CHAPTER 1

Introduction

1.1 Background Study

Intelligent Tutoring System (ITS) is a software tool for monitoring students' learning and solving problems of particular subjects. It attempts to construct a system with 'human like' tutoring capabilities and tends to be more sophisticated than conventional Computer Aided Instruction (CAI). At present, ITS is gaining popularity in education and much research and software has been developed such as RAPITS which was based on teaching ideology of the COCA-1 (Cooperative Classroom Assistant) by Niger Major and the Intelligent Computer Aided Instruction (ICAI) system known as Aplusix [J.F Nicaud & M.Saidi]. ITS differs from traditional CAI packages especially in their use of Artificial Intelligent techniques.

ITS provides individualized tutoring or instruction. Each ITS must have these three components:

- knowledge of the domain
- knowledge of the learner (student)
- knowledge of teacher strategies (Instruction knowledge)

The domain refers to the topic or curriculum being taught. The learner refers to the student or the user of the ITS. The teacher strategies refer to the methods of instruction and how the material shall be presented. This requirement has been imposed since 1973 when it was introduced by Derek H. Sleeman and J.R. Hartley [Hartley & Sleeman, 1973].

The study is focused on mathematical Vector. The theory of vector is applied in field of study such as Engineering Mathematics and Mechanic. To be able to do mechanic, the concepts of Vector have to be properly understood. Vector can be used either in physics or mathematics and can be mathematically represent objects in motion and at rest. It can be represented in a

real world situation such as the movement of the train on a railroad. This movement can be calculated using vector by presenting its magnitude (speed of the traveling) and the direction. With the understanding of the vector concepts, students may implement it in many objects in the real world.

Almost any subject learnt requires skill in mathematics. Topics such as algebra and trigonometry mainly involve formulae and applications of formulae in problems without relating it to the real physical situations. Apart from formulae and their applications, vector requires concepts and visualizations of direction and position in the real situation. This increases the difficulty of learning vector. Theory of vector is applied in engineering mathematics and mechanics. Research has shown that students have difficulties in learning mechanics [Peters 1982, Sapiyan et. al. 1996]. Entities in mechanics such as force and velocity require concepts of vector.

In studying vector, many students face with problems especially in understanding the important fundamental concepts of vector such as the concept of direction and how they visualize it. The concept of direction usually makes students confused especially when they try to solve the vector calculation such as addition, subtraction or multiplication. Sometimes they do not attentive that the different direction will cause a different value even the length is same.

The ideal outcome of this study is to develop a system prototype in order to solve the above problems. Thus VECITS (Vector Intelligent Tutoring System) is developed to help students to overcome and guide them to solve this problem. It may act as a human tutor by providing a help and hint for them to refer. The details of the VECITS will be discussed in 3.5.1.

1.2 Objectives

In order to fulfill the requirements of students in having a complementary tool to do their own revision and improve their learning instead of merely reading the text book or notes delivered by traditional instructors, the VECITS developed must be able to act as a supporting tool to

foster effective learning by guiding and coaching them. Thus, the objectives of developing VECITS in this study is to

- provide an tutoring system for secondary school and undergraduate students in learning at their own pace according to their capability and enable them to do their revision at any time. This includes guiding them to do their exercises until they get the appropriate answers.
- offer individual guidance for students to do their exercises and trace the mistakes at each stage of solving the particular problem. VECITS instructs the students the next step to follow until they get the correct solution at that stage.
- give immediate response, featuring a two-way communication between VECITS and the student in a one to one tutoring manner.

1.3 Project Outline

This thesis presents a prototype system for tutoring mathematics vector. ITS for vector is developed to help students improve their skills in solving vector problems. This computer tutor is aimed to help students strengthen their understanding of the concept of vectors using various fundamental ideas such as trigonometry, algebra and geometry.

Students usually encounter difficulties in understanding vector and solving problems in it. The reason for this seems to be that vector requires the application of knowledge in geometry, trigonometry and algebra. Secondly, students have to learn the rules of vector itself such as rules of vector addition, subtraction and multiplication and the underlying theory of vector which is to applied in solving problem. Some of them are confused with the direction of vector. The direction is a vector characteristic, which requires students to visualize. Even if the vector magnitude is correct, failure for students to express the right direction causes serious errors in the analysis of the problem. Furthermore, statements of the problems given can be easily misunderstood.

