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INTRODUCTION

1.1 BACKGROUND OF THE STUDY

“Education must enable one to sift and weigh evidence, to discern the true from the false, the real from the unreal, and the facts from the fiction. The function of education therefore is to teach one to think intensively and to think critically.”

– Martin Luther King (1947).

"To contribute to the future" is the duty of each citizen, irrespective of his position either as a parent and educator, or as a consumer, as a worker, as a member of social or cultural organizations, as a private investor, or ultimately as a voter (Wolf, 2003). These people will be confronted with problems, new challenges and opportunities, about which they have to take decisions that will affect our future generations. The quality of such decisions depends on the quality of thoughts. But much of our thinking is biased, partial, vague or uninformed. It is here the role of education comes. Education makes the thinking goal-directed. It make the thoughts active which help you to analyze and evaluate what you see, hear and read to distinguish the good and bad, the relevant and irrelevant than accepting all in a passive way. Education helps to find solutions for problems we may encounter which is an end product of such active (critical) thoughts. It makes the mind creative and inspiring which enable us to think in a novel way that result in new innovations essential for bringing changes in the society. According to Piaget (as cited in Ripple and Rookcastle, 1964), “The Principal goal of education is to create men who are capable of doing new things, not simply repeating what other generations have done”. Novel ideas are the results of creative thoughts which is an outcome of
quality education. Such novel ideas are essential for new technological innovations.

**Importance of Science Education**

We are living in an era of technological advancements which has revolutionized the world itself and the whole world is now available at the finger tips. The basis of such advancements is none other than the quality of science education provided to its youngsters. Kothari (1966) pointed out that, the prosperity and strength of a country directly depends on the level of scientific and technical knowledge cultivated in the country and on its capacity to make use of that knowledge to serve practical ends. According to NPE (1986), “Science Education being an important component of education system should contribute to the solution of the problem of the country by developing desirable understanding, skills, abilities and attitudes.”

Thus, Science education is essential for National development and for the contributions of people at various levels and therefore its quality should be developed considerably so as to achieve its purposes and objectives. Science education not only contributes for national prosperity and technological advancements, but also sharpens our intellect, helps to explore the unknown world and leads to inventions that transforms the world and makes life more interesting. Science is not only a body of knowledge, it is also a way of thinking and doing, looking at things and events, an approach to learning as well as how to learn, and this applies equally to all area of intellectual enquiry (Sharma, 1989).

According to NPE (1986), “Science Education Programmes should enable the learner to acquire problem solving and decision making skills and to discover the relation of Science with different aspects of life”. Also Indian Education Commission (1964-66) recommends that the quality of Science teaching need to be developed considerably to achieve its objectives such as to promote an understanding of basic principles, to develop problem solving,
analytical skills and the ability to apply them to their problems of material environments and social living and to promote the spirit of enquiry and experimentation. Thus we can say that Science and our everyday life are interconnected. In school, science education is imparted through three main subjects – Physics, Chemistry and Biology. Physics is the basis of all sciences and is referred to as the study of physical world. It is the study of basic laws of nature and their application in various natural phenomena.

**Importance of Learning Physics**

Knowledge of Physics is essential as it is the part and parcel of the Physical world. It is the mother of all sciences without which the complete understanding of other subjects is not possible. Learning Physics is important as it teaches us a method of systematic thinking that allows us to once again understand how the things we rely on actually work.

Physics students usually possess excellent analytical, quantitative and problem solving skills. They have the ability to synthesize and analyze large quantities of data and present their analysis in an easily understandable form. When faced with a particular problem they are taught to systematically identify all factors contributing to the problem and work out how those factors interact in order to solve the problem. These are valuable skills that can be applied in a range of careers.

The explanations to all the mysteries around us (the regular repetitions of the day and night, the night sky with its bright celestial objects, the annual cycle of seasons, the eclipses, the tides, the volcanoes, the rainbow etc) are there in Physics. It is the basis of all the inventions made by man (T.V, fan, Fridge, air conditioners, mobile phones, computers etc). Thus if we have any doubt regarding the Physical world, there is an explanation in Physics.

