separate the focus groups in grades. For example, make sure everyone in the 6^{th} grade is in one focus group. Usually the younger kids will be influenced by the elder ones and you don't want this to happen.

JJ: That's a very good idea

HA: Also you have to be mentally prepared that these students don't have analytical thinking skills and so may not get very good opinions from them. You must try and find ways to counter that problem. You could do that maybe having different questions for different grades. The most important factor for you is to make sure that schools are open! Last year we had students interviewing kids at home, as they have a long break in the middle. Try, not to get into that situation because students don't want to be interviewed when they have holidays.

JJ: Our project deals with both, students and teachers. What advice could you give us on how to present material?

HA: Well I'm really not experienced with that. In most of my projects, we deal with technique and accessibility rather than with content. Basically my advice is that when you're making a web site, the most important question you need to ask is "who is your primary audience? In your case, the primary audience would probably be teachers. You may want to check with ABS; they usually have teacher interns working there who may give you some great advice.

JJ: How often do you use statistics in your field and can you give us an example?

HA: Basically, anytime I try to collect demographic information of some kind I'm using statistics. In experiments that have some variation in the process, you need statistics. I could go on with examples. Basically if you want students to be interested in statistics, it must appeal to them in some way. Students like real stuff. They like to know information about real places and real people. I know ABS has a lot of stuff already on their web site. One thing you could try is getting "sports statistics" into the web site, I assure you sports statistics are appealing to most students!

JJ: Thank you very much for information, you have been very helpful

HA: You're welcome, and if you have any other questions please do not hesitate to email me and ask.

Personal Interview with Professor Jonathan Barnett
Date: Feb, 2003

Interviewer: Josette Jaecksch
Note taker: Najmuddin Gunja

JJ: What do you expect ABS to have after we leave the project?

JB: Well basically, they would have a document, written by you, which will go out to the management and the document would explain the various plans that you have come up with, cost analysis etc. The management will then decide which plan to choose and then it will probably go out for bid.

JJ: Ok so what do they gain from this?

JB: Well if the plan is accepted, they will get funding to implement the plan

JJ: Ok

JJ: And do they normally seek outside assistance for these types of projects?

JB: Well the education unit has quite a tight budget. Most of the web related stuff is done in Canberra and there isn't too much of communication between the Victoria sector and the Canberra sector.

JJ: So most of the computer related aspects are taken care of in Canberra?

JB: Yes, the technicians are employed there

JJ: Well, you deal with a lot of people everyday, so we were wondering if you could provide some insight or recommendations on working with focus groups comprised of teachers and focus groups comprised of students?

JB: Hmmm, well for you the most important thing is the timing. When you'll be in Melbourne, there is going to be a time where there is going to be a long holiday and so you will not be able to contact teachers or children. So make sure you get organized quickly when you get there. Also when talking with teachers, you have to realize that they are professionals and so you must talk to them like professionals. In Australia usually, you would address the person by his first name after he or she has advised you to do so.

JJ: Ok

JB: Obviously when you're talking to students, the atmosphere should be a little more casual. You should not be too formal or too casual though! Students usually don't feel too comfortable with people dressed in formal clothes. Also the opposite isn't good either, because if you're dressed casually then they tend not to take you seriously

JJ: Yes that's true

JJ: Would you know of any high school or middle school teachers that we could contact in Worcester who would be useful to us?

JB: Uhmm, no sorry, I don't know anyone

JJ: Our project caters to different audiences, what advice would you give us on how to present material?

JB: Well that's hard to say, there is no right or wrong way to present material. Just make sure it doesn't offend anyone who looks at it.

JJ: When you were in high school, do you recall being educated in statistics?

JB: "laughs"

JB: Well that's 35 years ago! Nope, I don't really remember anything that I did in statistics in school, although I will say that I'm sure I must have done some probability.

JJ: In Fire Protection and Engineering, which is your field, how often do you use statistics and can you give us an example?

JB: Oh, statistics is very important in fire protection, in any field really. Right now, I know the main concern especially in Australia is the probability of failure of the system, with respect to fires, is a major concern to people. People have mentioned the one in a hundred year flood, now people in Australia are mentioning the one in two hundred years fires! "Laugh"

JJ: Well thank you very much for your time Professor

JB: No problem

Personal Interview with Professor William Clark
Date: February, 2003

Interviewer: Josette Jaecksch and James Vautin
Note taker: Najmuddin Gunja

JJ: We read your article about multimedia and interactive learning. Could you define what interactive learning is?

WC: Well first of all, interactive learning does not necessarily involve a computer. According to me, listening to a lecture is passive learning. Active learning would be doing an experiment in class. You have to do something with the material taught to you in order to learn it. This is interactive learning.

JJ: So what inspired you to choose this kind of approach in class?

WC: Well I've been listening to a lot of people; a lecture is not the best way to learn. There is a saying that a professor should be the guide on the side, not the sage on the stage! It basically boils down this, if you want to learn something, you're going to learn it however you can. Considering that twenty minutes is the maximum attention span of most students, I figured that maybe giving a lecture is not the best way to teach. That is the reason I tried this.

JJ: Do you think it worked?

WC: Well I have to admit that in the beginning I was very impatient. I expected students to give me answers immediately and I found it really hard. Also there is a tradeoff between presenting material and getting people to understand the stuff. For example, if I wanted you to play a trumpet, that's different from knowing how a trumpet works or how a professional plays a trumpet. I could give you a lecture on how to play a trumpet but that would be different from actually playing the trumpet, which would require some interaction.

JJ: Why do you think interactive learning works for students?

WC: Let me tell you what I did in my class. I put some of the background information on the computer for students to read outside of class. Then I realized that maybe I could use computers in the class, and they could go over the background in the class itself. This worked for most students because it was self paced. The students could figure out what they needed to learn at their own pace. In a sense, I believe it served a guide on the side to them.

JJ: To go back to your article, there is a statistics that about 11% of class disliked your computer aided learning too, why do you think this is so?

