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## ABSTRACT

# INTRODUCTION TO POLLUTION PREVENTION CONCEPTS IN FRESHMAN CHEMISTRY THROUGH SIMULATIONS AND HYPERMEDIA

**by**

**Anirban Bhaumik**

As citizens of the 20th century, a key issue we all are aware of is degradation of the environment. In the interest of teaching the environmental issues to freshmen engineers, this study develops a computer aided learning/teaching (CAL/T) tool .

This CAL/T tool consists of Internet based multimedia courseware and intelligent simulations. The courseware assembles the fundamentals of chemistry associated with current environmental issues such as air pollution, stratospheric ozone layer depletion and environmentally sensitive or *'clean'* manufacturing. The courseware targets early and comprehensive understanding of pollution prevention concepts with a focus on environmentally friendly manufacturing. The courseware includes: on-line text, audio-video education tools, video files of laboratory demonstrations, interactive computer software for environmental problem solving and laboratory simulation, on-line self assessment tests, information about faculty, and on-line evaluation tools to obtain students' feed-back to enhance faculty teaching. To enable the widest possible dissemination this courseware can be accessed by academia, industry, and governmental research and educational institutions through the World Wide Web.

# INTRODUCTION TO POLLUTION PREVENTION CONCEPTS IN FRESHMAN CHEMISTRY THROUGH SIMULATIONS AND HYPERMEDIA

by
Anirban Bhaumik

A Thesis
Submitted to the Faculty of
New Jersey Institute of Technology
in Partial Fulfillment of the Requirements for the Degree of
Master of Science in Chemical Engineering

Department of Chemical Engineering, Chemistry and Environmental Science

January 1998

## APPROVAL PAGE

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To
My Parents

## ACKNOWLEDGMENT

The author wishes to thank all those who have assisted with the research, especially his advisor Dr. Golgen Bengu. Professor Bengu provided inspiration, guidance, and direction as well as invaluable help throughout the research process.

Special thanks to Dr. Daniel Watts, Dr. Barbara Kebbekus and Dr. Robert Barat for serving as members of the committee and assisting in the refinement of the thesis.

The author is grateful to the National Science Foundation (NSF) for their funding through a Technology Reinvestment Project (TRP) grant, award number CTS-9413104, to the New Jersey Institute of Technology. Without this funding, the research would not have been possible.

Finally, a thanks to Mr. Abhijit Datta, Mr. Mallikarjun Yalaka and Mr. Srinivas Tolety without whom an interdisciplinary project of such a magnitude would not have been possible.

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# CHAPTER 1

# INTRODUCTION

## 1.1 Engineering and Environmental Decision Making

In the last decade engineering challenges have included issues such as global warming, ozone layer depletion, air pollution, Volatile Organic Compound (VOC) emissions etc. All of these challenges pertain to maintaining or improving the quality of the environment. In his book *"Earth in the Balance"* , Vice President Al Gore suggests that "the rescue of the environment is the central organizing principle for civilization" . However, if the environment needs to be rescued, then those now being educated will have to do what the present generation has been unable or unwilling to do; account for the environmental impact of the industrialization associated with higher standards of living.

It has taken mankind a long time to come to terms with the fact that industrialization often comes at the expense of environmental resources. Today successful technologies are the ones with minimal environmental impact, and the challenge of the future is to design such technologies. Therefore the focus in engineering education now is not only in technology but in environmental impacts of technology as well.

Future engineers and scientists will therefore be challenged in deciding which technology to adopt. As an engineer in the 21st century developing a new technology is not enough. One has to study the environmental impact too. And in applying this technology one has decide which technology amongst competing ones is more favorable

from the environmental perspective. In other words environmental decision making is one of the key qualities of an engineer.

### 1.2 Environmental Issues in Engineering Education

An engineering student acquires sound technical knowledge in a discipline, develops good problem-solving skills. But technical competence alone does not make an engineer. Being technically sound is a necessary but insufficient condition to be a good engineer. To be effective, engineers must be able to work in teams, communicate with people, think critically, they must be able to take decisions and above all engineers must understand the implications of their decisions on the world in which they live and be socially responsible for higher living standards.

Unfortunately engineering students are rarely if ever exposed to decision making in their undergraduate curriculum. One of the main reasons for that is perhaps the very nature of the educational system. Classes are rarely if ever interactive. They are primarily teacher centric. The teacher instructs the student to complete a certain assignment and the student works towards completing that, leaving little or no scope for self exploration. Till about a few years previously the technology constraint prevented assigning real-world problems to students.

This past decade has witnessed spectacular improvements in computers, in their computational capabilities as well as in their capability to communicate with each other. For the first time, with the click of a mouse button one could access an infinite storehouse of knowledge (Through the WWW), and yet that is now part and parcel of our everyday

life. These advancements in information technology have important applications to the field of education and engineering education in particular.

Advancements in computational capabilities enable students to simulate, visualize, model and experiment with complex real-world scientific problems, thus promoting exploratory and inquiry-based modes of learning, such as lifetime learning opportunities and improving creative learning abilities. The ability of computers to network, and exchange information can enable collaboration, interactive learning, and bring about a revolution in student-faculty interaction and supporting team-learning.

### 1.3 Education and the World Wide Web

The World-Wide Web (WWW, Web) is an Internet based client-server system that provides a graphical platform for distributing electronic information. Browsers (such as Netscape Navigator etc.) are programs that retrieve information from the WWW. These programs are easy-to-use (point-and-click) and their search capabilities are efficient research tools. Browsers navigate through the web using a protocol known as the Hypertext Transfer Protocol. (HTTP for short). This protocol forms the backbone of the WWW. Hypertext Transfer refers to the standard convention in which a Web page is transferred across a network from computer to computer. However any application that uses HTTP (irrespective of whether it is accessible over a network or not) is termed a hypertext application. A term commonly used together with hypertext is hypermedia, which is a collection of hypertext, images, video and audio.

A hypertext application is a collection of information in documents that contain highlighted words or phrases (anchors). The anchors define hyperlinks that lead to other

documents or other sections of the same document. The hyperlinks allow random access to information, and using a hypertext application is usually referred to as navigating or browsing. A hypertext user can click on a link and browse a new document, return to the original document, or click on another link and proceed along a different path to more information. It is the reader who actively decides on the path to take through the information and how in-depth to read each document. This random access and user control is a major distinction between hypertext applications and conventional textbooks, which are usually designed to be read sequentially. This is a major improvement, for this characteristic of hypertext applications closely mimics the non-linear characteristics of the human thought process.

For distributing information, however a hypertext application accessible through the Internet has several advantages compared to print or CD-ROMs. Internet based material can be updated or corrected instantly, and e-mail provides a rapid means of interactive communication between users and developers. Access to the material is world-wide, available anytime, anywhere, at a user's speed, and cost-effective (neglecting the large indirect cost of the network infrastructure, which exists for many reasons).

The major disadvantages of distributing educational material over the Internet are that many would-be users do not have Internet access, and that the bandwidth of the Internet limits the size and number of files that can be transferred effectively. Distribution of many large files and extensive video for real-time currently is preferred over a local-area network or CD-ROM. However, the combination of Internet based delivery with recordable CD-ROM provides the best of both alternatives.

As an educational medium the hypertext format of the WWW does not differ greatly in principle from multimedia programs on CD-ROM. The advantages of hypermedia educational materials include: an in-context access to related, remedial, or advanced information; incorporation of graphics, audio, and video; an illustration of the connections between advanced topics and basic principles. Programming capabilities allow production of interactive exercises such as drill and practice problems or simulations. Computers have great potential to perform tedious tasks such as grading and free up instructor time for conceptual discussions. Once individual documents are written, it is easy for an instructor to piece different topics together and tailor tutorials for specific courses or subjects. Providing hyperlinks to the remedial material is especially attractive since learning science often depends on previous learning of basic concepts. In the same way hyperlinks can lead to advanced material for enrichment.

The Web is expanding rapidly and new capabilities are in development, such as virtual reality modeling language (VRML). VRML provides a format for transferring and manipulating objects that can provide sophisticated three-dimensional visualization of chemical molecules and reactions.

Besides the advantages of using hypermedia and the WWW as an instruction medium, there are challenges such as the fact that browsing is not the same as learning, visualizing is not the same as understanding, and hypermedia cannot provide all aspects of the learning process. The way in which novices interpret graphical information is not the same as experts who already understand underlying concepts, and effective multimedia use depends on effective descriptive text that explains the concept that the

multimedia is demonstrating. The challenge of applying such new technology effectively will be to enhance rather than to substitute for a student's thinking and imagination.

But in spite of all these potential drawbacks hypermedia and the WWW, are potentially the most significant educational tools to come along in quite a while.

### 1.4 Environment and Chemistry

Chemistry affects our lives and our environment . It is the chemist who researches and produces things that we use in our everyday life, from the toothpaste, life saving drugs, fibers, plastics, synthetic rubbers and fertilizers, almost every product we use has passed through the hands of a chemist.

But in our desire to produce newer, better materials, our ecology has also been harmed. In 1971 poisonous wastes from a chemical plant in Japan found their way into fish living in the sea nearby. People living in the area started exhibiting the symptoms of mercury poisoning. The air around some manufacturing plants has become unfit to breathe as a result of industrial pollution. Before the advent of unleaded gasoline, lead from the exhaust of automobiles released into the air moved all over the earth by currents in the atmosphere, creating one more health hazard. Sometimes the very chemicals intended for benefit have boomeranged and instead of benefiting us, have become harmful. The insecticide DDT nearly caused the extinction of many species of birds, including the eagle, before it was banned by law. Why then did these products find their way into the market? The reasons may range from greed, faulty scientific reasoning to plain ignorance. People simply don't know what the effects of these products would be, and how they can affect us.

This example and others illustrate the dilemma, that has been learned in the last fifty years about environmental and ecological effects of substances. While products were developed and used in the past based upon the best understanding at the time, today, in the light of newer of information, we wonder why choices were made in the past. Chemists and others need to take care in making choices to always assure that the best information is used and all implications of the choice are considered In the US The Environmental Protection Agency (EPA) is the leading governmental agency looking after the health of the Environment, and the Food and Drug Administration (FDA) regulates the release of food and health related new products. There are other regulatory bodies involved with the job of protecting us and our environment. But are we then adequately protected?

Some consumer and environmental protection groups don't think so. They cite examples of gross negligence on the manufacturer's part and pure ignorance on the part of the consumer.

But then again, manufacturers contend that most products prove to be safe, and that stricter controls would affect the release of useful and beneficial products. Gaining a better understanding of the arguments for and against the manufacture of these goods, as well as developing skills in making appropriate manufacturing and purchasing decisions, are excellent reasons for studying chemistry.

# CHAPTER 2

# RESEARCHING AND DEVELOPING THE COURSEWARE

## 2.1 Critical Thinking and Environmental Concepts in Engineering Education

Engineering educators today must teach fields which encompass a greater range of technology than ever before. Engineering graduates, on the other hand, are expected to combine a detailed understanding of a specialty coupled with the flexibility to adapt to new technologies and a changing marketplace. Today's engineer must be able to see beyond technical issues he/she must be able to see the social implications of technology, and must have the a detailed understanding of how key concepts fit into a broader scientific concept. *(Hurst 1994)* The traditional method of engineering education assumes that scientific knowledge is clear and unambiguous, that there is a right and wrong answer to every problem, and that real problems can always be mathematically modeled. *(Healy 1994)* But this is simply not the case; science is a human and imperfect endeavor and quite often scientific decisions call for fine 'judgment calls'. The ability to make such 'calls' is rarely if ever taught to an engineer in his/her curriculum. The need of the hour is thus to develop a curriculum that incorporates tools and technologies, such as flexible, interactive multimedia that make the best use of science and technology, driven by the user at his or her pace and time, enabling the learner to explore and implement fundamental concepts *(Ranky, Bengu & Spak 1997),* and develope the critical thinking abilities necessary for an engineer in today's marketplace.

Technology has advanced significantly during the 20$^{th}$ century. Unfortunately it has taken a long time for mankind to realize that use of technology most often comes at

the expense of environmental resources. Today the limiting factor in using technology is often it's environmental impacts . Successful technologies that receive acceptance and wide application are the ones with minimal environmental impact. Thus it is but natural that the focus of engineering education is changing from technology to environmental impacts of technology *(Tansel 1994)*

One of the most useful texts for understanding principles of environmental education is the *Guide to Curriculum Planning in Environmental Education* written in 1985 by David C. Engleson. This book provides a great deal of insight into how environmental concern can be instilled into students and taught so that it is carried away from the classroom into the everyday lives of those who are being taught. The author writes of infusing an environmental ethic into an existing curriculum. Rather than trying to add a class, an existing class must be given an environmental component. In this way, the students are learning about preserving the integrity of the environment as they learn about the subjects which they will use during their lives.

From a review of existing literature on environmental education *(Class of 2000 Report, Earth in the Balance, Fundamentals of Ecology, A Sand County Almanac, Chemistry & Society)* four central ideas became apparent. First, the ideal of environmental concern must be infused into an existing curriculum. Teaching these types of ideals without a context is difficult and often does not carry into the fields where it is most needed. Second, the treatment of the material should be diverse and interdisciplinary to allow for the greatest understanding and applicability. Third, the information being taught needs to be accessible by the students. To accomplish this accessibility, the material should be presented in an interesting and thought provoking

way. Over-technical language should be used only when unavoidably necessary. Fourth, the material must be tied to the everyday lives of the students through examples and real-world explanations.

## 2.2 Computers in Engineering Education

We are now in the fourth decade of computer applications. The first two decades were characterized by the domination of mainframes and minicomputers. In engineering education much of the initial development in computers was targeted towards reducing repetitive calculations. The third decade the 1980s was characterized by the introduction of the first commercial microcomputer (the Apple II in 1978) and the mass marketing of software (word processors, spreadsheets, and databases) that fueled this revolution.

By 1990 personal computers (PCs) had become the second most common tool of communication - second only to the telephone. And now of course the computing environment is highly interconnected. Networks proliferate between computers, laboratories, buildings, campuses and across continents. The World Wide Web has revolutionized education. As a researching and collaborative tool it is perhaps without comparison. The world has truly moved towards a global village.

In this development, one of the most remarkable characteristics to note is continual improvement of performance to price ratio which has been sustained over the last four decades. The price of computing has dropped by fifty percent every two or three years ever since computers were marketed commercially *(Brynjolfsson 1993)* .

In the early 1980s, a word processor ran on a 64KB memory microcomputer, by the mid 1980s it required 640KB of memory, and now, no respectable application

software will requires less than several megabytes of memory. This extravagance in memory requirement has come about due to the improving price to performance ratio, and it has brought about a much more fault tolerant and user friendly interface, that makes the task of assimilation much less formidable for the common user. In fact emphasis on learning to program in FORTRAN and similar high level languages has diminished since software like MATLAB, MATHCAD, MATHEMATICA have relieved users of the need to program, removing the justification of teaching programming to non-computer science majors.

But, translated to the field of Engineering Education and Chemical Engineering Education in particular, what does this technological revolution mean? The following passage will attempt to answer that question.

Textbooks have changed substantially. Readers are now expected to use computers in solving problems. Spreadsheets such as MS-EXCEL, Lotus 1-2-3 etc. have taken out the drudgery in solving material balances and stoichiometry. With flowsheet simulators such as ASPEN and property libraries, the dual role of thermodynamics in process analysis and property estimation becomes very easy to teach and explain. In the days before computers, in teaching process control one would spend time on understanding inverse transformation techniques, and in preparing Bode and Nyquist plots in stability analysis. Now with the proper software one simply inputs the appropriate polynomials in the numerator and denominator of the transfer function in the Laplace domain, and then lets the computer carry out the tedious computation. Understanding and insight, which used to take a long time to develop, are now achieved

rapidly. Thus by using computers one can cover more territory and tackle realistic problems in less time *(Mah & Himmelblau 1995).*

Equally remarkable are the advances that have taken place in communication. With universal access to computer networks and ultimately to the internet, anyone can send anybody a message or be reached by E-mail. Through remote access, instructors can easily review class records and assign homework problems, they can easily conduct an electronic dialogue with colleagues at other campuses throughout he world, all without ever leaving their campus, or perhaps their own home. The Internet's World Wide Web (WWW) has blossomed over the last 3 years into one of the primary communications medium known to mankind. Every literate citizen of the world is becoming aware of the existence of the WWW. According to a survey by Intelliquest, about 24 million people in the United States, 12% of the population over age 16, accessed the Web at least once from March to May 1996.

Education Futurist Chris Dede advocates "learning-through-doing", which involves participation in educational experiences which are delivered in real-world problem solving contexts. The WWW supports this type of learning by making possible three innovative learning environments:

1. Synthetic environments, based on computer simulation techniques. They are primarily developed using techniques from the educational entertainment 'edutainment' industry, providing immersive experiences in environments that simulate real-world settings. Using cutting edge techniques such as Artificial Intelligence (AI), Virtual Reality (VR) etc.

2. Knowledge webs, built on multimedia/hypermedia architecture. These complement existing libraries, archives, and other traditional sources of information. These webs enable "just-in-time" learning that is deliverable when it is most needed. When required, the user, the student, simply clicks on a link and further information is delivered. On the Internet. Online archival resources are increasingly linked into the World Wide Web, accessible through "search engines" such as YAHOO, LYCOS etc. In such a context, knowing how to search scientific and engineering literature on the WWW is important, and knowing where to find such information has a significant impact on the professional life of a student *(Bungay & Kuchinski 1995)*.
3. Virtual communities, based on capabilities from computer-supported cooperative learning. They provide interactions that complement face-to-face relationships. Applications include mentoring, peer coaching, virtual scholars and mentors and collaborative tools. The true potential of the WWW is not only in accessing data but also in the ability of people to share emotions, experiences and strategies with people. The current technology allows one to broadcast images audio and full motion video along with textual information. In the words of Chris Dede "Hearing as well as seeing a person makes it possible to pick up subtle facial expressions, voice tone, and body language. From an educational standpoint this is exciting, because powerful learning approaches like collaborative learning become possible when people can share their personalities as well as their thoughts."

To develop a true Computer Aided Learning tool, the features of all three learning environments must be incorporated. To achieve this one must develop this tool for dissemination across the Internet.

## 2.3 Multimedia\Hypermedia Based Interactive Instruction

The 5 senses: touch, hearing, smell, sight and taste are the faculties that a human being uses to retain and understand information. It is difficult to choose one sense which is most effective since the usage of these faculties from person to person. *(Felder & Silverman 1988)* An effective teaching system is thus one that activates as many of the 5 senses as possible. In a conventional classroom, a teacher caters to mainly the auditory senses of the students. Unfortunately only 30% of the students are able to make full use of this learning in the first instruction. The remaining 70% require external supplements to compensate for their auditory deficiency. Multimedia based courseware programs have the potential to appeal to a greater number of senses than traditional instructional programs. They can excite students with animation, sound, and video. They can present complex processes, theories and facts in a manner second only to real-life situations. *(Basu, De, Basu & Marsh 1996)*

One of the challenges in teaching is catering to the needs of a wide variety of students. As mentioned earlier the usage of faculties varies from person-to person so too do learning styles. Different people learn material through different ways. According to Solomon's Inventory of Learning Styles *(Solomon 1992)* there are 4 different types of learners:

*Processing*(Active/Reflective) ---- Active learners learn best by doing something physical with the information, while reflective learners do the processing mentally *(Felder & Silverman 1988)*

*Perception*(Sensing/Intuitive) ---- Sensors prefer data and facts, on the other hand intuitive learners prefer theories and interpretations of factual information *(Felder 1989)*

*Input*(Visual/Verbal) ---- Visual learners prefer charts, diagrams and pictures while verbal learners prefer the spoken or written word.

*Understanding*(Sequential/Global) ---- Sequential learners make linear connections between individual steps very easily whereas global learners must wait till they get "big picture" before the individual steps fall into place.

In a survey taken at a sophomore-level introductory chemical engineering class of 143 students at the University of Michigan *(Montogomery 1995)*

- 67% of students are active learners, yet lectures are typically passive
- 57% of students are sensors, yet lectures are intuitive in nature
- 69% of students are visual, yet lectures are predominantly verbal
- 28% of students are global, and yet lectures seldom focus on the "big picture"

Multimedia based Instructional programs have the potential to address those learning styles not addressed by traditional teaching methods. As established by the previous survey 67% of students prefer a learning environment in which they are actively participating. To them discovery is an important part of the educational process. *(Yokomoto, Voltmer & Ware 1991)* Using hypertext in multimedia the student can explore on his own a course material that was previously limited to a "top down" approach. The idea is to use the power of multi-media to assemble course materials with various media text, sound, full-motion video, slides, animation and interactive software on a single powerful platform *(Bengu 1995)*

One of the primary advantages of multimedia is its potential for interaction. Interactive Multimedia or IMM gives the student the chance to interact with the computer, it enables the student to formulate and test hypothesis on their own initiative.

Interaction allows the student to participate in the decision process in the same way as they would in a group, as in engineering practice. The student learns and retains more because IMM enables students to observe real-world phenomena through motion or still pictures simultaneously with the text that shows the theories, definitions and mathematical models, thereby reducing the abstraction in the mathematical models. *(Chang, McCuen & Sircar 1995).*

### 2.4 Simulation in Engineering Education

One of the main tools of IMM is simulation of real life systems. Simulation is the science of creating a representation of a process or system for the purpose of experimentation and evaluation *(Gogg & Mott 1994)*. The idea is to adopt an approach that offers the student an opportunity to link classroom theory with practical applications. For although people learn by different means, they prefer to gain knowledge and skills through experiential opportunities *(Richardson 1994)*

Simulation allows the students to observe phenomena that are inaccessible because of danger or prohibitive cost. It also enables the students to experience responses to a wide array of input conditions and values of system parameters. This capability of the simulation environment, allowing the users to experiment is unique, and in the process of experimentation this helps the user to discover what additional information is needed to solve the problem. This powerful analytical tool can thus significantly facilitate the problem solving process *(Ram & Girdhar 1997)*.

Simulation tools are easily adaptable and can easily accommodate varying education/learning requirements. For example the same simulation tool can be used in

graduate levels of engineering education as well as in demonstrating to visiting high school students thinking of a career in engineering. Further, simulation tools are cost effective in terms of keeping the curriculum up to date by alleviating the difficulty associated with maintaining expensive laboratories. *(Bengu 1993)*

Simulation has been a major tool for military training. Combat engagement simulations allow soldiers and their simulated weapon systems to engage other soldiers on a virtual battlefield. These simulations are becoming increasingly realistic because of the continuing advances in computer and communication technologies *(Bell & Crane 1993)*. The effort to cut costs throughout the military has increased the importance of simulated training systems *(Mertens 1993)*.

Computer simulation has also been used in the industry for upgrading the knowledge level of professional engineers. The use of simulation methods and technology to build models of manufacturing systems has enabled the Ford Motor Company and its facilities and tooling vendors to work together towards common goals of high system productivity and quality coupled with early avoidance and correction of potential problems *(Williams 1993)*.

The development and use of computer simulations in association with design processes in the engineering industry is widespread, and it is thus essential that the newly graduated engineer be familiar with the principles and techniques involved in such procedures. In fact a simulation tool teaching young engineers the practical solutions to be faced in the industry was developed at the "Rochester Institute of Technology" using a simulated Automated Guidance Vehicle (AGV) material handling system as a learning tool. This system provides a hands-on-learning environment which physically

demonstrates the hardware as well as the software concepts associated with the AGV system *(Lwin 1994)*.

The list of simulation programs developed for engineering and science education is extensive. A partial list includes work by *Ram & Girdhar 1997, Lerman & Lapierre 1997, Jennings 1996, Bengu 1995, Huston, Barrance & Hiemeke 1994, Song 1992, Magin & Reizes 1990, Cleaver 1988, Levary 1986, Koen 1985, Whitman 1985, Hinton 1977.*

It is of course, necessary and essential that "hands-on" experience should be provided, to give engineering students a feel for the processes of measurement and a familiarity with the equipment and computer simulations should never displace a real laboratory experience *(Magin & Reizes 1990)*. In a study carried out a the Imperial College, London, U.K. it was found that students were not developing a critical awareness of the limitations of simulations as representations of actual behavior, it was proposed that simulations which are used as substitutes for, or extensions of laboratory experiments "do not reflect a clear understanding of the relationship between theory and observation in science, in particular between models and real-life" *(Tawney 1976)*. Further in using such simulation packages students rarely if ever display any concern for validating their results, this limitation is however easily got around by deliberately provoking errors in order to make the students aware of these sources of error *(Barnard 1985)*.

Many engineering devices and phenomena studied in experimentation courses involve complex dynamic processes that are not totally understood and thus cannot be modeled with precision. Indeed the *raison d'être* for studying experimentation is to

develop skills needed to solve problems which can only be solved through an empirical approach. The ideal approach to incorporating simulations would thus be to use it to study processes which are imperfectly understood, and thus cannot be modeled accurately, and where they are used to complement and not replace 'hands-on' experimentation *(Magin & Reizes 1990)*. Packages of this kind when coupled with the appropriate multimedia courseware provides learning experiences that cannot be achieved in a traditional classroom setting.

These tools allow students to test their own ideas and see results immediately. Such real time response has been shown to increase conceptual understanding *(Smith & Pollard 1986)*. With the increased power of today's personal computers and software, simulation - the interactive teaching tool has a much wider scope in the engineering curriculum.

### 2.5 Designing a Multimedia Computer Aided Learning or Teaching Tool

As reviewed in previous sections Computer Aided Learning (CAL) using hypermedia is a new approach to teaching that is increasingly becoming popular in both academic as well as non-academic settings. Authoring an effective CAL tool requires different skills than simply than just the ability to use a hypermedia authoring software. Computer based learning is not electronically packaged lectures, it's a new approach to teaching that needs to be mastered *(Du Boulay 1993)*.

Faculty members are well qualified subject experts, but unfortunately they have little understanding of what is required to have an effective CAL presentation *(Beaufait 1997)*. To design effective CAL tools one must be able to communicate effectively, to put

the matter across with the minimum overhead and hence must have expertise in technical communication. The CAL designer should obviously be aware of the subject matter and should thus have expertise in the field the CAL material is designed for. Since CAL materials utilize multiple media and are presented over computers and computer networks, the designer must have expertise in computer science as well. Finally to resolve the cognitive issues involved in an instructional presentation the author must be an expert in psychology.

To find one person with such skills is truly a herculean task, provided of course such a person is available at all! Designing a CAL tool is thus a collaborative inter disciplinary effort. And one must start out with a team comprised of experts in all these fields.

The first step in the development of a multimedia courseware, indeed in developing any software is a Project Definition and Needs Analysis. Once that has been accomplished, the development of the courseware can proceed.

### 2.6 Project Definition and Needs Analysis

As in any project one must begin by finding out what needs to be done, by first analyzing the audience (In our case the students) and then formulating the educational objectives that need to achieved by the CAL tool, i.e., goals analysis.

*Audience Analysis*: Designing an effective CAL tool requires knowing everything possible about the learners. The first thing that one needs to know about the learner is what they have already learnt. Unless students have prerequisite knowledge, it must filled in by the CAL tool *(Smith & Ragan 1993)*. Prior learning may be assessed by pre-testing,

interviewing, or reviewing training records. This information is important because the learners need subject-specific skills to navigate independently through a CAL lesson *(Steinberg 1989)*. If learners lack subject matter knowledge, instructional designers should consider creating CAL materials for them that feature traditional textbook structures or some other mechanism to help guide students through a lesson. This is because researchers report that some learners cannot draw conclusions from information presented in an hypermedia environment *(Murphy & Davidson 1991, Lanza & Roselli 1991)*.

How people learn is just as important as what they have learned. Each learner develops different strategies to help him or her master different subjects. Designers need to understand enough learning theory so they can design a CAL tool that many different learners can use, not just those who have acquired one specific learning strategy. Cognitive psychology provides this much needed information. That field contributes to CAL designers information related to perception, attention, information processing, memory, learning, and mental models *(Preece 1993)*. CAL designers must assess learning strategies as part of the audience analysis phase.

The physiological capabilities of learners are often ignored by CAL designers. For example, ergonomics (the study of human physiological factors in relationship to an environment) contributes to the goal of designing appropriate (e.g., comfortable to use) systems *(Preece 1993)*. Much of this research can be found in the human-computer interaction field, a growing field composed of computer scientists, cognitive psychologists and usability experts. Ergonomics contributes information related to screen colors, keyboard design, mouse design, and workspace design.

In addition how learners "perceive the task and the situation" that is, their attitude, should be taken into account *(Litchfield 1993)*. The concept of attitude encapsulates factors such as motivation to learn the material and anxiety about using computers. To improve the chances of designing a courseware that will help students accomplish learning goals if one must learn not only what they can do but also what they like to do or think they need to do. Therefore, attitude is among the learner characteristics that instructional designers need to assess before any programming begins.

In two studies *(Billings & Cobb 1992 and Larsen 1992)*, students with positive attitudes toward CAL scored significantly better on posttests than students with negative attitudes, suggesting that positive attitudes promote or motivate learning. In the early years of CAL, the novelty of working with computer-based animation and videos had been considered an important motivational factor. As CAL becomes more common and learners encounter computers at earlier ages, designers should plan to depend less on novelty as a motivating factor. According Keller's motivation model *(Keller & Suzuki 1988)* the elements of motivation are attention, relevance, confidence, and satisfaction. Designers can gain attention through audio and visual features. Relevance has at least two dimensions familiar to students: relevance to their past experiences and relevance to their future goals. Designers can build learner confidence by telling learners the objectives of lessons, providing early opportunities for success, and using devices such as embedded questions, self-scoring checks, and practice questions. Satisfaction is linked to reception of the learning material by the learners and transferability from the courseware medium to the learner. Factors that can decrease motivation include cognitive overload--the feeling of being lost and computer anxiety *(Litchfield 1993)*. Several CAL researchers note that

in conditions of complete learner control, many students report feeling lost *(Steinberg 1989, Lanza & Roselli 1991, Murphy & Davidson1991, Litchfield 1993)*. Lost learners do not know the path they followed to reach their current location within the lesson. They do not know how to conclude the lesson or if they have seen all the important elements. Two studies *(Lanza & Roselli 1991, Murphy & Davidson 1991)* suggest that low posttest scores correlate with problems encountered by lost learners. Providing feedback, information about the lesson supplied during the lesson *(Weise 1995)*, for the learner could eliminate this lost-learner problem *(Lanza & Roselli 1991)* The final element of attitude to be considered is "computer anxiety" defined as "the fear of using computers, as measured by physiological changes or responses on self-report instruments" *(Cambre & Cook 1985)*. According to several computer-anxiety studies *(Bohlin 1992, Bohlin & Hunt 1993, Grandgenett & Harris 1994, Honeyman & White 1987, Loyd & Gressard 1984)*, adequate hands-on instructional time reduces computer anxiety.

# CHAPTER 3

# THE COURSE WARE

## 3.1 Presenting the Course Ware

The courseware developed has been designed to be used as an educational tool. The means of presentation chosen would have to be versatile enough to interface with many different computer systems and sophisticated enough to present the courseware in a coherent way while still being simple enough to be used effectively. It was decided that the chosen medium should be accessible via a stand-alone computer, as part of a networked system, or loaded onto a server allowing it to serve as a World Wide Web (WWW) site which can be contacted using the internet. In this way, the maximum number of users could be reached.

It was decided that the text of the courseware should be transformed into a computer tool using Hypertext Markup Language (HTML). HTML inserts tags into a plain-text document such as one found in Microsoft Word. These tags allow a browser to display the marked text in a specific way. For example, if a page author wishes to underline a word, that word is placed between the appropriate tags. There are a wide range of tags which can be used to make formatting changes or even accomplish things such as blinking or scrolling text. HTML also allows for graphics in the form of compressed graphics files to be displayed. Any file in the Compuserve Bitmap Graphical Interface Format (GIF) or Joint Photographic Expert Graphics (JPEG) format can be referenced and thus displayed. The third and most significant feature of HTML is its ability to link HTML documents together through clickable links, thus providing the

necessary hypermedia environment. An author can designate a field (text, graphics etc.) which when clicked by a user accesses a different HTML page. All of these features make HTML an ideal medium for presenting the courseware. Once HTML was chosen, an HTML editor (Netscape Navigator Gold) was used to insert tags into the text of the case study.

### 3.2 Fundamentals of Chemistry, a Hypermedia Courseware Application

The objective is to introduce the environmental issues in manufacturing decisions to freshman chemistry students. Taking the state of the art in multimedia, the courseware introduces the real life application of chemistry in environmental issues. Each application study is linked to the appropriate sections of the fundamentals of chemistry courseware. Thus the students who can easily associate with common life experiences such as Ozone Depletion are motivated to further analyze the subject to find the basic chemical principles involved in these issues. The idea behind this approach is not only to provide information but also to improve the critical learning abilities of students.

This courseware application is so designed so as to obtain the maximum benefit from multimedia used to enhance the text describing the underlying concepts. The intelligent simulations embedded in the courseware encourage the student to develop and apply his critical thinking and imaginative powers. The feedback from the users continuously monitors the quality of the courseware, thus leading to improvements in the application. The quizzes have been designed such that they help the students search for data, collect, gather, analyze, synthesize and document it, rather simply reviewing the text.

There are 4 practical applications or case studies.