Also physics is the base for all technological advancements. Many of the technologies that are continually transforming the world today are the
results of important Physics researches. For example, research on the semiconductors enabled the first transistor to be developed in 1947. This outwardly simple device is the key component in all of our electronic systems, including computers, and it is now considered as one of the most important inventions in human history. Compare to the life style in 1990’s, our society has become very dependent on technology. We cannot even think about a day without smart phones and this seemingly simple device brings the whole world in front of you. Also it is the laws of optics that lead to the development of the optical fiber networks that enabled us to bring the world closer together. Likewise many other technologies conquered the world today. As already said, the basis of all such technological advancements is none other than the subject Physics and thereby it contributes for social change.

Even though the subject Physics is related to our everyday life, it is considered as a difficult subject and may be due to its abstractness. We cannot bring the whole world into the classrooms and this can be solved to a great extent by using technology integrated strategies.

**Importance of Problem Solving Ability in Physics**

Quantitative measurement is central to the growth of science, especially in physics, because the laws of nature happen to be expressible in precise mathematical equations. It is a cognitive ability to find or to create new solutions for the problem or to apply new rules to be learned. It is a process that starts when the initial encounter is made and ends when the obtained answer is reviewed in light of the given information.

Solving Problems plays an important role in learning Physics. Learning Physics without doing Problems (numerical) is incomplete. According to Plotzner (1994), the most efficient way of studying physics is independent solving of less complicated problems. One will get a clear understanding about the concepts learned in Physics only after solving the numerical problems associated with it. Also it plays an important role in developing transformative
skills such as hypothesizing, investigating, analyzing and interpreting data. So conducting any study in Physics education without analyzing the problem solving ability is imperfect. It is a usual belief that solving numerical problems in Physics requires high intellect and many students reported that they can learn the theory well, but can’t do the problems. Problem solving is a skill that can be developed through practice. According to Polya (1957), Problem Solving is an experimental skill such as swimming and can be developed. We can learn swimming by trying, watching others how they move their hands, legs and head and by practicing. Thus we can also develop the problem solving skill through practice.

**Importance of Critical Thinking in Physics**

As already said, the quality of our life depends on the quality of our thoughts. Good thoughts were goal directed, self corrective and based on evidence. It never sticks on to a particular mode of thinking but uses a variety of thinking based on the nature of the problem. Those varieties include scientific thinking, moral thinking, philosophical thinking, mathematical thinking, economic thinking etc. The person who uses different modes of thinking for solving a problem is called a critical thinker and the process is called Critical Thinking. Fisher (2011) defined Critical Thinking as an active process in which you think things through yourself, raise questions yourself, find relevant information yourself etc. rather than learning in a passive way from someone else. It requires strong evidence to support a particular argument or conclusion. A good critical thinker make correct inferences, interpret the data in an accurate way, make meaningful decisions and evaluate the arguments based on the available information.

Physics is a subject full of facts and concepts and majority of these concepts are abstract in nature. i.e. it is difficult to clarify such concepts using traditional methods such as Lecture method, which usually encourage rote learning and memorization The effect of this method is that it will create
inactive learners who cannot develop their Higher Order Thinking Skills. To understand Science concepts and to apply it to new and unfamiliar situation students require highly focused thinking called Critical Thinking. So Critical Thinking is essential for meaningful learning, understanding and application of various concepts in Physics. Critical thinking is a skill that can be developed using various methods like brain storming, small group discussions, questioning etc. If we use these methods in the learning strategy, the Critical thinking can be developed indirectly and will eventually lead to better Achievement in Physics. Also this will enable the students to make accurate decisions and to solve a number of problems in their daily life.

