CHAPTER I
INTRODUCTION

“Education does not exist in vacuum. It is determined by political and cultural milieu, beliefs, doctrines, economy, social mentality and predominant world views. These determining environments are now quickly changing. We should be in a position to understand them and be able to design education as the unified field force for development………and create a healthier future”.

(UNESCO, 1991, p.6)

Scientific and technological revolution imposes new challenges and responsibilities upon designing and altering the existing educational system. People are required to be resourceful to adjust themselves at a time of the surge of globalization. Education plays a major role in raising the potential of a society in contributing to the growth of knowledge and skills and thereby enhancing the nation’s capacity to face the challenges of global competitiveness. Education for the twenty-first century is based on the assumption that the challenges facing societies call for a fundamental review of education worldwide. So, efforts have been made everywhere to strengthen qualitative as well as quantitative improvements in education in the interface of the vision of twenty-first century. The UNESCO (1989) also emphasizes the renovation of educational systems to meet the challenges of the twenty-first century. While speaking at a function organized on the occasion of the first National Education Day, Pratibha Patil, President of India stressed the need to strengthen educational institutions in the country in order to raise the quality of education to greater heights. She also emphasized the need for upgrading teaching methodologies. In this context, restructuring as well as reorientation of education system is the dare need for the future of the society.

The present education system should have the capacity to nurture creative and scientifically talented citizens to meet the demands of the future. Science and technology are now established as forces of great power in the shaping of future. Hence today, while in the emerging global scenario, it is being realized that the only way to improve nations’ competitiveness is through better science education. It is also
considered that science helps to cultivate intellectual abilities like critical thinking, reasoning and problem-solving of learners. In India, the students prefer to opt for science groups, aiming at admission for engineering and medicine preferably. But it is feared that the graduates of the professional courses possess the required professional qualities and the all-time important skills in problem-solving and creative and logical thinking.

1.1 Need and Significance of the Study

The first decade of the twenty-first century saw a dramatic change in the outlook of parents and students in India in securing job in the context of knowledge explosion by means of Information Technology. Their attitude has become suddenly favorable to professional courses rather than the traditional courses prominent in the study of science, mathematics, social sciences and languages. The impact of this attitude made the authorities change the policy by allowing to start a large number of professional institutions, especially in the private sector.

The government policy opened up chances for all who pass the Higher Secondary Examination or its equivalent to get admissions for professional courses. The aftermath of the new policy is that the colleges that offer traditional courses struggle for their existence. There is a setback in the admission for non-professional courses.

Following the recommendations of the committee constituted by the Kerala State Higher Education Council, the government changed the policy of admission to professional courses by giving equal weightage to the performances of the applicants in the concerned subjects of their qualifying examination and entrance test. Since the marks obtained in the qualifying examination are considered for admission, the evaluators who are the teachers teaching in different institutions made their evaluation of the concerned subjects so liberal that the pass percentage in the qualifying examination suddenly increased by breaking all the previous records.

The admission policy of the government based on the recommendations of the Committee appointed by the Higher Education Council affected the academic standard of not only the professional courses, but the non-professional courses as well. It was reported that more than 90 percent of students failed in Engineering Degree Examinations. A recent report (The Keralakaumudi, March 10, 2012) shows that the
mass failure continues in other courses too. In the B. D. S (Bachelor of Dental Surgery) examination the failure was 70 percent, while it was between 95% and 75% in Nursing Examination in colleges in private sector. An earlier report of the study conducted by the Kerala University Computer Centre (The Hindu, Oct 17, 2008) also shows the poor show of the results since 2006 in self-financing engineering colleges (Figure 1.1).

![Figure 1.1. Electronics 2008 pass outs – distinction in various colleges under the University of Kerala (The Hindu, Oct 17, 2008).](image)

To sum up, admission policy and the recruitment policy jeopardized the students’ creative talents as well as their knowledge in the subject of study. From observations of the investigator regarding the present scenario of the education system, she is confident that a study related to enhancing students’ academic standard is absolutely significant to maintain an international standard.

