CHAPTER I

INTRODUCTION

Introduction
Science Education
Importance of Science Education at Higher Secondary Level
Certain Correlates of Science Achievement
Need and Significance of the Study
Statement of the Problem and Definition of Key Terms
Variables of the Study
Objectives of the Study
Hypotheses
Methodology in Brief
Scope and Limitations of the Study
Organisation of the Report
CHAPTER I

INTRODUCTION

1.1 INTRODUCTION

"Youth must be made to understand the beauty of doing Science, the pleasure of doing Science and the ultimate bliss of Science that improve the quality of life of humankind."

(Dr. A.P.J. Abdul Kalam)

Today, India has become one of the strongest countries in the world in terms of scientific manpower in capability and maturity. We are in a position not only to understand technologies that we may borrow but also to create our own technologies with extensive scientific inputs of indigenous origin. Now Science and Technology acts as an important contribution to National development and societal transformation.

In a world where power is determined by nation's share of the world knowledge, it is important for India to become a continuous innovator and creator of scientific knowledge. The science that we do today must have creativity, foresight and vision for it to be the centre of technology that we develop tomorrow for the competitive world. So, we must take the message and mission of successful scientists to youth so that they can understand the ways of contributing to the growth of the nation through careers in science.
1.2 SCIENCE EDUCATION

The rapid expansion of knowledge in different branches of science and its consequent impact on the daily life of people have set educationists of all the advanced countries to think about the position of Science Education in schools. Brownski (1976), a distinguished scientist and humanist, defines Science as the organisation of our knowledge in such a way that it commands or makes possible the explanation of more of the hidden potential found in the individual and in the environment. So, the unique potentialities of the child should be preserved and enriched by science education.

In every school, there are certain students who may become creative scientists. An important objective of science education is to locate and nurture these talented learners so that they may be directed to intellectually stimulating researchers and thus provide the nation with future scientists. The reflective thinking capabilities of children must be sharpened through the learning strategies of science. Thus, science education become one of the best vehicles to foster intellectual potentialities and independent thinking of individuals.

1.3 IMPORTANCE OF SCIENCE EDUCATION AT HIGHER SECONDARY LEVEL

In India, approximately seven million students appear for the plus two examination every year, and more than three million of them are from the science stream. In Kerala State, the annual intake of students in Higher Secondary Schools is more than 1,50,000 from the year 2000 onwards. The strength of Higher Secondary School students goes on increasing each year.
The admission records of Directorate of Higher Secondary Education, Kerala shows that number of students who join the Science group is three times more than that of Humanities and Commerce. Enrolment in Science group has raised steadily over the years.

It is an emerging trend that young students select Physics and Chemistry courses because of these subjects' potentialities for job opportunities. As a prerequisite for attending entrance examinations of many professions, they choose science group willy-nilly. As a result, commercialisation of learning takes place and vested interest groups try to disfigure science curriculum for entrance-oriented coaching. So, after higher secondary stage, students assume and feel that science is a mere collection of information. Rote memorisation of scientific facts devoid of meaningful understanding of it influences negatively on the thinking capacities of the learners. So, the science teaching especially Physical Science teaching in Higher Secondary classes has to be redefined with broader perspectives.

In this context, science instruction at Higher Secondary level should aim at the following behavioural changes.

- To prepare young learners to enter scientific professions and occupations.
- To prepare future scientists and technologists.
- To develop scientific research skills that are appropriate to meet the needs of professional training in science.
To develop the ability to identify and use scientific knowledge appropriately to make wise choices.

To make judicious critical judgements about the reliability and accuracy of information that is passed off as scientifically based.

To use required scientific knowledge constructively.

To generate knowledge and enhance intellectual capability.

To solve problems encountered in their professional and personal lives effectively.

1.4 CERTAIN CORRELATES OF ACHIEVEMENT IN SCIENCE

The academic achievement of an individual depends on variables of cognitive, affective and social-familial fields. Some of these variables are described below.

1.4.1 Intelligence

Traditionally, intelligence was defined in terms of ability to do abstract reasoning, ability to learn and ability to adapt in novel situations. The recent views of intelligence recognise active role of an intelligent person in terms of shaping and selecting an environment according to his or her choice.