**Andes Intelligent Tutoring System**

The Andes Intelligent Tutoring System (Andes ITS) was developed at the University of Pittsburgh in collaboration with the cognitive science program to develop students procedural knowledge in Physics at Undergraduate Level. Here the ITS interacts with Physics students just like a tutor. It is an artificially intelligent homework helper for Physics. That is, it replaces the pencil and paper that students would ordinarily used to solve physics homework problems. Students draw diagrams, enter equations and define variables with the same freedom that they have when using paper; yet, unlike a piece of paper, Andes tells students whether their entry is correct or not and provides hints when asked. To solve problems, students must master all the major and minor principles and Andes explicitly teaches all of them. That is even though Andes was developed for enhancing Problem solving Ability, it concentrates equally on the theoretical base behind each problems.

The design of Andes ITS was based on four general principles. First, Originality, where the interface is similar to pencil- and- paper solution. Second, flexibility, in which students are allowed to skip steps when applicable. Third, immediate feedback and Fourth, they can receive simple hints when fails to achieve the goal. In short teachers and students can
effectively use this tutoring system for better teaching and understanding of numerical problems in Physics.

The investigator was attracted by these features of Andes Intelligent Tutoring System (Andes ITS) and found that it is good for problem solving and it will become the best when we add the theoretical part also. So the investigator decided to develop a strategy based on Andes ITS which comprises both the theoretical and problem solving sections. The problem solving section will be included as such like the original Andes but will be modified according to the level of Higher Secondary School Students. The theoretical section concentrates to make the abstract concepts more clear through techniques which may indirectly enhance the Critical Thinking of students. The strategy uses the same principles of original Andes in each and every step i.e Originality, Flexibility, Immediate feedback and simple hints. By adopting this design, students can overcome a number of obstacles they are facing in the meaningful understanding of Physics and thus the Achievement in Physics can be enhanced.

1.2 NEED AND SIGNIFICANCE OF THE STUDY

The progress and prosperity of any nation is determined by its standards in science and technology, which is an outcome of the Science Education provided to its youngsters. It can stimulate moments of pleasure and wonder for all pupils and helps them to notice hidden connections. It equips people with uniquely powerful ways to describe, analyze and change the world.

Many of our students are not interested in learning science due to the reason that science courses give more stress to theoretical matters and are isolated from the world of work. Very little time is spent on experiments, which fails to give students the expected understanding of science concepts. It must be the teachers who shall take the initiative to make Science learning more interesting.
Among different subjects in science, Physics brings people to the world of reality. Physics is intimately involved in every moments of one’s life which is the practical application of its principles. But Students are losing interest in Physics due to the mismatch between the level of understanding and thinking of students and the intellectual demand of the subject. Nijru and Karuku (2015) identified that the factors that lead to Poor performance in Physics were lack of background knowledge in mathematics, teacher factor, assessment methods and administrative factors. Also, the investigator understood the major causes of this disinterest based on her experience in teaching Physics in Higher Secondary Classes. They are mainly the lack of enough time to cover the bulk syllabus, the practice of rote learning, the difficulty in solving numerical problems in Physics and the difficulty to apply the learned concepts to new and unfamiliar situations.

It is rightly reported in the Education Commission (1964-66) that “if science is poorly taught and badly learnt, it is little more than burdening the mind with dead information and it could degenerate even into new superstitions.” Teachers are still following the lecture method, which never makes the abstract concepts clear and therefore even in this era, the learning of physics is focused on rote learning and memorization.

Solving numerical problems in Physics requires the mastery of numerous skills like ability to visualize the problem, ability to draw diagrams related to the problem, ability to identify the variables given directly and indirectly in the problem, ability to memorize formulae, computation skills, ability to convert one unit to another etc. It will be quite easy for above average students to master all these skills, but average and below average students find it difficult to master all these skills the problem demands. While reviewing the related studies, the investigator identified the following factors that affect the problem solving skills of students such as the lack of ability in remembering equations in Physics, lack of practice of Physics problems, poor mathematical
skills, lack of motivation, poor understanding of definitions, laws, and basic principles of physics, lack of enough books or materials on problem-solving in physics, the weak association of students’ conceptual framework to the physical principles, the difficulty students’ possess in connecting the symbols to the physical quantities, difficulty in understanding the problem etc (Reddy and Panacharoensawad, 2017, Hegde and Meera, 2012, Ogunleye, 2009).