### 1.2 Statement of the Problem

Education is always in a state of flux. Whenever there occurs a change or reform people become alert. Recently they blamed the government and the authorities for their policies that caused inordinate rate of failures of students in professional courses as pointed elsewhere. They wanted the old system \textit{in situ}. The government, on the other hand provided some make-overs by starting Finishing schools for engineering graduates and establishing high quality institutions like IISER (Indian Institute of Science Education and Research) for a very small group of students, in addition to the IITs already existing in the country.

In non-professional courses, in order to attract students for admission, the pass percentage with too many first classes is inflated by teachers through liberalized valuation. In addition, the Examination Boards of the universities award moderation.
In schools, now the government of Kerala has passed orders to conduct eligibility test for the teachers. It is alleged that the step taken by the government is an eyewash to cover up the low academic standard of the students and the under development of their cognitive skills that are essential to pursue higher education.

In the above circumstances, the research question that, the investigator confronts is how the academic standard of the students and their cognitive skills required for the pursuit of higher studies can be improved. The problem that emerges for the study in this situation is stated as:

*How the students’ academic standard can be improved.*

1.2.1 Analysis of the problem

The complexity of the problem selected for study makes the investigator analyze it with a view to sorting out the major components of the academic standard and selecting appropriate pedagogic principles and theories for the development of those components.

*Components of academic standard*

There are, no doubt, dozens of factors that influence the academic standard of students. To mention a few of them are the curriculum, instructional strategies, infrastructural facilities, pedagogic principles and theories, and students’ skills in thinking and problem-solving.

It is cumbersome to study the effectiveness of all the variables for a doctoral thesis where a single research question is expected to deal with. The educational institutions have provided most of the facilities particularly infrastructural facilities and instructional facilities according to the norms of the government and the national bodies like NCTE (National Council for Teacher Education) and the AICTE (All India Council for Teacher Education) apart from those of the UGC. Still, the academic standard remains at a low ebb. The causes may be manifold.

The investigator had made an attempt to make a preliminary study at an early stage of her research by observing the classes in schools and contacting teachers for their views on the academic standard. She, by evaluating all her experiences, ventures to predict that the causes for the low academic standard are mainly due to students’ inability in conceptual learning and in applying problem-solving and thinking skills in their learning at school level. The authorities overlooked these pedagogical causes for
low academic standard in schools and continued the reforms of examination policies at higher stages of education. They should have monitored to see whether or not the teachers were applying those pedagogic principles and theories that would help for students’ conceptual understanding of the knowledge in the subjects they learn in schools and the development of their skills required for problem-solving and which have a transfer effect in their higher education and in their later life and profession too.

The investigator takes the liberty to present certain studies and literature in support of her analysis of the problems as a prerequisite to the statement of the title of the investigation:

Several studies reported that students of different backgrounds and different ages have basic preconceptions or misconceptions about physics concepts that affect students’ further learning and achievement (Clement, 1982; Eckstein & Shamesh, 1993; Halloun & Hestenes, 1985; Maloney, 1984; Palmer & Flanagan, 1997; Poon, 1992; Thijs, 1992; Bransford, Brown, & Cocking, 1999; Demirci, 2001).

In physical science, the best documented examples for misconceptions come from the realm of Newtonian mechanics. The basic misconception involves the relationship of force to motion, and for many students “motion implies force” (Clement, 1983). This fundamental conceptual difficulty seems to rest on several underlying assumptions:(1) a force applied to an object causes motion in the direction of the force; (2) an object affected by a constant force moves with constant velocity; (3) the rate of motion is proportional to the magnitude of the force; and (4) in the absence of force objects are at rest or are slowing down (Lycott, 1985) (cited in Mintzes et al., 1998, pp.75-76).

In another classical study by Seattle high school physics teacher Jim Minstrell (1982), students were asked about the forces acting on a book lying flat on a table. About half of the students failed to understand the table exerts an upward force on the book (Mintzes et al., 1998, p.75).