WC: Well, I guess that changes over time. Remember I did this experiment many years ago and the integration of computers into classrooms was a new concept. Some people at that time still preferred lectures. Also this new technique meant that students had to be active in class which many people didn't appreciate. Some students learn better with sound, so they preferred to hear me say it than read about it on a computer.

JJ: Do you still use your program?

WC: Oh yes I do! It still works although I have to keep updating it yearly so that it runs on the new programs. The program I have can call Excel and Math Cad. The crux of material doesn't normally change, luckily for me, as most of the stuff I have on it is classical chemistry. What I usually do now is have a power point presentation and take important notes from the presentation and place them on the web. The "my wpi" system is very useful as it allows me to do this. Usually I give small tests to students through this web site. It's a simple and easy way to get things done.

JJ: Ok

WJ: One of the main reasons I can still use my program today is because it is not very cheesy. Most of the original programs made years ago were very fancy and most people try not to use those programs. My main goal is to try and get up to speed with the best easiest way to get something useful done.

JJ: Have you considered using Java Applets?

WJ: Yes I have considered it. I have a book on Java. Unfortunately I'm not at expert programmer. Although I do realize that from a student's perspective, it's probably one of the best interactive activities available, I look at it from a teacher's perspective. A university or school could get the best program and hire the best teachers or professors. In my opinion, any teacher or professor should be able to come up with that he thinks is ideal for his or her class.

JJ: Do you see any disadvantages of learning online?

WJ: Well learning online makes life much easier for students. I'm worried that we try to be, the less the students will learn. Students must struggle to learn stuff, that's the best way to remember anything.

JJ: How often do you use statistics in your field?

WJ: Well, personally I don't use it that much, but I should! Usually in classes, we try to present data without going into the statistic specifics. Although I know we have statistics in our lab classes where students learn about scattering and replicating data. Also its not that easy to get accurate statistical information when you have really small groups.

JJ: Do you remember learning statistics when you were in high school or college

WJ: Hah, well high school I have no recollection, but I'm sure I learnt it in college.

JJ: Well thank you very much Professor for your help.

Personal Interview with Professor David Brown
Date: February, 2003

Interviewer: James Vautin
Note taker: Najmuddin Gunja

JV: Have you dealt with designing web sites for middle and high school students in the past?

DB: No I have not, but what age group are you looking at?

JV: Our focus is on students of ages 12 to 16.

DB: Ok, so basically you first identify who the primary user is, and I'm assuming it's the students

JV: Yes, that would correct

DB: Well students of the age group you have mentioned…think about what they like? In my personal opinion, they would probably be very game oriented if I'm not mistaken. So what you need to do is find out what students like. If I had to guess, I would say that's students are not really motivated to learn statistics. So you need to get something that is interesting, but still useful

JV: ok

DB: And of course, never forget the teachers. They are the hidden evaluators. You need to ask the teachers what they want on the site for the students to go and visit. You have to ask them, what kind of material is required, is it reference material, are there going to be evaluations, tests etc.

JV: Ok, would there be any sources you would recommend that generalize what appeals to different target groups?

DB: Yeah, there are a lot of texts out there. You may find some relevant information in Human Computer Interaction texts by Dix and by a few other authors. It seems that the kind of stuff you are interested in comes up in a lot of education conferences and Sig Chi conference, so you may want to check that out.

JV: Thank you, do you have any guidelines for designing this site?

DB: Well obviously you first need to decide what is the function of the web? As I have said before, games are usually a pretty safe option. But make sure the games you include are not too male oriented, because nowadays most games tend to go that way. Also the games should not be boring.

JV: We have one game short listed, its called Yahtzee.
DB: Well I don't know about you, but I was a 12 year old, I would that game very boring although it does involve statistics. Be careful about that, you don't want to bore the students. So what you probably have to do is ask students what games they like and what games they play. Ask them what kind of web sites they would like to

visit. Usually I would assume that they would love a lot of colour, and basically it better be exciting or no one is going to use it.

JV: Ok

DB: I have to say, that this is not going to be easy, i.e. getting a game on the web site. You may have to look at alternatives. Talk to Professor Heffernan, he was a high school teacher in mathematics and I think he is interested in local high schools here. He may be able to give you some better advice.

JV: Thank you for the contact, do you know of any existing theories on how to present educational activities on online?

DB: Well James, you've taken my Human Computer Interaction class, there is nothing more than what was taught in class. One thing you could do is talk to the guys down at the Academic Technology Centre, they may have some stuff to say about how to present activities

JV: Ok, is there any other information that you could give us that could help us in presenting material on the web site?

DB: Hmm, well you may want to find out how long the curriculum has been in place. If its relatively new, then the teachers may not be used to it as much, and so they may not want really innovative stuff. Also you need to check if the teachers can change the interface to add their own material. If it is updateable, then it would involve more scripting and more teaching to teachers!

JV: Ok

DB: And of course, computing power is a major issue. How many visitors are you going to have? The server should be able to handle it!

JV: Yes that's a good point, I didn't think of that!

DB: Well that's all I had to say, good luck with your project

JV: Thank you very much Professor

Personal Interview with Sara Hakim in Orange County, Texas
Date: February, 2003

Interviewer: Najmuddin Gunja
Note taker: Najmuddin Gunja

NG: Hi Sara, I needed some info from you regarding mathematics and statistics

SH: Hi, what do you want?

NG: If I wanted to find out which courses are taught in mathematics in high school and in
which year, how would I go about doing that?

SH: it's not a standard thing. It depends on the level of advancement in the individual student.

SH: but the typical coursework is:

SH: 9th- geometry

SH: 10th- algebra

SH: 11th- pre-calculus

SH: 12th- calculus

NG: So when are you taught statistics?

SH: apparently... statistics is a math elective

SH: I never did get to take it because it's always come into conflict with my Latin class

NG: So technically you could go by high school without statistics?

SH: yeah, most people do...

NG: very interesting

SH: very few people take statistics in high school

NG: I see...do you like math in general?

SH: It's ok

SH: Like, I was way ahead because I took pre-calculus in my freshman year and calculus in my sophomore year…and then I always had a schedule conflict with Statistics

SH: So I haven't had math for the past 2 year but it's all right.