1. Ozone Layer Depletion
2. Air Pollution
3. Paint Pollution
4. Aspirin Manufacturing

The fundamentals of chemistry module has 6 sections

### 3.2.1 The Science of Chemistry

The first section titled "The Science of Chemistry", as the name implies introduces the student to the origins of chemistry, and how chemistry affects our lives, thus justifying to the student why chemistry needs to be studied. This section then goes on to introduce the concepts of facts, laws, theories and hypotheses. The final topic in this section is about units, measurement and accuracy & precision

### 3.2.2 Matter and Energy

The second section titled "Matter and Energy" defines what matter and energy are, and discusses their relationship. It finally introduces chemistry as the science of matter.

### 3.2.3 Gases

The third section is "Gases", introducing to the freshman chemistry student, the properties of gases, gas laws. This section also includes an interactive simulation of gas laws. The student is asked to vary the pressures and temperatures of a gas and see for himself how the volume changes. After the simulation the student is asked to take a small self-evaluation test.

### 3.2.4 Solutions

The fourth section is "Solutions" introducing to the student the concept of solutes, solvents and solubility. This section also contains an interactive simulation where the student is asked to create an environmentally friendly paint. In preparing this paint the student has to choose the solvent to be used, from water or organic solvents and vary the percentages of solids (i.e. pigments, resins, binders etc.) to be added in the paint being prepared. In deciding the solvent and the percentages the student has to keep in mind the fact that organic solvents are VOCs and cause pollution problems, at the same time when choosing water as the solvent the student realizes that most pigments are organic and non-polar in nature and hence essentially insoluble in water. This increases the cost of making the paint and at the same lowers its properties.

### 3.2.5 Colloids

The fifth section is about "Colloids" introducing to the student the concept of solutions, suspensions and colloids, it ends with discussing the properties of colloids.

### 3.2.6 Chemical Equations

The final section is "Chemical Equations" and teaches the student how to set up a chemical equation and balance it.

Each section contains it's own self-evaluation tests, and is cross-linked with the associated case studies.

## 3.2 Self Evaluation Tools

Assessment and evaluation tools are of key importance in a hypermedia based courseware. Such a courseware relies on education through the use of diverse media, and keeping the students visually stimulated and entertained while learning something new. However entertainment is not education. How does one make sure that the students are truly learning something ?

One of the standard methods in teaching is to have students carry out assigned problems. This results from the general belief that students learn best by doing. Often textbooks are selected on the basis of the quality of their problem sets.

The tried and tested method consists of assigning sheets of homework or assignments at the end of each class, then collecting and grading the resulting mass of paper, for few students can be expected to bother with this "extra work". Even when homework is checked, it is likely that many students (who often need it most) will simply copy it from a friend or from the solutions manual. Thus few teachers can justify the time spent on collecting and checking homework. For this reason the value of such text based problem sets is lost on all but the very good students.

How can this problem solving strategy be modified into a more effective learning/teaching tool? One of the most common strategies is to use computerized problem sets that eliminate many of the disadvantages of conventional text based problem sets.

The procedure that we have used consists of asking the student to take a quiz, at the end of each section of the courseware. The quiz consists of ten multiple choice questions. These ten questions are randomly chosen and presented to the student from a set of a hundred questions, of the same level of difficulty.

The student's score in each test is recorded along with his social security number, and date and time that he took this quiz. This information is then emailed to the instructor, or guide. Since a repeated quiz will not result in the same set of the questions the student actually takes different tests each time he browses into the webpage containing the quiz program. This program has been designed such that a student will not be able to proceed to the next topic if he is unable to successfully pass the quiz.

### 3.2.1 Advantages over Text-Based Question Sets

1. *Personalized Question sets:* The program prepares a unique set of 10 questions for each student by randomly selecting from a fixed pool of 100 question. The problem types are same but the order and the question itself is randomized. So, from the student's point of view, each is getting a personalized set of questions. One obvious advantage is that it is not possible to simply copy someone else's work. There is also the feeling that they are working on their own personal set of questions. This has the effect of making this type of study somewhat like a game.

2. *Immediate feedback:* The program provides the answer to the student immediately after he has completed the quiz thus eliminating the unnecessary overhead and often frustrating delays associated with returning graded homework. Moreover after a student completes the assigned questions, the score is stored on a central data file, which can easily be merged or summarized along with other class grades. Thus minimizing the time spent by the instructor on administrative tasks.

3. *Graphics and Animation*: The provision for including Graphics and Animation to better explain the question an the concepts behind the question exists too.

## 3.3 Developing the Evaluation Tool

The evaluation tool has been designed to be a part of the internet based courseware. Because of this nature JAVA™ was chosen to be the development platform.

### 3.3.1 Interactive Internet Applications

A quiz program is necessarily interactive. The program prompts the user to choose the correct choice, and then once the student is done with the quiz, grades this exam. Unfortunately HTML has limited support for interactivity through the form mechanism. Forms let us write data entry and query kinds of pages. They are also useful when returning results that the user may wish to use in a new query. What they don't do is give us any way to validate the data without having to connect to the server. Server-side operations won't feel terribly interactive if network bandwidth is limited or the server is slow to respond.

Java can address this problem nicely. A Java applet can implement a form-like user interface. The Java code can examine the user's entries, apply validation rules and identify input problems from inside the browser. No communication with the server generally means a faster, more interactive environment.

### 3.3.2 What is Java ?

Java is:

- A programming language with a standard set of class libraries.
- A language and a subset of the libraries for use as embedded code (applets) in HTML web pages.
- A language to add animation and interactivity to three dimensional objects and scenes (VRML 2.0).

As a language, Java is strongly object-oriented. Java requires the use of objects. It offers neither global variables nor functions; all data items and functions must be members of a class. Beyond the characteristics of a language, programmers are aided or limited by the interfaces available to them. It is in this area that Java is particularly weak. Its classes permit a program to:

- read and write files
- draw colored points, lines and other primitive 2D shapes
- load and manipulate images

- create user interfaces, including multiple windows on the desktop
- communicate with network services, (not just HTTP)
- play sound files

Anything else must be provided by the programmer.

Most of the interest in Java centers around Java applets: little pieces of Java that are downloaded automatically to run on a web page. An HTML tag called APPLET attaches a Java applet to a page. The tag tells the browser what code to retrieve and how large a region to use as the applet's display area. PARAM tags provide the applet with parameter values:

```
<applet codebase="java" code="DaysSince" width=60 height=11>
 <param name="date" value="6 Feb 1995 1:00 PST">
 <param name="textColor" value="0000ee">
 <param name="URL" value="java/DaysSince.java">
</applet>
```

The applet is responsible for everything that happens within its display area. It cannot affect any of the HTML-specified contents of the page. It can communicate with other applets on the page. It can also cause the browser to load a new page. In some ways, an applet is like an image. Like the IMG tag, the APPLET tag identifies the size and contents of its rectangular region and the region's alignment within the page.

When a page containing an applet is retrieved, the applet's code is transferred as well. An applet is an object class based on the java.applet.Applet class. This class may refer to or inherit from other classes; each class is retrieved from the server in turn. (The standard classes are installed on the user's system along with the browser and are loaded directly from disk.) Linking of all the classes into one program happens at this point, with all of the classes from all the applets on the page sharing one address space. The code is checked for attempts to violate security, assuming none are found, it then begins to run.

Security is a big part of the Java run time environment. Any web page that a user retrieves may also cause Java code to be transferred and executed, without the user knowing that it happened. If a Java applet can write files, a rogue applet could destroy every writable file on the local system. If it can read files or open arbitrary network connections to other systems, it could pass private information back to the web server. It is for just this reason that Java applets are restricted in their access to local resources. In the current Netscape implementation a Java applet can not read or write local files, start other programs or open a network connection to any host except the one which supplied the page.

What's significant about Java is its pervasiveness, available or soon to be available on all Netscape-supported platforms, the portability of its byte code, one executable runs everywhere, assuming that all of its libraries are also available on the target system, and its acceptance within the industry.

### 3.4 The Algorithm of the Evaluation Tool

The Quiz program loaded onto the student's browser would be a Java applet. The student's scores need to be stored on a central file, thus a client/server architecture is necessary for such an application.

The client side Java applet would allow the student to log in to the system, by checking his/her Social Security Number with a file containing the list of students permitted to use this program. For students or users not registered in the course they could login as Guest. This applet would then randomly select 10 questions from a directory containing 100 questions on the server. The student would then go through the test, and these questions would then be graded immediately. The student's score is then stored on a central file on a central server. To achieve this a server side application was developed which would be acting as a daemon and listened on to a particular port number. The client side applet would send the student's score to this particular port on the server, and the server would then receive this data write it in the text file, and then terminate the connection with the client.

## 3.5 Flow Chart for the Client Side Applet

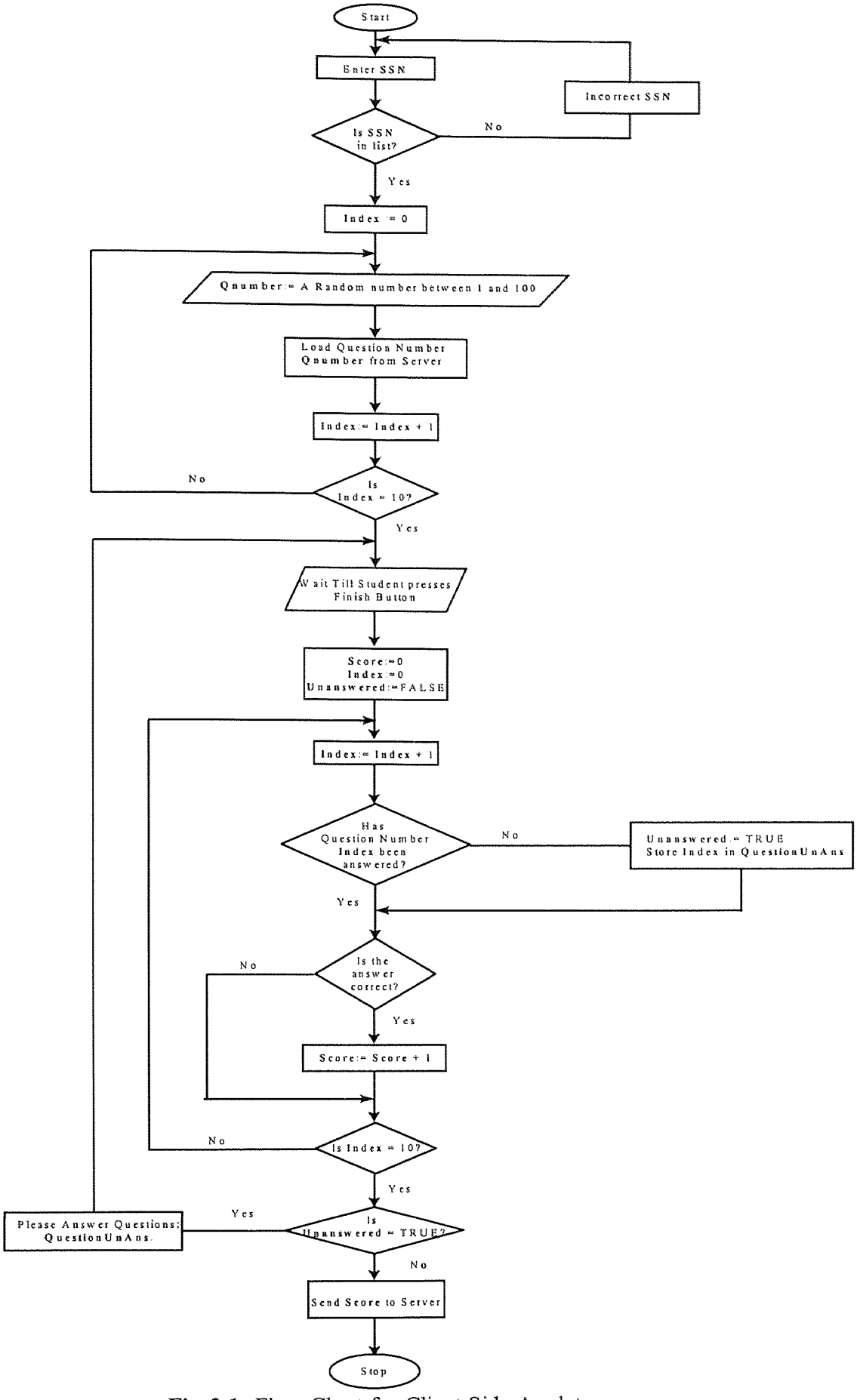
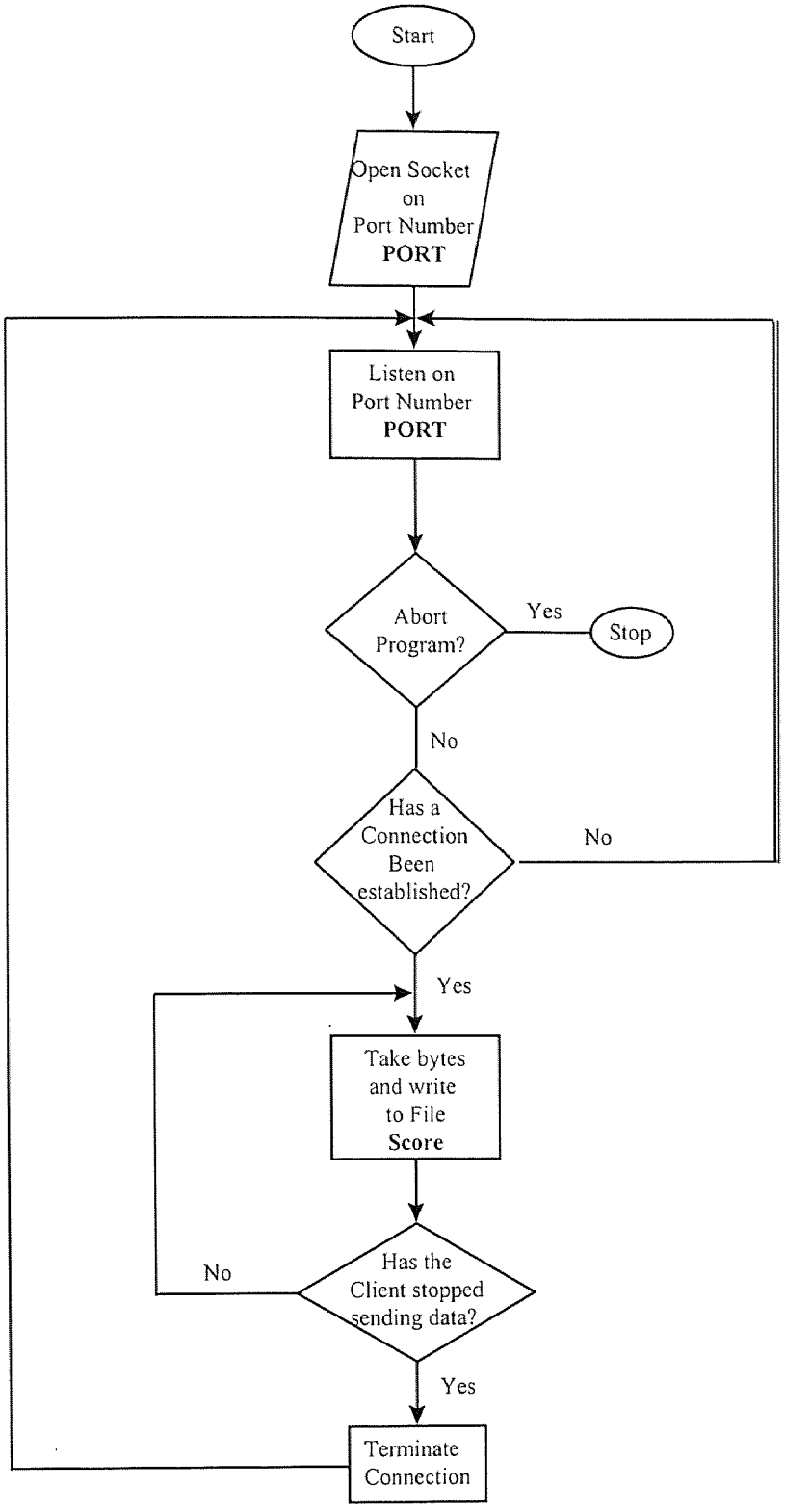



**Fig-3.1:** Flow Chart for Client Side Applet

## 3.6 Flow Chart of Server Side Program




Note: To Abort the Program, kill the process with Ctrl C. Keystroke

**Fig-3.2:** Flow Chart of Server Side Program

## 3.7 Interactive Simulation Modules

Two simulation modules have been developed using Gensym Corporation's Artificial Intelligence based Object Oriented simulation software G-2. This software offers a graphical, object-oriented environment for creating intelligent applications that monitor, diagnose, and control dynamic events in on-line and simulated environments.

### 3.7.1 Paint Pollution Simulation

This simulation introduces the concept of environmentally sensitive decision making. Students are assigned to create an environmentally friendly cost effective paint with good properties. In preparing this paint, the student has to choose the solvent to be used,

from water or organic solvents and vary the percentages of solids (i.e. pigments, resins, binders etc.) to be added in the paint being prepared. In deciding the solvent and the percentages of solids, the student has to keep in mind the fact that organic solvents are Volatile Organic Compounds (VOCs) and cause pollution problems. At the same time when choosing water as the solvent the student realizes that most pigments are organic and non-polar in nature and hence essentially insoluble in water which increases the cost of making the paint and lowers its properties. Based on these user defined proportions of the components, the paint is rated in three categories of (i) environmental impact, (ii)cost of the paint and (iii) paint properties.

Once the paint is rated, the simulation program intelligently analyzes the percentages of each of the components and guides the student towards a better paint, i.e., a more environmentally, cheap paint with good properties. As the student progresses through several iterations, he gains an understanding of the factors that influence the

various properties of a paint and exactly what makes a paint environmentally friendly namely the VOCs. The idea is to iteratively select a certain percentage of each of the components which makes the paint environmentally friendly, economically attractive with quality paint properties.

### 3.7.2 Gas Laws

The second simulation provides an interactive visualization of gas laws. Two approaches are used. The first approach is a demonstration through cartoon images following the figures used in the course notes, and the second approach is through an engineering standpoint. The student changes the temperatures and pressures of an ideal gas and views the effect of this change on the volume. The student can repeat experiments for different values of temperature or pressure and see the change in volume over various experiments. After the simulation the student is asked to take a small self-evaluation test. This simulation facilitates the learning process of gas laws through visualization and self exploration.

# CHAPTER 4

# FIELD TESTING

## 4.1 Introduction

Engineering Education is a process whereby a freshman student with little or no engineering knowledge is the input and the output is an engineer ready to work in industry. To continually improve such a process one must approach it from a total quality management (TQM) perspective. In the TQM approach, the needs of the customer which in our case is the student are paramount *(Bengu & Swart 1996)*. Thus in the development of any courseware one must always ask the student "Are you learning what we set out to teach?", "Is the content delivered clearly?". And based on student responses one must take corrective action early in the development of courseware. For later on, it might be too late to inspect quality and take action.

Taking into account such an approach the software was field tested with a group of students belonging to the target audience, and based on the results of this test and their recommendations, enhancements to the courseware were made. This software was field or '*Beta*' tested in two stages. The first stage was on a group of 8 students and was centered on the courseware and simulation modules. The second stage was on a group of 12 students who are part of a freshman chemistry course. This survey centered on the self-evaluation tool developed for use with the courseware. The detailed results of the survey are in the appendix.

## 4.2 Survey on Course Ware and Simulation Modules

The results of each section are presented as bar charts after each survey question. These results are presented in tabular format in Appendix B.

The initial section was designed to obtain information about the student's background (i.e., his major, his class and year), knowledge of the subject material i.e., chemistry and knowledge of computers.

### 4.2.1 Section - 1 : Participant Background

Of the 8 participants:

7 were Males and one was Female.

4 students were in there second year, 3 students were in their first i.e. freshman year and one student was in her $4^{th}$ year.

4 students stated that their majors required them to take a chemistry course at some level or the other. 3 students stated that their major did not require them to take a chemistry course. And 1 student had at the time of the survey not declared his major.

The next 4 questions asked the participant about his background

1. Whether the student used word processing programs, and if yes how often.
2. Whether the student used spreadsheet programs, and if yes how often.
3. Whether the student used a graphics software, and if yes how often.

4. Whether the student browsed the Internet, and if yes how often.

The answers to these questions are presented as a bar chart.

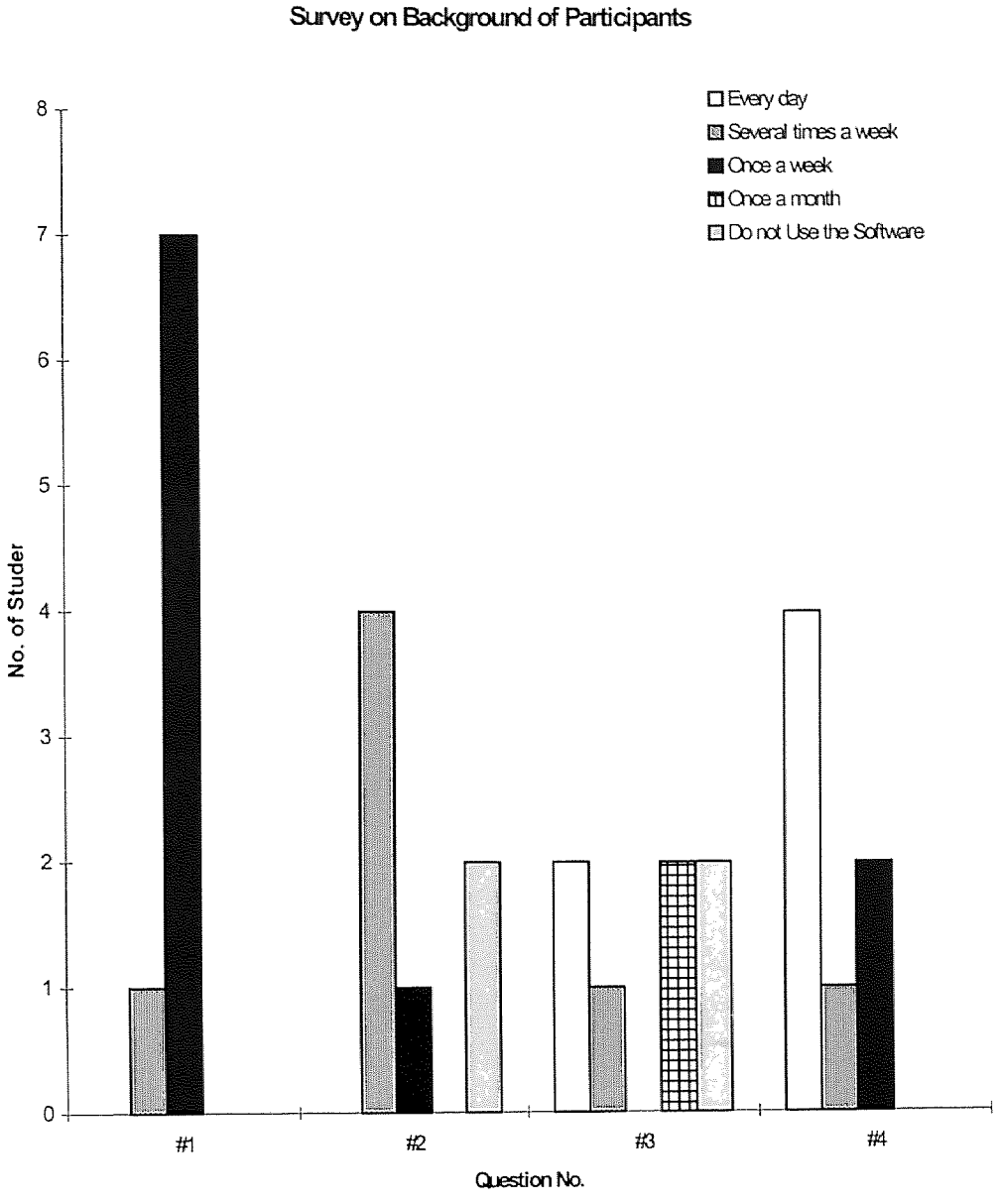



**Fig:4.1:** Bar Chart of Results of Questions on Participant Background

### 4.2.2 Survey Section - 2: Survey on Fundamentals of Chemistry

This section was designed to evaluate the student's comprehension of the *"Fundamentals of Chemistry"* module. The students were asked to answer 11 questions , the questions were from each of the chapters of this module. These were so designed that the student would be able to answer these questions after going through the module. After answering each question the students were asked to rate the degree of difficulty in finding the answer to this question from the chapter. They could choose any of the following:

1. Very Easy
2. Easy
3. Neither
4. Difficult
5. Very Difficult

In this way the ease of use and design of the courseware was tested.

From the first chapter *"Introduction to Chemistry"* the students were asked to answer the following question:

1. Name any 2 main goals of the alchemist?

All 8 students answered this question correctly.

From the second chapter *"Matter and Energy"* the students were asked to answer the following 2 questions:

1. What is 1 Btu?
2. What is the 2nd Law of Thermodynamics?

All 8 students answered these 2 questions correctly.

From the third chapter *"Gas Laws"* the students were asked to answer the following 3 questions:

1. What are the 3 basic principles of the kinetic theory?
2. What is Standard Temperature and Pressure?
3. What are Real and Ideal gases?

All 8 students answered these 3 questions correctly.

From the fourth chapter *"Principles of Solutions"* the students were asked to answer the following 3 questions:

1. What is Solution Equilibrium?
2. If the temperature rises what happens to the solubility?
3. What is Molality?

All 8 students answered this question correctly.

From the fifth chapter *"Principles of Colloids"* the students were asked to answer the following question:

1. What is the average size of colloidal particles

All 8 students answered this question correctly.

From the final chapter *"Chemical Equations"* the students were asked to answer the following question:

1. Calcium Bromide and Sulfuric Acid are reacted to give Bromic Acid and Calcium Sulfate. Balance the equation representing this chemical reaction.

All 8 students answered this question correctly.

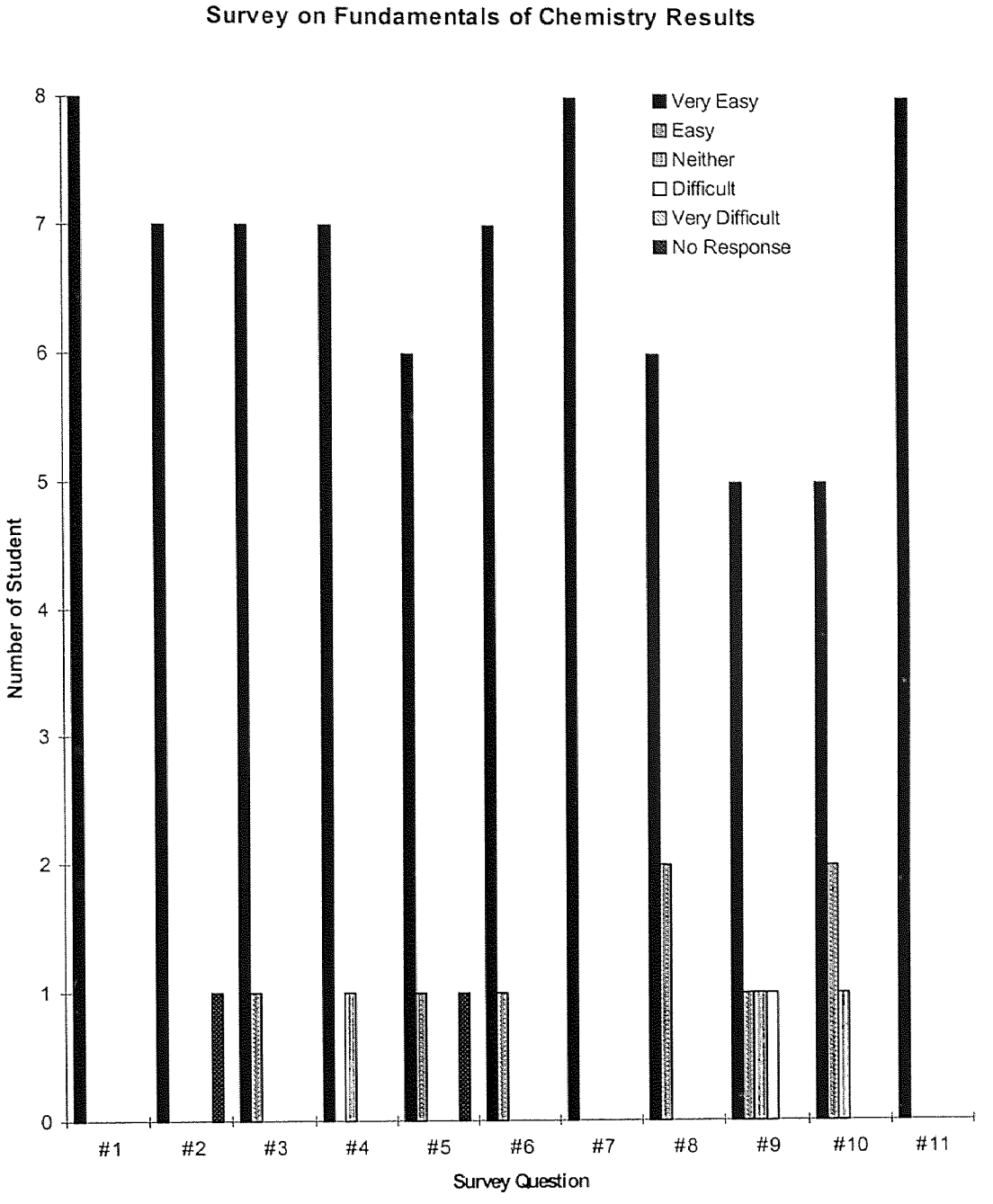



**Fig-4.2:** Bar Chart of Results of Survey on Usability of "*Fundamentals of Chemistry*" module.

### 4.2.3 Survey Section - 3 : Survey on Paint Preparation Module

The questions in this section were styled differently from this in the earlier section. The stress here was not in testing the knowledge imparted to the student from the simulation module but rather on surveying the design and usability of the simulation module. All the questions asked the student how helpful a certain area of the simulation module was. The students were asked to answer the following four questions:

1. How helpful is the simulation in imparting knowledge about paint pollution?
2. Are the directions helpful in preparing an environmentally safe paint?
3. Is the graph helpful in preparing the paint?
4. How helpful are the help screens?

They were asked to give their answer as any of the following.

1. Very Helpful
2. Helpful
3. Neither
4. Confusing
5. Very Confusing

And if necessary to comment on that area of the simulation module on which the question was based.

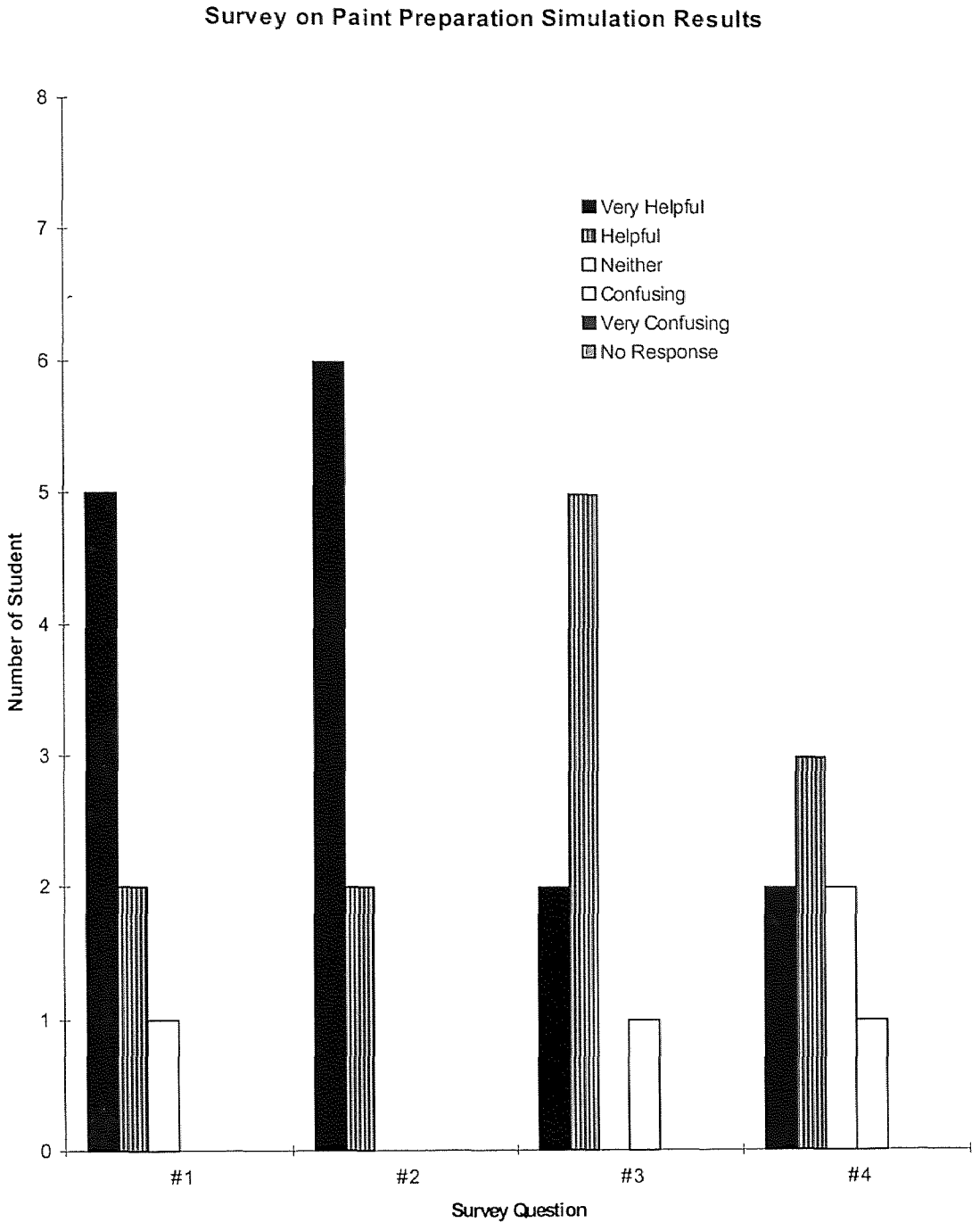



**Fig-4.3:** Bar Chart of Results of Survey on Paint Preparation Simulation Module

### 4.2.4 Survey Section - 4 : Survey on Gas Laws Simulation Module

As before the stress in the questions in this section tested the design and usability of the simulation module instead of testing the knowledge imparted to the student. All the questions, except the last one asked the student how helpful a certain area of the simulation module was. The last question was an exception, it tested the knowledge imparted to the student via the simulation module. The students were asked to answer the following four questions.