Recent studies in science education suggest that the use of teaching strategy for the presentation of models, metaphors and analogies will remove misconceptions and enhance better understanding. Orgill and Thomas (2007) reported that effective analogies motivate students, clarify students’ thinking, and help students to overcome
misconceptions and give students ways to visualize abstract concepts. When they are used appropriately, analogies can also promote students’ meaningful learning and conceptual growth.

It was found that instructional strategies for successful teaching of concepts primarily consist of presenting learners with examples and non-examples. The ability to regard separate entities as members of a single class has been thought to be critical in cognitive efficiency and may be a precursor to higher-order thinking (Hunt, 1962; Rosch, 1999). A series of divergent examples are useful in concept instruction, particularly when unique attributes are isolated and highlighted (Feldman, 1972). These examples can help learners generalize a concept to the widest circumstances.

From the available related literature of concept learning and misconceptions in science, the investigator observes that majority of studies indicated the right use of right examples and effective use of analogies play an important role in understanding concepts. Moreover, these concepts act as means for thinking that facilitates cognitive development (Gagne, 1977). Therefore, the aim of teaching physics, in the light of findings of researchers regarding students’ difficulties in understanding physics concepts, clearly spells out “the need for developing concepts” on the springboard of creative thinking that helps students “interpret and predict phenomena….” The instructional approaches followed today are not sufficient to focus in formulating concepts without shallowing by students’ preconceived notions. This suggested a need for more interactive and effective pedagogical pattern in physics for attaining concepts and developing creative thinking using both examples and analogies of the concept which would help students in learning physics concepts more effectively. This would help students to overcome the common misconceptions that students bring to the physics class rooms.

Concept learning and creative thinking are embedded in a range of skills taught in science including identifying, formulating hypotheses, making predictions, analyzing, making inferences and the like. Students are encouraged to develop skills that enable them to develop creative questions, to speculate, to suggest creative solutions to problems. This sort of thinking environment helps not only to develop proper understanding of concepts but also to enhance the creative potential of students by constructing their own conceptual understanding. These new conceptions help
students to remove their preconceived notions and misconceptions. Hence, science instruction should emphasize the development of conceptual understanding and development of creative thinking.

Several strategies and techniques have been adopted by teachers to develop cognitive abilities of students. But these are not sufficient to create a suitable thinking environment for developing creatively talented as well as scientifically literate students.

How can we provide a thinking environment suitable for minimizing preconceptions and misconceptions? Which strategy is suitable to develop a proper conceptual understanding and creative thinking? These are the problems faced by all teachers. Findings of researchers indicate that misconceptions may deeply penetrate into students’ minds and resist to change (Driver & Bell, 1986; Driver, 1989; Mutimucuio, 1998; Widodo, Duit, & Muller, 2002; Tytler, 2002). Misconceptions are related to lack of proper thinking skills. So students must construct their own understanding and must build new understanding out of the conceptions they already possess.

Concepts have computational properties that make them useful additions to rules for modeling human thinking (Thagard, 2005, p.63). Concepts act as building blocks for logical thought and are also considered as critical components of an individual’s cognitive structure. According to Tennyson and Park (1980), a concept is assumed to be a set of specific objects, symbols or events which share common characteristics (critical attributes) and can be labeled by a particular name or symbol. Concept learning is thus regarded as the identification of attributes of concepts. When concepts are learned from examples and analogies, we use higher order thinking skills like reasoning, logical thinking, analytical thinking, inductive generalization, creating new ideas and combinations etc., In the words of Lieberman (2000), the ability to group similar events together in concepts allows us to impose coherence on the turbulent stream of our perception.