NG: Oh ok.

SH: I'm not a huge fan of it though

SH: It's not my best subject

NG: If there was something that could be done to help promote interest in math in high schools, what would that be?

SH: I do not really know, maybe they should have more application stuff, because most people think math is just too abstract, that it doesn't apply to stuff

NG: go on

SH: I think a major incentive for people to take math the way the system is currently is that it's required

SH: For example, I think you have to have taken pre-calculus to graduate at my school

SH: I think people just think of math as evil, just because it has a bad reputation and different people are good at different aspects of math

NG: I see

SH: Like, I don't think very well spatially, so I didn't like geometry or trig AT ALL

SH: but I love algebra and I especially loved calculus.

NG: Do you think you would you be "more interested" if math were taught on the web ...by some interactive method?

SH: no

NG: why not?

SH: I'm not into that, I think math is one of those subjects where you need a live teacher, and you can sit there with a pencil in your hand and fill up a sheet of paper with scratch work till you figure it out.

SH: But I think the web thing is ok for lower level math

SH: but upper level... that's just not appealing to me

SH: because it's not that simple anymore

NG: What if the difficult things are made simpler by interactive means on the web, like including puzzles or math games?

SH: web puzzles aren't going to help people understand derivatives and integrals any better

SH: It's not like learning the multiplication tables

NG: How about Statistics? Couldn't that be learnt through some form of interactive approach on the web?

SH: hmmm, well, having had no experience in Statistics, I'm not really in a position to say...but from what I have heard interestingly, the most common complaint about statistics is that it's not *enough* math

NG: ha-ha…not "enough" math?

SH: well at my school, the statistics teacher isn't really good

SH: A lot of my friends are in the statistics class and most of them don't think of it as real math

NG: why not?

SH: I know someone who took it just so they wouldn't have to take calculus because the whole year you don't need to pull out a calculator

NG: Do you think maybe statistics is easy to learn?

SH: it looks that way, but it's really not

SH: but again, depends what you're good at

NG: this is Statistics AP correct?

SH: yes

NG: Ok....

NG: Why do you think Statistics is easy for people? (Besides not using a calculator)?

SH: I think because people think of math as hard, and statistics has a reputation of not being "real" math, then people take it because they think it's easy, but everyone I've talked to who originally thought that, actually ended up thinking it was really hard

SH: but that might just be because as I have already mentioned, the teacher isn't very good.

NG: So statistics is hard because the teacher isn't good?

SH: Yeah, I think that's a large part of it

NG: So if the teacher was good, statistics would be easy?

SH: not easy, but not as hard as it is now

NG: ok

NG: So I get the feeling that people are not interested in Statistics in general?

SH: Pretty much

NG: You mentioned earlier that you liked calculus. Why is calculus so interesting?

SH: umm... because you can use it for so many things

SH: and it's just cool

NG: So that's why it's interesting?

SH: actually, most people I know really like calculus

SH: I really liked knowing it when I was in physics because it made things easier

NG: Did you like the teacher?

SH: No actually the teacher wasn't very good.

NG: So if the teacher for calc wasn't good, shouldn't you have lost interest?

SH: I don't know, I liked it anyway

NG: So a teacher not being good has nothing to do with interest in a subject?

SH: No, the teacher has a lot to do with it but I think calculus is just so universally useful and interesting that it doesn't quite apply to that particular subject

NG: So your implication is that statistics is not useful?

SH: hmmm... I *guess* it is... but not in the same way that calculus is

SH: I think the only reason statistics is useful is like for sociology

NG: How sure are you about that?

SH: ha-ha not very, not having taken the class

SH: this is all just my opinion by the way

NG: Ok you will pleasantly surprised to know that anything and everything in the world requires statistics

SH: such as?

NG: anything u can think about

NG: any product that is approved by Food and Drug administration, any scientific article requires statistics, forming of a company requires some statistics

SH: yeah... done by sociologists who work for the FDA and for companies

SH: you just have to be interested in stuff like that

SH: I personally wouldn't be too interested.

NG: Actually statistics is used by a wide variety of people, for example statistics is a requirement to graduate in most engineering universities

SH: I don't doubt it

SH: it's important to have a basic knowledge of it

SH: but I don't know... I just don't think I could get into it

SH: but who knows

NG: Thank you very much Sara

Personal Interview with Pria Shah, Boston Massachusetts
Date: February, 2003

Interviewer: Najmuddin Gunja
Note taker: Najmuddin Gunja

NG: Hello Pria

PS: Hey

NG: How are you?

PS: I'm good

NG: Hey, are you in grade five or six?

PS: 6th

NG: Oh ok.

NG: Do you mind if I ask you some questions?

PS: ya sure (laughs)

NG: It's going to be like a mini-interview

PS: Ok go ahead

NG: ok cool

NG: Do u like mathematics?

PS: It's ok (smiles)

NG: So, what do you learn in your math class?

PS: Do you mean what I am learning right know?

NG: Yes, what are you learning in your math class right now?

PS: geometry

NG: And are you enjoying it so far?

PS: Yes!

NG: Is there anything in particular in geometry that interests you?

PS: I like polygons

NG: ok...any idea why you may like them?

PS: (smiles) I guess because there are so many kinds and all of them are different shapes

NG: So you like different shapes, very nice

NG: Ok, have you done any kind of statistics in your math class till now?

PS: No I don't think so

NG: do you know if you will be doing any kind of statistics in grade 6?

PS: what exactly do you mean when you say statistics?

NG: ok let me explain

PS: ok

NG: statistics is basically when you collect some kind of information and then figure out what the information means...

PS: ok

NG: for e.g. if I toss a coin

NG: I can get either heads or tails, correct?

PS: Yes

NG: So I can say...that when I toss a coin, I can get two options

NG: so that's the information I collected

PS: Oh ok

NG: and then when I actually toss the coin, just say I get heads.....so I make a note on a piece of paper…

PS: I don't think we will do much of that in 6th grade

PS: Oh wait, actually we do…we did it last year I think.