To apply the learned concepts to new and unfamiliar situations or to deal with application level questions, students requires abstract thinking or highly focused thinking called Critical thinking. Arulselvi (2016), Kishor (2012) and Rodrigues and Oliveira (2008) identified that integrating Critical thinking skills enhances Achievement in Physics of students both at secondary and senior secondary level. Unfortunately, very few possess these types of thinking and so it should be developed. But due to the limited time, teachers are more interested to deliver the contents through lectures which never support the abstract thinking or Critical thinking of students.

Thus Physics is considered as an exceptionally difficult subject, that its study requires special ability and intelligence; therefore everybody should not be burdened with the study of this subject; everybody is not able to learn it successfully. This attitude of students towards physics results in low pass percentage and low achievement scores in examinations.

Today, there are many models and strategies for effective implementation of Physics theory in the classrooms. But unfortunately, none of them included problem solving sections. As a preliminary step for developing the strategy, the investigator conducted group discussions with Physics teachers and students of Higher Secondary Schools. They strongly demanded to develop certain strategies that incorporates both the theoretical and problem solving sections. So the investigator decided to develop a strategy that comprises both the theoretical and problem solving sections.
Physics can be made more interesting by making the abstract concepts more concrete. Application of physical principles is necessary for understanding the real world and this can be achieved by integrating technology into the classrooms. Students can benefit in different ways from technology integration into everyday teaching and learning. In addition, the visualization and exploration of abstract physical concepts in multimedia environments can foster understanding in new ways. Technological environment may also allow teachers to adapt their instruction and teaching methods more effectively to their student needs. Moreover in order to thrive in a digital economy, in which we are living today, students will need digital age proficiencies. So the education system should incorporate new technologies in the curriculum to make the all-round development of the students which is the main goal of education.

Taking all these into consideration, the investigator decided to develop a Strategy based on Andes Intelligent Tutoring System that comprises both the theoretical and problem solving sections, which aimed to enhance the Problem solving ability, Critical Thinking and Achievement in Physics of Higher Secondary School Students. The Strategy helps the teachers and students of Physics to integrate teaching and learning of Physics to technology. The investigator strongly believes that the Problem Solving Ability, Critical Thinking and Achievement in Physics can be improved using the strategy developed based on Andes Intelligent Tutoring System.

Research Questions

1. Will the Strategy developed based on Andes intelligent Tutoring System enhances Problem Solving Ability, Critical Thinking and Achievement in Physics of Students at Higher Secondary Level?
2. Will the Strategy based on Andes Intelligent Tutoring System is more effective than present Activity Oriented Method of teaching in enhancing
Problem Solving Ability, Critical Thinking and Achievement in Physics of Students at Higher Secondary Level?

1.3. STATEMENT OF THE PROBLEM

The present study aims to develop a Strategy based on Andes Intelligent Tutoring system and to find out its effectiveness in improving Problem Solving Ability, Critical Thinking and Achievement in Physics among Higher Secondary School Students. Hence the present study is entitled “DEVELOPING A STRATEGY BASED ON ANDES INTELLIGENT TUTORING SYSTEM FOR ENHANCING PROBLEM SOLVING ABILITY, CRITICAL THINKING AND ACHIEVEMENT IN PHYSICS OF STUDENTS AT HIGHER SECONDARY LEVEL”.

1.4. OPERATIONAL DEFINITION OF KEY TERMS

Developing

The dictionary definition of Developing is, “grow or cause to grow, become more advanced, mature and elaborate”.

In the present study, the word developing means preparing a Strategy based on Andes Intelligent Tutoring System for enhancing Problem Solving Ability, Critical Thinking and Achievement in Physics of students at Higher Secondary level.