A large number of teaching strategies have been developed for teaching concepts. Tennyson and Merrill (1977) developed a set of instructional design guidelines to enhance concept teaching by reducing three kinds of classification errors: overgeneralization, under generalization and misconceptions. Tennyson and
Park (1980) proposed a four-step process for concept teaching. The first step is to determine the taxonomical structure of the content. Secondly, prepare a definition in terms of critical attributes. The third step is to arrange examples in rational sets. Lastly to arrange sets according to divergency and difficulty level. According to Borich (1996), both inductive and deductive methods help in concept learning. The examples and non-examples that define criterial and non-criterial attributes of a concept are needed for the teaching of concepts. All these strategies emphasized that the elements of a concept, particularly its attributes and examples play important roles in thought process directed to concept attainment.

Cognitive theorists such as Piaget, Bruner and Gagne emphasized that thinking is organized around conceptual structures. Bruner, Goodnow and Austin (1956) conducted some of the earliest studies on attainment of concept and developed the idea of concept attainment. Bruner (1956) asserts that learning is an active process in which students construct new ideas or concepts based on their current knowledge. Bruner’s concept attainment approach uses positive and negative examples to guide categorization into significant groups. This process of decision-making and categorization results in the attainment of concept. Based on the theory of concept attainment given by Bruner et al., (1956), Joyce and Weil (1972) developed concept attainment model. Many studies conducted in the area of concept learning and teaching strategies proved that concept attainment strategy is an effective and efficient instructional tool for understanding more abstract concepts of science. It is also effective for developing higher-level thinking skills like inductive reasoning, hypothesis formulation, logical reasoning etc.

Concept learning becomes meaningful only when students acquire the ability to construct the new conceptual understanding. Hence, it is also essential to provide opportunities for developing creative thinking skills along with concept learning. According to Lowenfeld and Brittain (1982), to teach towards creativity is to teach towards the future of society (p.70). Teaching strategies and techniques that stimulate both convergent and divergent thinking are important for stimulating creative thinking and are more challenging to creative students (Karnes et al., 1961). Such strategies and techniques create interest, sustain the attention and induce to think off in different directions in order to get the large number of solutions to the problem. Various
strategies and techniques of creative problem solving such as attribute testing, morphological analysis, brainstorming (Osborn, 1957), synectics (Gordon, 1960), inquiry training (Suchman, 1962) are used to develop creative efficiency (cited in Rather, 2001). Research reports that synectics is one of the effective strategies for developing creative problem solving ability of students. There are two strategies based on synectics procedures – creating something new and making the strange familiar. Making the strange familiar strategy is used to increase the students’ understanding and internalization of substantially new or difficult material. These Synectics strategies use metaphors and analogies to enhance creative thinking (Wald & Weil, 1974; Joyce & Weil, 1996; Weaver & Prince, 1990). Analogical reasoning is considered to be a process of identifying similarities between two concepts. Analogies are also considered as instructional tools for learning abstract concepts. Hence, the investigator felt the need to use analogies as thinking tools for concept learning and also for developing creative thinking. So the integration of both concept attainment strategy and synectics strategy is helpful for attaining concepts and at the same time it is effective for developing creative thinking. In this context, the investigator determined to prepare an instructional design that might improve concept learning and develop creative thinking.

This design can be used to help students to analyze examples and non-examples and process information in a logical way using the left part of the brain and then students visualize, feel and think those concepts formed in the first stage of the design in a creative way using analogies and metaphors with the help of the right domain of the brain. Hence, it tries to provide a suitable brain compatible learning environment which makes one to think in both convergent and divergent directions. This environment is highly beneficial to make learning of physics more meaningful in order to build a strong network of concepts in physics and to help in reducing misconceptions. In this juncture, the development of a new instructional design is inevitable for making the learning of physics more meaningful and with interest which in turn contributes to the formation of a society having creative abilities needed for this digital age.
1.2.2 Title of the Thesis

The investigator presumes that an instructional design integrating concept attainment strategy and synectics strategy would help solve the problem of removing misconceptions in physics which in turn would facilitate to develop concept learning and creative thinking. So the thesis is entitled as

“Preparation and Validation of an Instructional Design in Physics for Standard IX by integrating Bruner’s Concept Attainment Model and Gordon’s Synectics Model”

1.3 Operational Definition of Key Terms

Preparation

Preparation means the activity of putting or setting in order in advance of some act or purpose.