NG: Oh really?

PS: Yes! Then we see how many times that one thing happens

NG: Oh wonderful, what you did was statistics! (laughs)

PS: Oh, the teacher didn't tell us it was called statistics

NG: Maybe she called it Probability?

PS: Yes, I think that's what she called it.

NG: Well probability is a branch of statistics (smiles)

PS: oh ok

NG: Ok so did you enjoy probability last year?

PS: Yes I did

NG: How did your teacher explain to you what probability was?

NG: Do u remember?

PS: I'm not that sure

NG: Ok no problem

PS: If I remember correctly, I think we used ratios.

NG: Ah ratios

PS: Yes

NG: Ok so did you actually do the experiments in class or was it text book based?

PS: Well both, we did experiments in class and also from the text book.

NG: Oh ok...what other kinds of experiments did you do in class for probability besides the coin toss?

PS: Well once we used candy from a bag and used the colours to figure out something!
(laughs)

PS: Let me think, there were five different colours in a bag and we had to sort them out
and figure out their respective ratios or something like that.

NG: Ah very nice. Did you find that interesting?

PS: Yes!

NG: So you liked doing the activity yourself?

PS: Yes, I think experiments teach you more than the textbook.

NG: Very interesting opinion!

NG: So if I gave you an option to do hw or to perform some experiments, which one would you choose?

PS: Experiments

NG: (laughs) ok

NG: All right, do you have the Internet in classrooms?

PS: We have a computer lab in our school and sometimes we do research, but not for math class.

NG: Ah, so what subject is it used for then?

PS: We research science

NG: Have you played any math games on the computer?

PS: Yes I think I have

NG: Do you remember what kind of games?

PS: Uh the ones where you can practice multiplication, but that was last year. We haven't played any math games this year

NG: Hmm ok

NG: Do you feel the game helped you learn multiplication?

PS: Yes certainly

NG: Would you prefer to learn multiplication by playing a computer game or by conducting an experiment in class?

PS: I guess it wouldn't really matter, as they are both good.

NG: Ok but which one is more interesting in your opinion?

PS: (Smiles) Conducting an experiment I guess but the computer is a lot more fun

NG: Ah!

NG: So you prefer that the activity be more interesting rather than fun?

PS: Yes

NG: Very good

PS: Oh I forgot to tell you that on the computer near the end of this year, we will make some spread sheets using some formulas.

NG: Ah very interesting

PS: Yes

NG: That's also statistics, in case you didn't know!

PS: Really!

NG: Yes! Ok what if you could conduct experiments on the computer?

NG: Would you like that?

PS: Yes I would like that a lot, fun and interesting!

NG: For example that candy experiment that you told me about, what if it was on the Internet.

PS: That would be really cool

PS: Yes, I really like doing things on the computer and I also really like doing experiments.

NG: Very nice

NG: Ok another question. Is there any thing in mathematics that you find boring?

PS: Sometimes when you are reading out of the book with the teacher, I don't really get the concept right away and then it gets boring.

NG: Yes that's true, it's difficult to read math

PS: Yes I agree, anyway I have to go now.

NG: Oh, thanks a lot Pria! You have been a great help!

Pria: (smiles) No problem at all

Appendix D- Summarized Interviews

Summary of Interview with Professor Neil Heffernen
Date: February, 2003

Note taker: Josette Jaecksch

Main Points:

1) Interested in the idea of online activities, but would prefer more of a "smart tutorial" for students that would respond to student progress and needs.

2) Also suggested having a way for teachers to monitor student use and learning with the system.

3) Was not concerned with student preferences for activities, saying learning maths is just something the students have to do whether they like it or not.

Summary of Interview with Shauna Jaecksch
Date: February, 2003

Note taker: Josette Jaecksch

Main Points:

1) Personally has little interest in mathematics, but still has high marks in maths classes.

2) Sees little use for most of the topics covered in maths classes, particularly few real world applications of statistics other than sports.

3) Thinks lectures are boring and not the best way to learn, as each student learns at their own pace.

4) Thought interactive games might be more interesting if assigned in class but would not go looking for them if not required.

Telephone Conference with Teresa Dickinson
Date: April, 2003

Note taker: Najmuddin Gunja

Main Points

1) Make sure that the final report mentions that the recommended web site must fit in with accessibility guidelines that have been already been established.

2) ABS does not usually outsource projects.

3) ABS web site needs more colour.

4) Make sure the final report makes it clear that you are testing the features or characteristics of the activity rather than the activity itself.

5) Make a recommendation for future projects to try and link activities to grade levels.

6) Check and see if ABS has any specialists in creating Java-based interactive applications.

7) The graphing calculators used in schools is the TI-83

Summary of Interview with Gary Dunett
Date: April 14, 2003

Note taker: Najmuddin Gunja

Main points:

1) Talk to Chris Conrad who is the TA.

2) How is this going to work with a 26K modem?

3) You need to follow the W3C guidelines and also the HREO (Human Resources and Equal Opportunity (www.noie.gov.au)

4) Must meet accessibility guidelines.

5) For the visually impaired you could have some text that is accessible.

6) Colour-blind people cannot see shades of colours.

7) School accessibilities issues with Java.

Summary of Interview with Chris Conran
Date: April 14, 2003

Note taker: Najmuddin Gunja

Main points:

1) Title: Director – Technology Applications Technology Services Division

2) Deals with web sites, web site applications, publications etc.

3) Gary Dunnet is a major client, so before we do anything, it has to be accepted by Gary.

4) Should fit in with accessibility guidelines.

5) Look at the www.questacon.edu.au web site as it has similar interactive approaches that you are trying to achieve.

6) Flash can be reasonably accessible but it has problems, like JAW cannot support it.

7) Java has access problems due to firewalls as well as security issues with Java executable files.

8) Web site should cater to the lowest common denominator of accessibility-browsers, plug-in, modem speeds.

9) You could specify that Java or Flash need to be enabled for certain web pages of the ABS.

10) You could provide an alternative page to the interactive activity that could include text so that visually impaired students could learn the material.