1. How helpful is the application in imparting knowledge about gas laws?
2. How helpful are the help screens?

As before the students were asked how easy or difficult was it to find the answer to each of these questions were. They could answer any of the following:

1. Very Helpful
2. Helpful
3. Neither
4. Confusing
5. Very Confusing

The students were also ask to write their comments on each feature of this simulation.

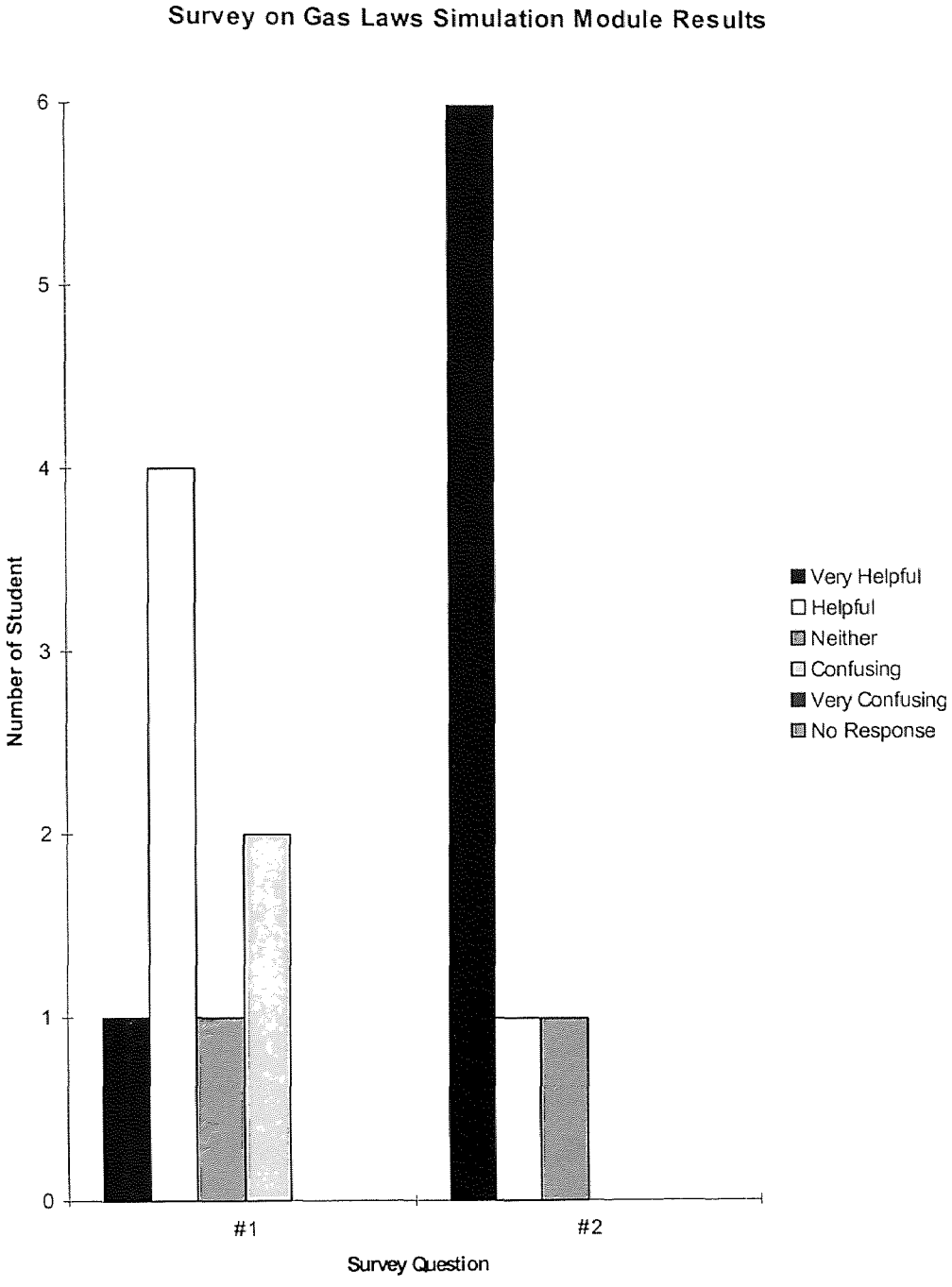



**Fig-4.4:** Bar Chart of Results of Survey on Gas Laws Simulation Module

### 4.2.5 Survey Section - 5 : Survey on Overall Usability

This section had two distinct parts. In the first part had 6 questions and asked the student to choose the best answer. The last four questions were qualitative in that they asked the student to answer what he felt about the courseware.

The first 6 questions:

1. Overall, reading the chapters were
2. The subject icons made using the Course Ware
3. Deciding which link to click on was
4. Understanding the chemistry was
5. Moving from one chapter to the other was
6. Using the Simulations were

These 6 questions asked the student about the usability of the entire courseware. The students were asked to answer these questions, by completing the sentences, from the following 5 choices.

1. Very Easy
2. Easy
3. Neutral
4. Difficult
5. Very Difficult

The next 4 questions asked the student about his/her perceptions of the courseware.

1. How did the speed at which you were able to access the various parts of the applications affect your assessment of the chapters?

2. Before your actual lab experiments, if you had videos of lab experiments being performed would this make the labs easier to understand?
3. How often did you loose yourself in the courseware, and where did this problem occur?
4. We would appreciate any additional recommendations you have to improve the courseware and simulations.

Unfortunately only 2 students answered these 4 questions. Their answers to the first question were "fast" and "rapid". Both the students answered in the affirmative to the second question. Both the students answered that they hadn't lost themselves anywhere in the courseware. In answering the final question, one student suggested that more graphics, images etc. be added to the courseware. The other student suggested that the courseware be more "alive".

The results of the first 6 questions are represented in chart format as:

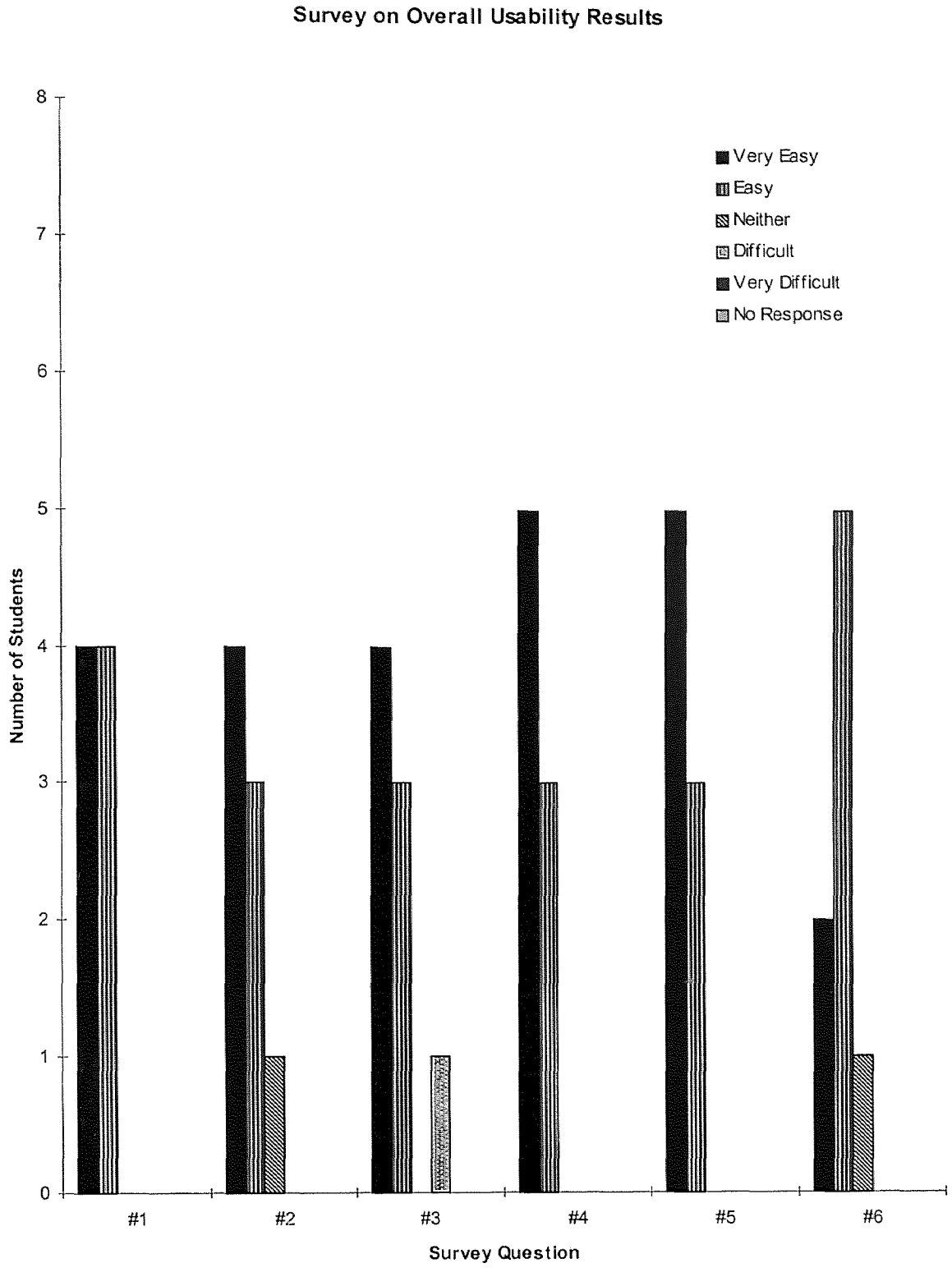



**Fig-4.5:**Bar Chart of Results of Survey on Overall Usability of Course Ware

### 4.3 Survey on the Self-Assessment Tool

This survey was carried out in an actual freshman chemistry class. The evaluation tool was tested on a freshman chemistry class, Chem. 126-102 taught by Dr. Barbara Kebbekus. After taking a quiz based on what they were taught in their earlier class. The students were asked to fill out short feedback form (Form attached in Appendix C), giving their impressions on the self evaluation program.

This survey consisted of answering 6 questions (In the form of statements). The first four questions were based on the quiz module and the last 2 based on the results module. The students were also asked to write down any further comments on the quiz program. Only three students decided to add any further comments. One student wrote "not bad, could be faster, more questions would be nice", another student wrote "this is cool" and the third student wrote "get with the program".

The respondent could "Strongly Agree" , or "Agree", or be "Neutral, Neither agree or disagree", or "Disagree" or else "Strongly Disagree" with the statement that formed the question.

The respondent's answers to each question/statement are displayed in the form of a Bar Chart.

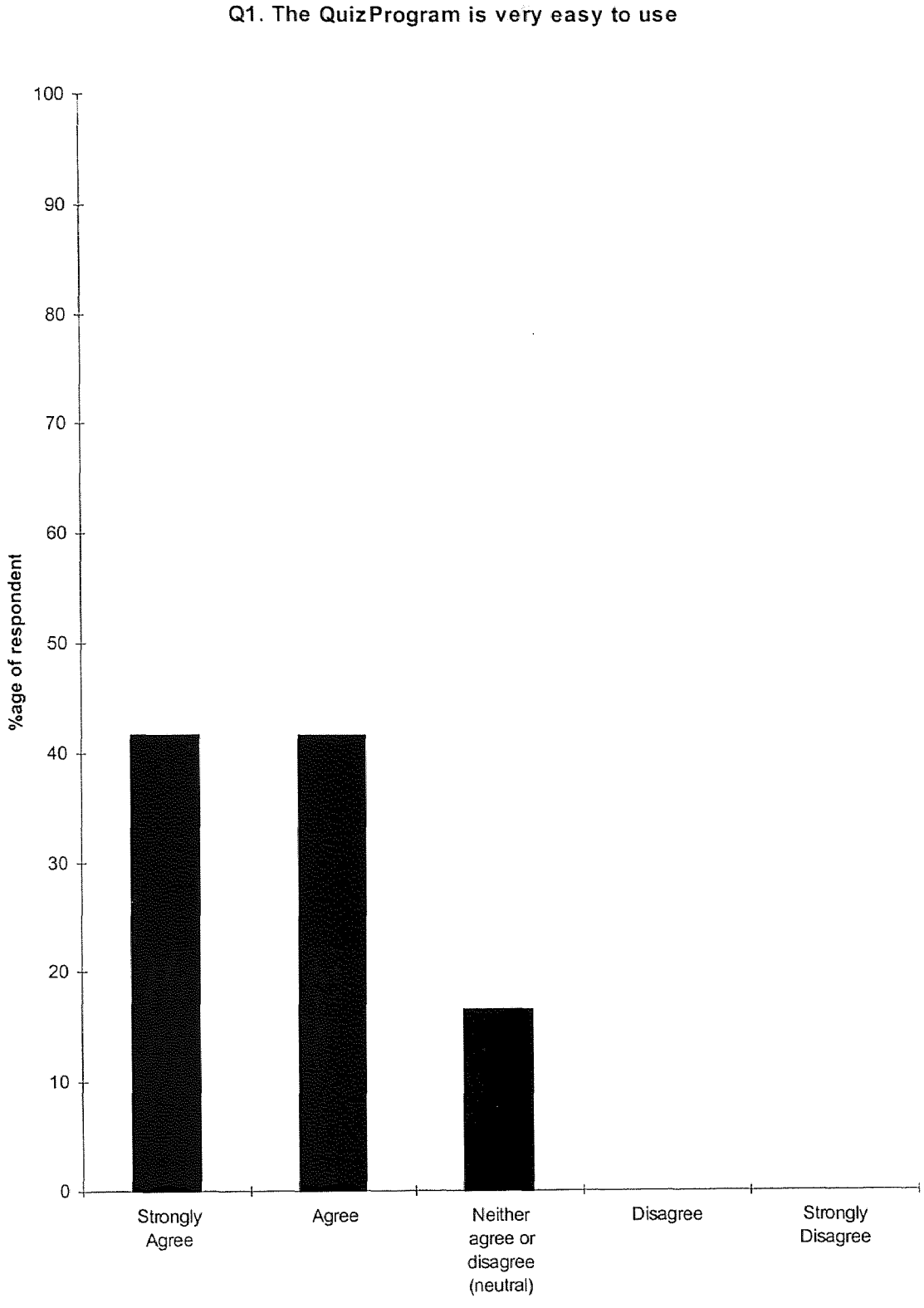



**Fig-4.6:** Bar Chart of Results of Question 1

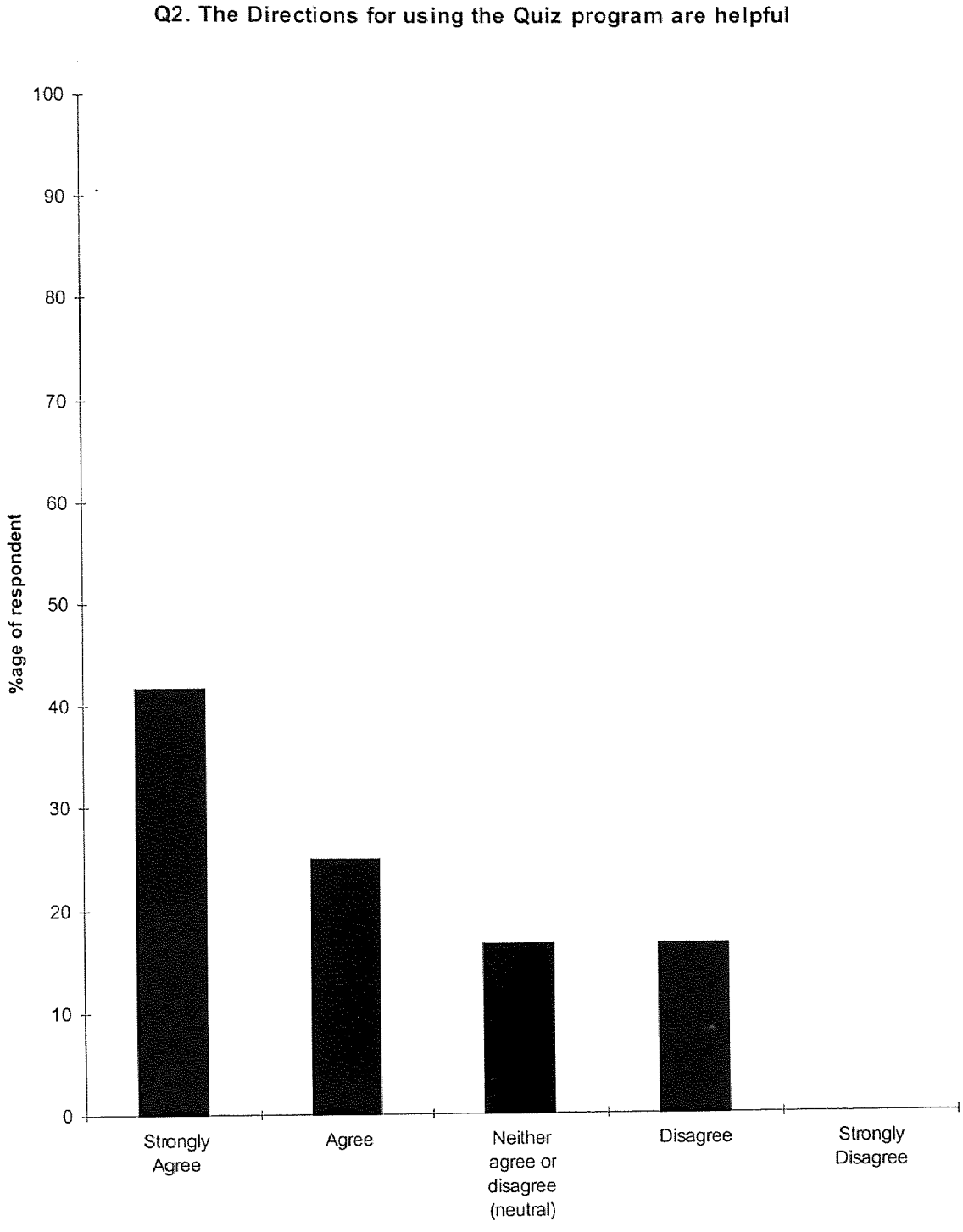



**Fig-4.7:** Bar Chart of Results of Question 2

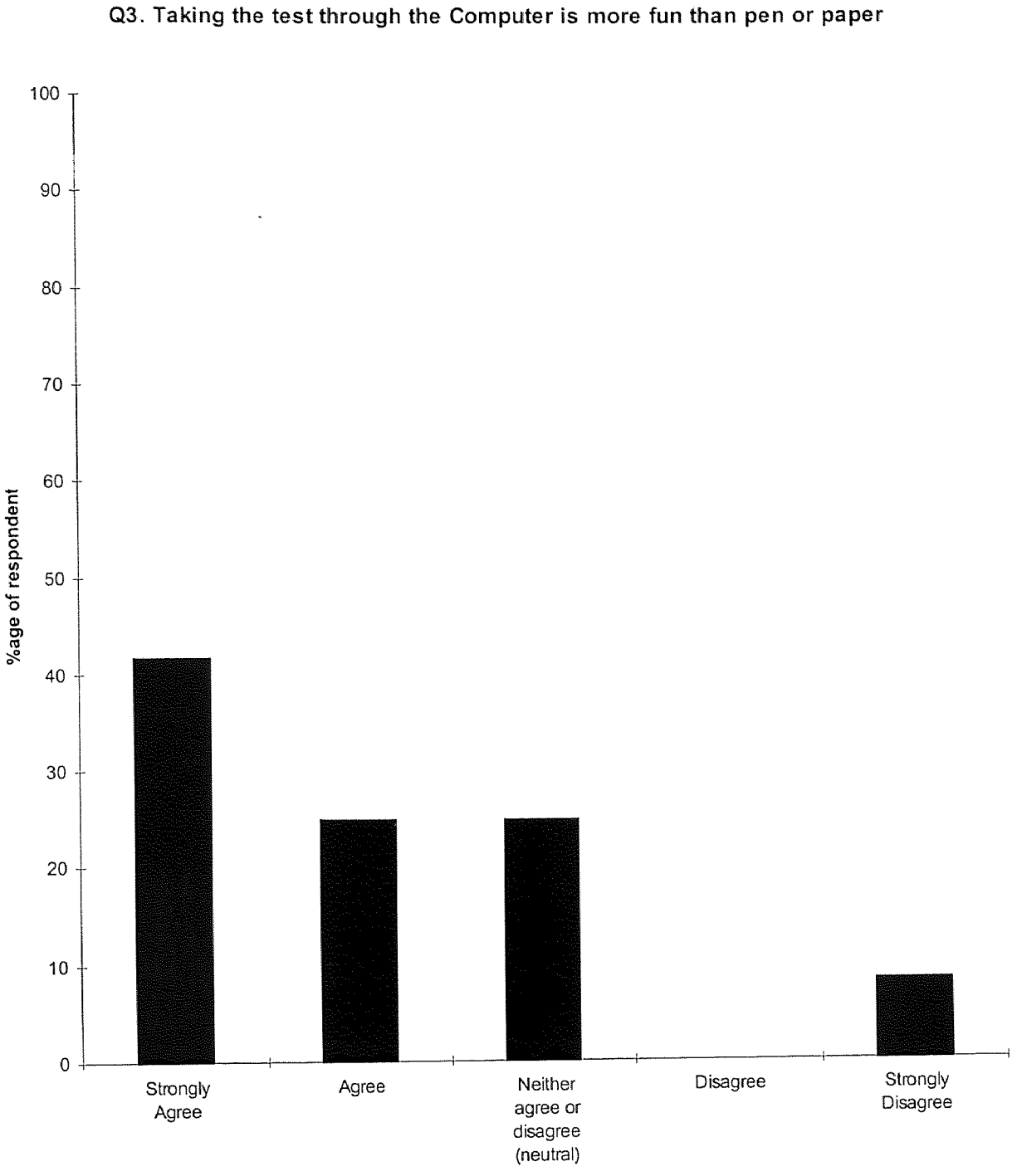



**Fig-4.8:** Bar Chart of Results of Question 3

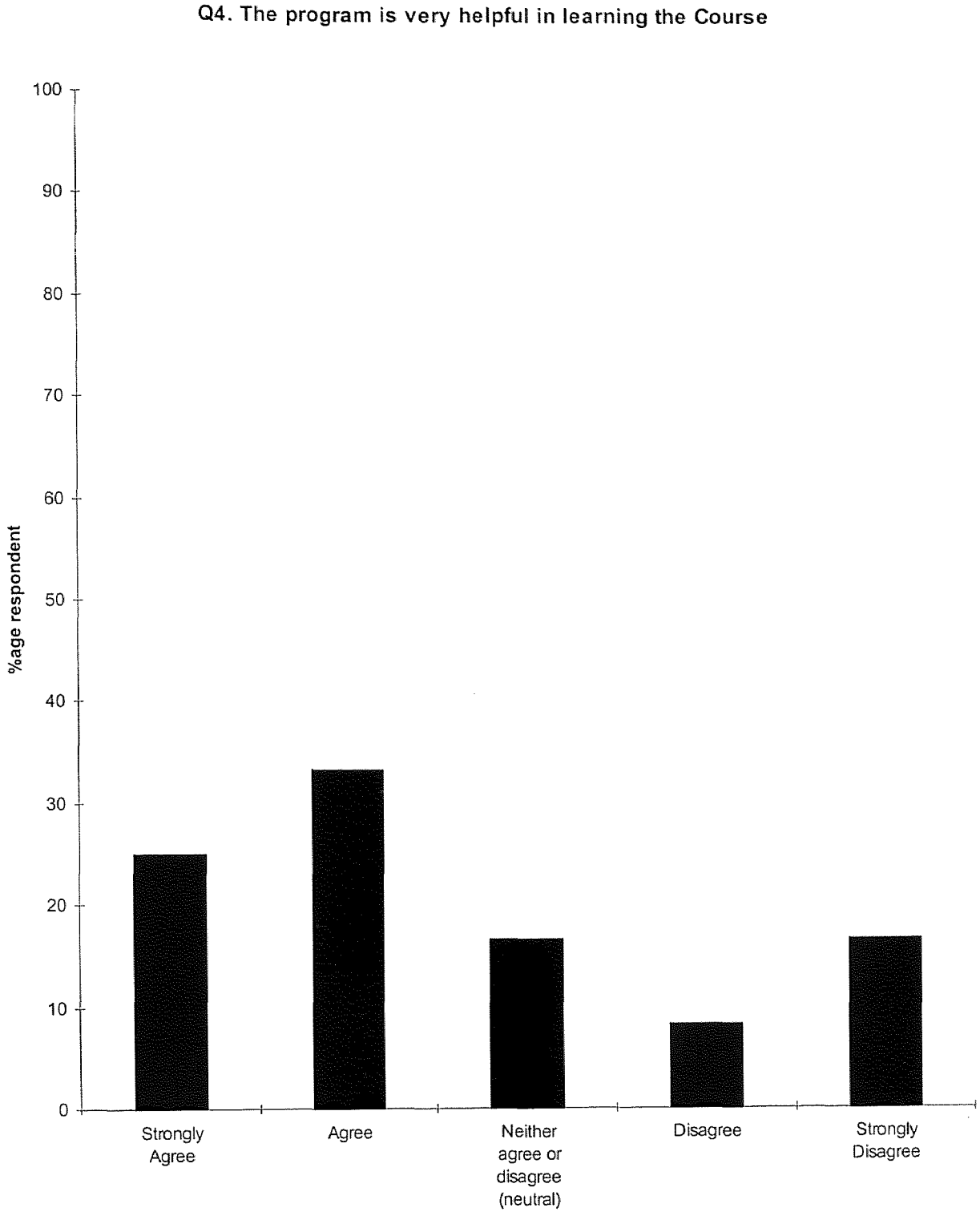



**Fig-4.9:** Bar Chart of Results of Question 3

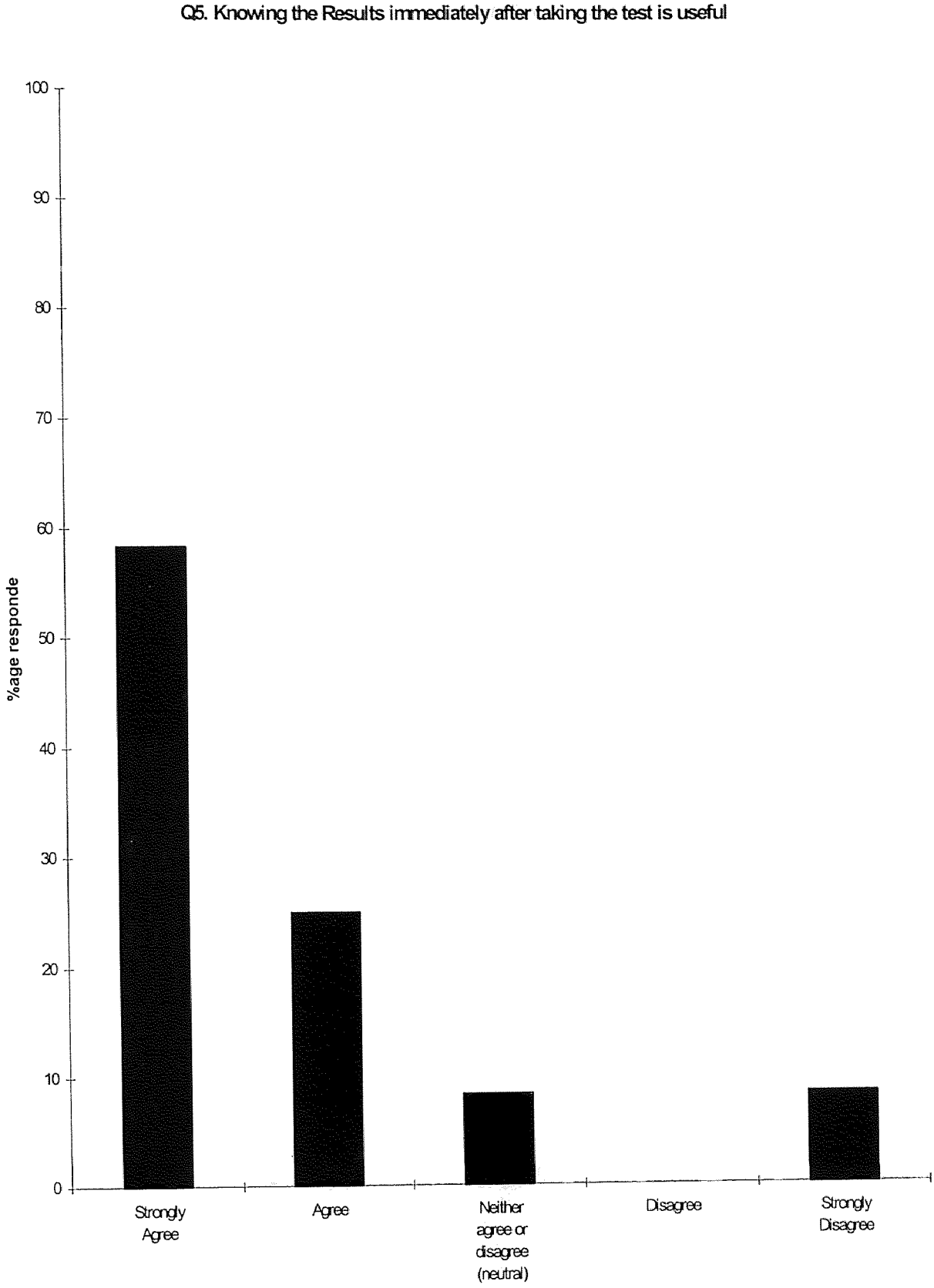



**Fig-4.10:** Bar Chart of Results of Question 5

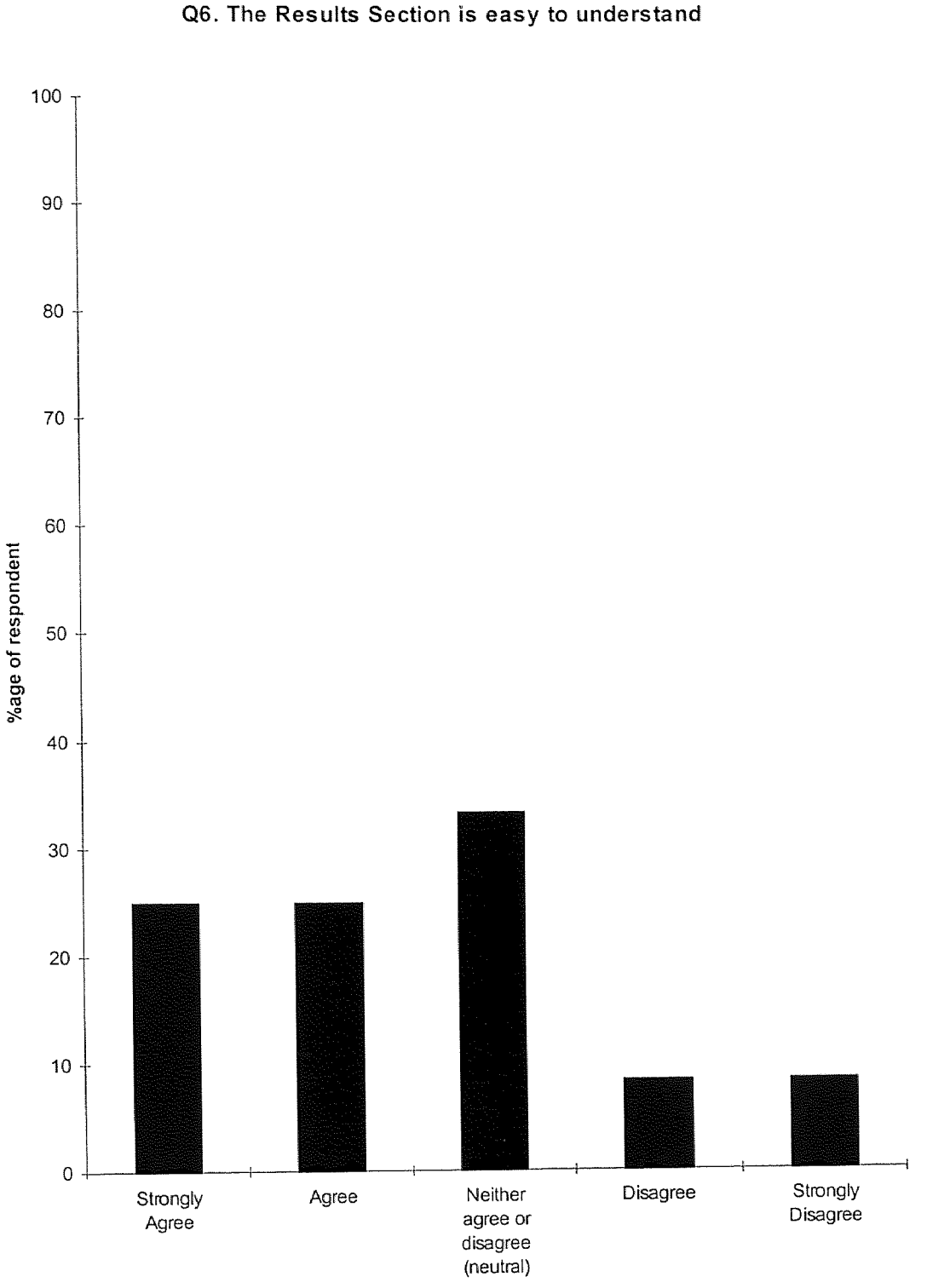



**Fig-4.11:** Bar Chart of Results of Question 6

# CHAPTER 5

# CONCLUSION

This objective of this courseware is to introduce environmental issues in freshman chemistry. This is accomplished by introducing the student to chemistry applied to environmental issues. From the applied chemistry case studies the student learns more about the fundamentals involved by accessing a series of hypertext links.

