

**THE PHYSICS INTELLIGENT TUTORING SYSTEM
WITH PROBLEM SOLVER**

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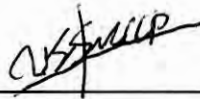
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This report is submitted in partial fulfillment of the requirements for the
Bachelor of Computer Science (Artificial Intelligence)

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
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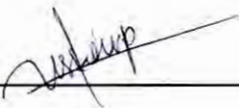
DECLARATION

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(DR. GEĐE PRAMUDYA ANANTA)

DEDICATION

To my parents, Yulianus Manta and Deti Fardiyati Salim;
my siblings, Hanni Maryam Manta and Danni Wahyudi Manta

ACKNOWLEDGEMENTS

I will praise The Lord who counsels me; even at night my heart instructs me. I have set The Lord always before me. Because He is at my right hand, I will not be shaken [Psalms 16:7-8].

I am most indebted to my beloved family; my parents who always give me ideas, feedbacks, and mental and spiritual support regarding this projects.

I am also very grateful for the supervision from Dr. Gede Pramudya Ananta, who gives me knowledge about Intelligent Tutoring Systems and intensive guidance throughout this project development.

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ABSTRACT

The Physics Intelligent Tutoring System with Problem Solver (PITS) is a windows-based application, developed using Microsoft Visual Basic .NET environment which applies existing Intelligent Tutoring System (ITS) framework to Physics subject, specialized in Kinematics and Dynamics for junior high school level. It aimed to help students in learning Physics at home. The PITS also integrated with Physics problem solver, a feature that can give answer and explanation to a physics question. It receives variable values as inputs and then searches for appropriate formula to calculate unknown variables as outputs. The system testing is conducted by distributing questionnaires to students and experts who have tried to use the system. It is concluded that the system has meet its design objectives.

ABSTRAK

The Physics Intelligent Tutoring System dengan Problem Solver (The PITS) ialah suatu aplikasi berasaskan Windows, dikembangkan dengan menggunakan Microsoft Visual Basic .NET yang mengaplikasikan kerangka Intelligent Tutoring System (ITS) kepada matapelajaran Fizik yang dispesifikasikan pada topik Kinematik and Dinamik untuk tingkatan sekolah menengah. Sistem ini bertujuan untuk membantu pembelajaran Fizik di rumah. The PITS juga terintegrasi dengan Physics Problem Solver, suatu fungsi tambahan yang mampu member cara penyelesaian dan jawapan untuk soalan-soalan Fizik. Ianya menerima nilai pembolehubah sebagai masukan dan kemudian mencari rumus yang sesuai untuk mengira pembolehubah yang tidak diketahui sebagai keluaran. Pengujian system dilakukan dengan mengedarkan borang kajiselidik kepada pelajar dan pakar yang telah menguji sistem. Sebagai kesimpulannya, The PITS telah memenuhi objektif reka bentuknya.

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CHAPTER I

INTRODUCTION

1.1 Project Background

Physics is a natural science that involves the study of matters, conducted in order to understand how the universe behaves. This involves sets of formulas that need to be sequentially examined to solve layers of sub-problem. Somehow, this becomes a complex problem for high school students in learning physics topics, such as mechanics, or kinematics. One way to help students on this matter is by explaining the steps on how to solve physics questions (problem). On the other hand, students also have difficulties when they have to study physics at home (without teacher).

Intelligent Tutoring System (ITS) refers to artificial intelligence computer system that provides customized instruction and feedback to students. ITS can be designed to help students in learning various school domains, such as Physics. There are already some researches, and projects on ITS, and nowadays this area is still a very interesting topics to be developed, but the application for this kind of application is still not eminent.