Validation

In this study, validation means testing the effectiveness of the design and establishing its efficacy.

Instructional Design

According to Glaser (1962), instructional design is an organized approach to creating instruction. Here, instructional design means it is an approach or strategy which involves sequential activities or tasks aimed at realizing learning needs.

Integration

In this study, integration means ‘bringing together’ or ‘combining’ Bruner’s concept attainment model and Gordon’s synectics model in an amalgamated form with the objective of optimizing academic standard of students by enhancing their ability to attain concepts and to develop creative thinking ability.

Bruner’s Concept Attainment Model

The concept attainment model developed by Joyce and Weil (1985) is based on the works conducted by Bruner and his associates (1956) on the process of concept attainment. This inductive strategy facilitates conceptual learning (Weil and Joyce, 1978, p.45). Here, the study adopted reception strategy of this model because the reception model is more direct in teaching students the elements of a concept and their use in concept attainment. This strategy is designed to lead students to a concept by asking them to compare and contrast examples that contain and do not contain the
characteristics or attributes of the concepts. It is based on the assumption that one of the best ways to learn a concept is by observing examples of it.

**Gordon’s Synectics Model**

Synectics is an interesting teaching strategy to the development of creativity designed by Gordon (1961) and based on this, Joyce and Weil (1985) developed Synectics model. The present study also adopted making the strange familiar strategy of synectics model for preparing the design. This strategy helps increase students’ understanding internalization of substantially new or difficult material (Passi and Martis, 1993, p.6). In this strategy, students compare analogies with target concepts by identifying similarities and differences and thus, making new concepts more meaningful.

### 1.4 Hypotheses

1. An integrated design of Bruner’s concept attainment model and Gordon’s synectics model is an effective instructional strategy for the students’ learning of concepts and their development of creative thinking.

2. The integrated design of Bruner’s concept attainment model and Gordon’s synectics model is a more effective strategy than the conventional method of teaching for the attainment of concepts in physics.

3. The integrated instructional design of Bruner’s concept attainment model and Gordon’s synectics model is a more effective strategy than the conventional method of teaching for the development of students’ creative thinking.

4. The gender, intelligence and socio-economic status of students have no effect on their attainment of concepts and creative thinking ability if they are taught using the combined design of Bruner’s concept attainment model and Gordon’s synectics model.

5. There is no difference in progress in the attainment of concepts and in creative thinking of students belonging to high socio-economic status (HSES) and low socio-economic status (LSES) when taught using Integrated Instructional Model (IIM) and conventional teaching method (CTM).

6. There is no difference in the progress in the attainment of concepts and in creative thinking of students belonging to high intelligent (HI) and low intelligent (LI) when taught using IIM and CTM.
1.5 **Objectives of the Study**

1. To prepare an Instructional Design in Physics based on Bruner’s concept attainment model and Gordon’s synectics model.
2. To prepare lesson plans for selected topics based on the Design based on the Integrated Instructional Model.
3. To prepare a test in achievement of concepts in physics for standard IX to evaluate the attainment of concepts in physics.
4. To compare the effectiveness of the Integrated Instructional Model and conventional method in attaining concepts in physics.
5. To compare the effectiveness of Integrated Instructional Model and conventional method in developing creative thinking of students.
6. To validate the new instructional design, Integrated Instructional Model by comparing it with that of the conventional method of teaching Physics in attaining concepts and in developing creative thinking skills.
7. To examine the influence of gender, intelligence and socio-economic status of students on the attainment of concepts in physics and also on the creative thinking ability when taught using Integrated Instructional Model.

1.6 **Scope and Limitations of the Study**

The present investigation was undertaken with the aim of developing a new instructional design in physics for standard IX. For developing this design, the investigator makes an attempt to integrate ‘reception strategy’ of concept attainment model and ‘making the strange familiar strategy’ of synectics model in realizing the major objectives of physics education such as meaningful learning of abstract concepts in physics and development of creative thinking.