State of the art multimedia and simulation tools were used in this courseware. The simulation modules were developed using an object oriented AI based software, Gensym Corporation's G-2 simulator. The assessment tools used will be intelligent on-line assessment, readily available to any user at his convenience.

This courseware provides distance learning capabilities to a traditional class. Due to the open architecture of this courseware, future addition and enhancement is not a problem. The instructor just has to present his courseware material in HTML format. This system is a permanent asset of the institute.

This system provides online assessment tools to provide an autonomous learning environment to support the traditional teaching system.

# APPENDIX A- SURVEY FORM

## Introduction

The Emission Reduction Research Center (ERRC) located at NJIT has received a National Science Foundation (NSF) grant to develop a computer aided teaching tool for use in first year chemistry classes. The objective of the tool is to integrate environmental ideas into the first year chemistry curriculum. More specifically, the project infuses the concepts of clean manufacturing and pollution prevention by relating these issues to fundamental chemical principles. Through the use of various disciplines such as economics, history, and political science, the environmental and industrial aspects of problems related to chemistry are presented. The tool developed by the ERRC consists of several interdisciplinary chapter modules which correspond to various areas of the first year chemistry curriculum. As well as an interactive simulation of gas laws and manufacture of an environmentally friendly paint.

The survey itself is broken into 5 sections. The first page provides the surveyor with demographic information which will be used to more effectively assess the results. The middle 3 sections of the survey consists of several tasks which the survey participant is asked to complete. A series of questions follows each task. These questions will provide the surveyor with the appropriate information about the usability and effectiveness of the chapter module. The final set of survey questions contained in section three are designed to assess the overall chapter modules. It is important to the study for the participants to answer all the questions in each of the five sections.

Since the surveys contained in this packet will be used by the ERRC to evaluate the modules, it is important to have a signed consent form. By signing below, you are agreeing to allow the members of the ERRC to use your responses as part of their project.

Signature_____ Date:_____

# Survey Section #1

Please print your answers to the following questions in the spaces provided or circle the appropriate answer for each of the following questions. Be as accurate and complete as possible.

Name:_____ ID#_____ SEX: F M

Major _____

Years : 1st 2nd 3rd 4th 5th Graduate Faculty Other:_____

CHEMISTRY BACKGROUND

Does your major require you to take chemistry? YES NO

How many semesters of chemistry have you successfully completed while in college?

Semesters completed: 0 1 2 3 4 more than 4

COMPUTER BACKGROUND

| Do you use word processing programs? YES NO |
|---|
| |
| If yes, then how often do you use the program? |
| Every day several times a week once a week once a month |

| Do you use spread sheet programs? YES NO |
|---|
| |

| |
|---|
| If yes, then how often do you use the program? |
| Every day several times a week once a week once a month |

| Do you use graphics programs? YES NO |
|---|
| |
| If yes, then how often do you use the program? |
| Every day several times a week once a week once a month |

| Do you browse the internet? YES NO |
|---|
| |
| If yes, then how often? |
| Every day several times a week once a week once a month |

# Survey Section #2

*Fundamentals of Chemistry*

Please use a graphic internet browser to access the web-page at
Once there enter the Fundamentals of Chemistry module and complete the following tasks.

Move to the first chapter and complete the following task

TASK #1

Name any 2 main goals of the alchemist?

| Answer: |
| --- |
| |
| |

How easy or difficult was it to find the answer to this question in the chapter?

Very Easy  Easy  Neither  Difficult  Very Difficult

Other Comments (Use back of page if necessary)

Now move to the 2nd Chapter and complete the following 2 tasks.

TASK #2

What is 1 Btu?

| Answer: |
| --- |
| |
| |

How easy or difficult was it to find the answer to this question in the chapter?

Very Easy Easy Neither Difficult Very Difficult

Other Comments (Use back of page if necessary)

TASK #3

What is the 2nd Law of Thermodynamics?

| Answer: |
| --- |
| |
| |

How easy or difficult was it to find the answer to this question in the chapter?

Very Easy Easy Neither Difficult Very Difficult

Other Comments (Use back of page if necessary):

Now move to the 3rd chapter and answer the following question. Then, please complete the next three tasks.

How easy or difficult was it to find your way to the 3rd Chapter?

Very Easy Easy Neither Difficult Very Difficult

Other Comments (Use back of page if necessary):

TASK #4

**What are the 3 basic principles of the kinetic theory?**

| **Answer:** |
| --- |
| |
| |

**How easy or difficult was it to find the answer to this question in the chapter?**

**Very Easy** **Easy** **Neither** **Difficult** **Very Difficult**

**Other Comments (Use back of page if necessary):**

TASK #5

**What is Standard Temperature and Pressure?**

| Answer: |
| --- |
| |
| |
| |
| |
| |
| |

How easy or difficult was it to find the answer to this question in the chapter?

Very Easy Easy Neither Difficult Very Difficult

Other Comments (Use back of page if necessary):

TASK #6

What are Real and Ideal gases?

| Answer: |
| --- |
| |
| |
| |
| |
| |

How easy or difficult was it to find the answer to this question in the chapter?

Very Easy Easy Neither Difficult Very Difficult

Other Comments (Use back of page if necessary):

Now move on to the section on solutions and complete the following task

TASK #7

What is Solution Equilibrium?

| Answer: |
| --- |
| |
| |
| |
| |
| |

How easy or difficult was it to find the answer to this question in the chapter?

Very Easy Easy Neither Difficult Very Difficult

Other Comments (Use back of page if necessary):

TASK#8

If the temperature rises what happens to the solubility?

| Answer: |
| --- |

| |
|---|
| |
| |
| |
| |
| |

How easy or difficult was it to find the answer to this question in the chapter?

Very Easy Easy Neither Difficult Very Difficult

Other Comments (Use back of page if necessary):

TASK#9

What is Molality?

| Answer: |
|---|
| |
| |
| |
| |
| |

How easy or difficult was it to find the answer to this question in the chapter?

Very Easy Easy Neither Difficult Very Difficult

Other Comments (Use back of page if necessary):

Now move on to Chapter 5 and complete the following task

TASK#10

What is the average size of colloidal particles?

| Answer: |
| --- |
| |
| |
| |
| |
| |

How easy or difficult was it to find the answer to this question in the chapter?

Very Easy Easy Neither Difficult Very Difficult

Other Comments (Use back of page if necessary):

Now move on to Chapter 6 and complete this task

TASK#11

Calcium Bromide and Sulfuric Acid are reacted to give Bromic Acid and Calcium Sulfate. Balance the equation representing this chemical reaction.

| Answer: |
| --- |
| |
| |
| |
| |
| |

How easy or difficult was it to find the answer to this question in the chapter?

Very Easy Easy Neither Difficult Very Difficult

Other Comments (Use back of page if necessary):

# Survey Section#3

*Paint Preparation Module*

**Please move on to the G-2 simulation on Paint Preparation, and answer the following questions.**

**Q. 1 How helpful is the simulation in imparting knowledge about paint pollution?**

**Very Helpful  Helpful  Neither  Confusing  Very Confusing**

**Other Comments (Use back of page if necessary):**

**Q.2 Are the directions helpful in preparing an environmentally safe paint?**

**Very Helpful  Helpful  Neither  Confusing  Very Confusing**

**Other Comments (Use back of page if necessary):**

**Q.3 Is the graph helpful in preparing the paint?**

**Very Helpful  Helpful  Neither  Confusing  Very Confusing**

Other Comments (Use back of page if necessary):

Q.4. How helpful are the help screens?

Very Helpful Helpful Neither Confusing Very Confusing

Other Comments (Use back of page if necessary):

# Survey Section#4

*Gas Laws simulation module*

**Please move on to the G-2 simulation on Gas Laws, and answer the following questions.**

**Q.1. How helpful is the application in imparting knowledge about gas laws?**

**Very Helpful  Helpful  Neither  Confusing  Very Confusing**

**Other Comments (Use back of page if necessary):**

**Q.2. How helpful are the help screens?**

**Very Helpful  Helpful  Neither  Confusing  Very Confusing**

**Other Comments (Use back of page if necessary):**

**Q.3. How easy or difficult was it to find out how to vary the pressures and temperatures in the simulation?**

**Very Easy  Easy  Neither  Difficult  Very Difficult**

**Other Comments (Use back of page if necessary):**

**Q.4. What happens to the volume of the gas when the fat man stands on it?**

| Answer: |
| --- |
| |
| |
| |
| |
| |

**How easy or difficult was it to find the answer to this question in the simulation?**

**Very Easy  Easy  Neither  Difficult  Very Difficult**

**Other Comments (Use back of page if necessary):**

# Survey Section #5

**Please circle the number that best answers the question, also feel free to make any comments that you feel would be helpful**

| | Very Easy | Easy | Neutral | Difficult | Very Difficult |
|---|---|---|---|---|---|
| 1. Overall, reading the chapters was | 1 | 2 | 3 | 4 | 5 |
| Comments: | | | | | |
| 2. The subject icons made using | 1 | 2 | 3 | 4 | 5 |
| Comments: | | | | | |
| 5. Deciding which link to click on was | 1 | 2 | 3 | 4 | 5 |
| Comments: | | | | | |
| 6. Understanding the chemistry was | 1 | 2 | 3 | 4 | 5 |
| Comments: | | | | | |
| 8. Moving from one chapter to the other was | 1 | 2 | 3 | 4 | 5 |
| Comments: | | | | | |
| 9. Using the Simulations were | 1 | 2 | 3 | 4 | 5 |
| Comments: | | | | | |

10. How did the speed at which you were able to access the various parts of the applications affect your assessment of the chapters?

11. Before your actual lab experiments, if you had videos of lab experiments being performed would this make the labs easier to understand?

12. How often did you loose yourself in the courseware, and where did this problem occur?

13. We would appreciate any additional recommendations you have to improve the courseware and simulations. (Please use back of page if necessary)

# APPENDIX B - SURVEY RESULTS

## Participant Details

| Name | ID | S | Y | M | R | S | WP | SS | GP | IB | #2.1 | #2.2 | #2.3 | #2.4 | #2.5 | #2.6 | #2.7 | #2.8 | #2.9 | #2.10 | #2.11 | #3.1 | #3.2 | #3.3 | #3.4 | #4.1 | #4.2 | #4.3 | #4.4 | #5.1 | #5.2 | #5.3 | #5.4 | #5.5 | #5.6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Abraham, T | XXX-XX-2390 | M | 1 | UD | NA | 0 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 2 | 3 | 3 | 1 | 3 | 2 | 2 | 4 | 2 | 1 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 2 |
| Bhahandare, A | XXX-XX-6632 | M | 1 | CIS | N | 0 | 3 | 1 | 4 | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 4 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 |
| Fleary, G | XXX-XX-0482 | M | 2 | CIS | N | 2 | 3 | 1 | 4 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 4 | 3 | 4 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Pundya, Y | XXX-XX-2035 | M | 2 | MIS | N | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 4 | 1 | 1 | 1 | 2 | 3 | 4 | 1 | 1 | 3 |
| Ray, D | XXX-XX-6515 | M | 2 | CS | Y | 2 | 3 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Swierska, E | XXX-XX-4600 | F | 4 | AS | N | 0 | 3 | 3 | 1 | 1 | 1 | NR | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| Tabao, D | XXX-XX-1242 | M | 2 | ME | Y | 2 | 2 | 0 | 0 | 2 | 1 | 1 | 1 | 1 | NR | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Traas, A | XXX-XX-6247 | M | 1 | CS | Y | 1 | 3 | 1 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

## Survey Section -1

| | #1 | #2 | #3 | #4 |
|---|---|---|---|---|
| Every day | 0 | 0 | 2 | 4 |
| Several times a week | 1 | 4 | 1 | 1 |
| Once a week | 7 | 1 | 0 | 2 |
| Once a month | 0 | 0 | 2 | 0 |
| Do not Use the Software | 0 | 2 | 2 | 0 |

## Survey Section - 2

| | #1 | #2 | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10 | #11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Very Easy | 8 | 7 | 7 | 7 | 6 | 7 | 8 | 6 | 5 | 5 | 8 |
| Easy | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 2 | 1 | 2 | 0 |
| Neither | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| Difficult | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Very Difficult | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| No Response | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

## Survey Section -3

| | #1 | #2 | #3 | #4 |
|---|---|---|---|---|
| Very Easy | 5 | 6 | 2 | 2 |
| Easy | 2 | 2 | 5 | 3 |
| Neither | 1 | 0 | 0 | 2 |
| Difficult | 0 | 0 | 1 | 1 |
| Very Difficult | 0 | 0 | 0 | 0 |
| No Response | 0 | 0 | 0 | 0 |

## Survey Section - 4

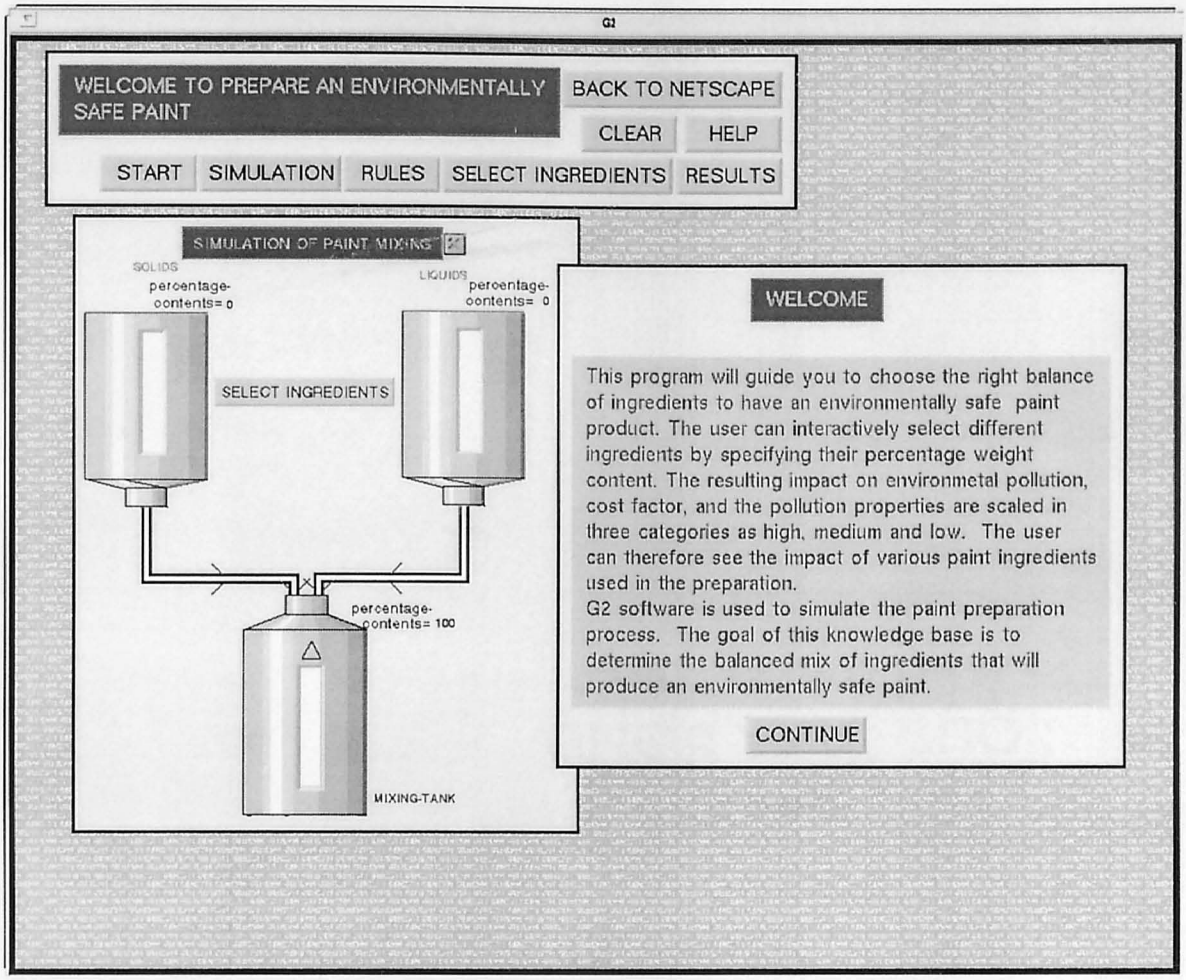
| | #1 | #2 | #3 | #4 |
|---|---|---|---|---|
| Very Easy | 1 | 6 | 6 | 5 |
| Easy | 4 | 1 | 1 | 2 |
| Neither | 1 | 1 | 1 | 1 |
| Difficult | 2 | 0 | 0 | 0 |
| Very Difficult | 0 | 0 | 0 | 0 |
| No Response | 0 | 0 | 0 | 0 |

## Survey Section - 5

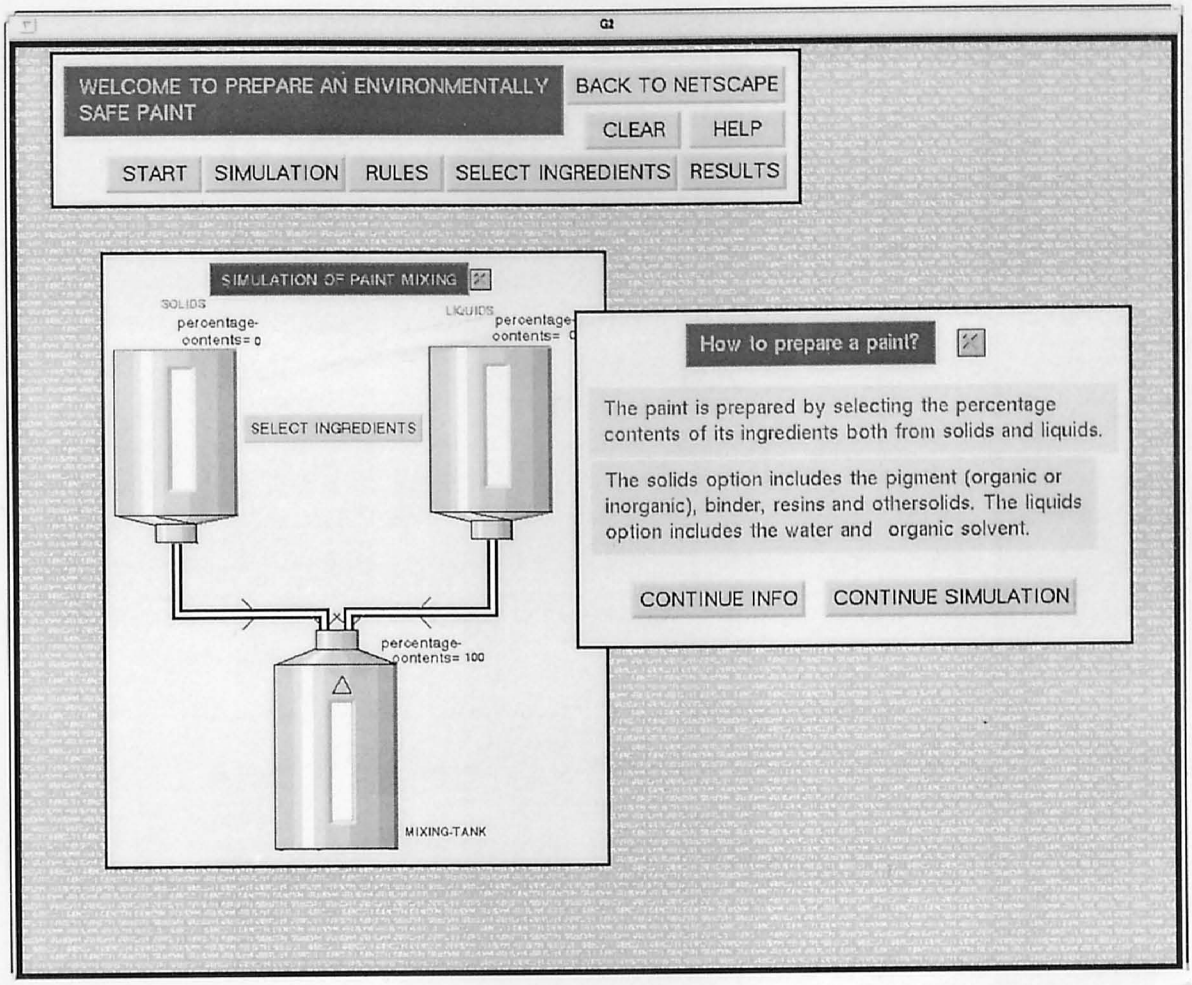
| | #1 | #2 | #3 | #4 | #5 | #6 |
|---|---|---|---|---|---|---|
| Very Easy | 4 | 4 | 4 | 5 | 5 | 2 |
| Easy | 4 | 3 | 3 | 3 | 3 | 5 |
| Neither | 0 | 1 | 0 | 0 | 0 | 1 |
| Difficult | 0 | 0 | 1 | 0 | 0 | 0 |
| Very Difficult | 0 | 0 | 0 | 0 | 0 | 0 |
| No Response | 0 | 0 | 0 | 0 | 0 | 0 |