One of typical well-known methods for students in studying Physics is learning from solving Physics questions and then if students have problems in answering one of them, they might ask their teacher or friends at school, but somehow it is difficult for them to get explanations and answer to that particular Physics question. So, it would be very helpful if Physics ITS have one feature that specialized in answering and give comprehensive explanations to a particular question that inputted by students itself, hence can improve the quality of student's home learning

1.2 Problem Statement

From the background, we can infer the problem statement: *How to develop an Intelligent Tutoring System that combined with problem solving feature, which is dedicated for students in learning physics in order to improve their home learning?*

1.3 Objective

The objectives of this project are:

- Build a model of Physics Intelligent Tutoring System (specialized in kinematics and mechanics topics)
- Provide friendly user interface that make students easier to use the ITS application
- Integrate a physics problem solving machine into the system to support students in learning by themselves

1.4 Scope

Physics Intelligent Tutoring System with Problem Solver is categorized as ICT in education and training, which is specialized in learning system for Physics. The technology adopted by this project is known as Intelligent Tutoring System, a subset field of Artificial Intelligence's Expert System.

This project's scope covers the prototype or model development of Physics ITS application, which is include its problem solving feature, and collect knowledge about the user. The ITS also specialized in the matters of topics; where in this project, the application will be focused to *mechanics* topic.

This project's target will be ranged from junior high school student to high school student who learn physics based on its relevance with the Physics's topic that covered in Physics Intelligent Tutoring System with Problem Solver.

1.5 Project Significance

The Physics Intelligent Tutoring System with Problem Solver is dedicated for students, especially high school students and junior high school students, or anyone who interested in learning basic Physics in kinematics and mechanics.

Physics Intelligent Tutoring System with Problem Solver is capable to provide a new learning environment to improve student's home learning. The ITS itself is different from ordinary learning or training applications, because in ITS, the system is designed to provide learning tutorial in different levels according to the student's level of understanding. This application's paradigm make ITS so interactive that it can give real feedback to students as the learning process take place.

Moreover, as the improvement of traditional ITS, Physics Intelligent Tutoring System with Problem Solver also equipped with Physics problem solver that can provide answer and step by step explanation to physics questions asked by the students themselves.

1.6 Expected Output

Physics Intelligent Tutoring System with Problem Solver is developed based on several existing domain knowledge regarding to Intelligent Tutoring System (ITS), and Physics tutoring applications, hence this project does not manage to discover something new, but this project is expected to add a new innovation to the current existing technology. In this case, we proposed Physics Problem Solver feature for the Intelligent Tutoring System, where this module is able to provide answer and its

elaboration or explanation for physics's questions asked by the students. This is of course, generates a new way and environment for students in their home learning.

In the other hand, to make the product of this project ready to be implemented and directly capable to help student in their home learning, it is expected that this product is easy to install, easy to use, and engage a complete bundle of its supporting software and plug-ins. Moreover, the most important thing is that this product is cross-platform, means that the vast majority of devices (computers) owned by students is capable to run Physics Intelligent Tutoring System with Problem Solver developed in this project.

1.7 Conclusion

Physics Intelligent Tutoring System with Problem Solver is developed to answer the problem statement in how to develop Intelligent Tutoring System that combined with problem solving feature which dedicated for students in learning physics in order to improve their home learning.

The Physics problem solver feature makes Physics Intelligent Tutoring System with Problem Solver different from typical ITS application. This feature allows students to ask Physics question to this application, and then get answer plus explanations for that particular question.

Finally, the introduction for this project has been elaborated. Literature review is the next activity, and discussed in the next chapter, along with the project methodology to explain the domain knowledge and main guideline in developing Physics Intelligent Tutoring System with Problem Solver.

CHAPTER II

LITERATURE REVIEW & METHODOLOGY

2.1 Introduction

There are several important things that are discussed in this chapter, the literature review, project methodology, requirements and some other things. This chapter is very important to establish a strong foundation for this project and provide a guideline on how the objectives can be satisfied. A number of journals, books and online literatures that are relevant to ITS application then retrieved to provide sufficient reference for this chapter.

2.2 Facts and Findings

2.2.1 Domain

The Physics Intelligent Tutoring System (PITS) is classified as Intelligent Tutoring System (ITS), a developed sub domain under Artificial Intelligence's well known domain called *Expert System*. ITS represents a more specific type of Instruction and Computer-assisted Instruction or Computer-aided Instruction, (or we can abbreviate them as CAI) refers to the use of computer so that it interactively assists students in their educational process (Shute & Psotka, 2001).

