TEACHING C PROGRAMMING WITH THE AID OF AN INTERPRETER – ONLINE INTERPRETER FOR NOVICE C PROGRAMMER

MANGALAM SANKUPELLAY[1*] & PRESHSHANAN SUBRAMANIAN[2]

Abstract. Online Interpreter for Novice C Programmer (IfNCP) is intended as an introductory learning package for the beginners of C programming language. IfNCP focuses on the graphical code interpretation to enhance user understanding. The system creates an on-line interactive learning environment using multimedia tools and graphical simulations.

Kata kunci:: C Programming, interpreter, learning package

Abstrak. *Online Interpreter for Novice C Programmer* (IfNCP) ialah pakej perisian pembelajaran bagi seseorang yang baru mula mempelajari bahasa pengaturcaraan C. IfNCP mengunakan antara muka grafik untuk mempertingkatkan pemahaman pengguna. Sistem ini menyediakan persekitaran pembelajaran yang interaktif dengan menggunakan multimedia dan grafik secara online.

Kata kunci: Bahasa pengaturcaraan C, *Interpreter*, pakej pembelajaran

1.0 INTRODUCTION

It has been observed in the educational field in particular, that the more variety of resources used in the learning process, the better the ability to enhance human capacity to absorb and retain facts of the learning material [1]. This is due to the simultaneous use of the visual senses combined with direct real-time interaction with the learning components.

Courseware has become norms in classrooms, training centers and other educational centers in the sense that it is slowly, but surely replacing hardcopy materials such as books, magazines and encyclopedias, due to the storage capabilities of storage media today. The Malaysian Education Ministry too is showing a keen interest in the usage of educational courseware in classrooms. Besides, courseware also provides a mean of including in motion into the learning materials, and motion has always attracted the attention of human eyes since the process of certain object can be presented [2].

Most beginners commence their programming venture with C. However, a thorough understanding of programming is essential to enable them to cope with the

[1&2]Faculty of Computer Science and Information Technology, University of Malaya, 50603 Kuala Lumpur, Malaysia.

* Corresponding author: Email: mangalam@um.edu.my

programming environment, which eventually will guide them to learn other advanced programming languages. Most beginners find it difficult to understand basic programming concepts due to lack of examples and hands on experience. Typically, students are given some lines of code to study with and they are expected to write their own program after that. However, they do not understand how the codes work or how the program functions if certain codes are changed.

Although there are a number of C learning packages available in the market such at C Programming by Steve Holmes [5], Programming in C: A Tutorial [6], C Tutor [7], and C How to Program [8], most of them do not support user interaction. The existing learning environment is more theoretical with the user dumped with factual text-based lessons and coding examples.

Hence, this research focused on producing an interactive on-line learning package on C programming language. It aims to educate novice programmers (beginners) on how to program in C, the basic programming language. The special feature of the system is that it graphically interprets codes line by line. Therefore, it enables users to understand the concept involved more efficiently. Users are able to understand the logic and function of each line of code in the interpretation process. Users are also able to make changes to C codes and observe how the function of the program also changes.

The objectives of the project are:

(1) The system is intended to produce a learning package, for the intended target users, especially for beginners (novice programmers) of the C programming language. It is targeted to assist novice users as introductory software to C programming language.

(2) Introducing C programming to a wide range of user through an on-line, effective learning environment.

(3) The learning package is to provide adequate information and further examples on relevant topics on C programming to enhance understanding and knowledge acquiring.

2.0 MULTIMEDIA LEARNING PACKAGES

Educators' goal is to facilitate learning - to help students gain knowledge, acquire specific skills and function successfully in a society. One of the greatest challenges to an educator is the diversity of students, especially in the different ways they learn. Multimedia can accommodate different learning styles. Some students learn better through association, others by experimentation; some are more visually oriented and others are more auditory [1]. Multimedia can present material in the way we think - in a manner that is nonlinear. It lets us review specific aspects as often as we like. It is motivating as it allows the user to take charge of his or her learning. Multimedia can provide feedback, adjust the level of difficulty, and evaluate skills [3]. Besides, it makes

learning a fun process. The rapid growth of the electronic base learning industry explains the important role played by multimedia elements in the education sector.

Interactivity is the key feature in a successful multimedia [4]. Interactivity in an information system gives the user some influence over access to the information and a degree of control over the outcomes of using the system. Although interactivity places some control over access and outcome in the hands of the user, the degree of control is strictly limited by the computer software providing the interactivity. In educational software, the user may be firmly channeled by the controlling software into pathways that suit the particular didactic purpose of the application.