Gardner (1983) proposed the theory of Multiple Intelligence consisting of eight intelligences; Linguistic, Logical-mathematical, Spatial, Musical, Bodily-kinesthetic, Interpersonal, Intrapersonal and Naturalistic Intelligences. All the individuals do not possess them in equal proportion. The particular situation or the context decides the prominence of one type of intelligence over the others.
Sternberg (1985) proposed componential, experiential and contextual sub theories of intelligence. Componential intelligence is concerned with components of mental functioning involved in cognitive tasks that underlie vocabulary, knowledge, insight and analogies. Experiential and contextual intelligence add creativity and practicality, respectively to the understanding of intelligence.

Das, Naglieri and Kirby (1994) proposed the information processing approach of intelligence. Intelligence includes Planning, Attention, Simultaneous and Successive processes (PASS Model).

According to the Indian view, an intelligent person shows the following four competencies:

✓ Cognitive competence such as sensitivity to context, comprehension, discrimination, problem solving and effective communication.

✓ Social competence such as following social norms, service to elders, obedience, helping the needy, showing concern for the environment.

✓ Entrepreneurial competence such as hard work, commitment, vigilance, goal-directed behaviour.

✓ Emotional competence such as control of emotions, honesty, politeness, realistic self-appraisal, good conduct.

This type of intelligence is termed as Integral Intelligence.

Even though the expression of Intelligence is not limited to any particular activity and domain or context, it is a manifestation of cognitive ability with reference to one's academic achievement. The scientific
vocabulary and scientific knowledge acquired by a person has direct link with one's intelligence. To get good achievement in science subjects, one has to think creatively, reason abstractly, make inference from data and understand relationship. These factors of Achievement in Science have close association with intelligence. Thus, Achievement in Science is an indicator of cognitive ability.

1.4.2 Scientific Creativity

Sternberg (1985) proposes that creativity is one type of intelligence. The creative intelligence is the ability to go beyond the given data to generate novel and interesting ideas. Thus, creativity is the higher order intelligence that helps a person to translate ideas into practical accomplishments.

Guilford (1967) presented the intellectual factors of creativity on his investigations. These are:

(i) Fluency (word fluency, ideational fluency, associational fluency and expressional fluency)

(ii) Flexibility (spontaneous flexibility and adaptive flexibility)

(iii) Originality

(iv) Elaboration

(v) Redefinition

(vi) Sensitivity to problems

Thus, many factors of intelligence and creativity overlap each other and these are interdependent also. Hence, a test of creativity measures creativity as well as intelligence since creative abilities are intellectual components.
When creativity is specifically directed to science, it reflects the scientific temper.

It is found that arts students show a bias towards convergent thinking ability (Hudson, 1966; Mackay and Cameron, 1968; Filed and Polle, 1970). Webster and Walker (1981) showed that science students have not performed as well as non-science students on tests of divergent thinking simply because the questions asked were related to non-scientific topics. It has not been an established fact that creativity generates regardless of content matter area and with reference to achievement in science, scientific creativity has its significance.

If science is to be developed as a creative subject, the creative spirit of children should be identified and stimulated. Creative people in science are problem seekers and problem solvers. So Scientific Creativity enhances the problem solving capacity and critical thinking of learners.

Scientific creativity includes processes that promote planning, producing and generating original scientific contributions. According to Cole (1970), this process engages the learner to acquire, organise, generalise, utilise and construct information creatively. In effect, Scientific Processes are equal to Scientific Creativity. Both scientific process and scientific creativity facilitate better meta cognitive skills and problem solving abilities. So, when we analyse the Achievement in Science of a learner, it is imperative that his scientifically creative talents are to be assessed.
1.4.3 Achievement Motivation

Achievement Motivation refers to the striving to perform difficult task as well as possible. Murray (1938) identified Achievement motivation along with the physiological and psychological needs contributing to personality development and achievement. According to Expectancy-value Theory of Achievement Motivation of Atkinson (1978), behaviour of a learner depends on how much individuals value a particular outcome and their expectation of attaining that outcome as a result of performing that behaviour.

The contemporary theory of Achievement Motivation proposed by Eccles (1983) and Wigfield (1994) shows how the students' cognitive process and perceptions of their environment works in an achievement situation.