This tutoring system is an attempt to overcome the problem stated above using an Artificial Intelligence approach. The main technique used in this tutoring system is coaching with hint

and help. The nature of the problem is such that a student cannot profitably practice using just an exercise book or the like. Sometimes students require something different from human teaching such as using 'electronic teacher' to learn and practice the exercise due to weaknesses and drawbacks of human teaching. In addition, students receive immediate feedback at various stages of solving the problem, indicating whether the answer is correct or wrong during each transition stage.

Students have the opportunities to practice on their own at their own pace according to their ability, without needing a teacher and receive helpful feedback beyond simply being told what the correct answer is without knowing the reasons for the wrong answer. As such, they can do their own revision anytime they want to. This tutoring system supplements the course lectures with practice and coaching. Normally, it requires several additional class sessions to present in adequate amounts to all students. With ITS, individual tutoring with two way feedback between ITS and student is conducted to all the students simultaneously. Hence, this computer tutoring is more effective for each individual.

VECITS developed here attempts to reinforce students learning by providing the domain knowledge in the first section and tutorial in the second section. Simple questions are attempted initially in order to familiarize students before they continue with more complicated questions. The tutor drives the instruction, but the student is allowed to get help and ask for explanations when required.

VECITS attempts to:

- provide a learning environment for vector including explanations, formulae and examples.
- provide help or advice and hints depending on the difficulties encountered by students at that instant in time.
- present appropriate problems with various degrees of difficulties and guide the student in solving them.

Computers are not able to think exactly like humans nor are they able to react or communicate like humans. To incorporate artificial intelligence into the computer system has been a

difficult task especially in teaching and learning. But with today's technology and the cooperation of teachers and program designers, ITS can be used in the classroom attending a variety of subjects such as mathematics, programming language, and others.

1.4 Project Scope

This study is intended to produce a system prototype and to introduce a concept of learning mathematical vector with domain knowledge in the classroom, and to illustrate the system by mapping this representation into computer interaction form. This system covers the concept of mathematics vector including explanations, formulae, calculations and animations of vector representation with various rules including changes in vector's direction. This system allows students to input their answer, which is then, diagnosed automatically line by line.

The system does not grade the answer but provides comments. As it provides guidance for students to answer the question correctly according to the right step at each stage until they get the correct answer, this implies that, there is no incorrect answer. They have to complete answering the question correctly stage by stage with the system guidance before they attempt the next question.

The system comprises of two main sections, namely the domain knowledge section and the tutorial section. The domain knowledge section consists of notes on the vector theory, while the exercises and problems are in the tutorial section. The students can easily refer to both sections in any order within the same session.

1.5 Target Users

The target users are secondary school pupils (Sijil Pelajaran Malaysia level) and college undergraduates. This system can help them evaluate their strengths and weaknesses in learning vector. In defining the target users, there are two groups of students to be classified as follows

1) Students who have previously learned the topic or related materials and have failed to recall some of the procedure skills. For example, in studying vector, student needs to know the basic skills of vector calculation and knowledge required in other topics such as trigonometry and calculus. Vector is also a prerequisite topic in other areas of study.
2) Students who have no basic skills of the subject will face more difficulties. Many of them are easily frustrated and lack the confidence to tackle the difficult problems that may be within their ability to solve if they acquire the concept. This type of student needs to be motivated by initially providing simple questions and exercises and gradually giving them more difficult questions to attempt.

1.6 Thesis Organisation

Chapter 1: Introduction

The ITS components are generally described in the introduction. The choice of the topic vector and the target users are given. The objectives and features of the tool to meet the objectives are stated.

Chapter 2: Literature Review

In this chapter, the various issues concerning in VECITS and ITS development are examined such as multimedia concepts in ITS, that comparison between Computer Assisted Instruction and Intelligent Tutoring System, the models used in ITS and the feedback features in ITS. Besides that the existing of ITS are also discussed.

Chapter 3: Domain Knowledge in Mathematics Vector

In this chapter, the concept of mathematical problem solving is discussed. Furthermore, the characteristics of vector such as Direction and Magnitude, the arithmetic of vector such as vector addition, subtraction and multiplication, the difficulties in learning and solving vector is also discussed.

Chapter 4: Methodology in Developing VECITS.

This chapter discussed about the methodology used in VECITS development which is focused on the model involved in the design phase, features used and the feedback characteristics.

Chapter 5: Implementation

This chapter discussed about the tools used in the development phase, the topic selection, the generation of the problem and the description of the system which discussed about the system feature and the description of the design. The strength and the weaknesses of the system are also discussed in this chapter.

Chapter 6: Conclusion and Future Enhancement

This chapter concluded all the content from the chapter 1 to chapter 5 and also discussed about the future planning for this study.