Strategy

Strategy refers to a general plan or set of plans designed to achieve a particular goal. It involves setting the goals, determining activities to satisfy the goals and organizing resources to utilize the actions.

In the present study, Strategy refers to the plan of action designed to attain the objectives formulated.
Andes Intelligent Tutoring System

Andes Intelligent Tutoring System is a program designed to interact with Physics students like a tutor which aims to develop students procedural knowledge of Physics Problem Solving.

In the present study, the investigator selected Andes Intelligent Tutoring System as a base to develop a Strategy which incorporates both the theoretical and problem solving section for enhancing Problem Solving Ability, Critical Thinking and Achievement in Physics of Students at Higher Secondary Level.

Enhancing

The dictionary definition of enhancing is, “to increase, intensify or further improve the quality, effectiveness or value”.

In the present study, enhancing means further improving the abilities, skills and achievement of students.

Problem Solving Ability

Problem Solving Ability is the cognitive capability of a person to perform mental or arithmetic operations to find solutions based upon his/ her knowledge.

In the present study Problem solving ability refers to the ability to perform arithmetic operations to find solutions to mathematical problems in Physics using his/ her conceptual knowledge. It also refers to the ability to understand the concepts, ability to change the theoretical concepts into mathematical expressions, ability to recognize the data given in the problem, ability to identify correct units related to the data, ability to perform arithmetic operations to reach final solution and the ability to explain the solution in relation to the problem.
Critical Thinking

“Critical Thinking is the ability to analyze facts, generate and organize ideas, defend opinions, make comparisons, draw inferences, evaluate arguments and solve problems” (Chance, 1986, p.6). “It is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action” (Scriven & Paul, 1992)

In the present study Critical thinking refers to the highly focussed thinking essential for solving problems in everyday life as well as for solving the application level questions in the subject Physics.

Achievement in Physics

Achievement in Physics refers to the performance of students in the subject Physics that can be measured in terms of scores of the Achievement Test in Physics developed for the purpose.

Higher Secondary Level

It comprises the levels plus one and plus two. In the present study Higher Secondary level refers to the XII Students of Kerala State.

1.5 OBJECTIVES OF THE STUDY

1. To analyse the present status of teaching Physics at Higher secondary level.

2. To develop a Strategy based on Andes Intelligent Tutoring System to enhance Problem Solving Ability, Critical Thinking and Achievement in Physics of Students at Higher Secondary Level.
3. To find out the effectiveness of the Strategy based on Andes Intelligent Tutoring system on Problem Solving Ability, Critical Thinking and Achievement in Physics of Students at Higher Secondary Level for total sample and relevant sub samples.

4. To find out the effectiveness of present Activity Oriented Method on Problem Solving Ability, Critical Thinking and Achievement in Physics of Students at Higher Secondary Level for total sample and relevant sub samples.

5. To compare the effectiveness of the Strategy based on Andes Intelligent Tutoring System with that of present Activity Oriented Method in enhancing Problem Solving Ability of Students at Higher Secondary Level for total sample and relevant subsamples.

6. To compare the effectiveness of the Strategy based on Andes Intelligent Tutoring System with that of present Activity Oriented Method in enhancing Critical Thinking of Students at Higher Secondary Level for total sample and relevant subsamples.

7. To compare the effectiveness of the Strategy based on Andes Intelligent Tutoring System with that of present Activity Oriented Method in enhancing Achievement in Physics of Students at Higher Secondary Level for total sample and relevant subsamples.

8. To find out the effectiveness of the Strategy based on Andes Intelligent Tutoring System and Activity Oriented method in retaining Problem Solving Ability, Critical Thinking and Achievement in Physics of Students at Higher Secondary Level.

9. To compare the effectiveness of the Strategy based on Andes Intelligent Tutoring System and Activity Oriented method in retaining Problem
Solving Ability, Critical Thinking and Achievement in Physics of Students at Higher Secondary Level.

1.6. HYPOTHESES OF THE STUDY

1. There is significant difference in the Problem Solving Ability of students at Higher Secondary Level taught using the developed Strategy based on Andes Intelligent Tutoring System and the present Activity Oriented Method.