Students' initial motivation beliefs centre on Task specific self-concepts which are the students' perceptions of their ability. Perceptions of task difficulty is another important factor. The overall value of any task depends on its attainment value, interest value and utility value. The individual's perceptions concerning the likelihood of success at the task is known as expectancy. Research shows that higher expectancies for success are positively related to various forms of achievement behaviour (Bandura, 1986; Eccles, 1983; Wigfield, 1994).

DeCharms (1976) put forward the idea of Achievement Motivation training that aims to help students to develop thoughts and behaviour typical of learners high in Achievement motivation. Following activities are included in Achievement Motivation training to make better academic performance.
- Development of self-concept
- Realistic goal setting
- Achievement motivation thinking
- Personal responsibility training
- Development of concrete plans to accomplish goals.
- Evaluation of goal progress.

Thus, Achievement Motivation training is to be integrated with regular classroom content, rather than include it as an activity with special content.

Creative students usually generate their own goals; they are self-regulating and self-monitoring. Understanding the true self is important for achievement of a learner and creativity will be possible only when the individual is with one's self. Haywood et al. (1992) suggested that each individual has scope for intellectual development if he possess achievement motive. So, studying the achievement of an individual in relation to Intelligence and Creativity would be more meaningful if it peruse the achievement motive also.

**1.4.4 Home Environment**

Home is the first institution which is responsible for the education of the child and parents are the first educators. Home environment includes the conditions, forces, and external stimuli at home which impinge upon the individual. The physical, social as well as intellectual environment of the home is a reinforcing force which shapes the individuals.
Educational and cultural level of parents, parental attitude towards education, value orientation of the family members, and socio-economic status of the family normally affect the achievement of every child. All the above mentioned factors have significant impact on the intellectual development, creative potentialities and achievement motive of children.

Parental characteristics associated with higher rates of divergent production in children are

- low degree of punishment in the home
- low pressure for conformity
- absence of intrusiveness
- emotional support for the child
- self-acceptance

(McCandless, 1973)

Bloom (1964) in detailed analysis of Wolf's (1963) work, gives a list of thirteen process variables that can be used to describe the interactions between parents and children in so far as intellectual development is concerned.

A. Press for achievement motivation

1. Nature of intellectual expectations of child
2. Nature of intellectual aspirations for child
3. Amount of information about child's intellectual development
4. Nature of rewards for intellectual development
B. Press for language development

5. Emphasis on use of language in a variety of situations.
6. Opportunities provided for enlarging vocabulary
7. Emphasis on correctness of usage
8. Quality of language models available

C. Provision for general learning

9. Opportunities provided for learning in the home
10. Opportunities provided for learning outside the home
11. Availability of learning supplies
12. Availability of books
13. Nature and amount of assistance provided to facilitate learning in a variety of situations.

Thus, Home Environment is a crucial component that influences the academic achievement, intellectual development, creative capacities and achievement motivation of an individual. So, parents might well help their children to achieve higher achievements through monitoring their children's learning tasks.

1.5 NEED AND SIGNIFICANCE OF THE STUDY

Academic achievement is the prime concern of psychologists, educators, learners as well as parents. Achievement in Science is of key importance at the Higher Secondary level since it provides a base for higher studies which is inevitable for admissions of various medical and engineering professions. So, achievement in science at this stage has to be scrutinised.
Almost all recently generated science teaching strategies insist the importance of developing the creative talents of the learners concerned.

Review of related literature shows that achievement in science depends mainly on three learner characteristics.

1. Cognitive variables like Intelligence, Aptitude, Creativity, Problem Solving skills and so on.
3. Environmental variables like Home Environment, class atmosphere, peer group, socio-cultural and similar variables.