# APPENDIX C - PAINT POLLUTION SIMULATION SCREENSHOTS

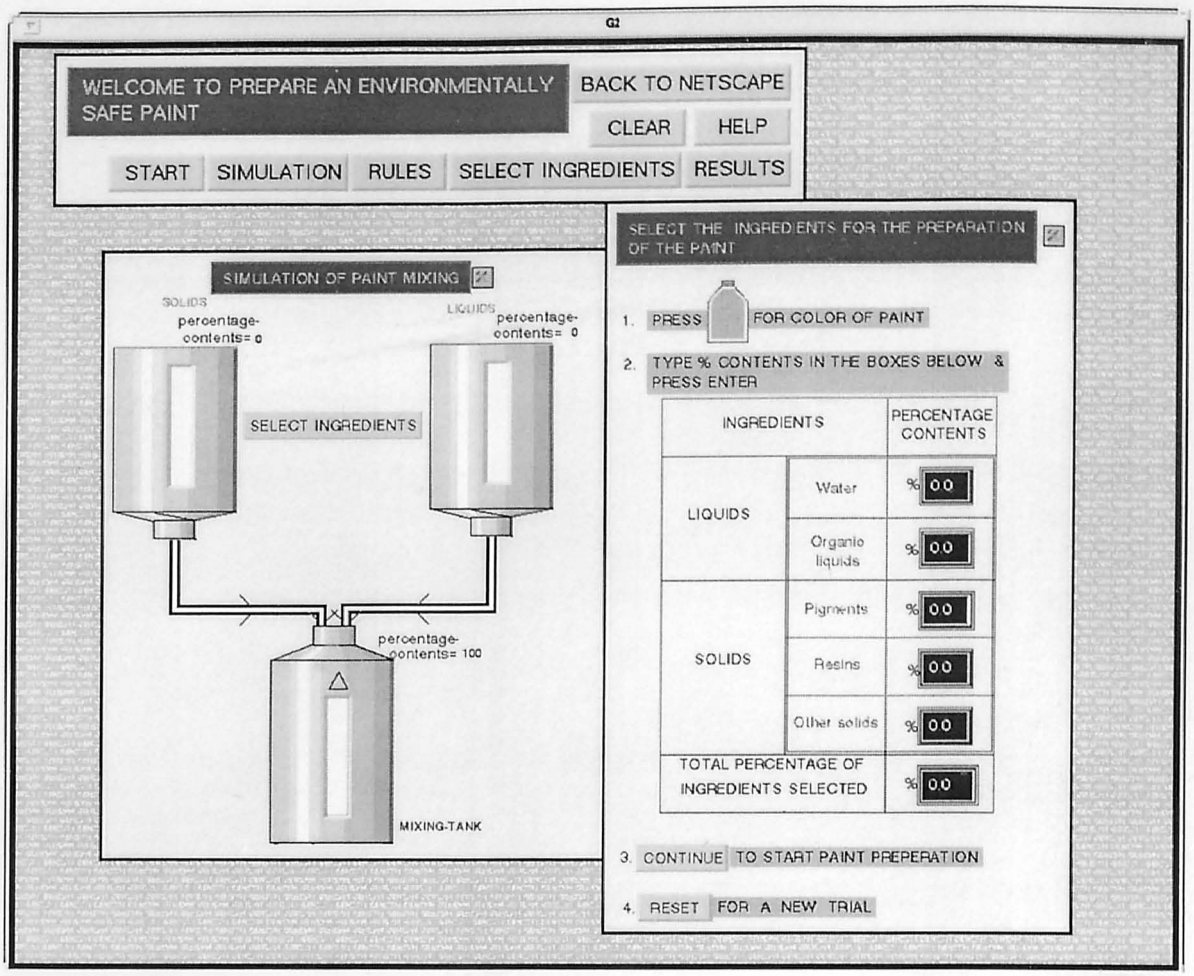
Screen - 1 : Introductory Screen



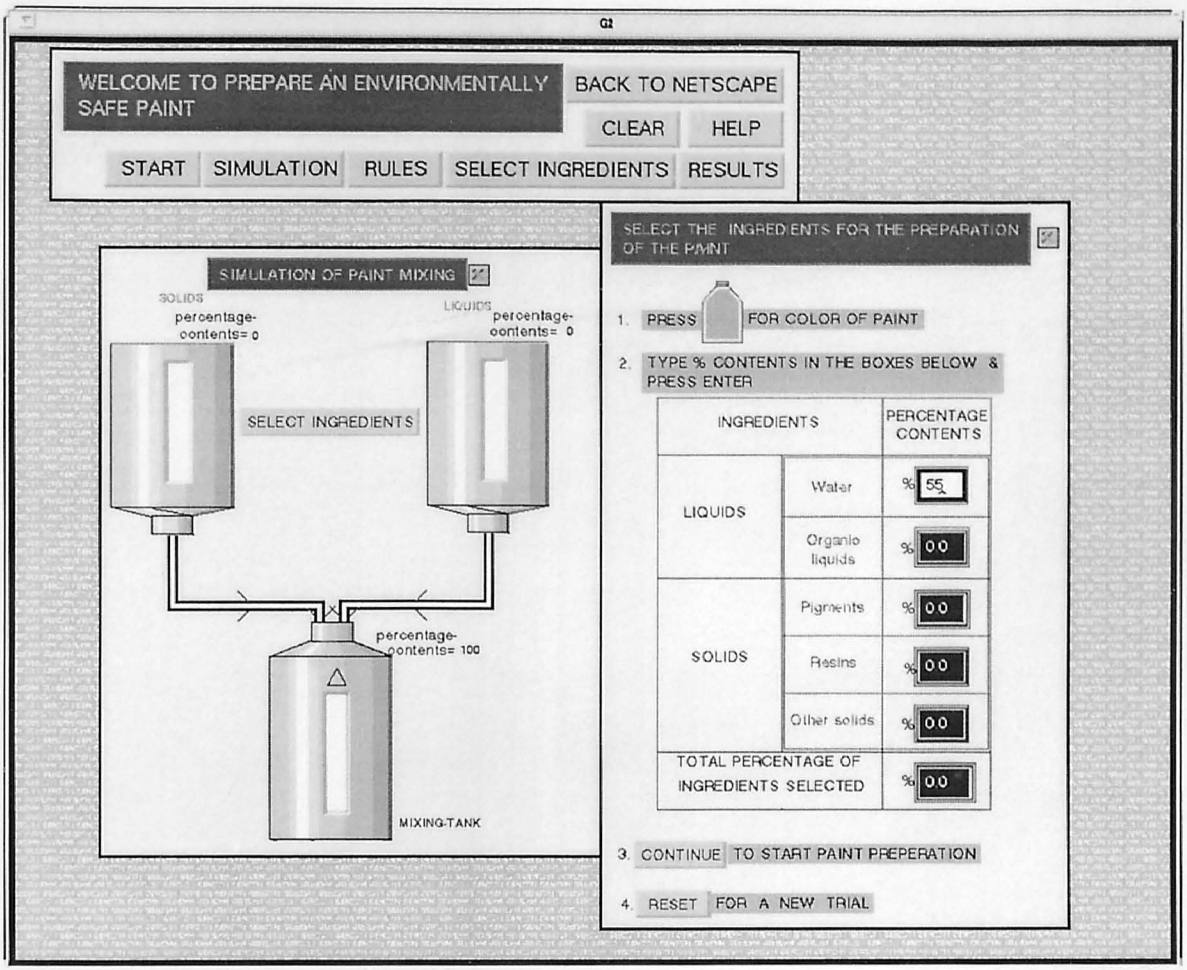
Screen - 2 : Help Screen



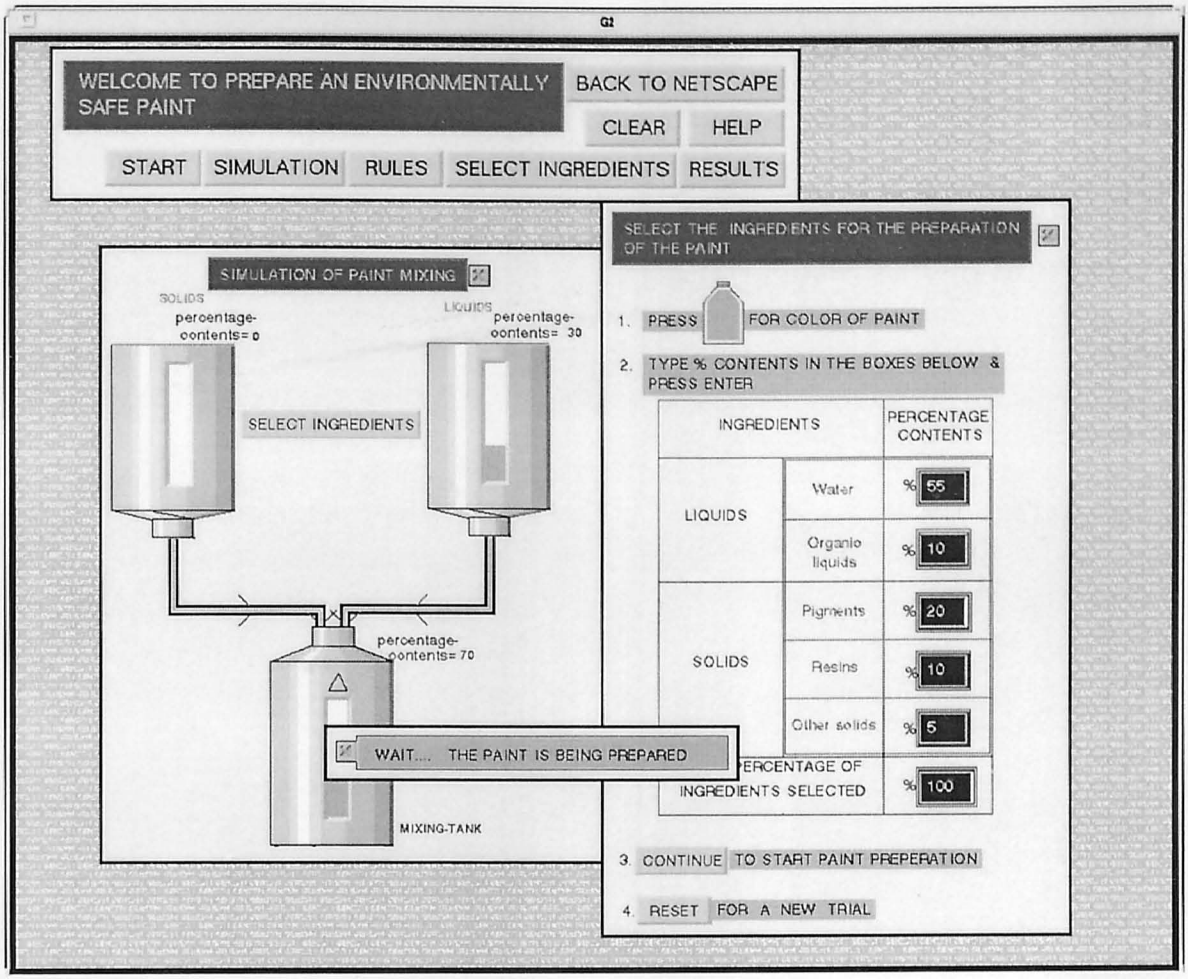
Screen - 3 : Entry Screen



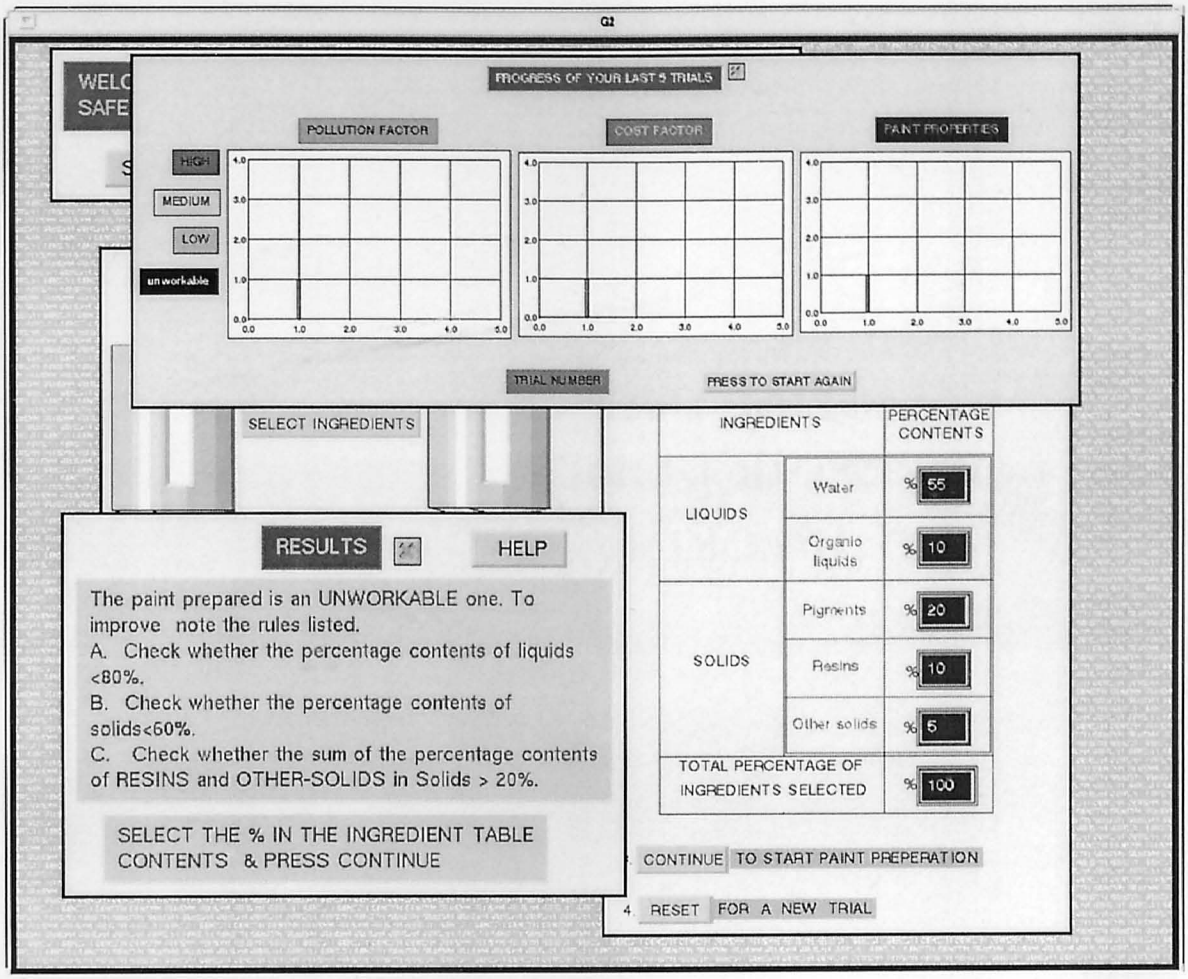
Screen - 4 : Entry Screen



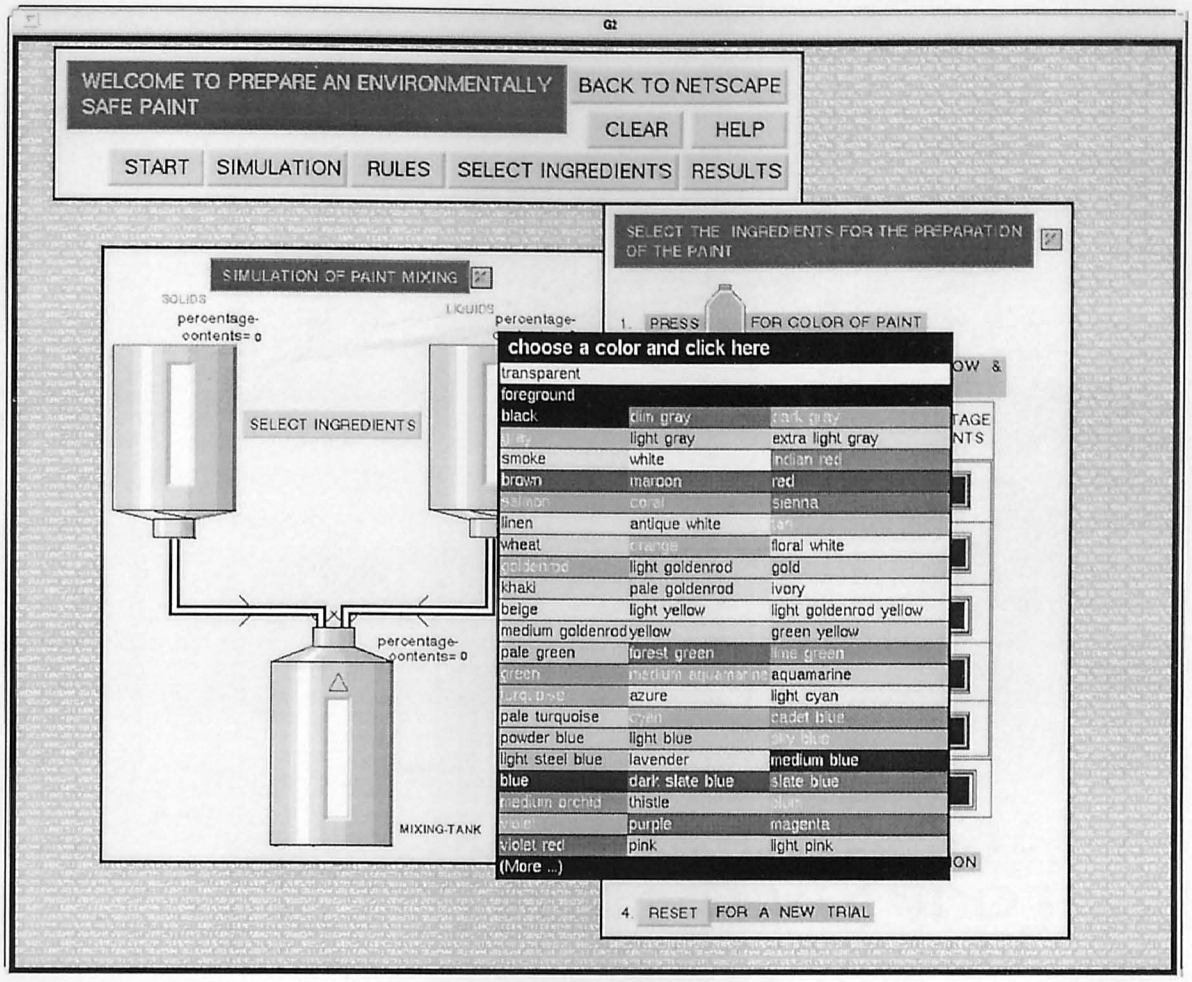
Screen - 5 : Paint Preparation Screen



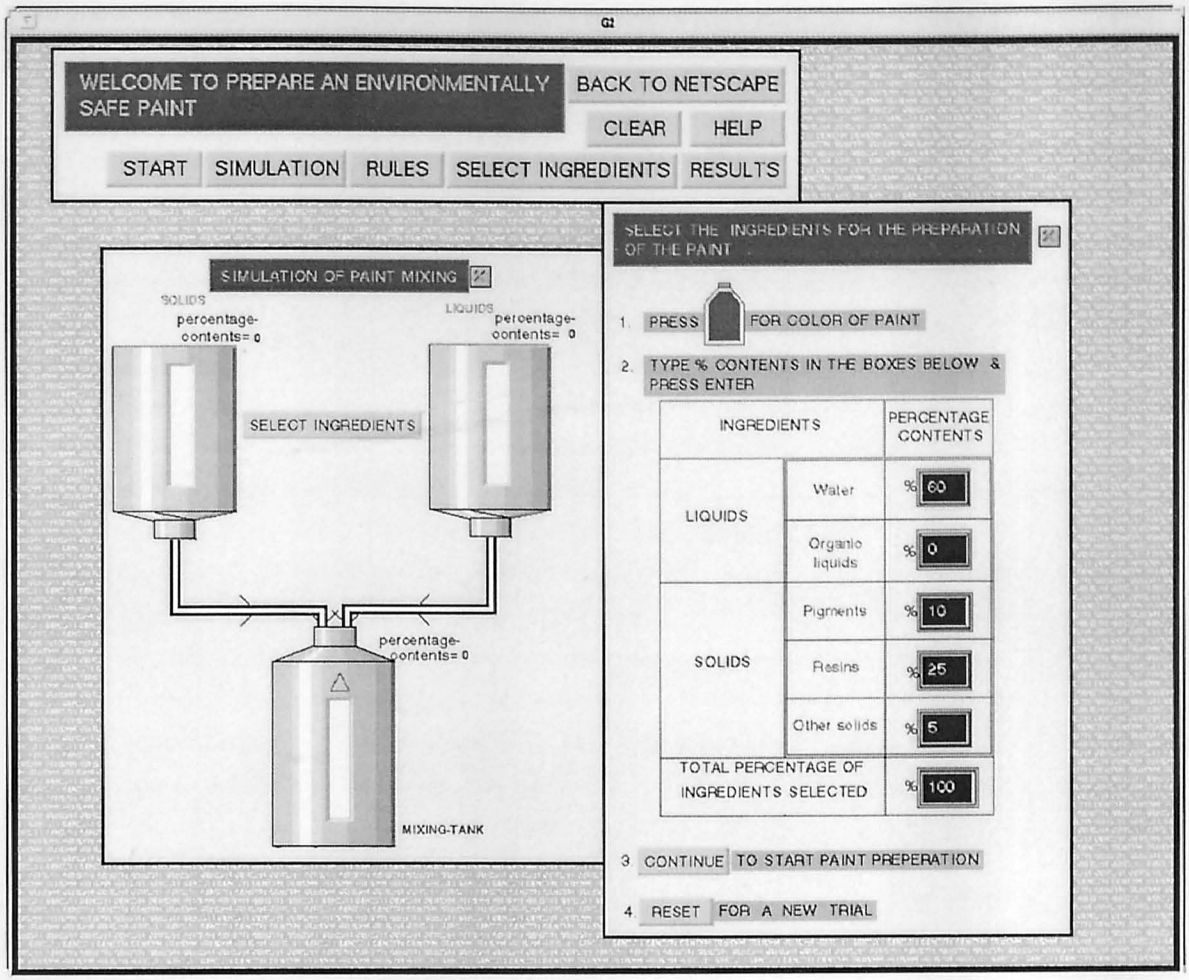
Screen - 6 : Result Screen



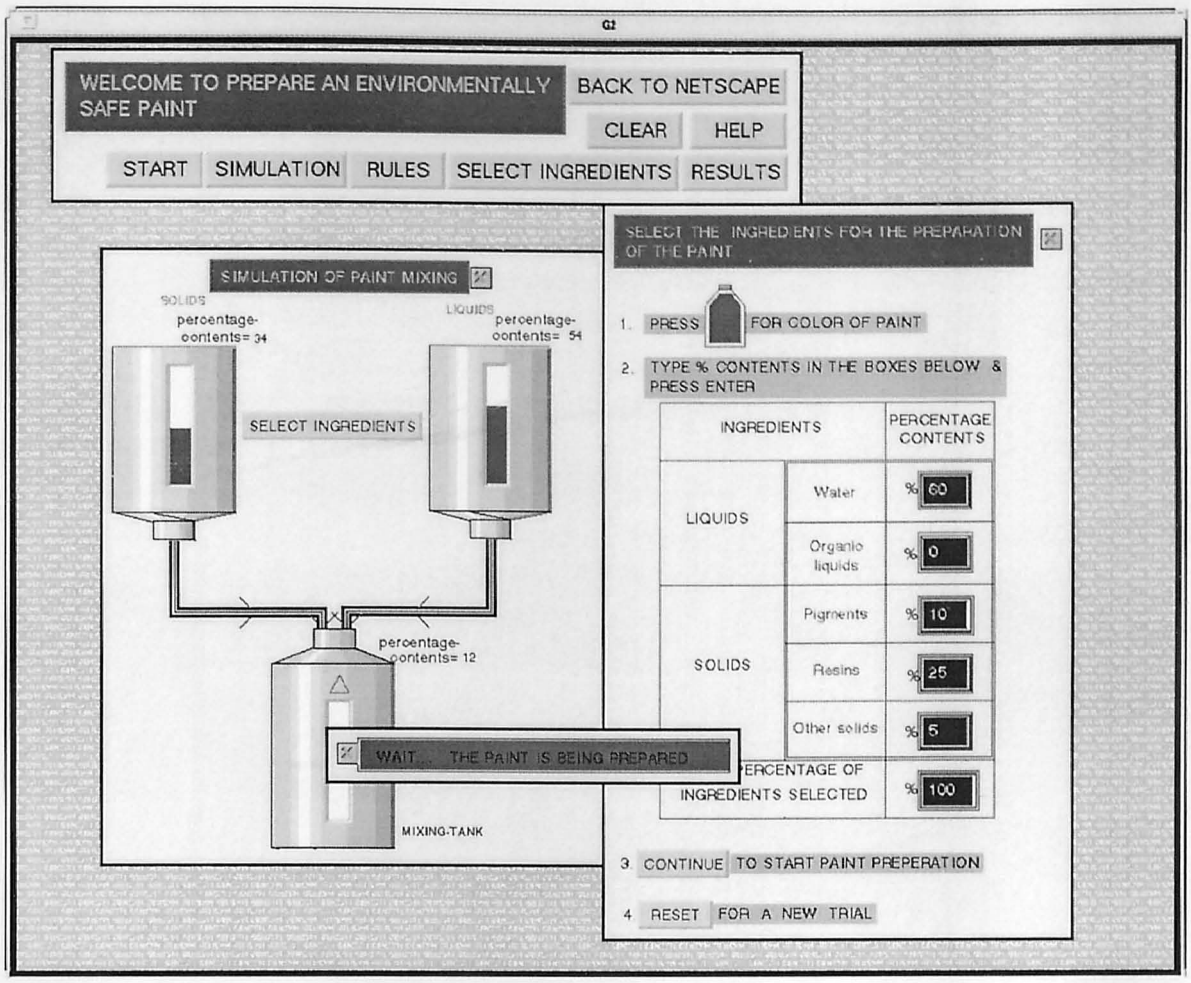
Screen - 7 : Color Change (2nd Iteration)



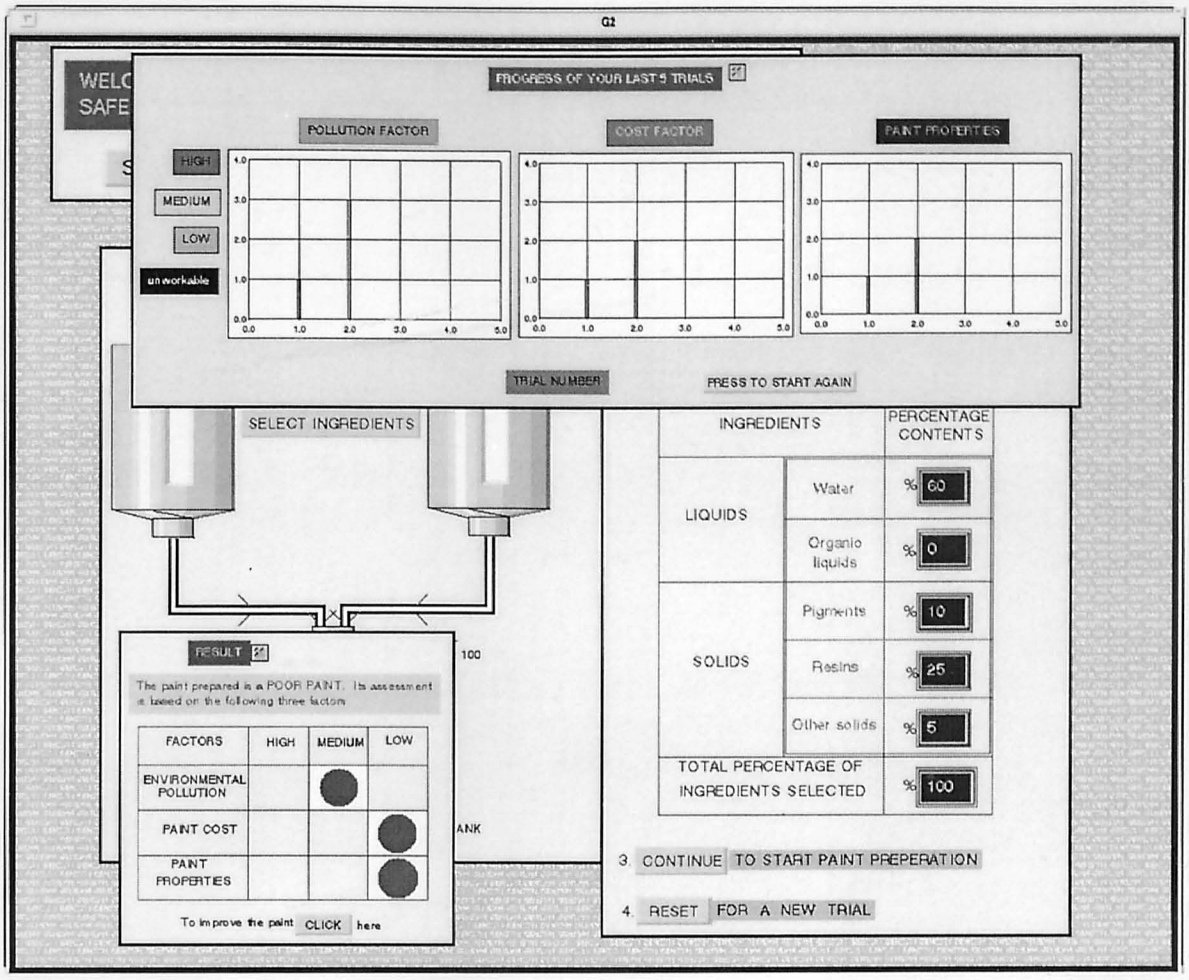
Screen 8 Entry Screen (2nd Iteration)



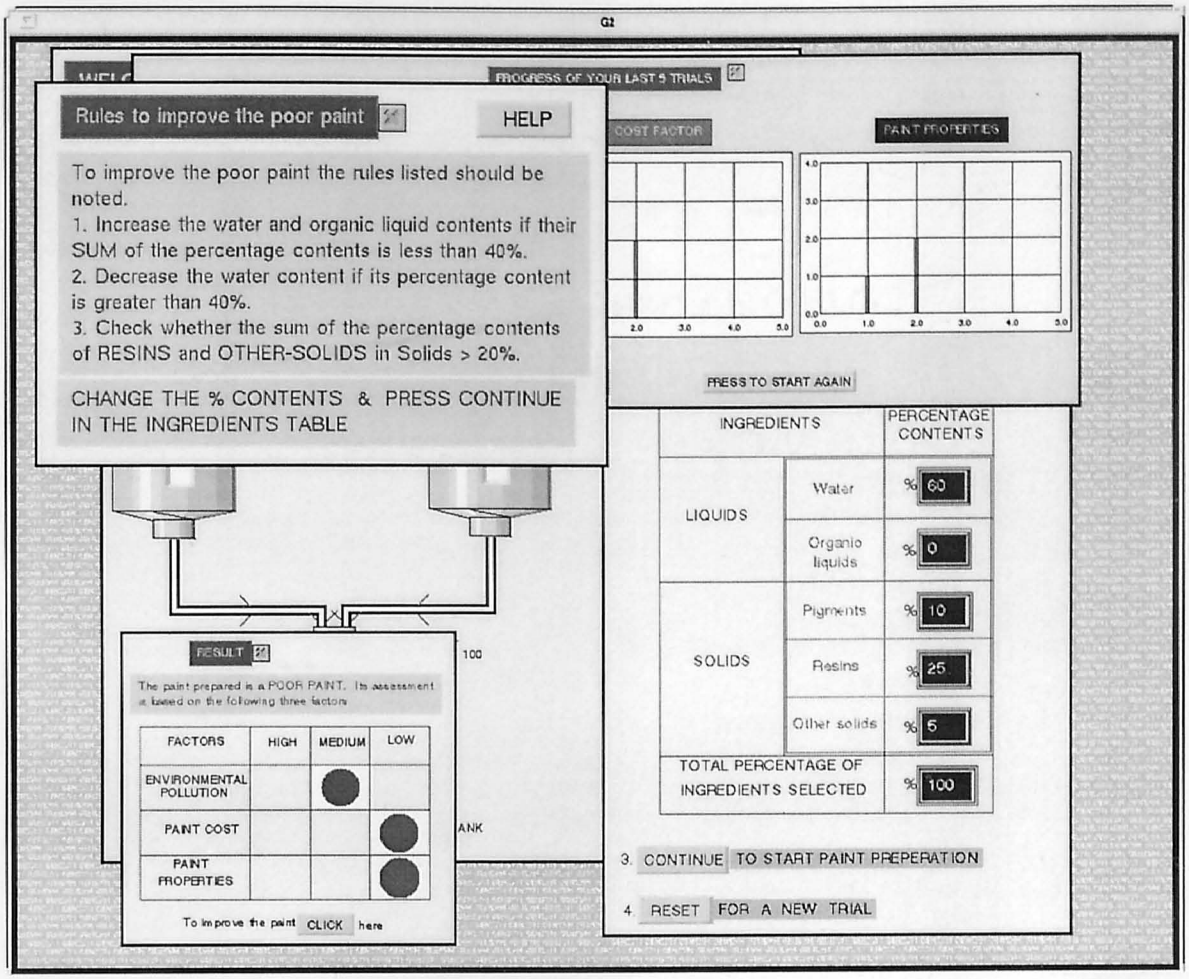
Screen - 9 : Paint Preparation Screen (2nd Iteration)



Screen -10: Results Screen (2nd Iteration)

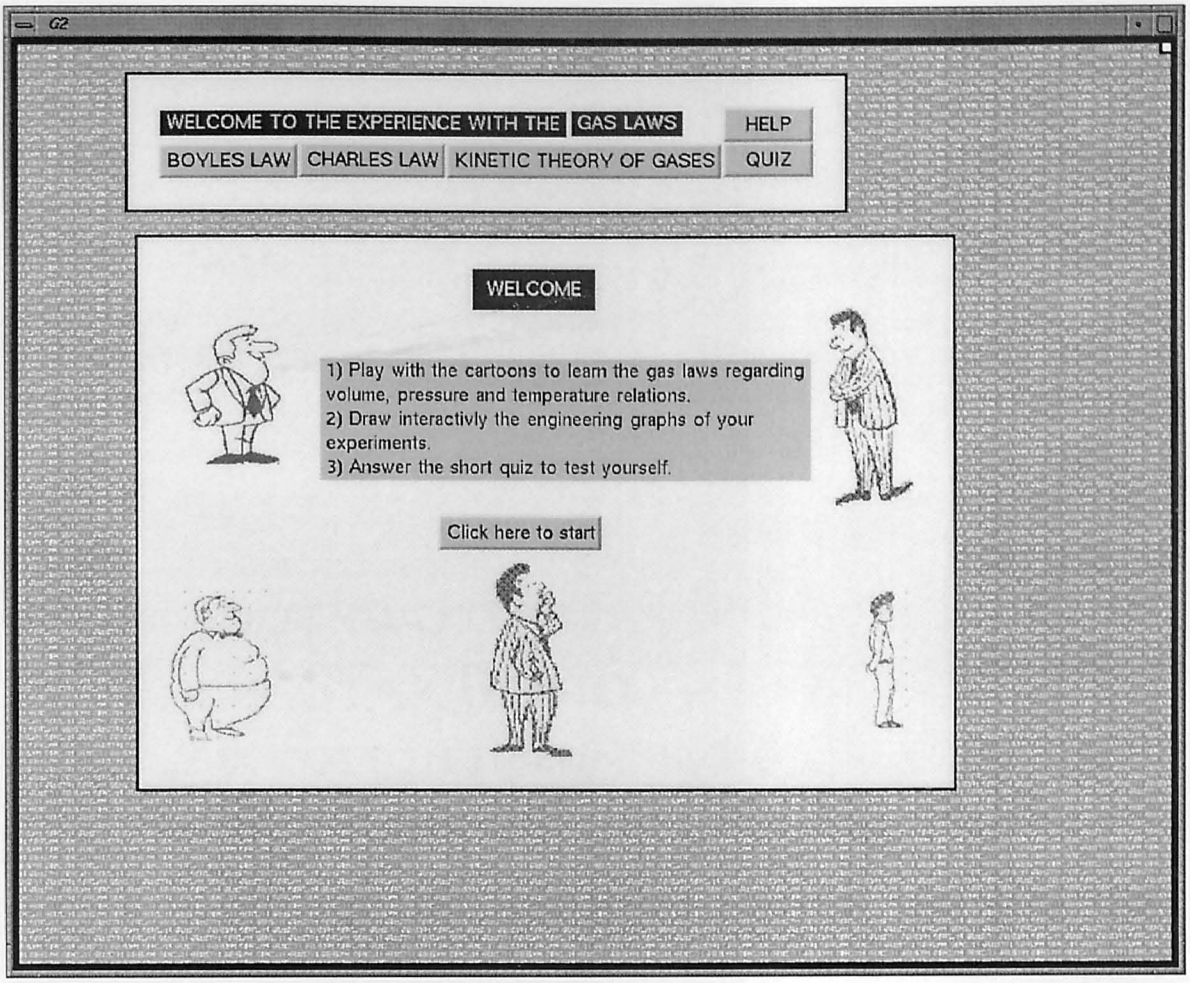


Screen - 11 : Improvements (2nd Screen)