2. There is significant difference in the Problem Solving Ability (component wise) of students at Higher Secondary Level taught using the developed Strategy based on Andes Intelligent Tutoring System and the present Activity Oriented Method.

3. There is no significant difference in the Problem Solving Ability of students at Higher Secondary Level taught using the developed Strategy based on Andes Intelligent Tutoring System based on Gender.

4. There is significant difference in the Critical Thinking of students at Higher Secondary Level taught using the developed Strategy based on Andes Intelligent Tutoring System and the present Activity Oriented Method.

5. There is no significant difference in the Critical Thinking of students at Higher Secondary Level taught using the developed Strategy based on Andes Intelligent Tutoring System based on Gender.

6. There is significant difference in the Achievement in Physics of students at Higher Secondary Level taught using the developed Strategy based on Andes Intelligent Tutoring System and the present Activity Oriented Method.

7. There is significant difference in the Achievement in Physics (objective wise) of students at Higher Secondary Level taught using the developed Strategy based on Andes Intelligent Tutoring System and the present Activity Oriented Method.
8. There is no significant difference in the Achievement in Physics of students at Higher Secondary Level taught using the developed Strategy based on Andes Intelligent Tutoring System based on Gender.

9. There is significant difference in the Retention of Problem Solving Ability of students at Higher Secondary Level taught using the developed Strategy based on Andes Intelligent Tutoring System and the present Activity Oriented Method.

10. There is significant difference in the Retention of Critical Thinking of students at Higher Secondary Level taught using the developed Strategy based on Andes Intelligent Tutoring System and the present Activity Oriented Method.

11. There is significant difference in the Retention of Achievement in Physics of students at Higher Secondary Level taught using the developed Strategy based on Andes Intelligent Tutoring System and the present Activity Oriented Method of teaching.

1.7. METHODOLOGY IN BRIEF

Methodology describes the procedure adopted to satisfy the objectives set for the study. The main objective of the present study is to find out the effectiveness of the developed Strategy based on Andes Intelligent Tutoring System on Problem solving ability, Critical thinking and Achievement in Physics of students at Higher Secondary Level. Before developing the Strategy the investigator analyzed the present status of teaching Physics at Higher Secondary Level. For this the investigator adopted Survey Method. To find out the effectiveness of the developed Strategy, the investigator adopted Experimental Method. The design selected was Pre-test Post-test non-equivalent group design.
1.7.1 Population and Sample Selected for the Study

The Population of the Survey part consisted of Higher Secondary School Teachers of Kerala State. The sample selected for the Survey comprised of 35 teachers from four districts of Kerala selected through Random Sampling Technique.

The Population of the Experimental Part consisted of Higher Secondary School Students following Kerala State syllabus. For the present study the investigator selected a sample of 220 students of standard XII (110 students each in the Experimental group and Control group) from two schools (Mar Thoma Seminary H.S.S and M.D Seminary H.S.S) of Kottayam district. The sample was selected using random sampling technique.

1.7.2 Tools Used for the Study

1. Questionnaire on present status of Teaching Physics at Higher Secondary Level.
2. Lesson transcripts on the strategy based on Andes Intelligent Tutoring System for teaching Physics at Higher Secondary Level (prepared by the investigator).
3. Lesson transcripts based on present Activity Oriented Method for teaching Physics at Higher Secondary Level (prepared by the investigator).
4. Problem Solving Ability Test (PSAT, Prepared and Standardised by the investigator).
5. Critical Thinking Test (CTT, Prepared and Standardised by the investigator).
6. Achievement Test in Physics (Prepared and Standardised by the investigator).
7. Raven’s Standard Progressive Matrices.
1.7.3 Statistical Techniques Used

The scores obtained by each student in their Pre-test, Post–test and Delayed Post-test were tabulated and subjected to appropriate statistical techniques. The major statistical techniques used in the study are

- ‘t’ test
- ANOVA
- ANCOVA.