Among the models of teaching, information processing models emphasize processing of information and the improvement of ability to master information. Amongst the information processing models, concept attainment model uses positive and negative examples and proved to be an effective instructional pattern for attaining concepts whereas synectics model is an effective approach for developing creative thinking using analogies and metaphors. But the research studies conducted in the blending of different models of teaching, especially in the area of strategies for developing both critical and creative dimensions are very rare. In the Fifth survey of
educational research, Singh and Jaimini (1997) suggested a need to open up new vistas of research and application in classroom teaching in the area of integration of models of teaching (p.445). Hence, here the attempt is to merge these two strategies into a single instructional design without eliminating the major tasks of these strategies. The scope of this study is also to determine the effectiveness of this design for realizing the goals of the present era.

This design can be helpful for students to get opportunity to attain the concepts inductively by comparing positive and negative examples of the concepts and then allowing them to think divergently using proper analogies of the concepts. This design therefore, tries to give opportunities for developing skills like formulating and testing of hypotheses, comparing or associating ideas, generalizing concepts, analyzing, identifying similarities and differences, creative problem solving, inductive thinking etc., If teachers could take advantage of this kind of more creative and thought provoking environment, the dual purpose of attaining concepts effectively by students and developing their skills in creative thinking could be achieved.

Considering its importance in teaching physics, this design inspires teachers in providing a more systematic and creative learning environment for learning physics concepts more meaningfully. The findings of the study may be helpful to curriculum planners to make necessary changes in curriculum and to suggest innovative strategies for learning physics.

The study was mainly experimental by nature. As the study is intended to prepare an instructional design in physics for standard IX, 9th standard students were taken as the sample. Due to practical difficulties of implementing experimental method, the investigator confined her study to Thiruvananthapuram district only. For the purpose of experimentation, the sample was taken from four schools from Thiruvananthapuram district.

Since the investigator selected intact class groups instead of equated groups, the statistical technique ANCOVA was employed to analyze the data.

Only ten concepts from 9th standard curriculum of Kerala State syllabus were selected for the study.

The study was confined to integrate only two models of teaching.
The major factors of creativity are fluency, flexibility, originality and elaboration. But the investigator limited her study only to measure creativity in general. The tool used by investigator to assess creative thinking of students is ‘Test of Creative Thinking’ constructed by Madhavan Nair (1975).

Despite the aforementioned limitations, all possible efforts were made to conduct the study as reliable and objective as possible.

1.7 Organization of the Report

The report of the study is presented in six chapters.

Chapter I: - Introduction

This chapter contains need and significance of the study, statement of the problem, definition of terms, hypotheses formulated, objectives of the study, scope and limitations of the study and organization of the report.

Chapter II: - Theoretical Perspective

This chapter deals with an overview of the related area of the study. It covers with goals of science education, conceptual understanding and strategies for teaching concepts, strategies for developing creative thinking, concept attainment model and synectics model and the integration of models of Bruner and Gordon.

Chapter III: - Review of Related Literature

The studies related to the problem are reviewed briefly in this chapter. This includes studies concerning concept learning, concept attainment model, creative thinking, analogies and metaphors, synectics model and development of new strategies.

Chapter IV: - Methodology

This chapter describes the method adopted, variables selected, tools employed, description of tools, collection of data and statistical techniques used for the study.

This chapter also contains the outline of Instructional Design prepared by the investigator. The phases, tasks and the principles or theories adopted for the preparation of the design are illustrated.

Chapter V: - Validation of Instructional Design

This chapter presents the details of analysis of the data collected. It contains statistical techniques used, interpretation of the results, tenability of hypotheses and discussion of results.
Chapter VI: - Conclusion

Chapter six gives summary of the study, followed by conclusions arrived at, implications of the study, and suggestions made for further research.

This is followed by the Bibliography and Appendices pertaining to the study. The APA (2010) manual format is followed throughout the study, making allowances for justifiable modification wherever necessary (Publication Manual of the APA, 1997, p. 332).