11) It should be compatible with the AGLS (Australian Govt Locator Services). This is a tagging service where people come in and spider sites.

12) You could use SVG (Scalable Vector Graphics) program....it's scripted 2D graphics, similar to flash, has scripted animation, can be made accessible fairly easily, can cut and paste because it is text, can include timed sounds, comes as part of the acrobat reader in new versions, although Netscape 6.0 has some restrictions.

13) Sound and html can be done on lotus notes and can be put online easily.

14) Project recommendations as they now stand are very feasible, need a "go" from Gary.

Appendix E- Focus Group Responses

Teachers' Responses

The responses collected from the teachers in the focus group session were gathered and inputted in a Microsoft Excel spreadsheet. The comments in the tables are those mentioned by the teachers when asked a variety of questions. In some questions, teachers answered in monosyllables while in others a more detailed answer was provided.

Complete Teacher Responses to Activities

Name of Activity	**Dice Rolling Simulation**	**Plop It**	**Circle Graph**
Has learning value?	simulation good but needs context	Entering data manually is good	Yes
Will use in classroom?	Progression from simple to complex	Yes	Guided
Use as homework?			only after taught in class
Will interest students?		would love	
Will recommend to other teachers?			
Other Comments	Two concepts create confusion	much control is good	good science application
	need more controls for range	grade 8, 9	hate pie charts but this good
	too simple	Add and remove points is good	primary levels; no flexibility
Easy to use?		Yes	Yes
Interesting?		Yes	Yes
Appealing?		Yes	Yes
Educational?	Yes	Yes	
Difficult?	Yes		
Awkward?			

Name of Activity	Dice Table	Gambler's Ruin	Racing Game
Has learning value?	quiz about other activities		effective in teaching
Will use in classroom?		on the board as easily	
Will use as homework?			
Will interest students?			needs better graphics
Will recommend to other teachers?			
Other Comments	not worth logging on for	more scales, control, detail	liked dice animation
	no open ended questions	Needs environment	
	ok as tutorial		graph demonstrates well
Easy to use?			
Interesting?			
Appealing?	Add quiz on other activities		Yes
Educational?			
Difficult?	yes- table confusing		
Awkward?			

Name of Activity	**Fire Simulation**	**Histogram**
Has learning value?	probability; students learn	better than graphing calc
Will use in classroom?	Yes	
Will use as homework?		
Will interest students?	Would love it; very interested	Would love this
Will recommend to other teachers?	Yes	
Other Comments	lot of fun; open-ended	more explanation; more controls; fix use of colour;
	good control	Scale; standard deviation;
		discrete and scroll bar; negatives, exponential numbers are bad
Easy to use?		
Interesting?	Yes	
Appealing?	Yes	
Educational?	Yes	
Difficult?		
Awkward?		

The following is a table of the general comments made by teachers at the end of the focus group.

Complete General Comments

General comments	Needs more background and context for any and all activities
	think not just click- questions on expected outcomes first
Other possible activities	box plot like histogram
	standard deviation
	Venn diagrams
	time series
	Smoothing
	De-seasonalising data
	population trends
	Challenges
	Download to calc
	conditional probability
	binomial distribution
	Same data – different representation
Suggested topics for data	real life- pop trends
	current events
	Upcoming events
	teenage Internet use

Students' Responses

Complete Responses to Dice Rolling Simulation

	Group 1	**Group 2**	**Group 3**
Enjoy activity	Very cool; I like anything that moves; animations	Cool; fun; there was movement; is red line average?	Yes, this makes life easier; its fun
Do other activities like this?	Yes; no	Slot machines; gambling; other choices	Not really
Did you learn anything	Bell curve	No; need instructions; you went too fast	Not really
How to improve it	Change the no. of possibilities on the dice; use Flash		**More colour**

Complete Responses to Plop it!

	Group 1	**Group 2**	**Group 3**
Enjoy activity	Fun; useful as it cannot be done on a calculator; Computer is much more useful for this type of activity	Colourful; we don't have to do anything; gives the answer	Yes; its cute; cool when it moves; it's easier than calculating it
Do other activities like this?	Yes, definitely; As long as its cool	Yes; its easy to do; normal calculator doesn't do it	Yes
Did you learn anything	Yes It tells us the average	Yes; I get it; median; there can be more than one mode	Not much
How to improve it			More colours and noises

Complete Responses to Circle Graph

	Group 1	**Group 2**	**Group 3**
Enjoy activity	Yes	Yes; its colourful; shows what you did	Yes; it's cool; interesting; pretty colours
Do other activities like this?	Yes; No	Yes; 3D charts	Yes
Did you learn anything	We could learn from this	Shows percentages	Shows percentages
How to improve it	Initial input required to limit total; control	Hard to type in; use buttons for values	

Complete Responses to Dice Table

	Group 1	**Group 2**	**Group 3**
Enjoy activity	Not fun; very boring	Boring; excruciating; don't like it	No, not interactive; didn't understand; yes, it gets you thinking
Do other activities like this?	No	No	Yes while studying; no it's boring
Did you learn anything		No; not really; didn't work	Not really
How to improve it	More involvement; should have pop-ups	Need instructions; we want to roll dice	Change the colours

Complete Responses to Gambler's Ruin

	Group 1	**Group 2**	**Group 3**
Enjoy activity	This is ok	Yes	Yes
Do other activities like this?	Yes, have a series of graphs and find out how long it takes to lose money	More interaction needed	Yes
Did you learn anything	Comparing probabilities	Not much; yes how much money you could lose; don't go to casinos!	Winning is nice
How to improve it	Needs limits; controls and instructions; Have multiple games and show which game is playing	More control needed; need to explain what's happening; slot machine screen	Australian dollars signs; bigger fonts; slot machine; need to explain what's happening

