CHAPTER 1
INTRODUCTION

This dissertation discusses on the development of Intelligent Multimedia Help System for Arithmetic (ARITHELP). ARITHELP provides the user with learning materials, practice and help facilities. It is an intelligent system, which can predict what the user wants to do, and present information based on this prediction. The system learns during its existence. In other words, it learns, from each situation which response permits it to reach the solution. The term "intelligent" can be referred as the system’s ability to know what to teach, when to teach and how to teach the subject. It has the capacity to understand, learn, reason and solve problems.

Normally, students get help from channels such as teachers, friends, and books. However, there may be no answer, no exercise answer, not enough explanation and limited example of question provided. This does not help if students need solutions immediately. They will feel frustrated and discouraged. The learning curve would be steep at first, which flattens out before real skill is acquired. It shows that a help facility’s role is to encourage the student to seek out the full functionality of the subject they are learning.

The help system has become popular in recent years since it facilitates with ease anyone to seek assistance at a computer terminal or through on-line help system rather than use of a user manual. The help system is the intermediary between the teacher or book and the learner. It allows the volitional control of learning by the learner rather than the instructor and facilitates noncontiguous communication between the student and instructor. It provides access to a range of help materials. The help system may consist of text and graphic files that are linked through the help button or other command keys to a computer application. It is therefore possible to have an intelligent tutoring system together with the help system. Hence, learners can solve their problem at the same time as the learning processes take place.
Algebra help system is an example of the help system that provides help for student who have an algebra problem. It provides a wide array of resources including tutorials, extra problems, algebra calculators and address of persons who can be contacted for further help. Another examples available are the vector and physic help system.

ARITHELP provides a quick and easy help for arithmetic using multimedia concepts. Multimedia helps to make education more attractive and effective by providing higher levels of interactivity. It can be used to support teaching which can transform the conventional instructor into a facilitator of the learning process. Furthermore, an interactive multimedia or hypertext may allow the user to communicate easily with the system.

1.1 PROBLEM DESCRIPTION
Currently, learners are using channels such as teachers, friends, and books to obtain help to solve problems. The teacher lectures in front of the class while students sit at desks in rows and listen, take notes and occasionally ask questions. The knowledge obtained is then applied to practical exercises within a class or taken home. Homework is an important component of the learning process which help students to consolidate what they have learned in the non-regimented atmosphere of their own homes. As such the above mentioned channels is an inefficient helper to students who may need solutions immediately. In addition, if students were to work alone on their homework assignment, they would be liable to make mistakes which if not noticed would be repeated several times throughout the assignment. For example, imagine the following scenario where an arithmetic student is stuck on a homework problem which is part of an assignment due tomorrow but there is nobody to help. It may not be of help to ask an older brother or sister, mom or dad or friends, who may not understand the problem. The teacher is not available at midnight. A book too may be of no help.
Sometimes an operation is easy to solve and at times it may be difficult to find the answer. The term ‘help’ is used to denote a student who face problems in doing the arithmetic problems. The student may be a secondary, primary or higher level student. They may not use a book to find the solution because of the following reasons:

- No answer can be found in a single book. It would cost the student more to find solutions in another book.
- No solutions are given in a single book. As such the student would not know the precise answer.
- There are not enough explanations given in a book.
- There may be limited examples provided.

In addition, human expertise may become unavailable. The talents of an expert may be lost through death, retirement or job transfer. Experts tend to be expensive and demand high salaries or service fees, which may not be affordable by educational institute. The teachers become experts when they have specialized knowledge about the problem. Figure 1.1 show how human helps the student.

![Figure 1.1: Human Problem Solving](image)

The teacher’s knowledge is stored in the long-term memory. When providing an advice or help to the learner, the teacher would firstly obtain facts about the problem and stores them in his short-term memory. The teacher then reasons out the problem by combining the facts from the short-term memory with those from the long-term memory. Through this process, the teacher infers new problem information and eventually arrives at a conclusion about the problem. It is the process that ARITHELP aims to emulate.
1.2 INTELLIGENT MULTIMEDIA HELP SYSTEM FOR ARITHMETIC (ARITHELP)

The Intelligent Multimedia Help System (ARITHELP) is developed by applying interactive multimedia and hypermedia. The system offers the learner solutions to their problem instead of teaching them about the course. It is an interactive system, which apply the multimedia concept such as text, graphics, audio and animation to deliver the help content in an intelligent way. This instructional software that integrates text, sound and computer animation presents material and help to student in a multimedia form that maximize its effectiveness.

