

Universiti Teknologi MARA

**Development of Web-based Tutorial for Data
Structure Using Animation**



SyahdatulHikmah Binti Mohammad Jafri

**Thesis submitted in fulfilment of the requirements
for Bachelor of Computer Science BCS (Hons.)
Faculty of Information Technology and
Quantitative Sciences**

28 May 2007

DECLARATION

I certify that this thesis and the research to which it refers are the product of my own and that any ideas or quotation from the work of other people, published or otherwise are fully acknowledged in accordance with the standard referring practices of the discipline.

MAY 27,2007-05-27

SYAHDATULHIKMAH MOHAMMAD JAFRI

2005614680

Acknowledgements

Alhamdulillah, praise is to Allah S.W.T. With the bless from the Almighty God, finally, this research has been successfully finished. A large number of people have contributed over the year to finish or complete this research and I would like to thank everyone who had commented on the research and made constructive suggestion for the changes. A special thanks is dedicated to Puan Norasiah Mohammad and Assoc Prof Dr.Naimah Mohd Hussin for their helpful comments, suggestion and guidance in order to conduct a good research paper.

Special thanks goes to my parents for their help and support. Besides, I also would like to thank my friends especially Fatimah Munirah and Mohd Fadzly who have been very supportive toward the completion of this research. I appreciate every single thing that all of you had done.

Last but not least, I do believe that if there is a will, there is always a way. No matter how hard to finish this research, I had tried my best. Thanks a lot from deep of my heart.

SyahdatulHikmah Binti Mohammad Jafri,

May 2007

Table of Contents

Acknowledgement.....	iii
List of figure.....	vii
List of table.....	viii
Abstract.....	ix
Chapter 1.....	1
1.1 Problem statement.....	1
1.2 Project aim.....	2
1.3 Project objective.....	2
1.4 Project scope.....	2
1.5 Expected outcome/Deliverable.....	3
Chapter 2.....	4
2.1 Introduction.....	4
2.2 Fundamentals of Data Structure and it's implementation.....	4
2.3 What are web-based learning and computer-based learning.....	6
2.4 Using multimedia, animation or simulation tools in education.....	8
2.5 Design and development of web-based learning.....	9
2.6 Principles of composition.....	10
2.7 Text,graphics,color and animation.....	11
2.8 Hypertext.....	13
2.9 Usability.....	13

2.10 Graphic user interface (GUI) and java applet.....	13
2.11 Prototype.....	14
2.12 Conclusion.....	14
Chapter 3.....	18
3.1 Data collection.....	18
3.1.1 Interviewing.....	19
3.1.2 Questionnaire.....	19
3.1.3 Observing.....	19
3.1.4 Published materials.....	20
3.1.5 The existing Data Structure learning tools.....	20
3.2 Data analysis.....	20
3.3 Project design and implementation.....	21
3.3.1 Dreamweaver MX.....	22
3.3.2 jGRASP.....	22
3.4 Project testing and analysis.....	23
3.5 Project model.....	23
3.6 Project framework.....	24
Chapter 4.....	25
4.1 Interface design.....	25
4.2 Content design.....	36
4.3 Project implementation.....	37

4.3.1 Part of coding.....	37
4.3.2 Screenshot of the applet.....	39
Chapter 5.....	41
5.1 Testing.....	41
5.2 Analysis.....	44
Chapter 6.....	44
6.1 Conclusion.....	48
6.2 Recommendation.....	49

List of Figures

Figure 1: 18 steps for developing Web-based learning materials.....	10
Figure 2: The end product of system prototyping is a working model of the information system, ready for implementation.....	17
Figure 3: Design phase.....	21
Figure 4: Project Model.....	23
Figure 5: Project Framework.....	24
Figure 6: Menu Hierarchy.....	26
Figure 7: Storyboard for header panel	28
Figure 8: Storyboard for footer panel	30
Figure 9: Storyboard for link_button panel	31
Figure 10: Storyboard for stack panel	34
Figure 11: Storyboard for stack_applet panel	36
Figure 12: Screenshot for deleteAt operation in array.....	40
Figure 13: Screenshot for insert operation in array.....	40
Figure 14: Testing Phase for First Group.....	42
Figure 15: Testing Phase for Second Group.....	42
Figure 16: Overall reaction to the learning tool.....	45
Figure 17: Learning tool.....	47
Figure 18: Comparison of using the learning tool to textbook and face-to-face teaching.....	48