1.8 SCOPE OF THE STUDY

The present study aims to develop a strategy based on Andes Intelligent Tutoring System for enhancing Problem Solving Ability, Critical Thinking and Achievement in Physics of Students at Higher Secondary Level. The use of such strategies that incorporates Intelligent Tutoring Systems brings desirable changes both qualitative and quantitative. Also majority of concepts in Physics are abstract in nature which requires strong imagination and deeper thinking and it demands the use of computer supported strategies. It enables new ways of teaching and learning rather than what they have done in a better way. The use of such strategies shifts from teacher centered pedagogy characterized by rote learning and memorization to a learner centered pedagogy. The present strategy utilizes available web resources without hindering face to face instruction. This will surely help the students to understand the concepts that are abstract in nature.

With the help of this strategy students can easily solve a number of mathematical problems in Physics within a short time. It eliminates their difficulties in the traditional problem solving method and will surely enhance the confidence level of students. The study incorporates the benefits of a wide range of learning methods and techniques according to the students cognitive styles which will enhance the Critical Thinking ability of students in a quite natural way. After teaching through this strategy, the students will be able to focus their thinking and they approach the problem from different perspectives.
The findings of the study will help the teachers, parents and policy makers in the field of education to understand the application of this strategy in teaching Physics. The study will surely make the teaching and learning a more enjoyable task. The findings will help the curriculum planners to introduce these type of innovative strategies in the curriculum that supports concrete experiences. It is hoped that this study will be helpful for all those who are concerned with the field of Physics education.

1.9 LIMITATIONS AND DELIMITATIONS OF THE STUDY

Limitations are matters that arise in a study which are out of the researchers control (Simon & Goes, 2013). The following are the limitations of the study.

- Unexpected power failures and connectivity problems in between the experiment.
- Lack of Availability of schools with proper computer facilities.
- As the study was conducted in Standard XII, the time was utilized ‘to the brim’ due to the time limit from the school authorities during the experiment.
- The investigator could not find enough studies regarding Andes Intelligent Tutoring System.

Delimitations are those characteristics that define the boundaries of the study. The delimitations are in the control of the researcher (Simon, 2011). The following are the delimitations of the present study.

- The present study was confined to two Aided Higher Secondary schools of Kottayam district due to the lack of availability of computer facilities.
- The investigator delimited the study to standard XII.
- The investigator selected the unit ‘Current Electricity’ from standard XII due to its relevance.
- The investigator selected only three dependent variables for the study based on the discussions with experts in the field.
Despite these limitations, the investigator conducted the study on proper lines with maximum possible degree of objectivity and precision.

1.10 ORGANIZATION OF THE REPORT

The study has been reported in six chapters, the details of which are given below.

Chapter I: Introduction

This chapter was intended to throw flash upon the background of the study, the need and significance of the study, statement of the problem, operational definition of key terms, objectives, hypotheses, methodology in brief, scope and limitations of the study and organization of the report.

Chapter II: Theoretical Overview

This chapter throws light on the theoretical background of Intelligent Tutoring Systems, Andes Intelligent Tutoring System, Problem Solving Ability, and Critical Thinking.

Chapter III: Review of Related Literature

A survey of related literature and results of studies conducted on Andes Intelligent Tutoring System, Critical Thinking, Problem Solving Ability and Achievement in Physics is presented in this chapter.

Chapter IV: Methodology

This chapter contains the description of the method adopted for the study, design selected for the study, variables selected, tools employed, procedure adopted for experimentation and the statistical techniques used for the study.
Chapter V: Analysis and Interpretation of Data

In this chapter, the details of the analysis and interpretation carried out based on the collected data using relevant statistical techniques are presented under appropriate heads.

Chapter VI: Summary and Conclusions

This chapter contains the major findings of the study, conclusions, educational implications and suggestions made for further research.

The report is followed by a fairly exhaustive bibliography. The Bibliography is followed by a series of Appendices pertaining to the study.