The ARITHELP development is mainly based on the expert system paradigm. It is designed to model problem solving ability of a human expert. The ARITHELP is an intelligent help system developed as a helping aid for a course on Arithmetic to enhance students' understanding of arithmetic such as whole numbers and fractions. This system provides help function for the beginner and intermediate user whose face arithmetic problems. As students work through problems, the ARITHELP monitors their progress like a human expert help. The system also provides just-in-time feedback, hints on strategy and new problems that address diagnosed areas for improvement. Besides being a computer help, ARITHELP is designed to perform as a teacher by providing learning materials and exercises for practice. ARITHELP may look like an intelligent tutoring system but instead of tutoring, it also provides help materials to the learner. In order to teach and help effectively, the system must understand the current skill level and cognitive state of the student who uses it.

Psychology, education, cognitive science, artificial intelligent and human factors all play a role in the development of ARITHELP. ARITHELP also apply hypertext and hypermedia as a presentation medium. It emulates a human teacher in the sense of teaching level and teaching technique.
ARITHELP basically attempts to model a one-to-one human help situation. This is because a one-to-one help is the 'gold standard' of learning, which consistently yields the best helping outcomes. The student's interact with the system may look like a traditional CAI question and answer system. ARITHELP incorporates an expert system designed to model the problem-solving ability of a human expert. It provides the framework to code, organize and retrieve knowledge about a specific domain. It also has the capability for reasoning, justifying, interpreting, predicting, diagnosing, monitoring, planning and controlling student behavior.

It models the human problem solver and recognizes the human capability of using a variety of methods to solve problems. It is smart enough to be able to provide 'ideal' and correct answer including an immediate response. In addition, it is capable of demonstrating the correct method of solving a problem. ARITHELP also monitors the student's progress as they work through solving the problem and determine the correctness or error of every step without waiting for a final answer. The system watches each step of the student's answer or action in response to the question. Each time the student makes an error, ARITHELP will diagnose the problem. It will then attempt to offer remedial solutions by providing detailed advice about how the system would do the step. For example, if the user wants to know how to add the quantity (7+10), it does not just display the answer 17, but a step by step solution are properly illustrated by the system. The description of the modules developed follows.

1.2.1 Main modules

The system consists of three main modules:-

1. Learning
2. Practice
3. Help index.
1.2.1.1 The Learning Module
At times, students may face problems in understanding the lesson being taught by their lecturer. This module provides the lesson by teaching a student who need help to understand arithmetic of whole numbers and fractions. It applies an animation technique, which show the step-by-step solution. The students can try to solve the problem on their own. At the same time, the system will check on the correctness of the answers and give an intelligent feedback on the answer given. The system also gives hint on how to solve the problem when requested by the user.

1.2.1.2 The Practice Module
In this module, the system does not let a student enter a wrong value and provide immediate feedback. This module provides a set of questions for students to apply their understanding. As students learn through the chapters, they can try to do the practice questions provided by themselves. The student can choose the lesson to practice on in accordance to their requirement. The test at the end of every chapter is provided to help the student access their understanding of the material. The system will show the step-by-step instruction to proceed to the next step when requested.

1.2.1.3 The Help Module
The system tries to understand what plan or goals the student is pursuing as the student does an activity. It offers help when asked and at times offer unsolicited help. Below is the list of help functions provided by ARITHELP.
• The system provides a suitable hint when requested for help. It gives step by step instruction in order to solve the problem.
• The system applies an animation technique to show how an expert solve problems.
• The system demonstrates on-line on how to use the system.
• The system provides a help index, which contains a list of arithmetic term together with its description. Hence, the student may search for help material according to their requirement.
1.2.2 Sub modules

The system consists of two sub-modules: -
1. Beginner
2. Intermediate

1.2.2.1 Beginner

This sub-module teaches about the whole number of arithmetic. Whole number of arithmetic can be used by anyone who reads at a second to third grade reading level and understands basic number concepts such as counting. The lesson coverage includes addition, subtraction, multiplication and division of the whole numbers.