2.1 Multimedia Learning Package for C Programming Language : A Review

"C Programming package" is more to a text-based, factual learning environment where descriptions of certain C features are discussed and sample codes are illustrated [5]. The codes are not executed to show the desired output. Therefore, users' understandability on the codes executions is limited because the execution process is not included. Users will have to copy the codes and run them in a C compiler to view the output. Therefore, this package serves more as a reference rather than a learning package. User interaction is limited and no interactive features are included to enhance user interaction. User could not input any form of data to view the code execution process. Level of interactivity is low.

"Programming in C: A Tutorial" is more like an e-book [6]. Users are dumped with text-based notes and sample codes. It includes discussions on C features and sample codes. However, no tutorial section is included. This package does not encourage users to involve in depth learning but it serves more as a reference rather than a learning package.

"C Tutor" is an interactive learning package [7]. It is integrated with multimedia elements: animation, sound and graphics to enhance user interaction. It covers all major topics in C language. Besides, the software is provided with a good guided navigation capability with excellent information arrangement features.

However, it does not include user input capabilities [7]. User can only view codes and information displayed. User could not input any form of data into the system. Besides, the code execution process is hidden.

"C How to Program package" is in form of a CD-ROM that accompanies the 'C How to program' book [8]. It is a window-based software. It provides links to variety C source codes sites on the Internet. Besides, it provides coding examples in the Visual C++ platform. Therefore, user can view the codes and compile them at the same time. It covers all major topics in C from I/O features to struct. However, the package does not incorporate the use of multimedia elements such as sound and graphics to enhance user interaction. Lessons presented in multimedia formats are

more effective than single formats (illustrations or text alone) due to the process of dual coding [9].

3.0   FRAMEWORK OF IFNCP

Figure 1 depicts the system hierarchy of the IfNCP. There are two main modules in IfNCP, the user module and the administrator module.
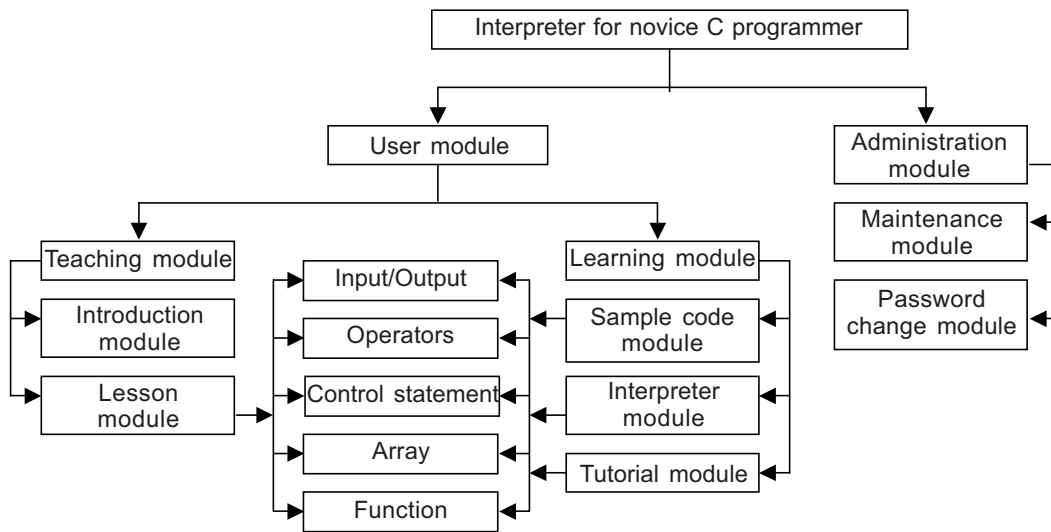


Figure 1   Hierarchy of IfNCP

3.1   User Module

User module has two important sub-modules, the teaching sub-module and the learning sub-module. The teaching sub-module is similar to conventional learning packages. It provides users with the introductory and notes on C programming. IfNCP concentrates on five main topics in C, namely, input/output, operators, control statements, arrays and functions. IfNCP is intended for the use of novice programmers, thus it only concentrates on the introductory topics in C programming.