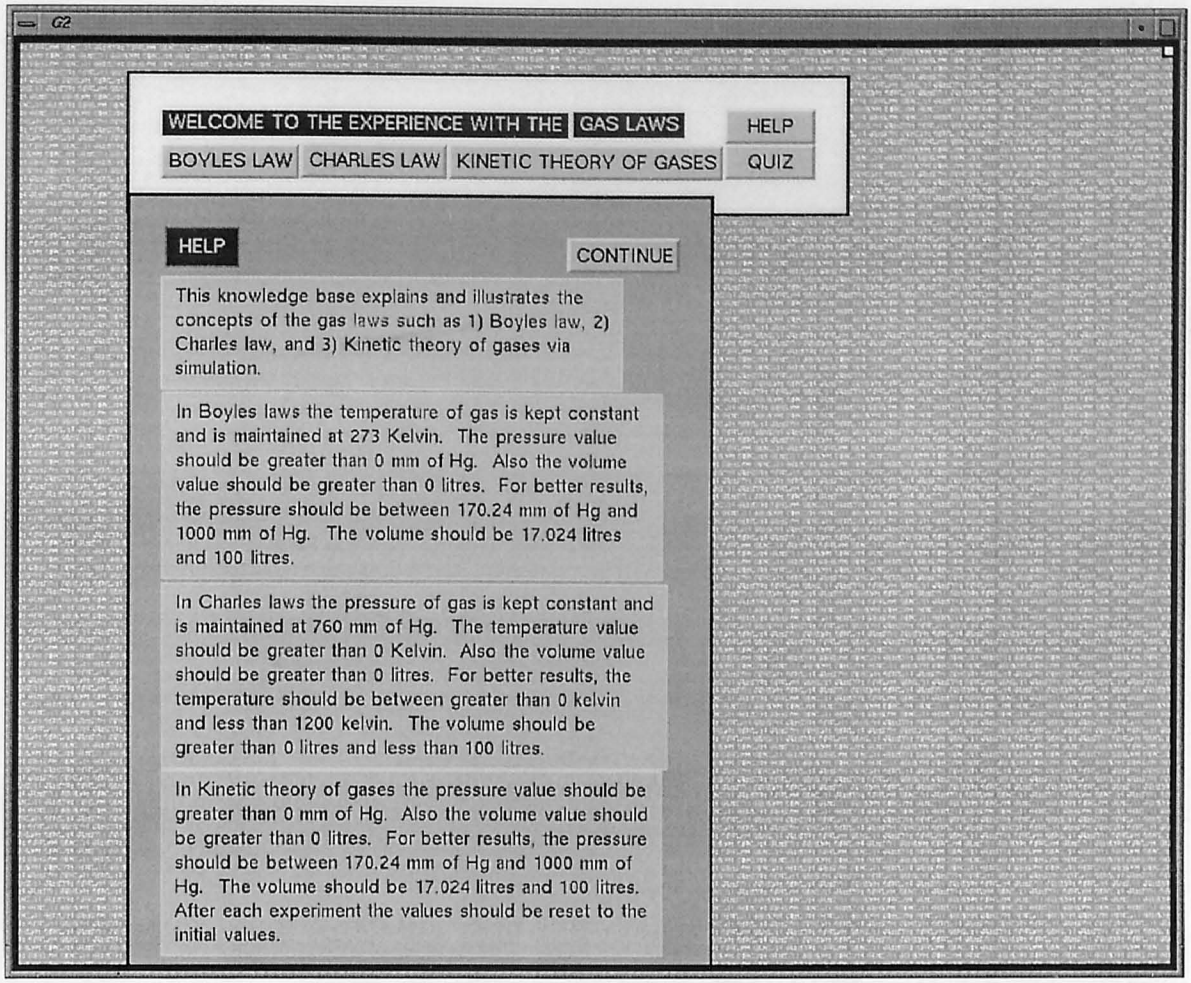


# APPENDIX - D : GAS LAWS SIMULATION

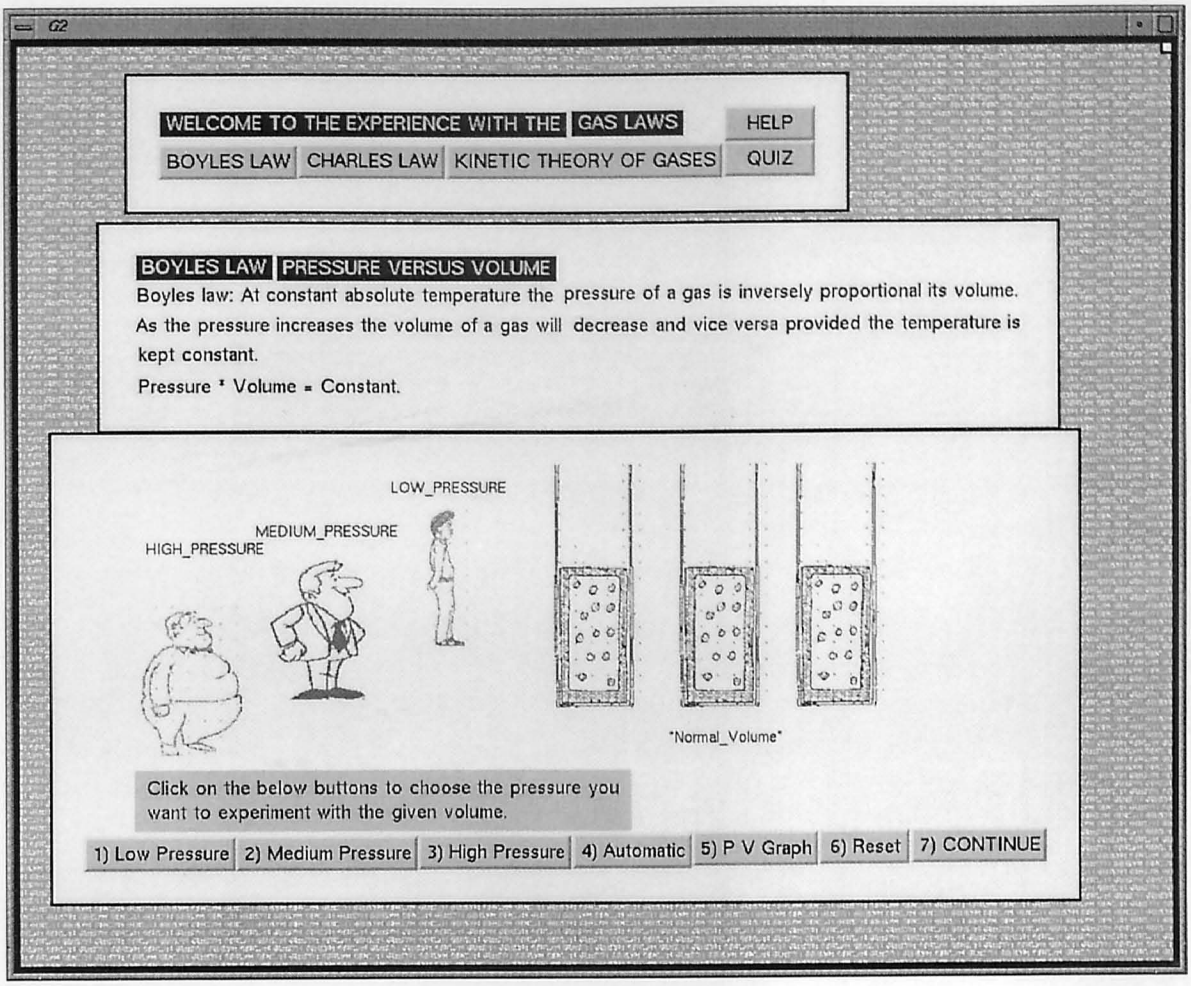
Screen - 1: Introductory Screen



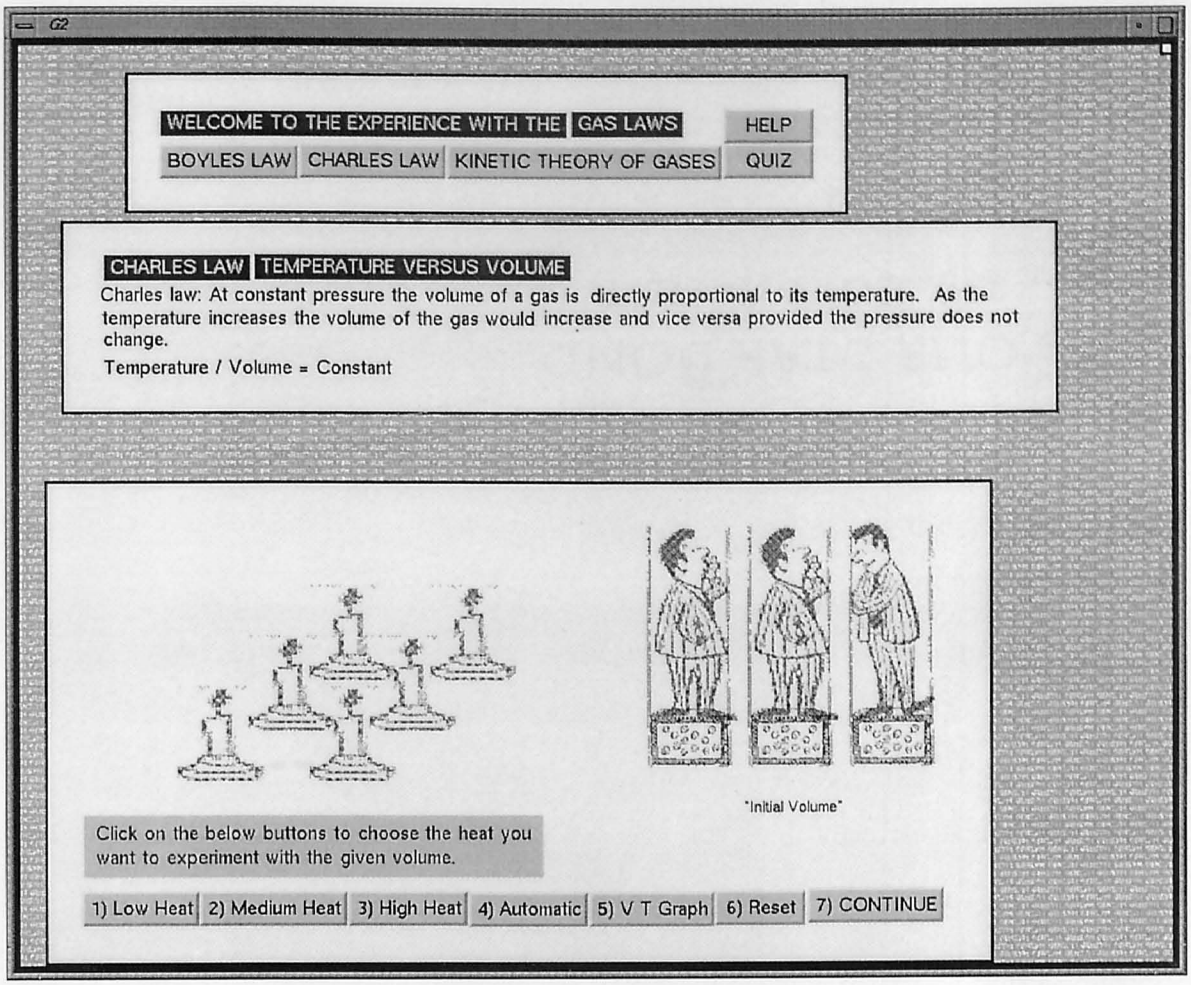
Screen - 2: Introductory Screen



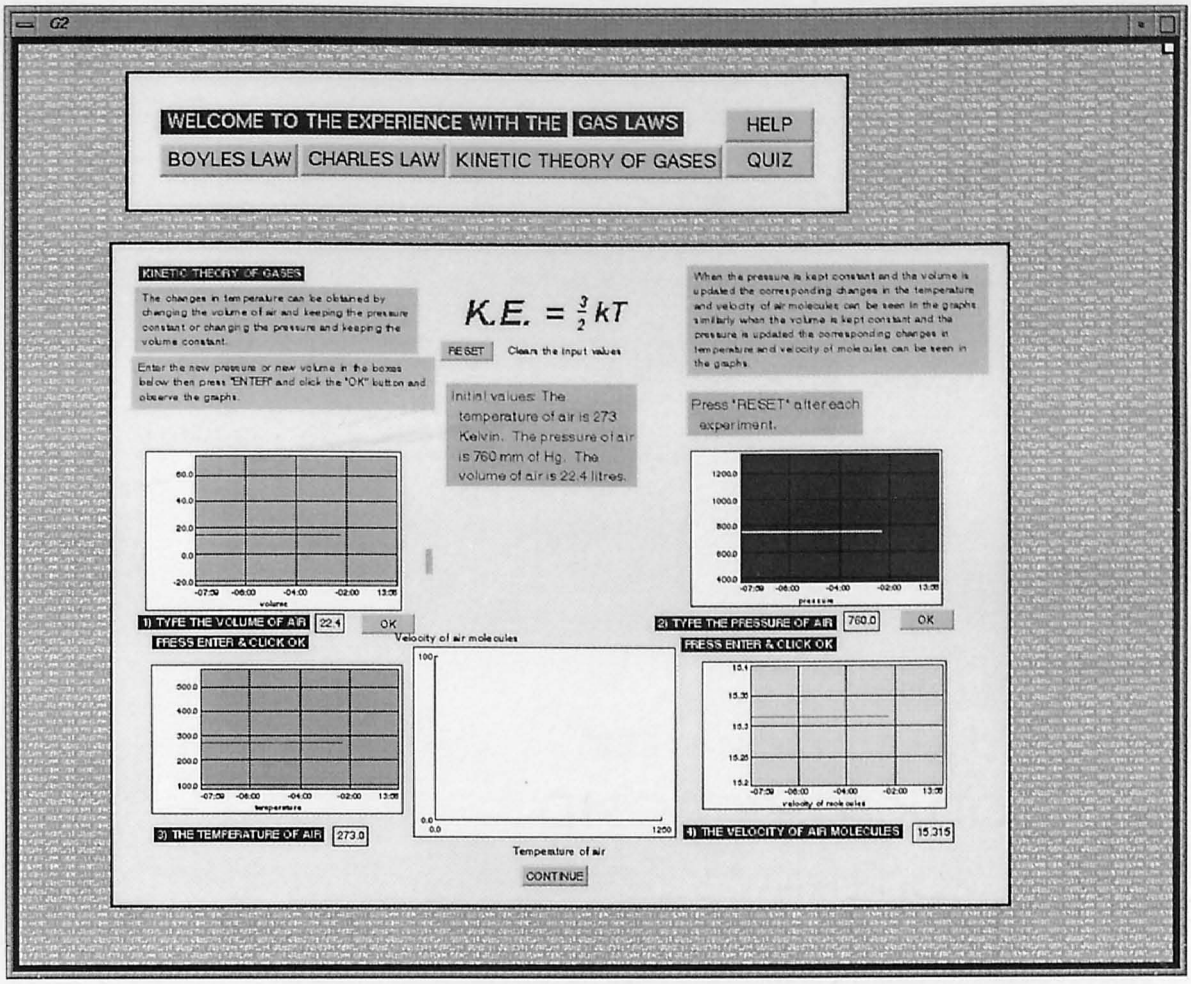
Screen - 3: Boyle's Law, Cartoon Approach



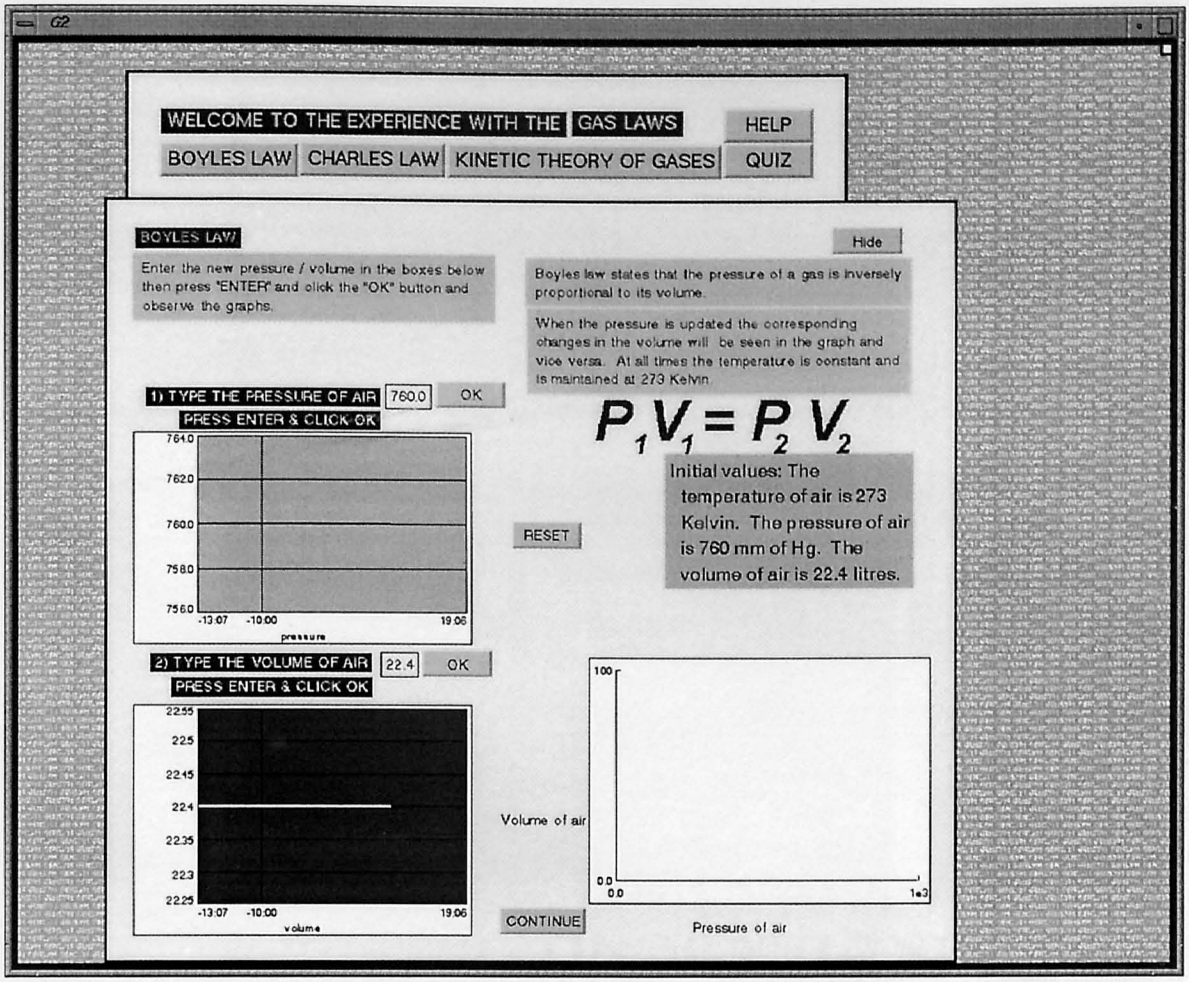
Screen - 4: Charles Law, Cartoon Approach



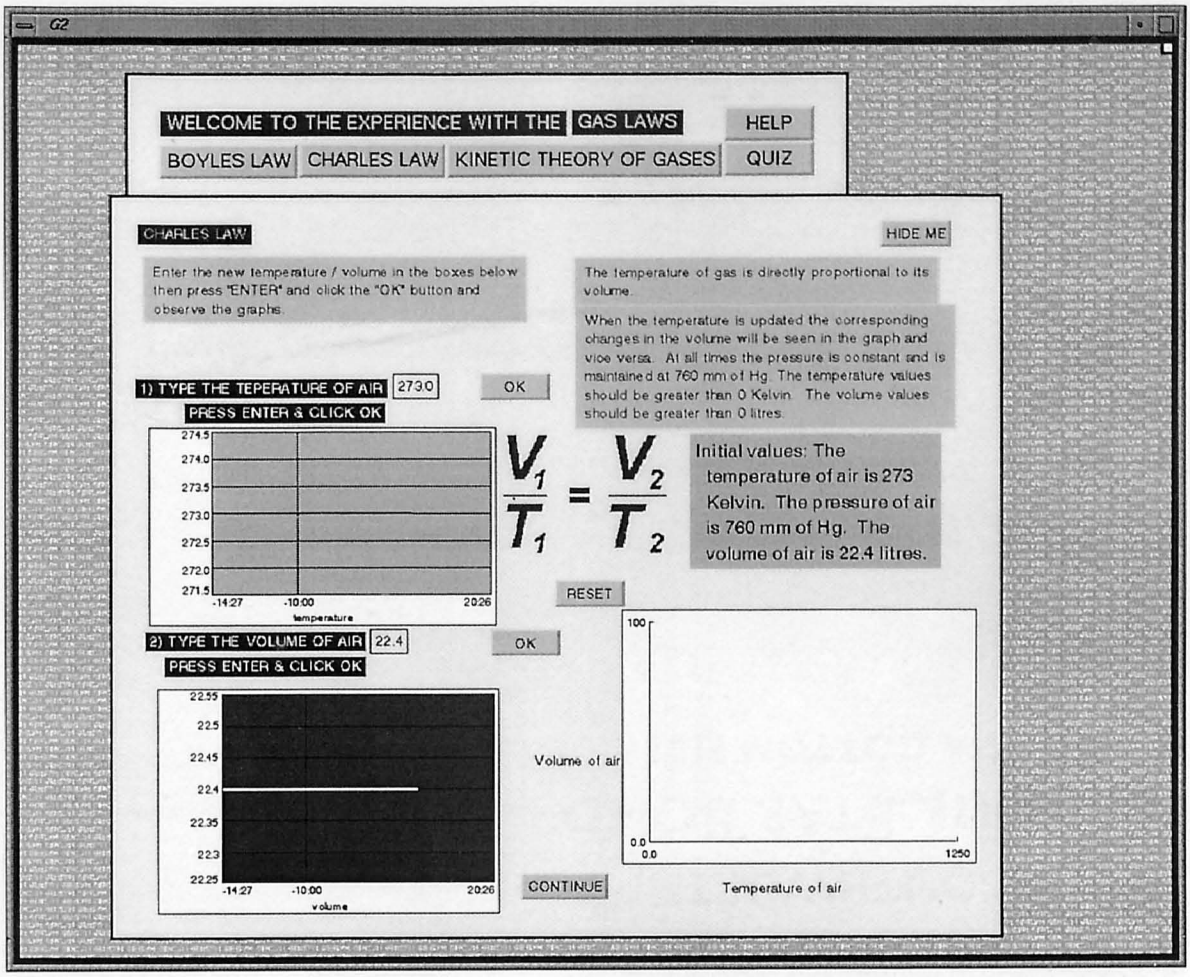
Screen - 5 : Kinetic Molecular Theory, Graphical Approach



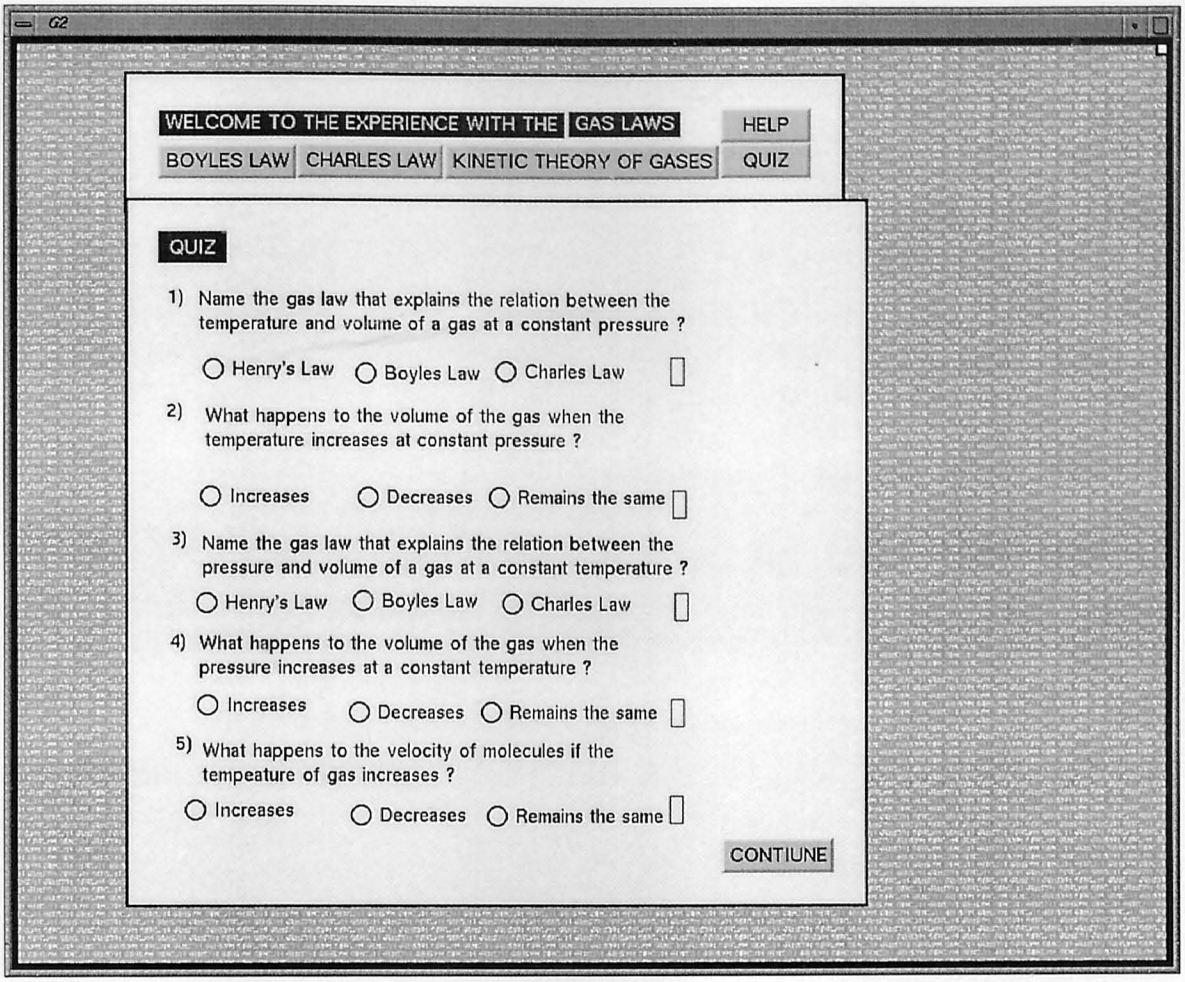
Screen - 6 : Boyle's Law, Graphical Approach