List of Table

Figure 1: The screen.....	46
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Abstract

Web-based learning tools provide integrated environments of various technologies to support diverse educators' and learners' needs via the Internet. Data Structure is one of the core or elective subjects for the students taking Diploma in Computer Science, and Bachelor in Computer Science. In order to gain more understanding of this course, that is Data Structure, students will always go and refer to overseas university's websites. However, the contents of those websites sometimes do not cover or fit with the UiTM's syllabus. In Malaysia, there is also no Data Structure website that teaches the student especially with an animation. So, this Data Structure Web-Based Tutorial Using Animation is significant for the user especially the students to give a clear understanding for them to learn Data Structure by referring to the visualization tool besides to develop a self-tutoring environment. In this project, we use prototyping as a benchmark for us to evaluate the project, which later will be used to develop the final version of the project. For the data collection, we did some interviews, observations as well as referring to the published materials and the existing Data Structure learning tools. We discussed the findings from this study in relation to basic usability issues that must be attended to when designing this web-based learning tool. For the design stage, there are two sections, which are the content design and the interface design. We also reported on students' perceptions of whether the tools have positively or negatively affected their learning in the course and their recommendations. The target of this project is to produce a prototype of a Data Structure Web-Based Tutorial Using Animation for the users to learn, feel enjoy with and understand the fundamental of Data Structure.

CHAPTER 1

INTRODUCTION

The Internet has revolutionised modern culture and universities are no exception. For example, the students in computing science classes assume that notes are available online and are up-to-date. Lecturers for the most part welcome this technology as it allows one to have a central repository of notes that are visible to students on campus and remotely through the Web. This report is about the development of a learning tool, which is the Web-based Tutorial for Data Structure Using Animation. This project will give benefits to the UiTM's students especially for the students who take Data Structure course.

This learning tool will provide an animation or visualization tool and it is hoped that it will help the students to imagine or to get a better understanding of the particular topic such as Array. It is because the fundamental of Data Structure is very important for them in the future especially when they want to design a program. Besides, it will give an enjoyable self-learning environment for the users to learn this subject and they also can test their understanding of it by downloading and answering the questions tutorial provided.

1.1 Problem Statement

Nowadays, there are many types of online learning facilities such as tutorials, notes and quizzes. They facilitate the students to do revision or set as references for their studies. Data Structure is one of the core or elective subjects for the students who take Diploma in Computer Science (*CS110*), and Bachelor in Computer Science (*CS230*). Some of the

students from the other courses also need to learn this subject. Basically, this subject teaches students to understand the principles behind the efficiency of program design.

In order to gain more understanding of Data Structure, the students will always have to go and refer to the overseas university's websites. However, the contents of those websites sometimes do not cover or fit to UiTM's syllabus. The interfaces of some of the websites are also not user friendly for the user especially the novice. Therefore, a few changes need be done to ensure that the web contents can be fully utilized by the UiTM's students.

1.2 Project Aim

The aim of this project is to develop a self-tutoring environment by using web based technology for the users to learn Data Structure.

1.3 Project Objective

The objectives of this project are:

1. To apply web-based learning which focus on the Data Structure Object (the basic structure of Data Structure).
2. To develop self-tutoring environment for the users to learn Data Structure Object by referring to the visualization tool.

1.4 Project Scope

Develop an applet, which allows the users to self-learning on the fundamental of Data Structure. This application will only cover the basic structure of Data Structure, which are Array, Linked List, Queue, and Stack. Below are the lists of the functions for each basic structure of Data Structure:

Array : insert,delete at

LinkedList :insert front, insert last, delete front, delete last, search

Queue : enqueue, dequeue, front, back

Circular Queue : enqueue, dequeue, front

Stack : push, pop, top

1.5 Expected Outcomes/Deliverable

The expected outcomes or deliverable of this project are the online notes, exercises and past semester final exam paper for the basic structure of Data Structure (Array, Linked List, Queue and Stack).

CHAPTER 2

LITERATURE REVIEW

This chapter presents some reviews of relevant literature. For this purpose, we had reviewed some reading materials from the newspaper, Internet, journals, books and documents related to the research's topic. We found that there are many various opinions as well as arguments regarding this matter. The following paragraphs are what we had reviewed and understood.