    C programming is not a theoretical subject. It is a topic that requires extensive practice and understanding. Therefore, the learning sub-module is used to familiarize and refresh the student's memory on the topics learned in the teaching sub-module. Thus, it also concentrates on the five introductory topics in C programming.

    Learning sub-module provides programmer with sample codes, tutorials and a special module, the interpreter. The sample codes and tutorials are commonly found in any C learning package. Tutorials are for users to practice on their own. The students are then able to compare their answers with the model answers provided in IfNCP.

    However, IfNCP provides an added advantage with the interpreter module to help a novice programmer to master the fundamentals of C programming. The interpreter

sub-module is an interactive module. Users are able to key in C codes into the interpreter sub-module and the system would translate each line of C code into natural English language. This helps users to comprehend the mechanism behind each line of C code and strengthen their programming skills. User are also able to change parts of the C codes and observe the output. Figures 1 and 2 represent the hierarchy and flow chart of IfNCP, respectively.
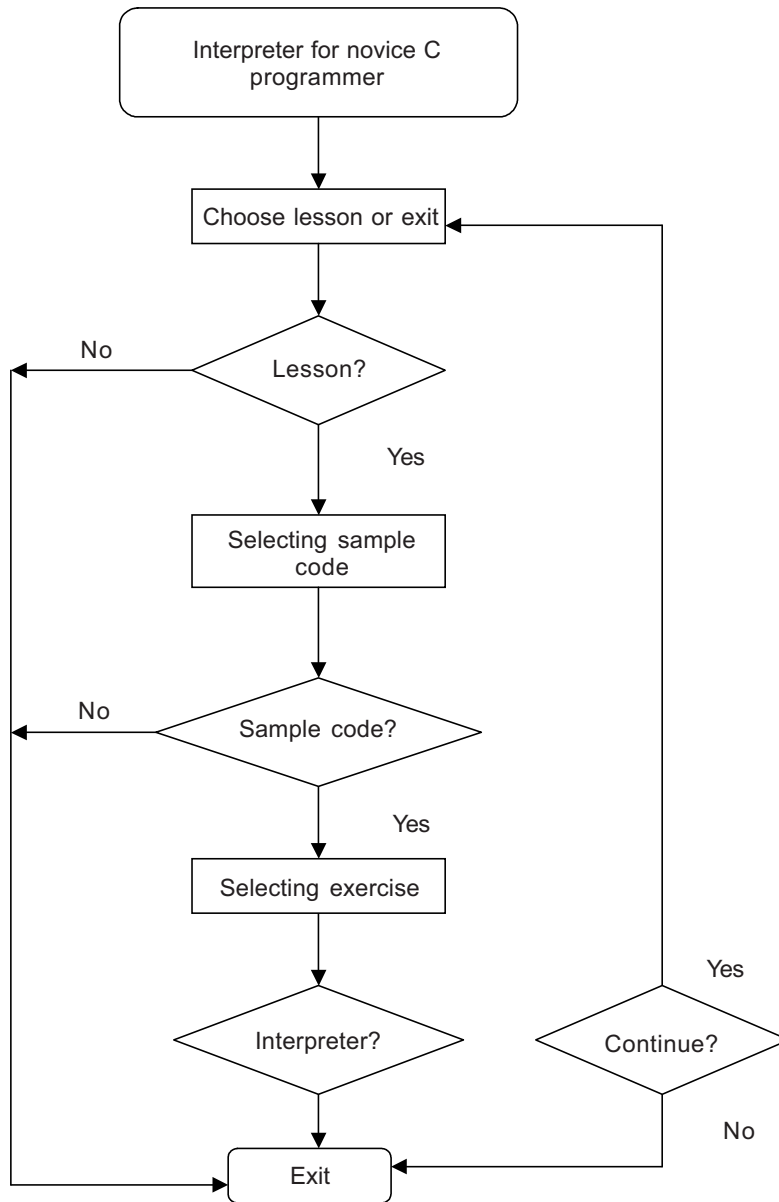

Figure 2   Flow chart of IfNCP

The IfNCP was developed using the following tools:

(1)   Microsoft Windows 2000 for the operating system
(2)   Ms Visual Studio.NET for the application tool
(3)   Adobe Photoshop 7.0 for graphics editing
(4)   Microsoft Internet Information Services (IIS) 5.0 for the web server
(5)   Internet Explorer 6.0