Screen - 7 : Charles Law, Graphical Approach



Screen - 8 : Pop Quiz



# APPENDIX E: QUIZ APPLICATION

## Section -1 Quiz Client Program

```
//The QuizClient Applet by Anirban Bhaumik NJIT started 2.10.97
//All comments and suggestions to axb0234@megahertz.njit.edu

import java.awt.*;
import java.lang.*;
import java.io.*;
import java.net.*;

import java.util.*;
import java.applet.Applet;

public class QuizClient extends java.applet.Applet{


//The Panel on which the Questions and choices are displayed

        Panel Qcards;

//The String which identifies each string

        final static String QUESTION1 = "Question 1.";
        final static String QUESTION2 = "Question 2.";
        final static String QUESTION3 = "Question 3.";
        final static String QUESTION4 = "Question 4.";
        final static String QUESTION5 = "Question 5.";
        final static String QUESTION6 = "Question 6.";
        final static String QUESTION7 = "Question 7.";
        final static String QUESTION8 = "Question 8.";
        final static String QUESTION9 = "Question 9.";
        final static String QUESTION10 = "Question 10.";

//The user Name Choice List

        List idChoice = new List(4, false);

//Displays The Social Security Number

        TextField SSNo = new TextField(22);

//This is the String  that stores the SSNo

        String SS ;

//The Maximum Number of students that is supported by the program

        final static int MAX_USER = 100;

//This is the Array of Strings that stores the SSNo from the Students Data File

        String SocSec[] = new String[MAX_USER];

//This is the String  that stores the username

        String name ;

//The Area to display the question and available answers

        TextArea QuestionText1 = new TextArea(15, 80);
        TextArea QuestionText2 = new TextArea(15, 80);
```

```
        TextArea QuestionText3 = new TextArea(15, 80);
        TextArea QuestionText4 = new TextArea(15, 80);
        TextArea QuestionText5 = new TextArea(15, 80);
        TextArea QuestionText6 = new TextArea(15, 80);
        TextArea QuestionText7 = new TextArea(15, 80);
        TextArea QuestionText8 = new TextArea(15, 80);
        TextArea QuestionText9 = new TextArea(15, 80);
        TextArea QuestionText10 = new TextArea(15, 80);


//The Network Status display

        TextArea Status = new TextArea(6,70);

//The URL for the set of questions, must be the same from where this applet is loaded!!

        URL theURL;

//The Correct Answer

        char correct_answer1;
        char correct_answer2;
        char correct_answer3;
        char correct_answer4;
        char correct_answer5;
        char correct_answer6;
        char correct_answer7;
        char correct_answer8;
        char correct_answer9;
        char correct_answer10;


//The answer the user has chosen

        char answer1;
        char answer2;
        char answer3;
        char answer4;
        char answer5;
        char answer6;
        char answer7;
        char answer8;
        char answer9;
        char answer10;



//The Choice Radio Buttons

        CheckboxGroup ABCD1 = new CheckboxGroup();
        CheckboxGroup ABCD2 = new CheckboxGroup();
        CheckboxGroup ABCD3 = new CheckboxGroup();
        CheckboxGroup ABCD4 = new CheckboxGroup();
        CheckboxGroup ABCD5 = new CheckboxGroup();
        CheckboxGroup ABCD6 = new CheckboxGroup();
        CheckboxGroup ABCD7 = new CheckboxGroup();
        CheckboxGroup ABCD8 = new CheckboxGroup();
        CheckboxGroup ABCD9 = new CheckboxGroup();
        CheckboxGroup ABCD10 = new CheckboxGroup();

//The Main Control buttons

                Button startButton = new Button("Start");
                Button finishButton = new Button("Finish");
                Button answerButton = new Button("Answers");
                Button nextButton = new Button("Next");
                Button prevButton = new Button("Previous");
                Button firstButton = new Button("First");
                Button lastButton = new Button("Last");
                Button resultButton = new Button("Results");
```

```
//The number of questions the user has answered correctly

        int correct_num = 0;


//This determines which file it is

        int fileindex = 0;

//This variable determines whether the user maybe allowed to proceed

        boolean abort = true;

//This variable determines whether the user maybe allowed to see the answers

        boolean finished = false;

//The panels that make up the APP

        Panel UserDetailsPanel = new Panel();
        Panel MainControlsPanel = new Panel();
        Panel StatusPanel = new Panel();
        Panel panel1;

        public void init(){

                int indexposition = 0;
                for(indexposition = 0;indexposition<MAX_USER;indexposition++){
                        SocSec[indexposition] = " ";
                }

                String mdname = null;
                InputStream rdname = null;
                String is = null;
                int idChoiceindex = 0;

                setBackground(Color.white);

// Setting up the list of students

                mdname = getParameter("studentfile");
                try {
                        rdname = new URL(getDocumentBase(), mdname).openStream();
                 } catch (Exception e) { }

                try{

                        DataInputStream dis = new DataInputStream(rdname);
                        is = dis.readLine();
                        while (is != null) {
                                StringTokenizer st = new StringTokenizer(is);
                                while (st.hasMoreTokens()) {
                                        String uname = st.nextToken();
                                        SocSec[idChoiceindex] = st.nextToken();
                                        idChoice.addItem(uname);

                                }
                                idChoiceindex++;
                                is = dis.readLine();
                        }
                } catch (Exception e) { }

                SSNo.setText("Please Enter SS#");



                Status.setEditable(false);
                Status.setFont(new Font("Courier",Font.BOLD+Font.ITALIC,12));
                Status.setBackground(Color.white);
                Status.setForeground(Color.blue);
```

```
            Status.setText("Please choose your username\nThen key in your SS number and
press Enter");


                startButton.setForeground(Color.blue);
                finishButton.setForeground(Color.blue);
                answerButton.setForeground(Color.blue);
                nextButton.setForeground(Color.blue);
                prevButton.setForeground(Color.blue);
                firstButton.setForeground(Color.blue);
                lastButton.setForeground(Color.blue);
                resultButton.setForeground(Color.blue);

                startButton.setFont(new Font("Courier",Font.BOLD+Font.ITALIC,12));
                nextButton.setFont(new Font("Courier",Font.BOLD+Font.ITALIC,12));
                finishButton.setFont(new Font("Courier",Font.BOLD+Font.ITALIC,12));
                answerButton.setFont(new Font("Courier",Font.BOLD+Font.ITALIC,12));
                prevButton.setFont(new Font("Courier",Font.BOLD+Font.ITALIC,12));
                firstButton.setFont(new Font("Courier",Font.BOLD+Font.ITALIC,12));
                lastButton.setFont(new Font("Courier",Font.BOLD+Font.ITALIC,12));
                resultButton.setFont(new Font("Courier",Font.BOLD+Font.ITALIC,12));



                QuestionText1.setEditable(false);
                QuestionText2.setEditable(false);
                QuestionText3.setEditable(false);
                QuestionText4.setEditable(false);
                QuestionText5.setEditable(false);
                QuestionText6.setEditable(false);
                QuestionText7.setEditable(false);
                QuestionText8.setEditable(false);
                QuestionText9.setEditable(false);
                QuestionText10.setEditable(false);

                QuestionText1.setFont(new Font("TimesRoman",Font.ITALIC+Font.BOLD, 16));
                QuestionText1.setForeground(Color.red);
                QuestionText2.setFont(new Font("TimesRoman",Font.ITALIC+Font.BOLD, 16));
                QuestionText2.setForeground(Color.red);
                QuestionText3.setFont(new Font("TimesRoman",Font.ITALIC+Font.BOLD, 16));
                QuestionText3.setForeground(Color.red);
                QuestionText4.setFont(new Font("TimesRoman",Font.ITALIC+Font.BOLD, 16));
                QuestionText4.setForeground(Color.red);
                QuestionText5.setFont(new Font("TimesRoman",Font.ITALIC+Font.BOLD, 16));
                QuestionText5.setForeground(Color.red);
                QuestionText6.setFont(new Font("TimesRoman",Font.ITALIC+Font.BOLD, 16));
                QuestionText6.setForeground(Color.red);
                QuestionText7.setFont(new Font("TimesRoman",Font.ITALIC+Font.BOLD, 16));
                QuestionText7.setForeground(Color.red);
                QuestionText8.setFont(new Font("TimesRoman",Font.ITALIC+Font.BOLD, 16));
                QuestionText8.setForeground(Color.red);
                QuestionText9.setFont(new Font("TimesRoman",Font.ITALIC+Font.BOLD, 16));
                QuestionText9.setForeground(Color.red);
                QuestionText10.setFont(new Font("TimesRoman",Font.ITALIC+Font.BOLD, 16));
                QuestionText10.setForeground(Color.red);



//The main Layout of the applet

                Panel TextPanel1 = new Panel();
                Panel TextPanel2 = new Panel();
                Panel TextPanel3 = new Panel();
                Panel TextPanel4 = new Panel();
                Panel TextPanel5 = new Panel();
                Panel TextPanel6 = new Panel();
                Panel TextPanel7 = new Panel();
                Panel TextPanel8 = new Panel();
                Panel TextPanel9 = new Panel();
```

```
Panel TextPanel10 = new Panel();

Panel ChoicePanel1 = new Panel();
Panel ChoicePanel2 = new Panel();
Panel ChoicePanel3 = new Panel();
Panel ChoicePanel4 = new Panel();
Panel ChoicePanel5 = new Panel();
Panel ChoicePanel6 = new Panel();
Panel ChoicePanel7 = new Panel();
Panel ChoicePanel8 = new Panel();
Panel ChoicePanel9 = new Panel();
Panel ChoicePanel10 = new Panel();


Panel Question1 = new Panel();
Panel Question2 = new Panel();
Panel Question3 = new Panel();
Panel Question4 = new Panel();
Panel Question5 = new Panel();
Panel Question6 = new Panel();
Panel Question7 = new Panel();
Panel Question8 = new Panel();
Panel Question9 = new Panel();
Panel Question10 = new Panel();


//Laying out the Question panel

GridBagLayout gridBag_Q1 = new GridBagLayout();
Question1.setLayout(gridBag_Q1);
GridBagConstraints cQ1 = new GridBagConstraints();
cQ1.gridwidth = GridBagConstraints.REMAINDER;
cQ1.fill = GridBagConstraints.HORIZONTAL;
gridBag_Q1.setConstraints(TextPanel1, cQ1);
Question1.add(TextPanel1);

cQ1.fill = GridBagConstraints.VERTICAL;
cQ1.weightx = 1.0;
 cQ1.weighty = 1.0;
gridBag_Q1.setConstraints(ChoicePanel1, cQ1);
Question1.add(ChoicePanel1);

GridBagLayout gridBag_Q2 = new GridBagLayout();
Question2.setLayout(gridBag_Q2);
GridBagConstraints cQ2 = new GridBagConstraints();
cQ2.gridwidth = GridBagConstraints.REMAINDER;
cQ2.fill = GridBagConstraints.HORIZONTAL;
gridBag_Q2.setConstraints(TextPanel2, cQ2);
Question2.add(TextPanel2);

cQ2.fill = GridBagConstraints.VERTICAL;
cQ2.weightx = 1.0;
 cQ2.weighty = 1.0;
gridBag_Q2.setConstraints(ChoicePanel2, cQ2);
Question2.add(ChoicePanel2);


GridBagLayout gridBag_Q3 = new GridBagLayout();
Question3.setLayout(gridBag_Q3);
GridBagConstraints cQ3 = new GridBagConstraints();
cQ3.gridwidth = GridBagConstraints.REMAINDER;
cQ3.fill = GridBagConstraints.HORIZONTAL;
gridBag_Q3.setConstraints(TextPanel3, cQ3);
Question3.add(TextPanel3);

cQ3.fill = GridBagConstraints.VERTICAL;
cQ3.weightx = 1.0;
 cQ3.weighty = 1.0;
gridBag_Q3.setConstraints(ChoicePanel3, cQ3);
```

```
Question3.add(ChoicePanel3);


GridBagLayout gridBag_Q4 = new GridBagLayout();
Question4.setLayout(gridBag_Q4);
GridBagConstraints cQ4 = new GridBagConstraints();
cQ4.gridwidth = GridBagConstraints.REMAINDER;
cQ4.fill = GridBagConstraints.HORIZONTAL;
gridBag_Q4.setConstraints(TextPanel4, cQ4);
Question4.add(TextPanel4);

cQ4.fill = GridBagConstraints.VERTICAL;
cQ4.weightx = 1.0;
 cQ4.weighty = 1.0;
gridBag_Q4.setConstraints(ChoicePanel4, cQ4);
Question4.add(ChoicePanel4);

GridBagLayout gridBag_Q5 = new GridBagLayout();
Question5.setLayout(gridBag_Q5);
GridBagConstraints cQ5 = new GridBagConstraints();
cQ5.gridwidth = GridBagConstraints.REMAINDER;
cQ5.fill = GridBagConstraints.HORIZONTAL;
gridBag_Q5.setConstraints(TextPanel5, cQ5);
Question5.add(TextPanel5);

cQ5.fill = GridBagConstraints.VERTICAL;
cQ5.weightx = 1.0;
 cQ5.weighty = 1.0;
gridBag_Q5.setConstraints(ChoicePanel5, cQ5);
Question5.add(ChoicePanel5);

GridBagLayout gridBag_Q6 = new GridBagLayout();
Question6.setLayout(gridBag_Q6);
GridBagConstraints cQ6 = new GridBagConstraints();
cQ6.gridwidth = GridBagConstraints.REMAINDER;
cQ6.fill = GridBagConstraints.HORIZONTAL;
gridBag_Q6.setConstraints(TextPanel6, cQ6);
Question6.add(TextPanel6);

cQ6.fill = GridBagConstraints.VERTICAL;
cQ6.weightx = 1.0;
 cQ6.weighty = 1.0;
gridBag_Q6.setConstraints(ChoicePanel6, cQ6);
Question6.add(ChoicePanel6);

GridBagLayout gridBag_Q7 = new GridBagLayout();
Question7.setLayout(gridBag_Q7);
GridBagConstraints cQ7 = new GridBagConstraints();
cQ7.gridwidth = GridBagConstraints.REMAINDER;
cQ7.fill = GridBagConstraints.HORIZONTAL;
gridBag_Q7.setConstraints(TextPanel7, cQ7);
Question7.add(TextPanel7);

cQ7.fill = GridBagConstraints.VERTICAL;
cQ7.weightx = 1.0;
 cQ7.weighty = 1.0;
gridBag_Q7.setConstraints(ChoicePanel7, cQ7);
Question7.add(ChoicePanel7);

GridBagLayout gridBag_Q8 = new GridBagLayout();
Question8.setLayout(gridBag_Q8);
GridBagConstraints cQ8 = new GridBagConstraints();
cQ8.gridwidth = GridBagConstraints.REMAINDER;
cQ8.fill = GridBagConstraints.HORIZONTAL;
gridBag_Q8.setConstraints(TextPanel8, cQ8);
Question8.add(TextPanel8);

cQ8.fill = GridBagConstraints.VERTICAL;
cQ8.weightx = 1.0;
 cQ8.weighty = 1.0;
gridBag_Q8.setConstraints(ChoicePanel8, cQ8);
```

```
                Question8.add(ChoicePanel8);

                GridBagLayout gridBag_Q9 = new GridBagLayout();
                Question9.setLayout(gridBag_Q9);
                GridBagConstraints cQ9 = new GridBagConstraints();
                cQ9.gridwidth = GridBagConstraints.REMAINDER;
                cQ9.fill = GridBagConstraints.HORIZONTAL;
                gridBag_Q9.setConstraints(TextPanel9, cQ9);
                Question9.add(TextPanel9);

                cQ9.fill = GridBagConstraints.VERTICAL;
                cQ9.weightx = 1.0;
                 cQ9.weighty = 1.0;
                gridBag_Q9.setConstraints(ChoicePanel9, cQ9);
                Question9.add(ChoicePanel9);

                GridBagLayout gridBag_Q10 = new GridBagLayout();
                Question10.setLayout(gridBag_Q10);
                GridBagConstraints cQ10 = new GridBagConstraints();
                cQ10.gridwidth = GridBagConstraints.REMAINDER;
                cQ10.fill = GridBagConstraints.HORIZONTAL;
                gridBag_Q10.setConstraints(TextPanel10, cQ10);
                Question10.add(TextPanel10);

                cQ10.fill = GridBagConstraints.VERTICAL;
                cQ10.weightx = 1.0;
                 cQ10.weighty = 1.0;
                gridBag_Q10.setConstraints(ChoicePanel10, cQ10);
                Question10.add(ChoicePanel10);

//Specifying the UserDetailsPanel

                UserDetailsPanel.setLayout(new FlowLayout());
                Label user = new Label("UserName");
                user.setForeground(Color.blue);
                user.setFont(new Font("Courier",Font.BOLD+Font.ITALIC, 12));
                UserDetailsPanel.add(user);
                UserDetailsPanel.add(idChoice);
                Label SocSec = new Label("SS #");
                SocSec.setForeground(Color.blue);
                SocSec.setFont(new Font("Courier",Font.BOLD+Font.ITALIC, 12));
                UserDetailsPanel.add(SocSec);
                UserDetailsPanel.add(SSNo);

//Specifying the MainControlsPanel

                MainControlsPanel.setLayout(new FlowLayout());
                MainControlsPanel.add(startButton);
                MainControlsPanel.add(firstButton);
                MainControlsPanel.add(nextButton);
                MainControlsPanel.add(prevButton);
                MainControlsPanel.add(lastButton);
                MainControlsPanel.add(finishButton);
                MainControlsPanel.add(answerButton);
                MainControlsPanel.add(resultButton);
                finishButton.disable();
                answerButton.disable();
                startButton.disable();
                prevButton.disable();
                nextButton.disable();
                firstButton.disable();
                lastButton.disable();
                resultButton.disable();

//Specifying the TextPanel
                GridBagLayout gridBag_Text1 = new GridBagLayout();
                TextPanel1.setLayout(gridBag_Text1);
                GridBagConstraints c1 = new GridBagConstraints();
                c1.gridwidth = GridBagConstraints.REMAINDER;
                c1.fill = GridBagConstraints.HORIZONTAL;
                Label Q1 = new Label("Question 1.", Label.CENTER);
```

```
                Q1.setForeground(Color.blue);
                Q1.setBackground(Color.white);
                Q1.setFont(new Font("Courier",Font.BOLD+Font.ITALIC, 12));
                gridBag_Text1.setConstraints(Q1, c1);
                TextPanel1.add(Q1);
                c1.fill = GridBagConstraints.VERTICAL;
                c1.weightx = 1.0;
                 c1.weighty = 1.0;
                gridBag_Text1.setConstraints(QuestionText1, c1);
                TextPanel1.add(QuestionText1);

//Specifying the ChoicePanel

                ChoicePanel1.setLayout(new FlowLayout());
                ChoicePanel1.add(new Checkbox("A", ABCD1, false));
                ChoicePanel1.add(new Checkbox("B", ABCD1, false));
                ChoicePanel1.add(new Checkbox("C", ABCD1, false));
                ChoicePanel1.add(new Checkbox("D", ABCD1, false));

//Specifying the TextPanel

                GridBagLayout gridBag_Text2 = new GridBagLayout();
                TextPanel2.setLayout(gridBag_Text2);
                GridBagConstraints c2 = new GridBagConstraints();
                c2.gridwidth = GridBagConstraints.REMAINDER;
                c2.fill = GridBagConstraints.HORIZONTAL;
                Label Q2 = new Label("Question 2.", Label.CENTER);
                Q2.setForeground(Color.blue);
                Q2.setBackground(Color.white);
                Q2.setFont(new Font("Courier",Font.BOLD+Font.ITALIC, 12));
                gridBag_Text2.setConstraints(Q2, c2);
                TextPanel2.add(Q2);
                c2.fill = GridBagConstraints.VERTICAL;
                c2.weightx = 1.0;
                 c2.weighty = 1.0;
                gridBag_Text2.setConstraints(QuestionText2, c2);
                TextPanel2.add(QuestionText2);

//Specifying the ChoicePanel

                ChoicePanel2.setLayout(new FlowLayout());
                ChoicePanel2.add(new Checkbox("A", ABCD2, false));
                ChoicePanel2.add(new Checkbox("B", ABCD2, false));
                ChoicePanel2.add(new Checkbox("C", ABCD2, false));
                ChoicePanel2.add(new Checkbox("D", ABCD2, false));

//Specifying the TextPanel
                GridBagLayout gridBag_Text3 = new GridBagLayout();
                TextPanel3.setLayout(gridBag_Text3);
                GridBagConstraints c3 = new GridBagConstraints();
                c3.gridwidth = GridBagConstraints.REMAINDER;
                c3.fill = GridBagConstraints.HORIZONTAL;
                Label Q3 = new Label("Question 3.", Label.CENTER);
                Q3.setForeground(Color.blue);
                Q3.setBackground(Color.white);
                Q3.setFont(new Font("Courier",Font.BOLD+Font.ITALIC, 12));
                gridBag_Text3.setConstraints(Q3, c3);
                TextPanel3.add(Q3);
                c3.fill = GridBagConstraints.VERTICAL;
                c3.weightx = 1.0;
                 c3.weighty = 1.0;
                gridBag_Text3.setConstraints(QuestionText3, c3);
                TextPanel3.add(QuestionText3);

//Specifying the ChoicePanel

                ChoicePanel3.setLayout(new FlowLayout());
                ChoicePanel3.add(new Checkbox("A", ABCD3, false));
                ChoicePanel3.add(new Checkbox("B", ABCD3, false));
                ChoicePanel3.add(new Checkbox("C", ABCD3, false));
                ChoicePanel3.add(new Checkbox("D", ABCD3, false));
```

```
//Specifying the TextPanel
                GridBagLayout gridBag_Text4 = new GridBagLayout();
                TextPanel4.setLayout(gridBag_Text4);
                GridBagConstraints c4 = new GridBagConstraints();
                c4.gridwidth = GridBagConstraints.REMAINDER;
                c4.fill = GridBagConstraints.HORIZONTAL;
                Label Q4 = new Label("Question 4.", Label.CENTER);
                Q4.setForeground(Color.blue);
                Q4.setBackground(Color.white);
                Q4.setFont(new Font("Courier",Font.BOLD+Font.ITALIC, 12));
                gridBag_Text4.setConstraints(Q4, c4);
                TextPanel4.add(Q4);
                c4.fill = GridBagConstraints.VERTICAL;
                c4.weightx = 1.0;
                 c4.weighty = 1.0;
                gridBag_Text4.setConstraints(QuestionText4, c4);
                TextPanel4.add(QuestionText4);

//Specifying the ChoicePanel

                ChoicePanel4.setLayout(new FlowLayout());
                ChoicePanel4.add(new Checkbox("A", ABCD4, false));
                ChoicePanel4.add(new Checkbox("B", ABCD4, false));
                ChoicePanel4.add(new Checkbox("C", ABCD4, false));
                ChoicePanel4.add(new Checkbox("D", ABCD4, false));

//Specifying the TextPanel
                GridBagLayout gridBag_Text5 = new GridBagLayout();
                TextPanel5.setLayout(gridBag_Text5);
                GridBagConstraints c5 = new GridBagConstraints();
                c5.gridwidth = GridBagConstraints.REMAINDER;
                c5.fill = GridBagConstraints.HORIZONTAL;
                Label Q5 = new Label("Question 5.", Label.CENTER);
                Q5.setForeground(Color.blue);
                Q5.setBackground(Color.white);
                Q5.setFont(new Font("Courier",Font.BOLD+Font.ITALIC, 12));
                gridBag_Text5.setConstraints(Q5, c5);
                TextPanel5.add(Q5);
                c5.fill = GridBagConstraints.VERTICAL;
                c5.weightx = 1.0;
                 c5.weighty = 1.0;
                gridBag_Text5.setConstraints(QuestionText5, c5);
                TextPanel5.add(QuestionText5);

//Specifying the ChoicePanel

                ChoicePanel5.setLayout(new FlowLayout());
                ChoicePanel5.add(new Checkbox("A", ABCD5, false));
                ChoicePanel5.add(new Checkbox("B", ABCD5, false));
                ChoicePanel5.add(new Checkbox("C", ABCD5, false));
                ChoicePanel5.add(new Checkbox("D", ABCD5, false));

//Specifying the TextPanel
                GridBagLayout gridBag_Text6 = new GridBagLayout();
                TextPanel6.setLayout(gridBag_Text6);
                GridBagConstraints c6 = new GridBagConstraints();
                c6.gridwidth = GridBagConstraints.REMAINDER;
                c6.fill = GridBagConstraints.HORIZONTAL;
                Label Q6 = new Label("Question 6.", Label.CENTER);
                Q6.setForeground(Color.blue);
                Q6.setBackground(Color.white);
                Q6.setFont(new Font("Courier",Font.BOLD+Font.ITALIC, 12));
                gridBag_Text6.setConstraints(Q6, c6);
                TextPanel6.add(Q6);
                c6.fill = GridBagConstraints.VERTICAL;
                c6.weightx = 1.0;
                 c6.weighty = 1.0;
                gridBag_Text6.setConstraints(QuestionText6, c6);
                TextPanel6.add(QuestionText6);
```

```
//Specifying the ChoicePanel

                ChoicePanel6.setLayout(new FlowLayout());
                ChoicePanel6.add(new Checkbox("A", ABCD6, false));
                ChoicePanel6.add(new Checkbox("B", ABCD6, false));
                ChoicePanel6.add(new Checkbox("C", ABCD6, false));
                ChoicePanel6.add(new Checkbox("D", ABCD6, false));

//Specifying the TextPanel
                GridBagLayout gridBag_Text7 = new GridBagLayout();
                TextPanel7.setLayout(gridBag_Text7);
                GridBagConstraints c7 = new GridBagConstraints();
                c7.gridwidth = GridBagConstraints.REMAINDER;
                c7.fill = GridBagConstraints.HORIZONTAL;
                Label Q7 = new Label("Question 7.", Label.CENTER);
                Q7.setForeground(Color.blue);
                Q7.setBackground(Color.white);
                Q7.setFont(new Font("Courier",Font.BOLD+Font.ITALIC, 12));
                gridBag_Text7.setConstraints(Q7, c7);
                TextPanel7.add(Q7);
                c7.fill = GridBagConstraints.VERTICAL;
                c7.weightx = 1.0;
                 c7.weighty = 1.0;
                gridBag_Text7.setConstraints(QuestionText7, c7);
                TextPanel7.add(QuestionText7);

//Specifying the ChoicePanel

                ChoicePanel7.setLayout(new FlowLayout());
                ChoicePanel7.add(new Checkbox("A", ABCD7, false));
                ChoicePanel7.add(new Checkbox("B", ABCD7, false));
                ChoicePanel7.add(new Checkbox("C", ABCD7, false));
                ChoicePanel7.add(new Checkbox("D", ABCD7, false));

//Specifying the TextPanel
                GridBagLayout gridBag_Text8 = new GridBagLayout();
                TextPanel8.setLayout(gridBag_Text8);
                GridBagConstraints c8 = new GridBagConstraints();
                c8.gridwidth = GridBagConstraints.REMAINDER;
                c8.fill = GridBagConstraints.HORIZONTAL;
                Label Q8 = new Label("Question 8.", Label.CENTER);
                Q8.setForeground(Color.blue);
                Q8.setBackground(Color.white);
                Q8.setFont(new Font("Courier",Font.BOLD+Font.ITALIC, 12));
                gridBag_Text8.setConstraints(Q8, c8);
                TextPanel8.add(Q8);
                c8.fill = GridBagConstraints.VERTICAL;
                c8.weightx = 1.0;
                 c8.weighty = 1.0;
                gridBag_Text8.setConstraints(QuestionText8, c8);
                TextPanel8.add(QuestionText8);


//Specifying the ChoicePanel

                ChoicePanel8.setLayout(new FlowLayout());
                ChoicePanel8.add(new Checkbox("A", ABCD8, false));
                ChoicePanel8.add(new Checkbox("B", ABCD8, false));
                ChoicePanel8.add(new Checkbox("C", ABCD8, false));
                ChoicePanel8.add(new Checkbox("D", ABCD8, false));

//Specifying the TextPanel
                GridBagLayout gridBag_Text9 = new GridBagLayout();
                TextPanel9.setLayout(gridBag_Text9);
                GridBagConstraints c9 = new GridBagConstraints();
                c9.gridwidth = GridBagConstraints.REMAINDER;
                c9.fill = GridBagConstraints.HORIZONTAL;
                Label Q9 = new Label("Question 9.", Label.CENTER);
                Q9.setForeground(Color.blue);
                Q9.setBackground(Color.white);
                Q9.setFont(new Font("Courier",Font.BOLD+Font.ITALIC, 12));
```

```
                gridBag_Text9.setConstraints(Q9, c9);
                TextPanel9.add(Q9);
                c9.fill = GridBagConstraints.VERTICAL;
                c9.weightx = 1.0;
                 c9.weighty = 1.0;
                gridBag_Text9.setConstraints(QuestionText9, c9);
                TextPanel9.add(QuestionText9);

//Specifying the ChoicePanel

                ChoicePanel9.setLayout(new FlowLayout());
                ChoicePanel9.add(new Checkbox("A", ABCD9, false));
                ChoicePanel9.add(new Checkbox("B", ABCD9, false));
                ChoicePanel9.add(new Checkbox("C", ABCD9, false));
                ChoicePanel9.add(new Checkbox("D", ABCD9, false));

//Specifying the TextPanel
                GridBagLayout gridBag_Text10 = new GridBagLayout();
                TextPanel10.setLayout(gridBag_Text10);
                GridBagConstraints c10 = new GridBagConstraints();
                c10.gridwidth = GridBagConstraints.REMAINDER;
                c10.fill = GridBagConstraints.HORIZONTAL;
                Label Q10 = new Label("Question 10.", Label.CENTER);
                Q10.setForeground(Color.blue);
                Q10.setBackground(Color.white);
                Q10.setFont(new Font("Courier",Font.BOLD+Font.ITALIC, 12));
                gridBag_Text10.setConstraints(Q10, c10);
                TextPanel10.add(Q10);
                c10.fill = GridBagConstraints.VERTICAL;
                c10.weightx = 1.0;
                 c10.weighty = 1.0;
                gridBag_Text10.setConstraints(QuestionText10, c10);
                TextPanel10.add(QuestionText10);

//Specifying the ChoicePanel

                ChoicePanel10.setLayout(new FlowLayout());
                ChoicePanel10.add(new Checkbox("A", ABCD10, false));
                ChoicePanel10.add(new Checkbox("B", ABCD10, false));
                ChoicePanel10.add(new Checkbox("C", ABCD10, false));
                ChoicePanel10.add(new Checkbox("D", ABCD10, false));



//Specifying the StatusPanel

                GridBagLayout gridBag_Status = new GridBagLayout();
                StatusPanel.setLayout(gridBag_Status);
                GridBagConstraints cs = new GridBagConstraints();
                cs.gridwidth = GridBagConstraints.REMAINDER;
                cs.fill = GridBagConstraints.HORIZONTAL;
                Label Status_Label = new Label("Help/Status Display", Label.CENTER);
                Status_Label.setForeground(Color.blue);
                Status_Label.setBackground(Color.white);
                Status_Label.setFont(new Font("Courier",Font.BOLD+Font.ITALIC, 12));
                gridBag_Status.setConstraints(Status_Label, cs);
                StatusPanel.add(Status_Label);
                cs.fill = GridBagConstraints.VERTICAL;
                cs.weightx = 1.0;
                 cs.weighty = 1.0;
                gridBag_Status.setConstraints(Status, cs);
                StatusPanel.add(Status);


// The Question CardPanel is the Panel on which the questions are loaded

                Qcards = new Panel();
                Qcards.setLayout(new CardLayout());
                Qcards.add(QUESTION1, Question1);
                Qcards.add(QUESTION2, Question2);
                Qcards.add(QUESTION3, Question3);
```

```
                Qcards.add(QUESTION4, Question4);
                Qcards.add(QUESTION5, Question5);
                Qcards.add(QUESTION6, Question6);
                Qcards.add(QUESTION7, Question7);
                Qcards.add(QUESTION8, Question8);
                Qcards.add(QUESTION9, Question9);
                Qcards.add(QUESTION10, Question10);
//Set the Layout for the main applet

                panel1 = new Panel();

                GridBagLayout gridBag_panel1 = new GridBagLayout();
                panel1.setLayout(gridBag_panel1);
                GridBagConstraints cpanel1 = new GridBagConstraints();
                cpanel1.gridwidth = GridBagConstraints.REMAINDER;
                cpanel1.fill = GridBagConstraints.HORIZONTAL;

                gridBag_panel1.setConstraints(UserDetailsPanel, cpanel1);
                panel1.add(UserDetailsPanel);
                cpanel1.fill = GridBagConstraints.VERTICAL;
                cpanel1.weightx = 1.0;
                 cpanel1.weighty = 1.0;
                gridBag_panel1.setConstraints(MainControlsPanel, cpanel1);
                panel1.add(MainControlsPanel);



                setLayout(new FlowLayout());
                add(panel1);
                add(Qcards);
                add(StatusPanel);


        }

        public boolean action(Event evt, Object arg){

                int fileno;

                if(evt.target instanceof TextField ){
                        SSCheck(idChoice.getSelectedItem());
                        return true;
                }
                if(evt.target instanceof List){
                        if((idChoice.getSelectedItem()).equals("Guest"))
                                {       SSNo.setText("000-00-0000");
                                        startButton.enable();
                                        SSCheck(idChoice.getSelectedItem());
                                }
                        return true;
                }
                if(evt.target instanceof Button){
                        if((String) arg == "Start" && abort != true){
                                fileno = getRandom(0,9,0);
                                correct_answer1 = getQuestion("q"+fileno, QuestionText1);
                                fileno = getRandom(10,19,10);
                                correct_answer2 = getQuestion("q"+fileno, QuestionText2);
                                fileno = getRandom(20,29,20);
                                correct_answer3 = getQuestion("q"+fileno, QuestionText3);
                                fileno = getRandom(30,39,30);
                                correct_answer4 = getQuestion("q"+fileno, QuestionText4);
                                fileno = getRandom(40,49,40);
                                correct_answer5 = getQuestion("q"+fileno, QuestionText5);
                                fileno = getRandom(50,59,50);
                                correct_answer6 = getQuestion("q"+fileno, QuestionText6);
                                fileno = getRandom(60,69,60);
                                correct_answer7 = getQuestion("q"+fileno, QuestionText7);
                                fileno = getRandom(70,79,70);
                                correct_answer8 = getQuestion("q"+fileno, QuestionText8);
                                fileno = getRandom(80,89,80);
                                correct_answer9 = getQuestion("q"+fileno, QuestionText9);
```

```
                                fileno = getRandom(90,99,90);
                                correct_answer10 = getQuestion("q"+fileno, QuestionText10);

                                Status.setText("Click on the Choice you think is correct\nTo
goto the next question press Next\nTo return to the earlier question press Previous\nWhen
you have finished the quiz press Finish");
                                ((CardLayout)Qcards.getLayout()).first(Qcards);

                                finishButton.enable();
                                nextButton.enable();
                                prevButton.enable();
                                firstButton.enable();
                                lastButton.enable();
                                startButton.disable();
                                return true;
                        }
                        if((String) arg == "Start" && abort == true){
                                Status.setText(Status.getText() + "\nYou cannot give the
quiz until\nyou have entered a valid SS#");
                                return true;
                        }
                        if((String) arg == "Finish"){
                                Score();
                                return true;
                        }
                        if((String) arg == "Answers"){
                                Answer();
                                return true;
                        }
                        if((String) arg == "Next"){
                                ((CardLayout)Qcards.getLayout()).next(Qcards);

                                return true;
                        }
                        if((String) arg == "Previous"){
                                ((CardLayout)Qcards.getLayout()).previous(Qcards);
                                return true;
                        }
                        if((String) arg == "Last"){
                                ((CardLayout)Qcards.getLayout()).last(Qcards);
                                return true;
                        }
                        if((String) arg == "First"){
                                ((CardLayout)Qcards.getLayout()).first(Qcards);

                                return true;
                        }
                        if((String) arg == "Results"){
                                remove(Qcards);
                                finishButton.disable();
                                nextButton.disable();
                                prevButton.disable();
                                firstButton.disable();
                                lastButton.disable();
                                startButton.disable();
                                answerButton.disable();
                                remove(StatusPanel);
                                remove(panel1);
                                int numberofColumns = NumberofStudRead();
                                String urlloc = getParameter("url_address");
                                Chart resultGraph = new Chart(this, correct_num,
numberofColumns, 825, 300, urlloc);

                                add(resultGraph);


                                return true;
                        }
                return true;
                }
        return true;
```

```
        }

// This method checks the SS numbers from the Database

        public void SSCheck(String username){
                        SS =  SSNo.getText();
                        int listPosition = idChoice.getSelectedIndex();
                        if(SS.equals(SocSec[listPosition])){
                                                abort = false;
                                                name = username;
                                                startButton.enable();
                                                Status.setText("Please press Start to
Continue");
                                        }
                                        else{
                                                Status.setText("You have entered an
incorrect/invalid SS Number. \nPlease retype and press Enter");
                                                abort = true;
                                        }


        }


// This method loads the question from the server

        public char getQuestion(String file_name, TextArea QuestionText){
                InputStream conn;
                DataInputStream data;
                String line;
                StringBuffer buf = new StringBuffer();
                String Raw_Question;
                String Finished_Question;
                char correct_answer = ' ';

//The URL must be the site from where this applet is loaded!!

                String fname =  file_name + ".txt";

                try{this.theURL = new URL(getDocumentBase(), fname);}
                catch( MalformedURLException e){
                        Status.setText(Status.getText() + "\nBad URL: " + theURL);
                }
                try{

                        conn = theURL.openStream();
                        data = new DataInputStream(new BufferedInputStream(conn));
                        while ((line = data.readLine())!= null){
                                buf.append(line + "\n");
                        }
                        Raw_Question = buf.toString();
                        correct_answer = Raw_Question.charAt(0);
                        Finished_Question = Raw_Question.substring(1,Raw_Question.length()-
1);
                        QuestionText.setText(Finished_Question);
                        if(correct_answer == '.') { correct_answer = 'A';}
                        if(correct_answer == '$') { correct_answer = 'B';}
                        if(correct_answer == '?') { correct_answer = 'C';}
                        if(correct_answer == '!') { correct_answer = 'D';}


                }
                catch(IOException e){
                        Status.setText(Status.getText() + "\nServer not Responding!!");
                }
                return correct_answer;
        }

//This method scores the students exam
```

```
	public void Score(){

		String unanswered = " ";

//This variable keeps track of whether the question has been attempted or not

		boolean attempt1 = false;
		boolean attempt2 = false;
		boolean attempt3 = false;
		boolean attempt4 = false;
		boolean attempt5 = false;
		boolean attempt6 = false;
		boolean attempt7 = false;
		boolean attempt8 = false;
		boolean attempt9 = false;
		boolean attempt10 = false;

		correct_num = 0;

		if(ABCD1.getCurrent() == null){
			unanswered = " 1,";
			attempt1 = false;

		}
		else{
			answer1 = ((ABCD1.getCurrent()).getLabel()).charAt(0);
			attempt1 = true;
			if(answer1 == correct_answer1){
				correct_num++;


			}
		}
		if(ABCD2.getCurrent() == null){
			unanswered += " 2,";
			attempt2 = false;

		}
		else{
			answer2 = ((ABCD2.getCurrent()).getLabel()).charAt(0);
			attempt2 = true;
			if(answer2 == correct_answer2){
				correct_num++;


			}
		}

		if(ABCD3.getCurrent() == null){
			unanswered += " 3,";
			attempt3 = false;

		}
		else{
			answer3 = ((ABCD3.getCurrent()).getLabel()).charAt(0);
			attempt3 = true;
			if(answer3 == correct_answer3){
				correct_num++;


			}
		}
		if(ABCD4.getCurrent() == null){
			unanswered += " 4,";
			attempt4 = false;

		}
		else{
			answer4 = ((ABCD4.getCurrent()).getLabel()).charAt(0);
```

```
        attempt4 = true;
        if(answer4 == correct_answer4){
                correct_num++;


        }
}
if(ABCD5.getCurrent() == null){
         unanswered += " 5,";
         attempt5 = false;

}
else{
        answer5 = ((ABCD5.getCurrent()).getLabel()).charAt(0);
        attempt5 = true;
        if(answer5 == correct_answer5){
                correct_num++;


        }
}
if(ABCD6.getCurrent() == null){
         unanswered += " 6,";
         attempt6 = false;
}
else{
        answer6 = ((ABCD6.getCurrent()).getLabel()).charAt(0);
        attempt6 = true;
        if(answer6 == correct_answer6){
                correct_num++;


        }
}
if(ABCD7.getCurrent() == null){
         unanswered += " 7,";
         attempt7 = false;
}
else{
        answer7 = ((ABCD7.getCurrent()).getLabel()).charAt(0);
        attempt7 = true;
        if(answer7 == correct_answer7){
                correct_num++;


        }
}
if(ABCD8.getCurrent() == null){
         unanswered += " 8,";
         attempt8 = false;
}
else{
        answer8 = ((ABCD8.getCurrent()).getLabel()).charAt(0);
        attempt8 = true;
        if(answer8 == correct_answer8){
                correct_num++;


        }
}
if(ABCD9.getCurrent() == null){
         unanswered += " 9,";
         attempt9 = false;
}
else{
        answer9 = ((ABCD9.getCurrent()).getLabel()).charAt(0);
        attempt9 = true;
        if(answer9 == correct_answer9){
                correct_num++;
```

```
                }
            }
            if(ABCD10.getCurrent() == null){
                unanswered += " 10,";
                attempt10 = false;
            }
            else{
                answer10 = ((ABCD10.getCurrent()).getLabel()).charAt(0);
                attempt10 = true;
                if(answer10 == correct_answer10){
                    correct_num++;


                }
            }

            if(attempt1 == false || attempt2 == false || attempt3 == false|| attempt4
== false|| attempt5 == false|| attempt6 == false|| attempt7 == false|| attempt8 == false
|| attempt9 == false || attempt10 == false){
                Status.setText("You have not answered question no." + unanswered+
"\nPlease answer them.");
            }
            else{
                Status.setText("You have correctly answered " + correct_num + "
questions out of 10 ");
                getAppletContext().showStatus("Author Anirban Bhaumik 1997");
                sendData();
                finished = true;
                answerButton.enable();
                finishButton.disable();
                Status.setText(Status.getText() + "\nYou may view the Answers
by\npressing the Answers button");
            }


    }


    public void sendData(){
        int portno = 4321;
        String machine = "bengu-pc2.njit.edu";
        portno = Integer.parseInt(getParameter("port_number"));
        machine = getParameter("machine_name");
        new Client(SS, correct_num, portno, machine);
        Status.setText(Status.getText() + "\nSending Data to Server");
        resultButton.enable();
    }

    public int getRandom(int ll, int ul, int factor)
    {
        int trial_num;
        Random r = new Random();

        do{
            trial_num = Math.round((r.nextFloat())*10);
            trial_num = trial_num + factor;

            }while(!((trial_num <= ul)&&(trial_num >= ll)));
        return trial_num;
    }

    public void Answer(){

        if(finished == true){
            QuestionText1.setText(QuestionText1.getText() + "\n\nThe correct
answer was " + correct_answer1 + " You answered " + answer1);
            QuestionText2.setText(QuestionText2.getText() +"\n\nThe correct
answer was " + correct_answer2 + " You answered " + answer2);
            QuestionText3.setText(QuestionText3.getText() + "\n\nThe correct
answer was " + correct_answer3 + " You answered " + answer3);
```

```
                        QuestionText4.setText(QuestionText4.getText() + "\n\nThe correct
answer was " + correct_answer4 + " You answered " + answer4);
                        QuestionText5.setText(QuestionText5.getText() + "\n\nThe correct
answer was " + correct_answer5 + " You answered " + answer5);
                        QuestionText6.setText(QuestionText6.getText() + "\n\nThe correct
answer was " + correct_answer6 + " You answered " + answer6);
                        QuestionText7.setText(QuestionText7.getText() + "\n\nThe correct
answer was " + correct_answer7 + " You answered " + answer7);
                        QuestionText8.setText(QuestionText8.getText() + "\n\nThe correct
answer was " + correct_answer8 + " You answered " + answer8);
                        QuestionText9.setText(QuestionText9.getText() + "\n\nThe correct
answer was " + correct_answer9 + " You answered " + answer9);
                        QuestionText10.setText(QuestionText10.getText() + "\n\nThe correct
answer was " + correct_answer10 + " You answered " + answer10);

                }
                else{
                        Status.setText("Your data has not been sent to the Server, Please
contact the TA");
                }
        }

        public int NumberofStudRead(){

        int studnumber = 0;
        String isnumstud;

        try {
                        InputStream rdnumberofstud = new URL(getDocumentBase(),
"Data").openStream();


                try{

                        DataInputStream disnumstud = new DataInputStream(rdnumberofstud);
                        isnumstud = disnumstud.readLine();
                        while (isnumstud != null) {
                                StringTokenizer stnumstud = new StringTokenizer(isnumstud);
                                while (stnumstud.hasMoreTokens()) {

                                        studnumber =
Integer.parseInt(stnumstud.nextToken());

                                }

                                isnumstud = disnumstud.readLine();
                        }
                } catch (Exception e) {}


         } catch (Exception e) { }

        return studnumber;

        }


}


class Client
{
        int SERVER_PORT=4321;
        InputStream input = null;
        PrintStream output = null;
        public Client(String SS, int correct_num, int port_num, String IPNAME)
        {
                byte bytes[] = new byte[4096];
                Socket server = null;
               SERVER_PORT = port_num;
                int c;
```

```
                try
                {       //The name of the server goes here!!
                        server = new Socket(IPNAME, SERVER_PORT);

                        input = server.getInputStream();
                        output = new PrintStream(server.getOutputStream());

                       output.println( SS +" " + correct_num);

                        int nbytes;
                        byte b[] = new byte[1024];
          while((nbytes = input.read(b,0,1024))!= -1)
          {
             String str = new String(b,0,0,nbytes);

          }
                }
                catch(Exception exception)
                {

                        try
                        {
                                server.close();

                        }
                        catch(Exception e)
                        {


                        }

                }
          }


}


class Chart extends Canvas{
    static final int   VERTICAL = 0;
    static final int   HORIZONTAL = 1;

    static final int   SOLID = 0;
    static final int   STRIPED = 1;

    int                orientation;
    String             title;
    Font               titleFont;
    FontMetrics                titleFontMetrics;
    int                titleHeight = 15;
    int                columns;
    int                values[];
    Object             colors[];
    Object             labels[];
    Object             SSNo[];
    int                styles[];
    int                scale = 20;
    int                maxLabelWidth = 0;
    int                barWidth;
    int                barSpacing = 10;
    int                max = 0;

    int w,h;
    Container pappy;
    Dimension minSize;

    public Chart(Container parent, int UserScore, int NumberofBars, int initialWidth, int
initialHeight, String url_name) {
```

```
        parent = pappy;
        w = initialWidth;
        h = initialHeight;
        minSize = new Dimension(w,h);



        titleFont = new java.awt.Font("Courier", Font.BOLD, 14);
        titleFontMetrics = getFontMetrics(titleFont);
        title = "Position in Class";

        columns = NumberofBars;
        orientation = VERTICAL;

        values = new int[columns];
        colors = new Color[columns];
        labels = new String[columns];
        SSNo = new String[columns];
        styles = new int[columns];
        InputStream rdstuddata = null;


        int studnumber = 0;
        String isstuddata = null;

        try {
                        rdstuddata = new URL(url_name).openStream();


                try{

                        DataInputStream disstuddata = new DataInputStream(rdstuddata);
                        isstuddata = disstuddata.readLine();
                        while (isstuddata != null) {
                                StringTokenizer ststuddata = new
StringTokenizer(isstuddata);
                                while (ststuddata.hasMoreTokens()) {
                                        SSNo[studnumber] = ststuddata.nextToken();
                                        values[studnumber] =
Integer.parseInt(ststuddata.nextToken());
                                        if (values[studnumber] > max) {
                                                max = values[studnumber];
                                           }
//If you want the students to see the SS numbers of everybody then uncomment the next
statement and comment the one after that
                        //              labels[studnumber] = SSNo[studnumber];
                                        labels[studnumber] = " ";
                                        maxLabelWidth =
Math.max(titleFontMetrics.stringWidth((String)(labels[studnumber])),maxLabelWidth);
//If wanted the bars can be SOLID or STRIPED
                                        styles[studnumber] = SOLID;
//The values above User's score are red, the ones that are equal are green and the ones
below are blue

                                        if(values[studnumber]>UserScore) colors[studnumber]
= Color.red;
                                        if(values[studnumber]==UserScore) colors[studnumber]
= Color.green;
                                        if(values[studnumber]<UserScore) colors[studnumber]
= Color.blue;

                                }
                                studnumber++;
                                isstuddata = disstuddata.readLine();
                        }
                } catch (Exception e) {}


        } catch (Exception e) { }
//Making the students score STRIPED (It's the last bar in the chart)
```

```
        styles[columns-1] = STRIPED;

        switch (orientation) {
          case VERTICAL:
          default:
            barWidth = maxLabelWidth;
            resize(Math.max(columns * (barWidth + barSpacing),
                           titleFontMetrics.stringWidth(title)) +
                   titleFont.getSize() + 5,
                   (max * scale) + (2 * titleFont.getSize()) + 5 + titleFont.getSize());
            break;
          case HORIZONTAL:
            barWidth = titleFont.getSize();
            resize(Math.max((max * scale) + titleFontMetrics.stringWidth("" + max),
                           titleFontMetrics.stringWidth(title)) + maxLabelWidth + 5,
                   (columns * (barWidth + barSpacing)) + titleFont.getSize() + 10);
            break;
        }
    }

    public Dimension preferredSize() {
        return minimumSize();
    }

    public synchronized Dimension minimumSize() {
        return minSize;
    }

    public synchronized void paint(Graphics g) {
        int i, j;
        int cx, cy;
        char l[] = new char[1];

        minSize = new Dimension(w,h);
        resize(w, h);


        // draw the title centered at the bottom of the bar graph
        g.setColor(Color.black);
        i = titleFontMetrics.stringWidth(title);
        g.setFont(titleFont);
        g.drawString(title, Math.max((size().width - i)/2, 0),
                     size().height - titleFontMetrics.getDescent());
        for (i=0; i < columns; i++) {
            switch (orientation) {
              case VERTICAL:
              default:
                // set the next X coordinate to account for the label
                // being wider than the bar size().width.
                cx = (Math.max((barWidth + barSpacing),maxLabelWidth) * i) +
                     barSpacing;

                // center the bar chart
                cx += Math.max((size().width - (columns *
                                (barWidth + (2 * barSpacing))))/2,0);

                // set the next Y coordinate to account for the size().height
                // of the bar as well as the title and labels painted
                // at the bottom of the chart.
                cy = size().height - (values[i] * scale) - 1 - (2 * titleFont.getSize());

                // draw the label
                g.setColor(Color.black);
                g.drawString((String)labels[i], cx,
                             size().height - titleFont.getSize() -
titleFontMetrics.getDescent());

                // draw the shadow bar
                if (colors[i] == Color.black) {
                    g.setColor(Color.gray);
```

```
  }
  g.fillRect(cx + 5, cy - 3, barWidth,  (values[i] * scale));
  // draw the bar with the specified color
  g.setColor((Color)(colors[i]));
  switch (styles[i]) {
    case SOLID:
    default:
      g.fillRect(cx, cy, barWidth, (values[i] * scale));
      break;
    case STRIPED:
      {
          int steps = (values[i] * scale) / 2;
          int ys;

          for (j=0; j < steps; j++) {
              ys = cy + (2 * j);
              g.drawLine(cx, ys, cx + barWidth, ys);
          }
      }
      break;
  }
  g.drawString("" + values[i],
               cx,
               cy - titleFontMetrics.getDescent());
  break;
case HORIZONTAL:
  // set the Y coordinate
  cy = ((barWidth + barSpacing) * i) + barSpacing;

  // set the X coordinate to be the size().width of the widest
  // label
  cx = maxLabelWidth + 1;

  cx += Math.max((size().width - (maxLabelWidth + 1 +
                          titleFontMetrics.stringWidth("" +
                                                  max) +
                          (max * scale))) / 2, 0);
  // draw the labels and the shadow
  g.setColor(Color.black);
  g.drawString((String)labels[i], cx - maxLabelWidth - 1,
               cy + titleFontMetrics.getAscent());
  if (colors[i] == Color.black) {
      g.setColor(Color.gray);
  }
  /*g.fillRect(cx + 3,
             cy + 5,
             (values[i] * scale),
             barWidth);*/

  // draw the bar in the current color
  g.setColor((Color)(colors[i]));
  switch (styles[i]) {
    case SOLID:
    default:
      g.fillRect(cx,
                 cy,
                 (values[i] * scale),
                 barWidth);
      break;
    case STRIPED:
      {
          int steps = (values[i] * scale) / 2;
          int ys;

          for (j=0; j < steps; j++) {
              ys = cx + (2 * j);
              g.drawLine(ys, cy, ys, cy + barWidth);
          }
      }
      break;
  }
```

```
                g.drawString("" + values[i],
                             cx + (values[i] * scale) + 3,
                             cy + titleFontMetrics.getAscent());

                break;
            }
        }
    }
}
```