2.1 Introduction

Today, computer science students must be trained to have a thought of understanding of the principle behind the efficiency of program design. A Data Structure is any data representation and its associated operations. In general, the Data Structure is to be an organization or structure for a collection of the data items (Levitin 2007). It often refers to the data that is stored in the computer's memory. It is also an implementation for an ADT, Abstract Data Type (Shaffer 2001). It shows that Data Structure is very important for the computer science students. Online tutorial is an interactive training environment in which the users can view explanatory descriptions of user interface objects, actions that are regularly tied to realistic task scenarios (Ben 2005).

2.2 Fundamentals of Data Structure and its' implementation

In Data Structure there are array list, linked list, queue, stack and others. The approaches that are used to implement the list of ADT (*Abstract Data Type*) are the array-based list and the linked list (Shaffer 2001). An array is a sequence of items of the same data type that are stored contiguously in the computer memory and are made accessible by specifying a value of the array's index. Array is used to implement variety of the other Data Structure (Levitin 2007). In Levitin's writing, he also writes about the well-known

example of this, which is the string. It is used to compute the string length, comparing two string and others (2007). The application of the Array List object was in the high-precision arithmetic, which is needed for the public-key cryptography (Collins 2002).

While the linked list is a sequence of zero or more elements called nodes each containing two types of information that are the data and the pointer (Levitin 2007). It makes use of dynamic memory allocation (Shaffer 2001). According to Collins (2002), it is best suited for insertion and deletion for getting to the index of the first insertion and deletion. Linked list class can store the elements in the circular or doubly linked structure. Linked list does not require any preliminary reservation of the computer memory. A line editor is an example of application that use linked list (Collins 2002).

According to Collins, a list where the elements are deleted from one end of the structure (*front*) and new elements are added for the back (*back*) is called queue. It operates on the “first in first out” protocol (2002). A priority queue is to keep the items in order from the highest to lowest priority. Shaffer mentions that there are two implementations that are array-based queue and the linked queue (2001). Queue class plays an important role in the development of the computer models to study the behaviour of those systems. The examples for the queue are a simulated car wash, and flight simulators used to train the airline pilots.

Lastly, a stack is a homogeneous element, in which the latest element that is being inserted is the only element that can be removed, accessed or modified. It is referred as the top element (*peek*). The insertion of an element is known as *push* and the removal known as *pop* (Collins 2002). Besides that, Collins also said that the stack is a “Last In First Out (*LIFO*)” Data Structure. For an example, how the disks in the Tower of Hanoi

game are move. Stack is important by applying it in converting from infix to postfix (Collins 2002).

2.3 What are web based learning and computer based learning?

Advances in technology and the growth of telecommunications networks and projects have provided the educators and trainers with unique opportunities to enhance learning and teaching. Web-based learning (also known as online learning or e-learning) is one of the tools in which education is delivered. It offers huge opportunities for learning and access to the knowledge and information. It is delivered over the Internet using a web browser and is usually a self-paced learning medium, however some systems allow for the online testing and evaluation. It is often referred to as those delivery modalities that overcome the barriers of time and space to learning, thus the often-used phrase "anytime, anywhere learning"(Jackson 2006). Tinri *et al.*, wrote that Web based learning which supports the experimental design in molecular design offers students the opportunity to practice their design skills while addressing realistic research questions (2003). According to Jolliffe *et al.* (2001), the characteristics of web-based learning are:

1. The learning materials made up of the text, graphics, and the multimedia elements such as the video, audio and animation.
2. Synchronous or asynchronous communications applications such as the chat room, discussion forum and video conferencing.
3. The use of the web browser.
4. The storage, maintenance and administration of the materials on a web server.
5. TCP/IP and HTTP protocols are used to facilitate the communication between the learners and the learning materials or the resources.

There are some advantages in using the web based learning such as it can develop a self-tutoring environment by encouraging more independent and active learning by retrieving information from multiple sources (Anon 2000). On-line learning is now considered as the backbone of continuing the education and enables educators to reach populations that would be otherwise inaccessible (McEwen 2001). It also represents as an unstoppable technological revolution enabling the students to access information quickly and visually (Smith 2002), provides a useful source of supplementary materials and it is useful for self-assessment such as online tutorials and exercises. Kerka, sums up the disadvantages of limited bandwidth, which hampers the delivery of material especially in real-time applications, technical skills in computer operation and Internet navigation, which the students may not necessarily possess, and the ability to cope with any technical difficulties or problems that may arise. Even with the accessibility to the Internet at all can still be a problem for some people in rural areas and for the people with disabilities (1996).