Figure 3 presents the main page for IfNCP while Figure 4 presents the lessons page for IfNCP. Users are able to navigate between pages using the hyperlink provided.
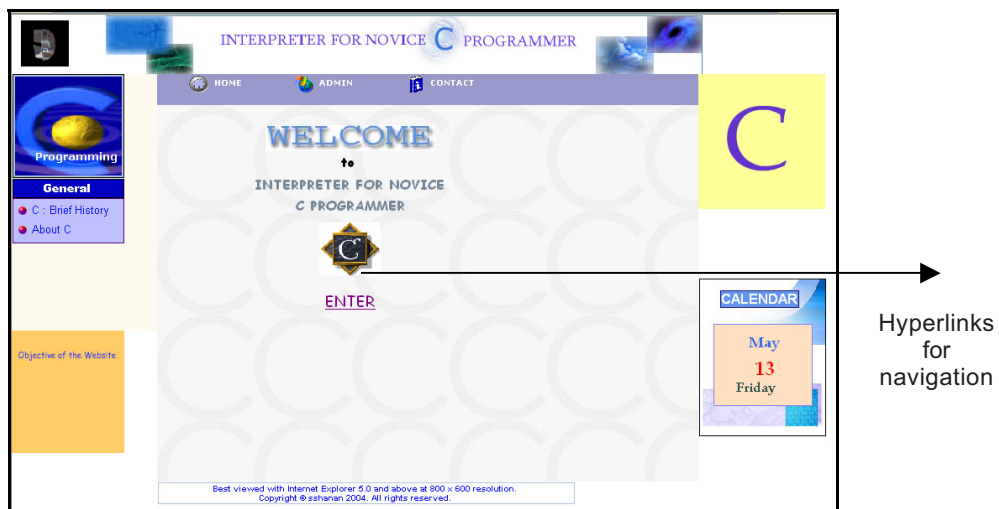

Figure 3   IfNCP's main page

**Figure 4**   Lesson sub-module main page

The different sub-modules in the user module of IfNCP are arranged systematically on the left side of each page. For example, in Figure 4, we can observe that users are able access all the sub-modules in the user module and at the same time view all the five topics available in the lessons sub-module. This approach instantly provides the user with site map and avoids users from getting lost in hyperspace.
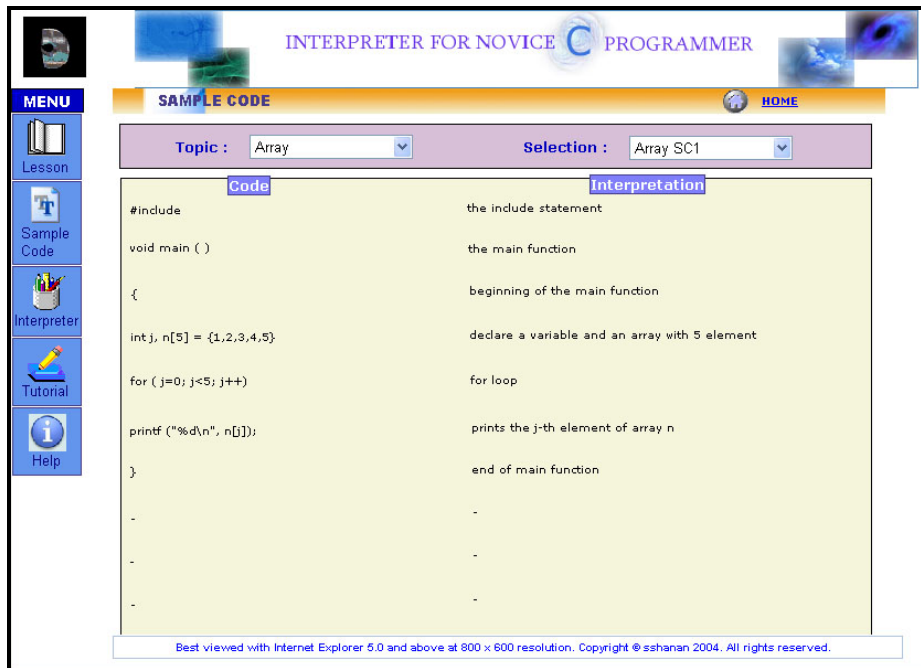

Figure 5   Interface sample codes sub-module

Figure 5 shows the sample codes sub-module. In this module, users can select a topic of interest and view sample codes along with line by line explanation of the codes.