Complete Responses to Car Racing

	Group 1	**Group 2**	**Group 3**
Enjoy activity	Love this activity	Yes, this is good; fun and math; you can rig the bet	Yes; fun
Do other activities like this?	Yes; We would look for activities like this	Yes	Yes
Did you learn anything	We learnt who has a better chance of winning	How to cheat; change the odds and let a car win	Kind of….maybe
How to improve it	Cars should be real; we need sound	Better graphics; more noises; bigger and better cars	Better looking cars

Complete Responses to Forest Fire

	Group 1	**Group 2**	**Group 3**
Enjoy activity	This is nice; good one	Yes; cool; fun; stats in it; we are arsonists; awesome	Yes; interesting; looks cool; interactive; tricky; fun
Do other activities like this?	Yes but with a warning (don't try this at home!)	Yes	Yes
Did you learn anything	Taught probability; Yes; but couldn't say what.	Some statistics; the logic behind it; statistics is cool	Yes, probability influences results
How to improve it	We need sound and a description of what's going on	Fire fighters should be there; The trees are too small and the animation could be better.	Not really; its good

Complete Responses to Histogram

	Group 1	**Group 2**	**Group 3**
Enjoy activity	This is ok….but a curve would be better; colour is nice	It was ok; boring; complicated; like the way graphs changed	No; don't care; liked colour
Do other activities like this?	We could do this for hw	Activities where you can change graphs	No
Did you learn anything	We learnt about interval sizes	No, couldn't understand	No
How to improve it	We should be able to type in our interval size		Didn't know concept to begin with

Appendix F - Cost Analysis Data

The selection of which firms to contact was based on previous firms that ABS had worked with, as well as appropriate entries as found in the Australian Yellow Pages. Appropriate firms were selected after a brief phone interview explaining our project and a request for a cost analysis. Below, we have listed the firms we attempted to contact and the results of each telephone call.

Attempted Contracts with Web Development Firms

Name	Local Phone Number	Status
Visual Purple	N/A	Out of Business
SENOJWEB	(03) 9417 3477	Successful
Info-OnScreen	N/A	Out of Business
Creative Vision Design Production	(03) 9629 8850	Successful
Net Media Interactive	(03) 9720 1913	Successful
Zero Gravity Multimedia	(03) 9722 9333	Successful
AAV Australia	(03) 9251 1844	Successful
Liquid Vision New Media	(03) 9820 4487	Out of Business
Lodestone Multimedia	(03) 9653 9480	Out of Business
IRM Multimedia	(03) 9696 9906	Successful
ISIS Communications LTD	(03) 9646 7466	Out of Business
Web Activation	(03) 9654 8266	Successful
Web Elements	(03) 9888 6248	No Java Expertise
Webcraft Media Productions	(03) 9478 7393	Out of Business
Web Evolve	(03) 9775 4342	No Java Expertise
Innographics Multimedia	(03) 9742 3746	Out of Business
Hi-Rise Productions	(03) 9510 2919	Out of Business

Appendix G – Evaluation of Sample Activities

Numerical evaluation of web based activities for possible use in focus groups

Activity		Effective			Interactive		Educational		Challenging		Sum A
	RATING	7			9		10		6		
		Visually	Audibly	Tactilely	Input	Control	Explain	Demonstrate	Knowledge	Challenge	
	WEIGHT	3	2	2	4	5	4	6	3	3	
stogram	Score	8	0	8	10	9	2	8	3	4	
	Weighted	24	0	16	40	45	8	48	9	12	
	TOTAL			28		76.5		56		12.6	173.1
ie Chart	Score	8	0	8	5	8	4	9	7	3	
	Weighted	24	0	16	20	40	16	54	21	9	
	TOTAL			28		54		70		18	170
Circle graph	Score	8	0	4	10	6	6	9	5	4	
	Weighted	24	0	8	40	30	24	54	15	12	
	TOTAL			22.4		63		78		16.2	179.6
Plop it!	Score	8	0	7	10	9	4	9	5	3	
	Weighted	24	0	14	40	45	16	54	15	9	
	TOTAL			26.6		76.5		60		14.4	177.5
Racing 1die	Score	9	0	8	6	8	6	9	7	6	
	Weighted	27	0	16	24	40	24	54	21	18	
	TOTAL			30.1		57.6		78		23.4	189.1
Box Plot	Score	5	0	6	8	7	5	9	2	4	
	Weighted	15	0	12	32	35	20	54	6	12	
	TOTAL			18.9		60.3		74		10.8	164
ice table	Score	6	0	6	7	5	8	6	7	10	
	Weighted	18	0	12	28	25	32	36	21	30	
	TOTAL			21		47.7		68		30.6	167.3
Fire	Score	10	0	6	5	5	3	7	6	1	
	Weighted	30	0	18	20	25	12	42	18	3	
	TOTAL			33.6		40.5		54		12.6	140.7
irectable fire	Score	10	0	8	7	7	5	7	5	3	
	Weighted	30	0	16	28	35	20	42	15	9	
	TOTAL			32.2		56.7		62		14.4	165.3
etter fire	Score	10	0	7	4	3	5	4	7	2	
	Weighted	30	0	14	16	15	20	24	21	6	
	TOTAL			30.8		27.9		44		16.2	118.9
Random vars	Score	10	0	6	4	5	7	10	8	3	
	Weighted	30	0	12	16	25	28	16	24	9	
	TOTAL			30.8		36.9		44		19.8	131.5
ambler's ruin	Score	7	0	1	1	1	3	5	5	0	
	Weighted	21	0	2	4	5	12	30	15	0	
	TOTAL			16.1		8.1		42		9	75.2
atsercise	Score	8	0	0	0	0	6	8	9	8	
	Weighted	24	0	0	0	0	24	48	27	24	
	TOTAL			16.8		0		72		30.6	119.4