Research suggest that the right cerebral hemisphere is involved in visual, non-verbal, spatial, divergent and intuitive thinking. Left cerebral hemisphere is involved in verbal, logical and convergent thinking. The right brain works more with creativity whereas the left brain works more with intelligence. Vast majority of school activities focus on the convergent functions dominated by the left side of the brain (Caine and Caine, 1997; Jansen, 1998). To teach most effectively to either side of the brain, we must balance outcomes and learning experiences to involve both sides whenever possible (Baker and Martin, 1998). Intelligence and creativity are two correlating variables that influence the scholastic performance. In relation to achievement in science, creativity in science is more consequential than general creativity.
The great scientists Edison and Einstein had no remarkable school records even though they were intelligent and creative human beings. The accomplishments of such renowned scientists were generated from their self-motivation. Thus, achievement motivation provide an explanation for the resourceful nature of an individual and the way he uses these resources to achieve higher level of excellence. But it rarely manifests itself uniformly across different achievement domains. Students typically show greater motivation to perform well in some subjects than others (Schunk, 1996). Since the achievement motive varies with the domain, how well such a global trait predicts achievement in science is questionable. Learners' cognitive and behavioural aspects cannot be treated individually because they are overlapping components (Sappand Farrell, 1994). These factors have strong causative roots of environmental nature. Parents have both a right and responsibility to be directly involved in their children's education. Family play a complementary role to the cognitive approaches of the classroom, by providing the bridge between cognitive skills and everyday life activities (Heywood, 1993). Parental pressure to perform well is more crucial at the higher secondary level. Determining which parental behaviours are most influential that encourage achievement strivings are complicated and research has yielded conflicting findings (Weiner, 1992).

Thus, on the strength of the theories and related literature on the topic, it has been assumed that studying the Achievement in Science at Higher Secondary level is significant with reference to Intelligence, Scientific
Creativity, Achievement Motivation and Home Environment. The analysis of the above mentioned cognitive, motivational and familial variables may open many new horizons to make educators and learners to think and act in terms of optimism and achievement and to pave the way towards progress and prosperity.

1.6 STATEMENT OF THE PROBLEM AND DEFINITION OF KEY TERMS

The problem taken up for the present study is entitled as "A STUDY OF THE RELATIONSHIP BETWEEN INTELLIGENCE, SCIENTIFIC CREATIVITY, ACHIEVEMENT MOTIVATION, HOME ENVIRONMENT AND ACHIEVEMENT IN SCIENCE OF HIGHER SECONDARY SCHOOL PUPILS OF KERALA."

The key terms used in the study are defined below.

(i) Relationship

In a simple relationship study, researchers obtain two scores for each subject and then use the pairs of scores to calculate a correlation coefficient.

Coefficient of Correlation is a single number that tells us to what extent two things are related; to what extent variations in one variable are accompanied by changes in the other.

(ii) Intelligence

Intelligence comprises the mental abilities necessary for adaptation to, as well as shaping and selection of any environmental context (Sternberg, 1997).
(iii) **Scientific Creativity**

The term stands for various aspects of divergent thinking ability in science (as defined by Guilford and his associates), estimated through its accepted characteristics, viz., measures of fluency, flexibility and originality and obtained using standardised test of Scientific Creativity.

(iv) **Achievement Motivation**

It is the need for achievement. It refers to the striving to perform difficult tasks as well as possible (Schunk, 1996).

It is the restless driving energy aimed at achieving excellence, getting ahead, improving past records, doing things faster, better, more efficiently and finding unique situations to difficult problems.

(v) **Home Environment**

It includes things, events and people in the real world in and around the family of the child that he might perceive or that might have some effect on him. In the present study, Home Environment means physical, cultural and emotional environment of the home.

(vi) **Achievement in Science**

The term refers standard performance in science of the students in the group under consideration for the annual examination. The variable Achievement in Science as used in the study measure the important curricular outcomes of Physics and Chemistry. The achievement levels of students are expressed in terms of total scores obtained for Physics and Chemistry in the Standard XI annual examination.
(vii) **Higher Secondary School**

The term higher secondary refers to the fourth stage of school education in Kerala. It consists of pupils in standard XI and XII.

1.7 **VARIABLES OF THE STUDY**

The study has been designed with Achievement in Science as the dependent variable and the following independent variables:

1. Intelligence
2. Scientific Creativity
3. Achievement Motivation
4. Home Environment

1.8 **OBJECTIVES OF THE STUDY**

The major objectives of the study are stated as follows:

1. To compare the three achievement groups in pairs (High-Average, Average-Low and High-Low) in respect of each of the independent variables (Intelligence, Scientific Creativity, Achievement Motivation and Home Environment) for the total sample and sub samples based on gender, place of residence and nature of the institution.