Figure 6 shows a screen shot of the interpreter sub-module. Users are given explanation for each line of C coding. However, in this interpreter sub-module, users are able to interactive change the codes and view the effect of their changes, as shown in Figure 7. The examples shown in Figures 6 and 7 explain to users the post and pre decrement operator. Figure 8 shows how an integer is passed to a function and the output is shown in Figure 9.
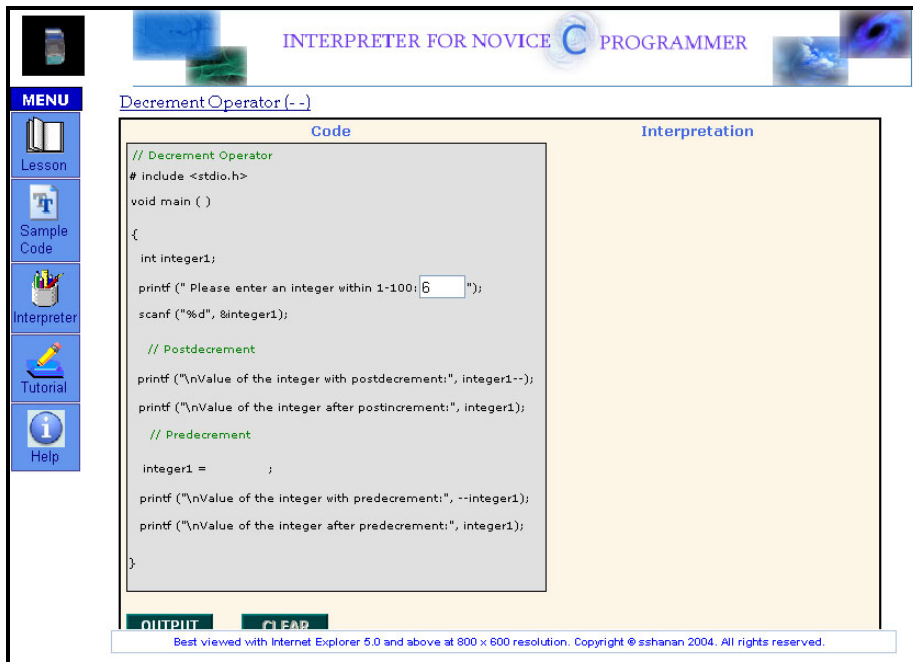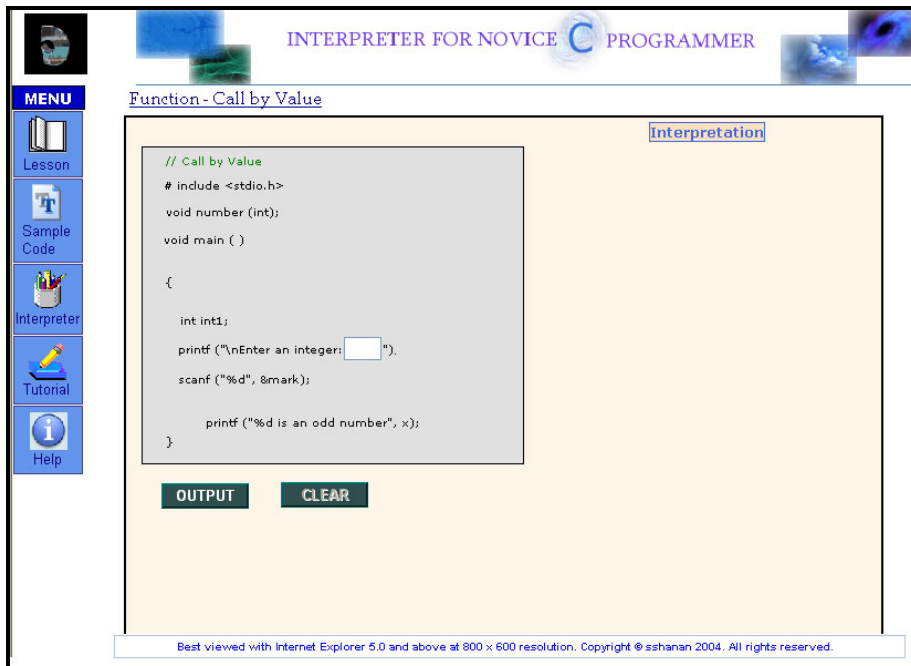
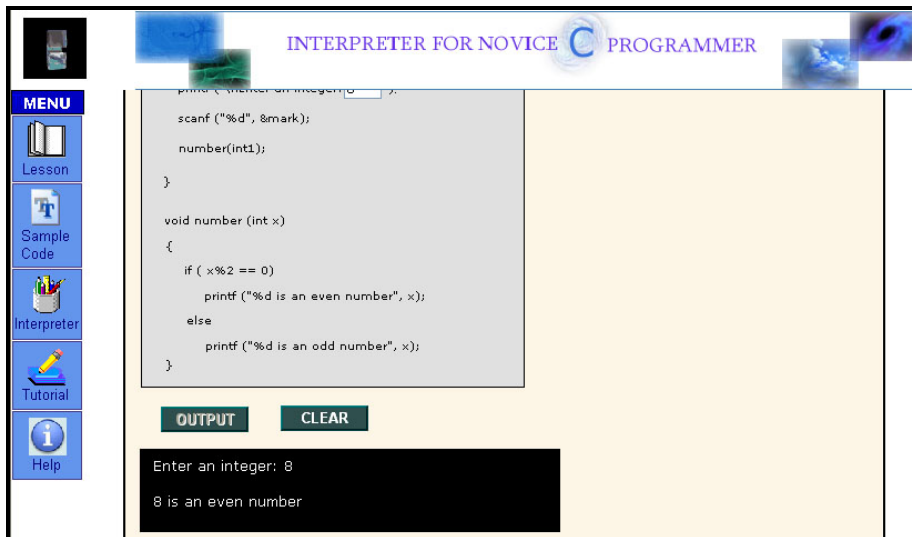**Figure 6**   Interface of interpreter sub-module
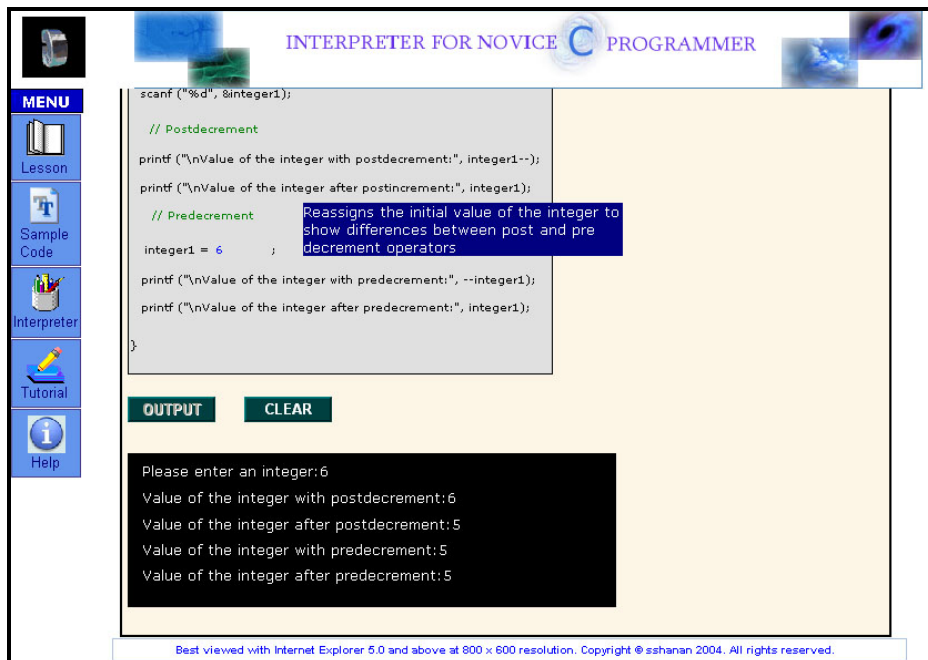
**Figure 7**   Output of interpreter sub-module