Activity		Colourful		Vision			Appeal		User-friendly		Sum B
	RATING	5		5			5		6		
		Number	Much	Audio	Add audio	Text	Equal		Understand	Use	
	WEIGHT	2	3	1	1	3			3	3	
Histogram	Score	7	5	0	5	4	10		4	8	
	Weighted	14	15	0	5	12			12	24	
	TOTAL		14.5			8.5		50		21.6	94.6
Pie Chart	Score	7	7	0	5	8	10		8	8	
	Weighted	14	21	0	5	24			24	24	
	TOTAL		17.5			14.5		50		28.8	110.8
Circle graph	Score	7	7	0	5	8	10		9	8	
	Weighted	14	21	0	5	24			27	24	
	TOTAL		17.5			14.5		50		30.6	112.6
Plop it!	Score	1	6	0	5	7	10		9	9	
	Weighted	2	18	0	5	21			27	27	
	TOTAL		10			13		50		32.4	105.4
Racing 1die	Score	8	6	0	8	6	7.5		10	10	
	Weighted	16	18	0	8	18			30	30	
	TOTAL		17			13		37.5		36	103.5
Box Plot	Score	4	7	0	5	8	10		9	9	
	Weighted	8	21	0	5	24			27	27	
	TOTAL		14.5			16		50		32.4	112.9
Dice table	Score	2	2	0	3	8	10		4	8	
	Weighted	4	6	0	3	24			12	24	
	TOTAL		5			13.5		50		21.6	90.1
Fire	Score	4	8	0	5	6	10		9	9	
	Weighted	8	24	0	5	18			27	27	
	TOTAL		16			11.5		50		32.4	109.9
Directable fire	Score	4	8	0	5	6	10		9	9	
	Weighted	8	24	0	5	18			27	27	
	TOTAL		16			11.5		50		32.4	109.9
Better fire	Score	5	10	0	5	6	10		9	9	
	Weighted	10	30	0	5	18			27	27	
	TOTAL		20			11.5		50		32.4	113.9
Random vars	Score	7	9	0	5	8	10		9	9	
	Weighted	14	27	0	5	24			27	27	
	TOTAL		20.5			14.5		50		32.4	117.4
Gambler's ruin	Score	1	1	0	5	10	10		6	7	
	Weighted	2	3	0	5	30			18	21	
	TOTAL		2.5			17.5		50		23.4	93.4
Statsercise	Score	5	3	0	3	9	10		8	10	
	Weighted	10	9	0	3	27			24	30	
	TOTAL		9.5			15		50		32.4	106.9

Total weighted scores of all evaluated activities

Activity	Sum of A+B
Histogram	267.7
Pie Chart	280.8
Circle graph	292.2
Plop it!	282.9
Racing 1die	292.6
Box Plot	276.9
Dice table	257.4
Fire	250.6
Directable fire	275.2
Better fire	232.8
Random vars	248.9
Gambler's ruin	168.6
Statsercise	226.3

Comparative table of final selections

Activity	Cite	Types							Rating	Repeats
Racing 1die	Interactivate	Demo	Sim		Game				292.6	
Circle graph	Interactivate	Demo		Calc		Graph			292.2	a
Plop it!	Interactivate	Demo		Calc		Graph			282.9	
Directable fire	Interactivate	Demo	Sim						275.2	b
Dice table	Interactivate						Table	Quiz	257.4	
Random vars	Csusb	Demo	Sim			Graph			248.9	
Gambler's ruin	Xanadu	Demo				Graph			168.6	
Histogram	Interactivate	Demo		Calc		Graph			267.7	a

Appendix H – Preliminary Focus Group Plan

VIC Client Services WDB
By: Iain Sutherland 17/12/2002 17:36

Web Dissemination for Schools - Focus Group Research

A key element of the Worcester Polytechnic Institute (WPI) student project is the design, development and conduct of focus group sessions and the analysis and presentation of results. This document provides an outline for how this might be achieved. ABS staff will co-ordinate the equipment, location and other administrative aspects of the focus group discussions leaving the project team to concentrate on integration of the focus groups into the overall project as described on the project web site <http://users.wpi.edu/~jbarnett/oz03/Project3.htm.> (**Subject:** Re: Projects; **Database:** VIC Client Services WDB; **Author:** NotesVIC01; **Created:** 04/12/2002; **Last editor:** Soo Kong; **Modified:** 04/12/2002; **Doc Ref:** NVIC-5GH635)

The Selection of Participants (ABS)

Teacher participants will initially be approached from those located in Melbourne that responded "yes", to the final question of our user review: "Would you be prepared to have us come back to you to follow up on your comments for more detail?. Further teachers may be found through other NESU contacts if required. Student participants will be approached on the recommendation of these teachers.

Set up of Focus Groups (ABS)

Focus groups will most likely take place at the ABS office. We anticipate that there will be one or two sessions for teachers and one or two sessions for students. Each session will have between 8 and 12 participants.

Selection of Web Educational Activities (WPI / ABS)

1. These should all be aimed at teaching students statistical/mathematical skills and concepts; preferably with outcomes defined in school Curriculum documents.
2. Should be selected on the basis that they are representative of a particular learning approach in terms of presentation style; the types of activity - such as interactive or static, focus on the concepts or on getting students to use data; and the content in terms of the concepts that the activities are trying to convey.
3. Some sites may be identified by the ABS education services team for inclusion in the sample as part of ongoing work in this area.

Development of Questions (WPI)

The focus groups should address the following issues for each activity / web site and be written to produce at least some quantifiable results A separate set of questions should be used for the teacher and student groups.

For Students:

- Does the activity inspire an interest in statistics?
- Does the activity make them want to find more like it?
- Do they feel that they have learnt something form the activity?
- If it demonstrates something that has been covered in class, is it easier to understand than earning from a textbook?

For Teachers:

- Do they see it as having learning value for the students?
- Is it something that they would get kids to use directly in class?
- Is it something that they would direct their students to?

Timetable for Focus Group Research

The following brief Schedule should allow plenty of time for the analysis and presentation phases.