2. To find out the relationship between the independent variables (Intelligence, Scientific Creativity, Achievement Motivation and Home Environment) for the Total sample and sub samples based on gender, place of residence, nature of the institution and achievement levels.

3. To find out the relationship between each of the independent variables (Intelligence, Scientific Creativity, Achievement Motivation and Home Environment) for the Total sample and sub samples based on gender, place of residence, nature of the institution and achievement levels.
and Achievement in Science for the total sample and sub samples based on gender, place of residence, nature of the institution and achievement levels.

4. To develop a multiple regression equation to predict the Achievement in Science using best predictors selected from the independent variables.

5. To find out the combined effect of the predictor variables on Achievement in Science.

1.9 HYPOTHESES

The study has been designed to test the following hypotheses:

1. Each of the independent variables selected will discriminate between students of various achievement levels for the total sample and sub samples.

2. There will be significant relationship between the selected independent variables when each variable is correlated with the other for the total sample and subsamples.

3. There will be significant relationship between each of the selected independent variables and Achievement in Science for the total sample and sub samples.

4. Achievement in Science can be predicted in terms of the highly correlating independent variables which are chosen as best predictors.

5. The combined effect of the predictor variables on Achievement in Science will be significant.
1.10 METHODOLOGY IN BRIEF

1.10.1 Sample

The study was conducted on a sample of 1120 Standard XII students from four districts of Kerala.

1.10.2 Tool

The investigator developed the following tools:

1. Test of Scientific Creativity for Higher Secondary school students
2. Home Environment Inventory

Other tools used for the study are:

1. Verbal Group Test of Intelligence
2. Raven's progressive Matrices Test
3. Achievement Motivation Scale

1.10.3 Statistical Techniques Used

(i) Two-tailed test of significance of the difference between means;
(ii) Pearson’s Product Moment Coefficient of Correlation;
(iii) Multiple Regression Equation;
(iv) Multiple Coefficient of Correlation

1.11 SCOPE AND LIMITATIONS OF THE STUDY

The theoretical base for selection of variables has stated in earlier contexts. The present study attempts to identify the effect of Intelligence, Scientific Creativity, Achievement Motivation and Home Environment on Achievement in Science. The findings of the study may stimulate the teachers, parents and students to redefine their approaches towards science
teaching, science learning and Achievement in Science. When scientific concepts are transacted through creative strategies, learning becomes a pleasant experience for learners and it enhances academic achievement. The study emphasises the role of teachers as well as parents in channelising the achievement motive of young learners for better performance.

Major limitations of the study are the following:

(i) The operational definition of Achievement in Science is confined to the scores of theory examination; skills for performing science experiments are not taken into consideration. The Achievement in Science is limited to achievement in Physics and Chemistry since these two subjects are of prime importance for various science groups.

(ii) The concept of Scientific Creativity has been confined to three components only. The other factors like elaboration, redefinition and sensitivity to problems were excluded considering practical limitations.

(iii) Due to paucity of time and other inconveniences, selection of independent variables was limited.

(iv) The sample for the study is selected only from four districts of Kerala, assuming that this represents the total population of Kerala.

1.12 ORGANISATION OF THE REPORT

The report has been organised into five chapters.

Chapter I contains the rationale for selecting the present problem, the significance of the variables selected, statement of objectives and
hypotheses, brief outline of the methodology and discussion on scope and
limitations of the study.

Chapter II provides a review of related literature.

Chapter III provides a description of the design of the study which gives
an account of the methodology in detail.

Chapter IV gives the analysis of the data collected and interpretation of
the findings.

Chapter V offers a brief summary of the study, conclusions,
educational implications of the findings and suggestions for further research.
REVIEW OF RELATED STUDIES

Studies related to Intelligence, Creativity and Academic Achievement
Studies related to Achievement Motivation and Academic Achievement
Studies related to Home Environment and Academic Achievement
Studies related to Intelligence, Creativity and Achievement Motivation
Studies related to Intelligence, Creativity and Home Environment
Studies related to Scientific Creativity
Major Trends Indicated by the Review