Figure 8   Uses of function shown

Figure 9   Output of interpreter sub-module

The administrator module is shown in Figures 10 and 11. The administrator module is protected by a password to ensure that only authorized person can make changes to the IfNCP system. The administrator is able to update, delete, add and save any changes to the content of the system, to ensure the system is always up to date.
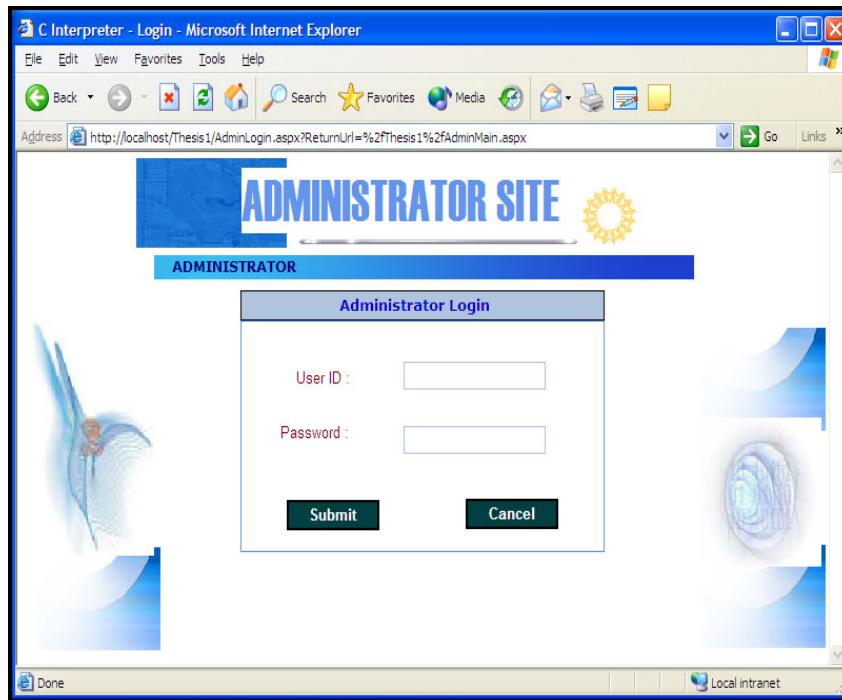
**Figure 10**   Main page of administrator module
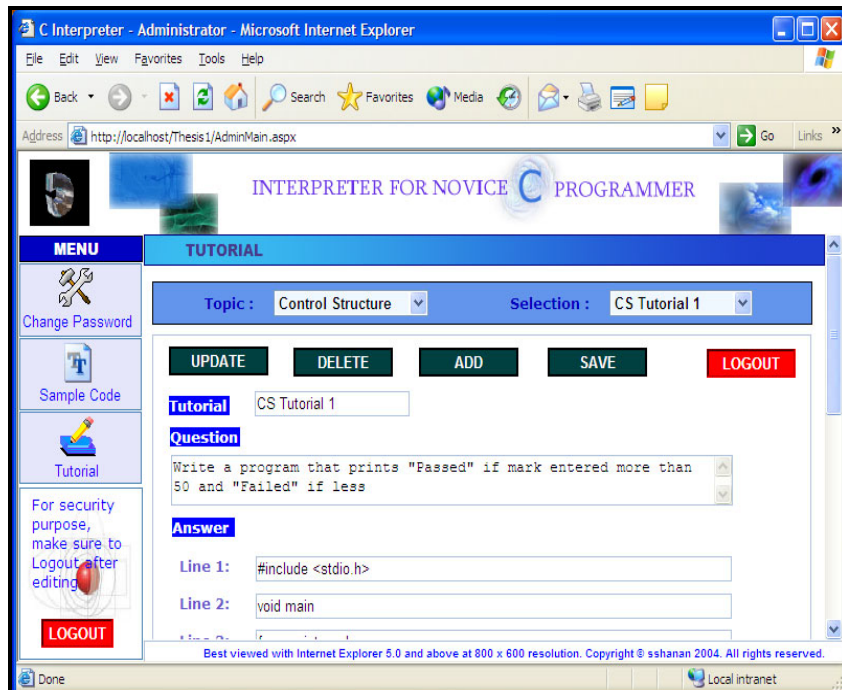
Figure 11   Updating the tutorial module using the administrator module

4.0   USER ACCEPTANCE

Table 1 shows the results of user evaluation of IfNCP. The system was evaluated by 50 first year computer science students. The first year students have no knowledge of C programming and are considered novice to C programming. The system was evaluated based on its interface design, navigation design, content appropriateness, performance and the effectiveness of its help module. The results of the evaluation are presented as histogram in Figure 12.