1.2.2.2 Intermediate

This sub-module teaches about Fractions. Fractions enable the student to label some of the points between counting numbers. The word fraction comes from the Latin fractus meaning to break. Fractions are used to describe subdivisions of the standard measurement units for length, time, money or whatever we choose to measure.

1.3 THESIS SCOPE

The scope of this thesis is to develop an intelligent multimedia help system of arithmetic’s program for beginner and intermediate students. The focus of this research is to provide an “intelligent” computer-based teaching system. The major goal is to study the creation, implementation and evaluation of an efficient and economical intelligent multimedia help system for arithmetic.

1.3.1 Definition of Arithmetic

Arithmetic is the study of numbers such as 1,2,3,4..... under various operations of which the simplest are subtraction, addition, multiplication and division. These are the so called “Four Rules”. The word arithmetic is derived from the Greek arithmos, meaning number.
1.3.2 The four rules of Arithmetic

\textit{a. Addition}

The symbol for addition is + (plus), from the Latin, meaning more; it is placed between two numbers to be added together. Thus, $8+7$ mean ‘eight plus seven’ or ‘seven plus eight’. We can use the symbol repeatedly between numbers to be added, e.g. $8+4+9+12$.

\textit{b. Subtraction}

The symbol for subtraction is – (minus), from the Latin, meaning less; it is placed between two numbers, when the second is to be taken away from the first. For example, $12-9$ means ‘twelve minus nine’ or ‘nine taken away from twelve’; $12-9=3$.

\textit{c. Multiplication}

When we have a number added to itself several times, we shorten the process considerably by multiplication. If seven rows of strawberry plants are laid out in a garden with 12 plants in each row, we could either add:

$12+12+12+12+12+12+12=84$ (7 lots of 12)

Or

$7+7+7+7+7+7+7+7+7=84$ (12 lots of 7)

The working is greatly reduced by writing either $7\times12=84$ or $12\times7=84$ and reading as ‘seven times twelve equals eighty-four’ or ‘twelve times seven equals eighty-four’. The symbol $\times$ means ‘multiplied by’ or ‘times’.

\textit{d. Division}

Division is the process of sharing. The sign for division is $/$, for example, $12/3$ means ‘twelve divided by three’ or ‘if twelve were divided into three equal group, how many would there be in each group.’
1.4 THESIS OBJECTIVES

Normally, students would prefer to get help from the system rather than manuals because of its efficiency and convenience. Thus, the objectives of this thesis are:-

1. To increase the learning of the participating arithmetic students by making more effective use of the time they spend studying examples and solving problems.

2. To slowly and steadily increase and improve the arithmetic solving capabilities. Therefore, frustrated students have a place to at least try to find the answer to their problem at the time they need it.

3. To lead the student in the instruction and ensure that their work is productive.

4. To provide help at their own time, place and pace.

5. To reduce the costs of printing the help manuals.

6. To improved the quality of the instructional contents.

7. To provide a quick and easy help.

8. To provide an interactive multimedia help by producing the contents in an intelligent way.

9. To provide an efficient learning environment to the students who may or may not have prior exposure to the subject content.

10. To investigate the effectiveness of an intelligent system in providing help.

1.5 THESIS ORGANIZATION

Chapter 1 describes about the problem of the current system, brief description of the system such as its scope and objectives. Chapter 2 covers the usage of multimedia in education. Several concepts related to multimedia used in ARITHELP are discussed such as hypertext, hypermedia and interactive multimedia. Chapter 3 provides a review of previous research, which were related to the system being developed. Different types of intelligent system, student modeling architecture, educational technology and reasoning method are discussed. Chapter 4 describes the components of ARITHELP which comprises the expert model, tutor model, student model and interface model. Chapter 5 focuses on the methodology of this thesis. The methods used to obtain the data, design and implement the system are discussed. Chapter 6 covers on the design of ARITHELP. It describes a screen design, interface design and methods of interaction provided for users. Chapter 7 highlights the implementation aspects of the system. The tools used for implementation and testing procedures are discussed. Finally Chapter 8 describes the problem encounter during the system development and its
solution. The system strengths, limitation and future enhancement of the system are discussed. Finally, the overall presentation of the thesis is concluded.