Computer based learning is a type of education in which students learn by executing special training programs on a computer (Anon 2006) It means the computer trains the students. Nowadays, nearly everyone has access to a personal computer at home, at work or at computer labs in schools or libraries. According to Wall Street Journal, computers are being used in a few adult programs to teach reading with excellent results. For example, Annabell Thomas was unable to read, despite her years in the New York City school system. After leaving the school, she had been taught by tutors and had enrolled in library literacy programs and adult education classes in order to overcome her handicap. Nonetheless, she never learns to read. Finally, Ms. Thomas, now 56, enrolled in a computer program and she was taught to read and write by a computer (Anon 1992).

2.4 Using multimedia, animation or simulation tools in education

According to Napps *et al.* (2002), programming is an activity requiring logical and verbal thinking which are required to successfully design and write software. This has led to the development of algorithm and Data Structure visualization tools, which allow a student to process a concept 'in parallel', both visually and logically. There are four reasons why visual programming is stimulating:

1. Pictures are more powerful than words.
2. Pictures aid understanding and retention
3. Pictures provide incentive for learning
4. Pictures are understood regardless of language.

Several informal surveys have shown that many computer science educators believe that visualization tools help learning. Animated demonstrations have been shown to be more effective at conveying the purpose and use of a tool than the static explanation (Baecker *et al.* 1991; Sukaviriya *et al.* 1990). However, professors mostly use these visualization tools in lectures to demonstrate concepts, as opposed from traditional tools, which are used either in homework or lab setting (Stasko *et al.* 1993). Static frames work just as well as smooth animations (Shaffer *et al.* 1996). More important than a smooth animation and visually appealing graphics are clear concise pictures containing all relevant information and suppressing extraneous details (Stasko *et al.* 1993). Besides, an animation can be easier to understand and remember than a textual representation, especially when one can interact with the animation by trying different input.

For example, according to Drakos, Matrix is a portable algorithm animation and simulation framework developed in Laboratory of Information Processing Science, (Department of Computer Science and Engineering) at Helsinki University of Technology. The system allows direct manipulation of basic Data Structures (1996). It is for the user to understand and think about algorithms. It presents graphical views of an algorithm in action, exposing properties that might otherwise be difficult to understand. Other studies showed that the benefits of animations for learner may not be clear, but that users usually enjoy this presentation style (Payne *et al.* 1992; Harrison 1995).

According to Catrambone *et al.* (2002), Hays (1996) asserted that animation is most useful when the instructional domain involves dynamic and / or spatial processes as key elements. The results of Hays's studies led him to the conclusion that animation is better than text at communicating concepts involving time and motion. More generally, to the extent that animations are explicit and deterministic in representing the elements and operations of a problem space, they disambiguate that problem space, making misinterpretations less likely. Scaife and Rogers (1996) called this phenomenon "*graphical constraining*".

2.5 Design and development of Web-based learning

There are major differences for us to design the Web-based learning materials and paper or CD ROM-based learning. Joliiffe *et al.* said that there are four basic issues, which are the material design, organizational design, page design and graphic design. The design material for Web-based learning must include interact metaphors, images and concepts to convey meaning and the function on the computer screen. It should not just concern at the information that we are going to present. We need to interact with it in the novel ways. Second is the organizational design. Any information to be used in the Web environment must be subdividing the large body of the information into its components part. So, the number of variables is kept to a minimum. This can be done by combining the graphic design and layout conventions. Next, the page should design more

independently and not be an isolated fragment of information, divorced from the large context through the lack of essential link. It must help engage the learners in their learning; it must direct the learners' attention. Lastly is the graphic design. We need to optimize the look and feel of the Web-based learning experience. It is important to the efficiency of the learning system. It must consider a design strategy for a reasonable download time for the learners (2001). They also said that there are 18 steps for developing the Web-based learning materials. All the steps are grouped into four basic steps for developing the learning materials. Below are the steps:

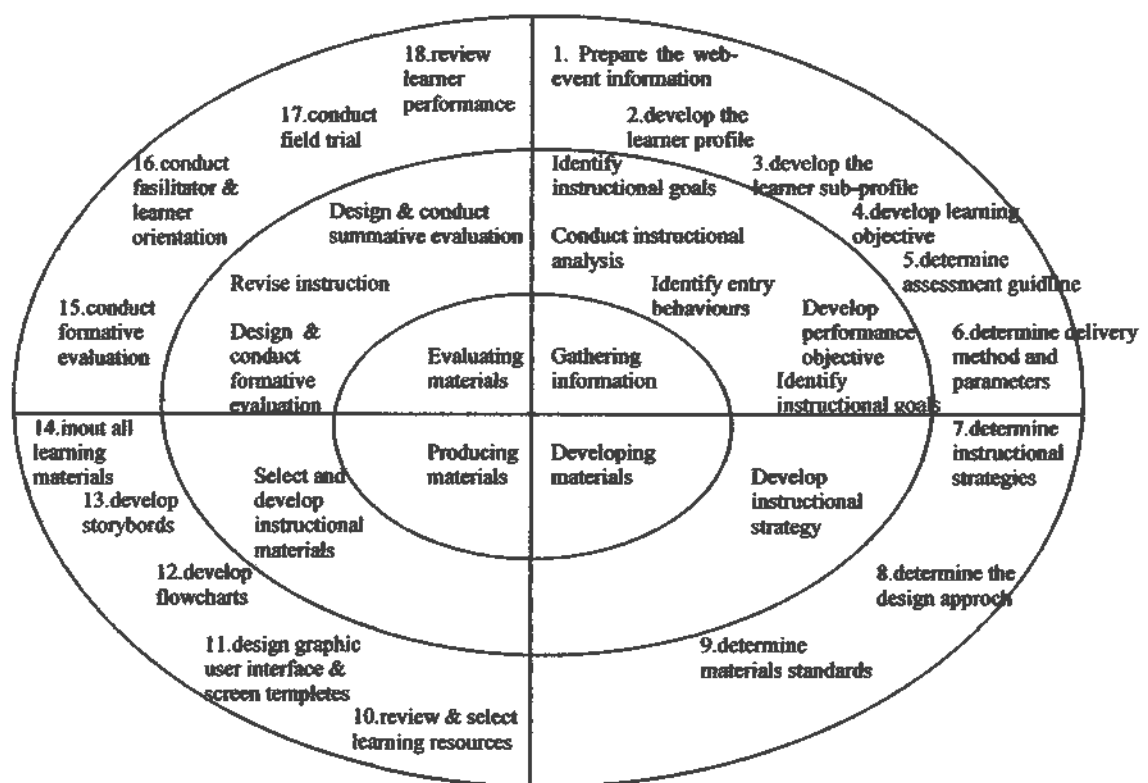


Figure 1. 18 steps for developing Web-based learning materials

2.6 Principles of composition

There are many disciplines contribute to the multimedia design. Unity and balance are desirable features of the multimedia composition. Unity refers to the whole of the

experience; all the elements forming the experience should belong together (Schwier and Misanchuk 1993). Harmony refers to how all the parts of the system fit together. The basic layout of the main components should be consistent across the screens. While balance is concerned with the visual 'weight' given to each of the component and the distribution of these object on the screen (Hotges and Sansnett 1993). When a screen is displayed, the user's attention should be attracted to the main object. The attention should then be drawn round the objects on the screen in a way that reveals the relationship between the elements. So, it is important that all the screens follow the same basic pattern to maintain harmony and consistency.

2.7 Text, graphics, color and animation

One of the advantages of a web-based learning event is that we can use many different sources of information including the multimedia resources. It is the great attraction of a Web-based learning event (Jolliffe 2001). Text and graphics are the basic components of multimedia system. The text provides the basic information and it may be supported by a relevant illustration. Besides, Jolliffe also said that we must provide a font and text size appropriate to the learners' need and consistent with the requirement of the material. The amount of the text can be display on a single screen base on the font size, the line spacing and the space taken up by permanent screen features has been correctly determined. The text arranged on the screen also must suit the reading needs of learners and consistent and the text color also must appropriate to the reading needs of learners and consistent. Pop up text also can be used to provide further information.

Graphics used in multimedia systems are divided into two types, which are bitmaps graphic or vector graphic. The different between these graphic types is the demand on the memory and processor of the computer (Boyle T. 1997). All graphics must have captions or titles. Consideration for the target audience is carefully considered before we select the graphics and it does not distract the learners from the material to be learnt (Jolliffe 2001).