Table 1   Results of user acceptance test

Subject	Excellent (%)	Good (%)	Moderate (%)	Poor (%)	Total (%)
Interface design	16	72	12	0	100
Navigation	24	60	16	0	100
Content	16	72	12	0	100
Performance	0	64	32	4	100
Help	0	16	72	12	100
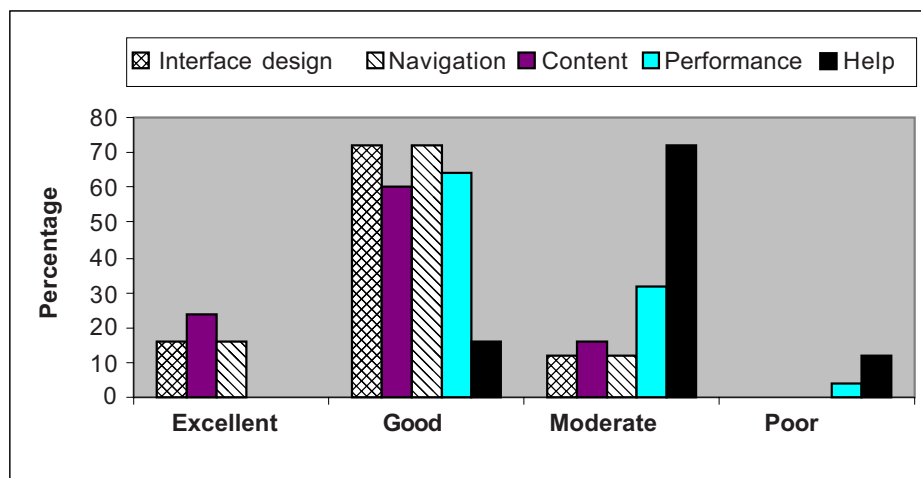
Figure 12   User's evaluation

In general, most users found the system good in terms of interface design, navigation and content appropriateness. However, users were not satisfied with the system performance and the effectiveness of the help module. These two aspects of the system require some additional enhancements in the future.

It would have been ideal to evaluate the understanding of students who used IfNCP as a learning tool and compare their understanding with students who have not used IfNCP. A complete study would have compared the C programming grades of the students who used with and without the use of IfNCP.

However, this study could not be undertaken due to lack of resources. The researchers lacked the financial and manpower resources to carry out the study. Also, the IfNCP system only includes five basic topics of C programming. On the other hand, the C programming course taught in classes is far more complex and cover more advance topics. Thus, the study would have not provided a balanced insight of the use of IfNCP system to help students.

Due to the lack of resources, the research team was only able to obtain some verbal insight with the students who evaluated IfNCP. Most evaluators (41 students) agreed that IfNCP gave them better insight and understanding of C programming. It had helped them comprehend the fundamentals of C programming much better in class and helped them with more complex programming concepts. Nevertheless, 9 evaluators stated that the system didn't increase their understanding in basic C programming.

5.0 CONCLUSION

IfNCP is a dynamic web-based application. The system is an interactive online learning package for novice C programmers which provide adequate information and assist in knowledge acquiring. It has helped beginners to learn C programming in an interactive manner.

IfNCP system only covers five basic C programming concepts. With more resources available in the future, it is expected that the IfNCP would be developed for more C concepts. Also, the effectiveness of IfNCP could be evaluated more in objective terms rather than subjective terms as carried out now.

REFERENCE

[1]   Shuman, E. J. 1998. *Multimedia in Action*. Belmont: Wadsworth Publishing Company.
[2]   Feldman, T. 1994. *Multimedia*. London: Chapman & Hall.
[3]   Edwards, A. D. N., and S. Holland. 1994. *Multimedia Interface Design in Education: Playing Graphics in Design and Use of Multimedia Courseware*. UK: University of Aberdeen.
[4]   Dix, A., J. Finlay, G. Abowd, and R. Beale. 2002. *Human Computer Interaction*. Cambridge: Prentice Hall International.
[5]   Holmes, S. C Programming. Scotland: University of Strathclyde Computer Centre. http://www.strath.ac.uk/IT/Docs/Ccourse/ (accessed on 6th August 2003).
[6]   Kernighan, B. W. Programming in C: A Tutorial. Bell Laboratories. Murray Hill. New Jersey. http://www.lysator.liu.se/c/bwk-tutor.html (accessed on 6th August 2003).
[7]   Stardotstar Software Limited. C *Tutor* (*CD-ROM*). India
[8]   Deitel, H. M., and P. J. Deitel. 2003. C *How to Program*. New Jersey: Prentice Hall.
[9]   Paivio, A. 1986. *Mental Representations: A Dual Coding Approach*. London: Oxford University Press.