## Section - 2 Quiz Server Program

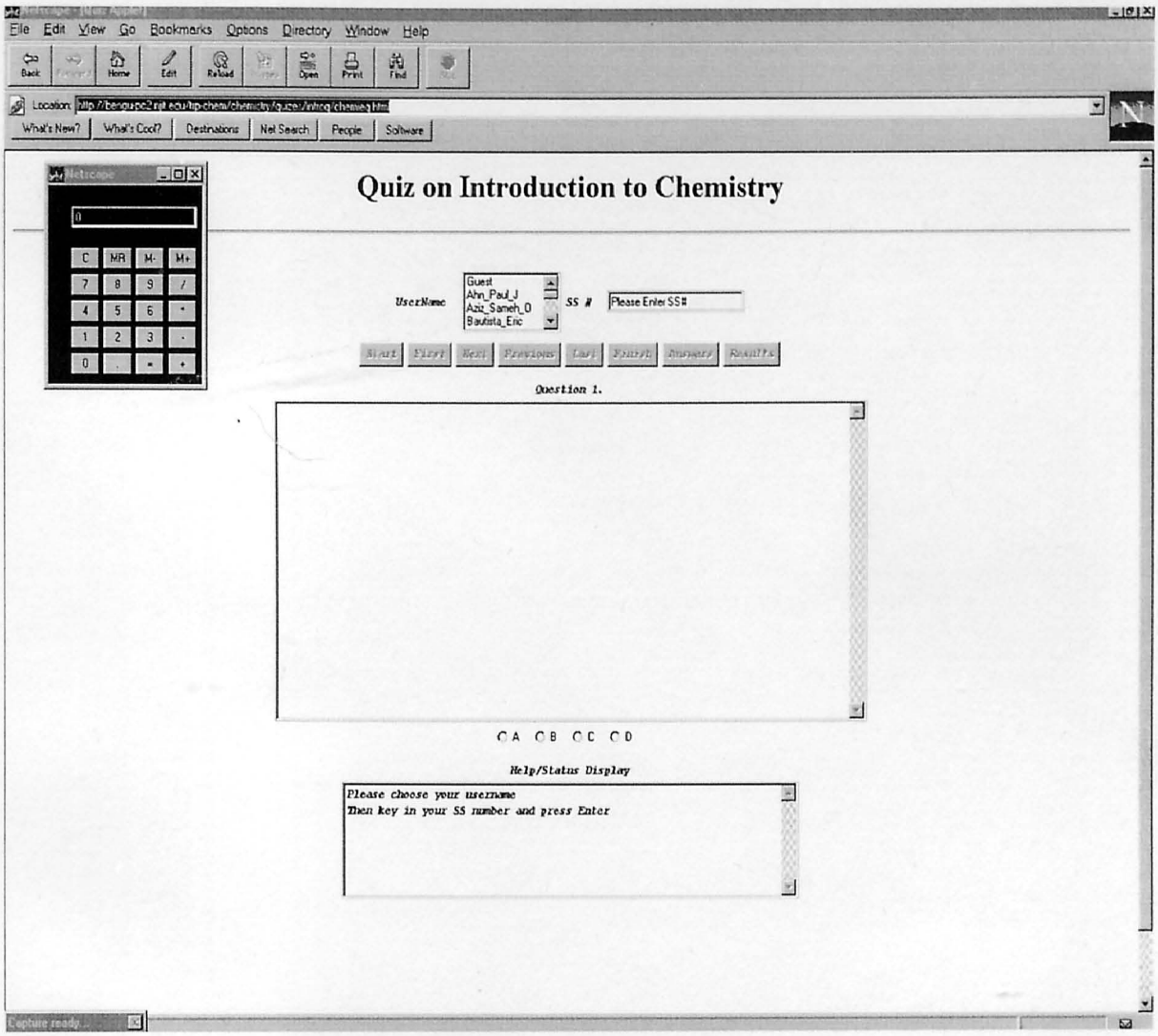
```
// QuizServer Program Author Anirban Bhaumik Started on 18.2.97

import java.net.*;
import java.io.*;
import java.util.*;
import java.lang.*;

class QuizServer
{
        private static final int DEFAULT_PORT=4321;
        private ConnectionManager cm = null;


        public QuizServer(int port)
        {
                System.out.println("Server is initializing to port " + port);

                cm = new ConnectionManager(port);
                cm.start();
        }

        public static void main(String args[])
        {
                int server_port;

                try
                {
                        server_port = Integer.parseInt(args[0],10);
                }
                catch(Exception e)
                {
                        System.out.println("Defaulting to port " + DEFAULT_PORT);
                        server_port = DEFAULT_PORT;
                }
                new QuizServer(server_port);
        }
}

// This guy waits for a connection then spawns a ServerConnection to deal with it
class ConnectionManager extends Thread
{
        private static int _port;
        private static Vector _my_threads = new Vector(5,2); //size of 5 initially, grow
by 2
        private ServerSocket _main_socket = null;


        public ConnectionManager(int port)
        {
                _port                                   = port;
        }

        public void run()
        {
                serveRequests();
        }

        private void serveRequests()
        {

                try {_main_socket = new ServerSocket(_port);}
                catch(Exception e) { System.err.println(e); System.exit(1);}

                ServerConnection temp_sc = null;

                while (true)
                {
```

```
                        try
                        {
                                Socket this_connection = _main_socket.accept();

                                temp_sc = new ServerConnection(this_connection);
                                temp_sc.start();

                                _my_threads.addElement(temp_sc);

                                //clean up the vector if needed
                                for(int i=0;i<ConnectionManager._my_threads.size();i++)

if(!((ServerConnection)(_my_threads.elementAt(i))).isAlive())
                                                _my_threads.removeElementAt(i);
                        }
                        catch(Exception e)
                        {
                                System.err.println("Exception:\n" + e);
                        }
                }
        }
}

class ServerConnection extends Thread
{
        private Socket                  _mysocket;
        private PrintStream     _output;
        private InputStream             _input;



        public ServerConnection(Socket s)
        {
                _mysocket = s;

        }

        private void doServerWork()
        {
               Date today = new Date();
               int numberofstud = 0;

               try
               {
                       File Inputfile = new File("Score.txt");
                       FileInputStream fis = new FileInputStream(Inputfile);
                       int a;
                       byte [] buffer = new byte[fis.available()];
                       while((fis.read(buffer)) !=-1){
                              a = fis.read();
                       }
                       fis.close();
                       File Inputfile3 = new File("Score");
                       FileInputStream fis3 = new FileInputStream(Inputfile3);
                       int a3;
                       byte [] buffer3 = new byte[fis3.available()];
                       while((fis3.read(buffer3)) !=-1){
                              a3 = fis3.read();
                       }
                       fis3.close();
                       File Inputfile2 = new File("Data");
                       FileInputStream fis2 = new FileInputStream(Inputfile2);

                       DataInputStream dis = new DataInputStream(fis2);
                        String is = dis.readLine();

                       while (is != null) {
                             StringTokenizer st = new StringTokenizer(is);
                             while (st.hasMoreTokens()) {
                                      numberofstud = Integer.parseInt(st.nextToken());
                             }
```

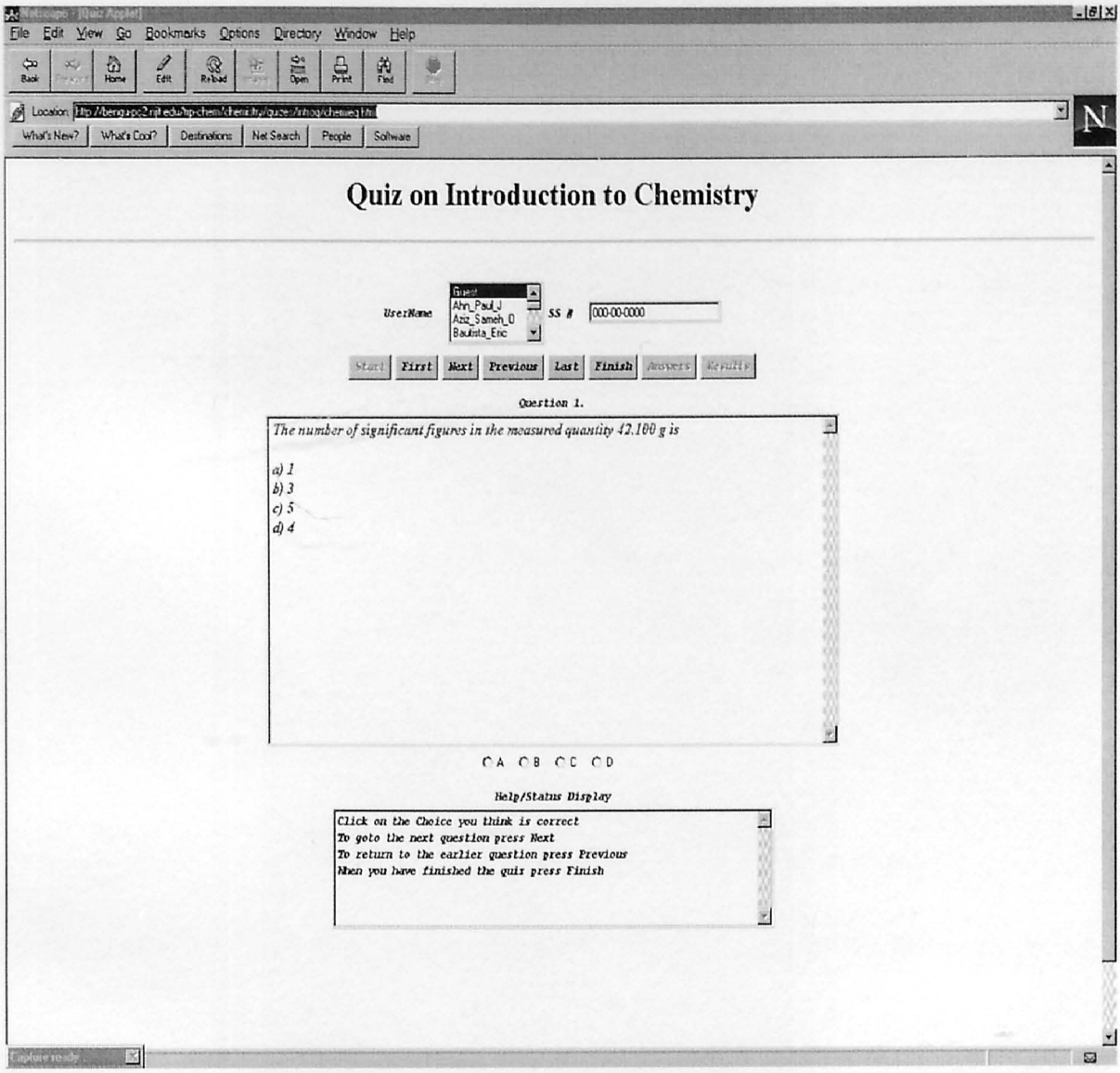
```
                        is = dis.readLine();
                    }

                    fis2.close();
                     try
                            {
                                    File filename  = new File("Score.txt");
                                    PrintStream fos = new PrintStream(new
FileOutputStream(filename));
                                    File filename3 = new File("Score");
                                    PrintStream fos3 = new PrintStream(new
FileOutputStream(filename3));
                                    File filename2 = new File("Data");
                                    PrintStream fos2 = new PrintStream(new
FileOutputStream(filename2));
                                    fos.write(buffer);
                                    fos3.write(buffer3);

                                    int c;
                                    while((c = _input.read()) != 10){
                                            fos.write(c);
                                            fos3.write(c);


                                    }
                                numberofstud = numberofstud + 1;
                                fos2.print(numberofstud);
                                fos.println(" " + today.toString());
                                fos3.println();
                                fos.close();
                                fos2.close();
                                fos3.close();

                                }
                                        catch(IOException e)
                                  {
                                        System.err.println("IOException : " + e);
                                         }
                }
                catch(FileNotFoundException e){

                        System.err.println("File Not Found on System: " + e);
                }
                catch (IOException e) {
                        System.err.println("I/O Error: " + e);
                 }



        }

        public void run()
        {
                 System.out.println("Connected to: " + _mysocket.getInetAddress() +":"+
_mysocket.getPort());
                 try
                 {
                         _output = new PrintStream(_mysocket.getOutputStream());
                         _input = _mysocket.getInputStream();

                         //Lets get busy!
                         doServerWork();

                         //We are outta here....
                         _mysocket.close();
                 }
                 catch ( Exception e )
                 {
                         System.err.println( "Exception:\n" + e );
                 }
```

# APPENDIX F: ONLINE QUIZ SCREENSHOTS

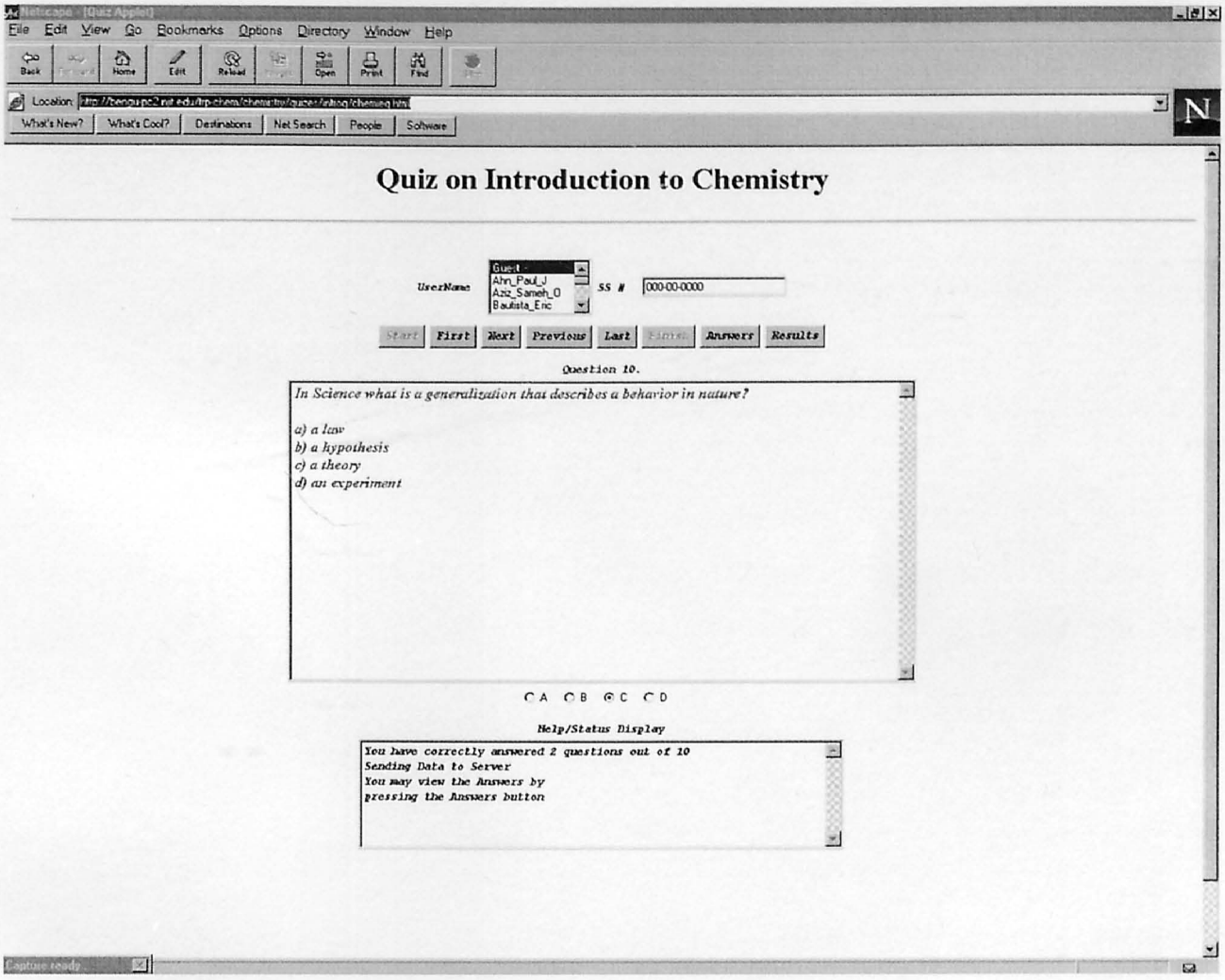
Screen -1



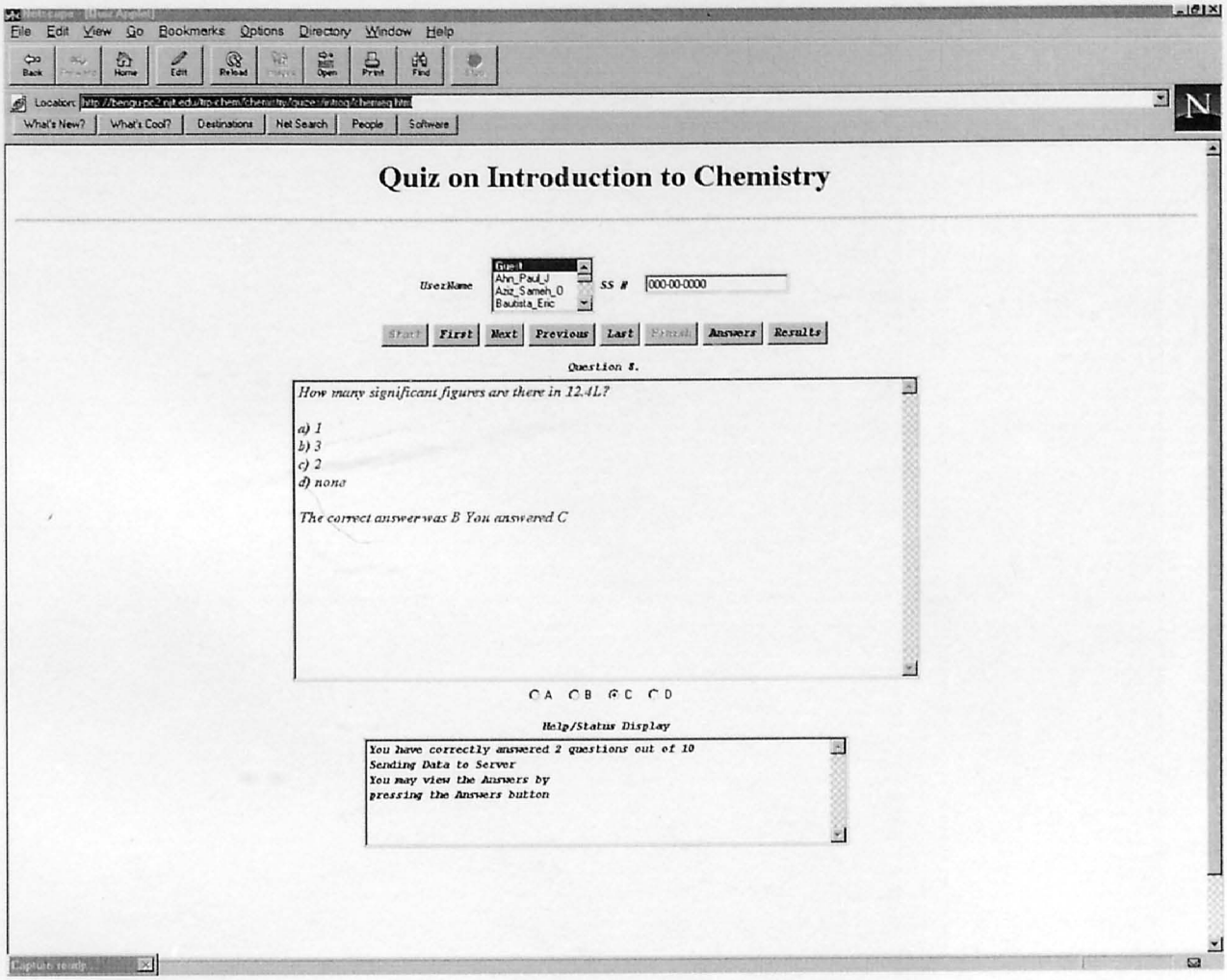
Screen - 2


File Edit View Go Bookmarks Options Directory Window Help
Back Forward Home Edit Reload Images Open Print Find Stop
Location:
What's New? What's Cool? Destinations Net Search People Software
Quiz on Introduction to Chemistry
UserName
Guest
Ahn_Paul_J
Aziz_Sameh_O
Bautista_Eric
SS #
000-00-0000
Start First Next Previous Last Finish Answers Results
Question 1.
The number of significant figures in the measured quantity 42.100 g is
a) 1
b) 3
c) 5
d) 4
A B C D
Help/Status Display
Click on the Choice you think is correct
To goto the next question press Next
To return to the earlier question press Previous
When you have finished the quiz press Finish

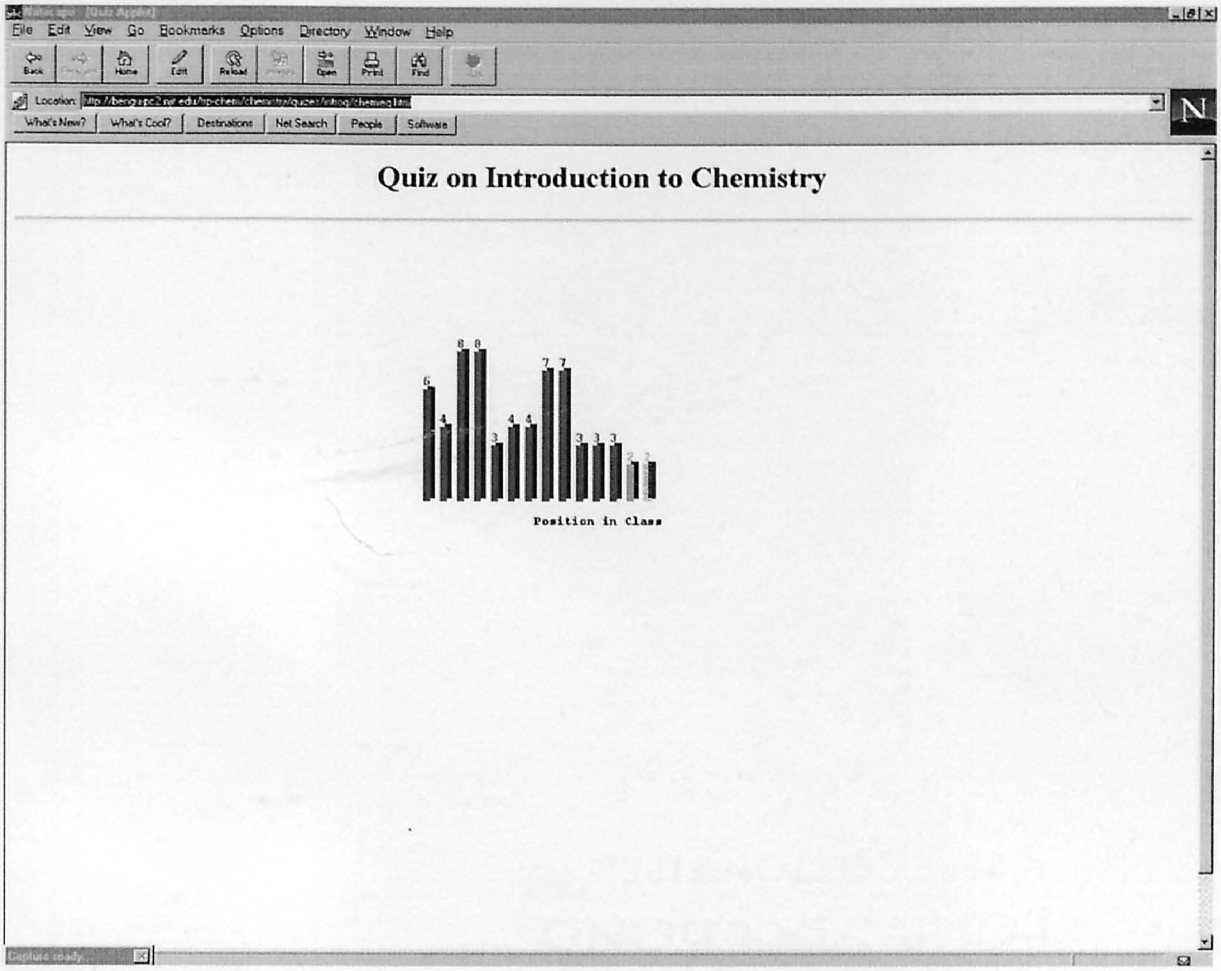
Screen - 3


File Edit View Go Bookmarks Options Directory Window Help
Back Home Edit Reload Open Print Find
Location:
What's New? What's Cool? Destinations Net Search People Software
Quiz on Introduction to Chemistry
UserName
Guest
Ahn_Paul_J
Aziz_Sameh_G
Bautista_Eric
SS #
000-00-0000
Start First Next Previous Last Enter Answers Results
Question 10.
In Science what is a generalization that describes a behavior in nature?
a) a law
b) a hypothesis
c) a theory
d) an experiment
A B C D
Help/Status Display
You have correctly answered 2 questions out of 10
Sending Data to Server
You may view the Answers by
pressing the Answers button

Screen - 4


File Edit View Go Bookmarks Options Directory Window Help
Back Forward Home Edit Reload Images Open Print Find Stop
Location: http://bengu.poc2.rpi.edu/itp-chem/chemistry/quizes/intro/chemseq.htm
What's New? What's Cool? Destinations Net Search People Software
Quiz on Introduction to Chemistry
UserName
Guest
Ahn_Paul_J
Aziz_Sameh_0
Baubista_Eric
SS #
000-00-0000
Start First Next Previous Last Reload Answers Results
Question 8.
How many significant figures are there in 12.4L?
a) 1
b) 3
c) 2
d) none
The correct answer was B You answered C
A B C D
Help/Status Display
You have correctly answered 2 questions out of 10
Sending Data to Server
You may view the Answers by
pressing the Answers button

Screen - 5


File Edit View Go Bookmarks Options Directory Window Help
Back Forward Home Edit Reload Images Open Print Find Stop
Location:
What's New? What's Cool? Destinations Net Search People Software
Quiz on Introduction to Chemistry
6 4 8 8 3 4 4 7 7 3 3 3 1 1
Position in Class

## APPENDIX G: COURSEWARE HIERARCHY

**Courseware**

| Text | Status | Labs | Status | Case Studies | Status |
|---|---|---|---|---|---|
| Science of Chemistry | Complete | Spectrometric Analysis of Phosphate | Complete | Ozone Depletion | Complete |
| Matter and Energy | Complete | Measuring the density of a solid and a liquid | Template Complete | Aspirin Manufacture | Complete |
| Gas Laws | Complete | Some Non-metals and their compounds | Template Complete | Air Pollution | Complete |
| Properties of Colloids | Complete | Water of Hydration | Template Complete | Paint Pollution | Complete |
| Chemical Equations | Complete | The Solvay Process and Paper Chromatography | Template Complete | | |
| Thermodynamics | Text Complete | Calorimetry: experiments based on thermodynamics | Template Complete | | |
| Chemical Kinetics | Text Complete | Analysis of acidic substances by titration | Template Complete | | |
| | | Molecular Weight of a volatile liquid | Template Complete | | |
| | | Molecular wt. Determination by freezing pt. Depression | Template Complete | | |
| | | Kinetics: the clock reaction | | | |
| | | pH buffers and Dissociation Constant $K_a$ | Template Complete | | |

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