Other than that, Jolliffe also mentioned that the choice of color always depends on the specific nature of the project. The color of the text must not more than three colors. This is because the learners will find it difficult to keep track of different color codes. The combination of the text and background color is chosen to maintain a high contrast between them (2001). Whatever the color that we choose, the background color should be soft on the eye and non-intrusive. According to Boyle T., the color choice of the foreground objects may affect by:

- Realistic portrayal of objects
- Aesthetic effect
- To convey color coded information
- To conform to standards

Lastly, the animation is use to add impact to a presentation. The visual impact of the animation should harness to serve the learning objectives. There are many forms of animation types that can be used to enhance the learning. There are:

- Moving objects across the screen
- User controlled movement of the objects
- Bitmap flipping
- Full animation files

There are different forms of animation that provide a variety of resources to achieve eye catching effects and it looks good certainly impress. However it is, it has to support the effective learning (1997).

2.8 Hypertext

Hypertext offers a reading environment which studies on the readers' strategic choices. The hypertext has drawn attention to reading activities that have received relatively little study by researchers concerned with printed materials. Browsing is one kind of reading activity that may be facilitated by hypertexts, deliberate searching is another (Marchionini *et al.* 1988).

2.9 Usability

Usability is one part of the overall acceptability of a computer system. Software of any type should meet the basic standards for usability. The usability evaluation is important part of the overall evaluation of web-based learning environments. The user interface of a web-based application has to be simple and effective to use. So, the users can concentrate on the information content and learning instead of interface. When it is easy and efficient to use, easy to remember, it has few errors and is subjectively pleasing (Nielsen 1993).

2.10 Graphical User Interface (GUI) and Java Applet

According to Wikipedia (2007), a graphical user interface (*GUI*) allows for interaction with a computer or other media formats which employs graphical images, special graphical element devices called "widgets", along with text to represent the information and actions available to a user. The actions are usually performed through direct manipulation of the graphical elements.

While for an applet, it is delivered in the form of Java bytecode. Java applets can run in a Web browser. Applets are use to provide interactive features to web application that can not be provided by the HTML (Wikipedia 2007).

2.11 Prototype

Prototypes are 'instruments' used within the software development process and different kinds of prototypes are employed to achieve different goals. The 'product' prototype has been variously defined within the prototyping literature and an early definition is that of Pape *et al.* (1992) who considers an information systems prototype to be:

"... a system that captures the essential features of a later system, is the most appropriate definition of a prototype. A prototype system, intentionally incomplete, is to be modified, supplemented, or supplanted."

Prototypes can be developed technically in different ways. Software construction can be seen as the design and implementation of a number of different software "layers" from the user-interface to database query language or the operating system. Horizontal prototyping involves the building of specific layers such as the user-interface alone. Horizontal prototyping is also called mock-up prototyping. Vertical prototyping involves the building of selected parts of the target system through all layers. Vertical (or functional) prototyping is used when particular aspects of functionality need to be demonstrated.

2.12 Conclusion

In conclusion, Data Structure is very important element for every programmer in order to design an efficient program. It is very difficult for the people especially people related to the Information Technology area who do not have any basic in Data Structure to learn this subject or to imagine how this particular Data Structure for an example the method, *public Boolean add (Object o)* in ArrayList do the process. So, it is very important for them to have a visualization tool to help them in order to understand this course crystal clear.

The 1998 Study by the Educational Testing Service (ETS) found that in improving educational outcomes, technology could play a positive role. Shank argues (1995) “for massive educational change to happen in this country, the computer will have to be the medium of change.” Computers can allow for individualized instruction, along with allowing students to explore without fear of failure, and to use multiple input structures (audio, video and text) in a way that works best for them. In conclusion, Data Structure is very important element for every programmer in order to design an efficient program.

It is very difficult for the people especially people related to the Information Technology area who do not have any basic in Data Structure to learn this subject or to imagine how this particular Data Structure. For an example the method, *public Boolean add (Object o)* in ArrayList do the process. So, it is very important for them to have a visualization tool to help them in order to understand this course crystal clear. The ‘1998 Study’ by the Educational Testing Service (ETS) found that the technology could play a positive role in improving educational outcomes. Shank argues (1995) “for massive educational change to occur in this country, the computer will have to be the medium of change.” Computers can allow for individualized instruction, along with allowing the students to explore without fear of failure, and to use multiple input structures (audio, video and text) in a way that works best for them.