The development of ITS continues, and nowadays, CAI is widely used as an alternative to the traditional classroom instructional learning. CAI is classified into

several types based on its teaching and learning strategy approaches (Fook & Sidhu, 2007).

2.2.2 Existing System

The early development of ITS can be traced back to 1950, where B.F. Skinner, psychologist from Harvard used the term 'programmed instruction' to appoint any instructional system in which materials were presented in a series of small steps. Those steps required an active response from the learners or users, and then the system will provide an immediate feedback. This technology was the vanguard to the usage of computer tutorials in education (Fook & Sidhu, 2007).

Nowadays, there are many ITS-based projects that aimed to help human in learning specialized skills, or teach human about certain topics. Some of the examples are:

- F-16 Maintenance Skills Tutor (Marsh, 1999)
- LISP Tutor (Anderson, Farrell, & Sauer, 1984)
- Interactive Computer Identification and Correction of Language Errors (ICICLE) (McCoy, 2010)
- ComMentor: Socratic Tutoring for High-Level Command Skills (Domeshek, Holman, & Ross, 2002)

There are many techniques to complete those ITS projects, but the main framework is still the same. The PITS itself utilize tutorial technique combined with drill and practice approach. The PITS presents a non-democratic way to deliver teaching to the students. This technique is chosen because of its simplicity.

2.2.3 Technique

There are some other approaches that are also applicable and related with The PITS development such as simulation and problem solving.

Simulation can be classified as a high end courseware, where student are presented with computerized model or virtual situation of problem environment. The

system can be so interactive to respond student's actions and behaviors. Simulations usually used in advance system with complex teaching material (Fook & Sidhu, 2007). The PITS does not use this method because it is required an advance and massive multimedia engineering works which the resources are inadequate for such things.

Problem-solving can be described as a platform for students to learn by doing. System with problem-solving usually consists of tutorials, drills, practices, even simulation in one bundle. This method aimed to help students practice to solve problem in certain topic (Fook & Sidhu, 2007). The PITS does not use this method, because the resources available are unable to satisfy the requirements for problem-solving method.

A note should be taken; that "*Problem Solver*" in The PITS is not refers to problem-solving method. *Problem Solver* in The PITS refers to a special feature (or module) where students can request for answer and explanation to a physic question by inputting variables values to the *Problem Solver machine*.

2.3 Project Methodology

The PITS is developed using Object Oriented Analysis and Design approach. The system is composed from several class (or objects) that interact with each other to generate its intelligent behavior.

2.4 Project Requirements

2.4.1 Software Requirement

There are several softwares which are used to develop the system, and its report. Below is the list of them.

- Microsoft Visual Studio 2008 with Visual Basic Compiler
- Microsoft SQL Server 2005

- Microsoft Project 2007
- Microsoft Office Professional 2007
- Corel Draw Graphic Suite X3
- StarUML 5.0.2

2.4.2 Hardware Requirement

There is no special hardware requirement for the PITS. The system designed to be able to run on school-standard personal computer with multimedia capability.

2.5 Project Schedule and Milestones

Project schedule for The PITS development is described with the milestone graph below.