Category / Description	Responsibility	Start	End
Background Research			
Identify between 8 and 12 web based educational activities with a mathematics/statistics emphasis for presentation to students and teachers	WPI students	Dec 02	Feb 03
Write up brief summary of the learning approach taken by each group of activities	WPI students	Dec 02	Feb 03
Selection of participants, admin etc.	ABS staff	Feb 03	Mar 03
Develop questions	WPI students/ABS	Jan 03	Feb 03
Information Gathering			
Conduct focus groups	WPI students/ABS	Mar 03	April 03

Appendix I – Email dialogue with Interactivate

Subject: Re: Request for copy of class files for educational presentation
From: "James Vautin" <maxx@WPI.EDU>
Date: Wed, March 12, 2003 7:28 pm
To: "Bethany Hudnutt" <bhudnutt@shodor.org>
Priority: Normal

Hello,

I am a university student working with the Australian Bureau of Statistics (ABS).

The National Educational Services Group of ABS is currently looking into a web dissemination project similar to yours, except based around Australian statistics curriculum. We are looking to come up with recommendations for development of such a site. I am conducting a focus group to generate some ideas of activities, and as a demonstration I'd like to include yours.

The problem is, I won't have internet access during the demonstration, so I was wondering if I could get your site onto my drive for the demo..

I can't just mirror it onto CD, as the activities are java -- and it is loading a lot of classes in the background -- of which I have no idea what the names are.

I was wondering if it would be possible to obtain a zip of the classes so that they'll run off my hard drive.

The use is just for this demonstration later this week - if I can't do that then I might be forced to show a video of their usage or just take screen shots.

Please let me know if this would be available.

Thanks,
James Vautin

Subject: Re: Request for copy of class files for educational presentation
From: "Bethany Hudnutt" <bhudnutt@shodor.org>
Date: Thu, March 13, 2003 11:38 am
To: "James Vautin" <maxx@WPI.EDU>
Cc: "Bob Panoff" <bob1@shodor.org>
Priority: Normal

James,
So glad you are finding the materials useful!

We do have a download site available though I first need a statement from you (via email is fine) that says you agree to use interactivate and interactivate materials only for educational, non-profit reasons.

Sincerely,
Bethany Hudnutt

Math Education Specialist,
Project Interactivate Manager
The Shodor Education Foundation, Inc
923 Broad Street, Suite 100, Durham, NC 27705
VOX: +1-919-286-1911 FAX: +1-919-286-7876
E-mail: bhudnutt@shodor.org http://www.shodor.org

"The mathematical sciences particularly exhibit order, symmetry, and
limitation; and these are the greatest forms of the beautiful."
-Aristotle

Subject: Re: Request for copy of class files for educational presentation
From: "James Vautin" <maxx@WPI.EDU>
Date: Wed, March 13, 2003 5:42 pm
To: "Bethany Hudnutt" <bhudnutt@shodor.org>
Priority: Normal

Dear Bethany,

I agree to use interactive and interactive materials only for educational, non-profit reasons. The web dissemination project we are working on is for students of level 6-10 in Australian (Victorian and New South Whales) public schools. After our project is complete I would be happy to provide you with information on what we are hoping to develop!

Thanks so much,

James Vautin

Subject: Re: Request for copy of class files for educational presentation
From: "Bethany Hudnutt" <bhudnutt@shodor.org>
Date: Fri, March 14, 2003 9:27 am
To: "James Vautin" <maxx@WPI.EDU>
Priority: Normal

James,
The url for the download site is at
http://www.shodor.org/interactivate_wdist
username: wdist
password: 1nt3r@ct

If there is anything we can do to be of assistance, please let us know. We may be able to share some of what we've learned in the development. You also have our permission to link to our site in your project, if you find any of the activities there that align with your curriculum.

We would be interested in hearing your plan, once you have a more complete picture.

Take care,
Bethany

Subject: Re: Request for copy of class files for educational presentation
From: "James Vautin" <maxx@WPI.EDU>
Date: Wed, March 12, 2003 7:28 pm
To: "Bethany Hudnutt" <bhudnutt@shodor.org>
Priority: Normal

Bethany,

Thank you for your help in all of this.

We have found the Interactivate program to be an extraordinary development -- these activities are right on target with a lot of what we are recommending to the Australian Bureau of Statistics. (emails are quoted at the end of this email if you what to see what I mentioned a few weeks ago).

In our recommendation, which will hopefully be used to get funding for outsourcing the project to a multimedia development firm, we want to note the copyright status of Interactivate. Many of the activities that we would like to recommend be developed are similar to, or based on activities in Interactivate, with ideas of advancement (sounds, animations) and pertinence to Australian high school curriculum. Could a development firm use the source of the Interactivate project to decrease costs on our end if proper credit was given on the site and source was shared back? Have the source files ever been given out before? If the source files are not available, what is the copyright of the IDEAS behind the java applets otherwise?

ABS is a government agency and, as always, the project remains as a non-profit educational initiative to be used in Australian public schools.

I will be in contact further about some of this.

In the meantime, please let me know what the possibilities are.

Thank you,

James Vautin

Subject: Re: Request for copy of class files for educational presentation
From: "Bethany Hudnutt" <bhudnutt@shodor.org>
Date: Wed, April 2, 2003 11:51 am
To: "James Vautin" <maxx@WPI.EDU>
Priority: Normal

James,

Thank you for all the compliments. I think we should be able to work something out. We have given out our code before, though only in select cases where a partnership can be formed. Hearing what you are thinking of developing, I do think we could make this into a mutually beneficial partnership.

For our own benefit, we would be interested in the materials that you propose to develop as well. It would be good to compare multi-media versions of our applets and student-learning with current versions. Would you all be willing to share the newly developed code with us?

Could you also give a little more information on the project? How would the project be disseminated? Will the new software also be web-based? Will it also be written in java? Could you send a list of the activities you would like to use and maybe a detailed description on how you plan to change one or two of them as example?

Also, just to share some of our own experience with you that is something you may not have considered rather than outsourcing the project to a for-profit development company. Most of our applets were programmed by student interns at the high school and undergraduate level. Being that you are housed at a university, this may be a good option for you to consider working with your school's computer science department. It saves considerable money and beyond that it is a fantastic experience for students to be involved in a project that has real meaning outside of just getting a grade. Either way, we are still willing to work with you but in this manner the project even further benefits educational goals.

I look forward to hearing more from you.

Bethany

ps - just from my own curiosity, where in Australia are you located?