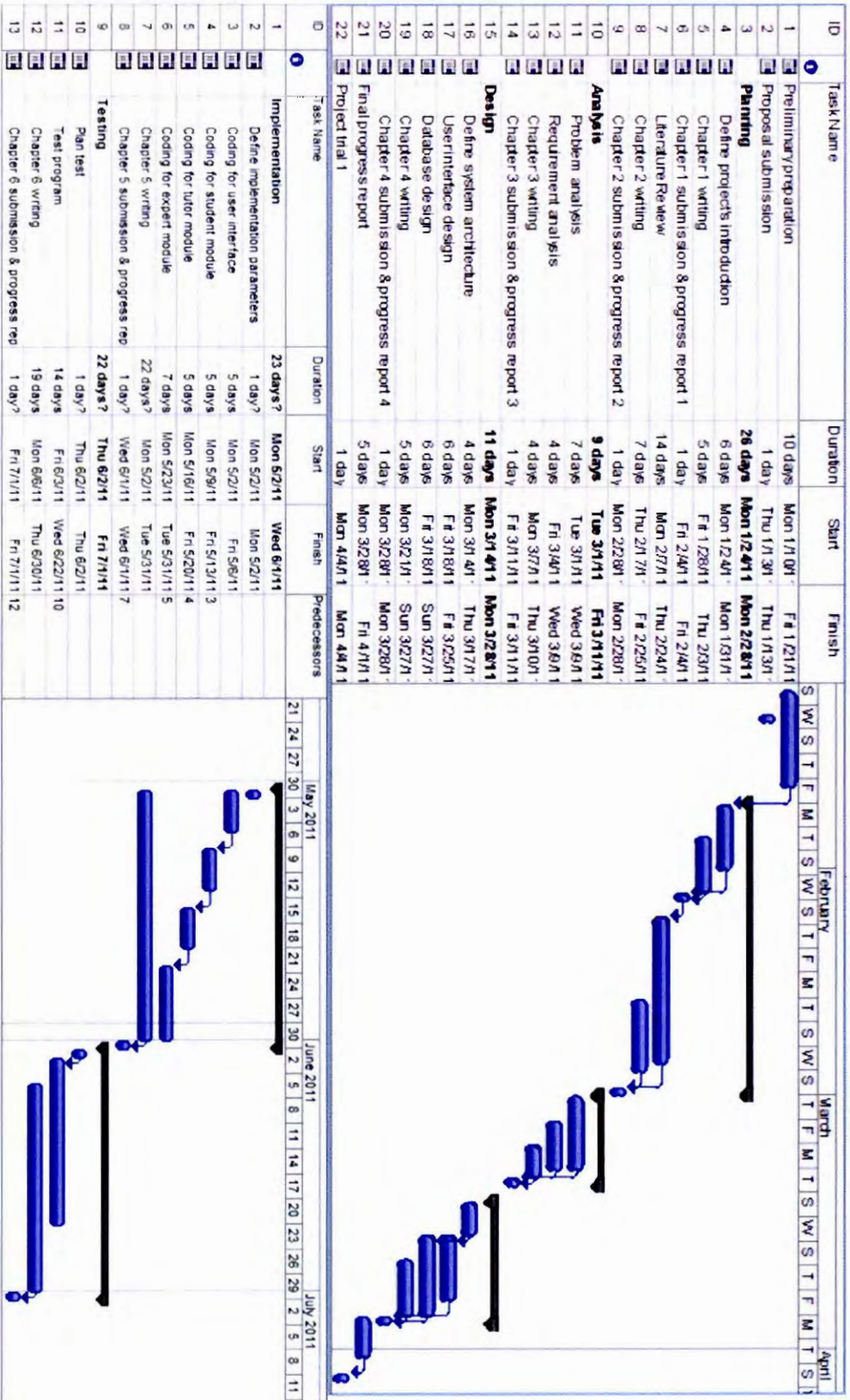


Figure 2.1: Project Schedule & Milestone

2.6 Conclusion

ITS is actually an old technology, its development has been started since 1950 but the word "perfect" for tutoring systems is not achieved yet. Year to year, there are many breakthroughs regarding to this topic and until now, it's still becoming an interesting area for researchers.

The PITS is developed using existing technique called non-democratic tutorial because of its simplicity. This technique forces the students to do activities according to the instructions that have been programmed sequentially. However, since the main feature is the Problem Solver machine, students can always use this feature except when the exam session comes.

Object Oriented Analysis and Design is chosen as the project methodology to ease the formation of modules and message sending between them. Finally, after all substantial standards for The PITS are determined,

In the next chapter, analysis phase of The PITS development is elaborated to get a comprehensive description about system's requirements.