SYNOPSIS
of the thesis entitled

EFFECTIVENESS OF A SCIENTIFIC TEMPER PACKAGE ON CERTAIN COGNITIVE AND AFFECTIVE VARIABLES OF STUDENTS AT SECONDARY LEVEL

Elizabeth Joshua Supervising Teacher**: Dr. Jayasree P.**

Introduction

Science is the way of understanding the world, a perspective and a pattern of thinking that begins early in one's life. It is a great human enterprise that is not only endless and faceless but also stable and fluid. The role of science promises to be greater in the future because of the ever more-rapid scientific progress. Our society is becoming increasingly dependent on science and technology. Over the last few decades, computers and communication technologies had a significant impact on the ways in which we learn, teach, communicate and gain access to information. In recent years, media assume an increasingly important role in every aspect of instructional planning and designs. Science and technology have profoundly influenced the course of human civilization. Science has provided us remarkable insights into the world we live in. The scientific revolutions of the 20th century have led to many technologies, which promise to herald wholly new eras in many fields.

Science has several rewards, but the greatest is that it is the most interesting, difficult, pitiless, exciting and beautiful pursuit that mankind has devised so far. In fact, if one were to consider the best art produced in the last century it can be termed as "Science". India has the third largest scientific and technical manpower in the world. Science and technology, however, is used as an effective instrument for growth and change. It is being brought into the mainstream of economic planning in the sectors of agriculture, industry and services. The contributions and achievements of Indians in the fields of science and technology, architecture, and culture is widely acknowledged. India's achievements in space today are the result of the foresightedness of Vikram Sarabhai, one of the greatest sons of India. India today is considered as one of the prominent countries conducting many space activities. India's achievements in space technology contribute to its missile technology,

including the Agni-V, advancements of fields like biotechnology, electronics, space and atomic energy. Achievement that is worth mentioning is India's accomplishments in the electronics field. India has been doing great in terms of micro-electronics, telematics, software and high performance computing developments. India has been able to do many great things since its official freedom from the British dominance.

Science education has an important role to play in the all-round cultural and societal development of human kind and for evolving a civilized society. The essence of scientific spirit is to think globally and act locally, since scientific knowledge is universal in nature while the fruit of science have some site specificity. Science untangles the threads that create the tapestry of our living world. It tries to work out how the threads merge in the overall ecological networks creating and maintaining the human kind and also contributes to the thought process of human beings. Probably, it can also be the spirit that can possibly reverse the steady downward trend of our world's health and wealth. All societies in the world have ways to educate their young members to ensure that they become full participants in society, are able to contribute and develop it and so become more human (Savater, 2004). Science education introduces the valued aspects of the culture of society as well as important cultural aspects of the members of that society. It has its own structure, ways of thinking and working. It has its own beauty, awe and wonder and offers a powerful way of looking at the world (Chalmers, 1999).

Science instruction is the foundation for scientific and technological advancements of society. In the midst of overall anxiety of the modernization drive, education especially Science Education should automatically get a strategic priority. Traditional teaching methods are employed, teachers mainly focus on how to deliver knowledge and the lecture is centred on the content of the course. Students are treated as a sponge, ready to absorb knowledge. Despite that the conventional methods of teaching have been more or less similar around the world; the adaptation of teaching strategies and styles to different social, economic and educational contexts has been always an issue for consideration. The tremendous growth of technology and computer applications affected almost every aspect of everyday life, worldwide. This is also the case in the field of education; the latter has changed dramatically by endorsing applications that help students improve their written and verbal abilities as well as help them develop new skills that broaden their potentials. The up-and-coming

trends changed the present scenario and adopted the constructivist approach which is moral and more focus on innovative activities and knowledge acquisition. Active learning involves students and helps them to have an in-depth understanding of the course through induction of practice; in other words, the inductive teaching has better results than productive teaching (Adler, 1999). Activity based instruction could be the most solid fundamental idea in our educational world. It allows students to work in a setting that moves, is motivational, and usually stirs the mind instead of allowing structural boredom of the same old way of teaching. It allows the student a chance to look at an idea that may be abstract to begin with, only to have Maslow's highest stage of need to creep in and take over as the aesthetic needs comes blossoming out of us as a group. It isn't just teacher based. It is learner based, and the course that the teacher is teaching will flow into all sorts of ideas and take on a personality of all its own.

The growth of science is fast and vigorous but the progress of science education is still lagging behind. Science education especially, in schools have not generated the critical spirit of budding young potential scientists and this will lead to disastrous consequences to the scientific and technological temples of this country (Bhargava & Chakrabarti, 2007). Unscientific ideas and thoughts, which adulterated believes one grow with and practice during one's life time. Amanda (2004) reported the existence of strong superstitious belief among higher secondary students. Women's death due to Black Magic treatment was reported in the Decan Herald (2014). Similar case was also reported in the same about the death of an 18 year old college girl due to Black Magic ceremony (The Hindu Daily, 2014). This is a relevant example for the unscientific prevailing in the educationally forward society. It is highly unfortunate that in the land where Vedic astrology was born, most people, even a lot of astrologers, have a lot of misconceptions and blind beliefs about several basic facts of astrology. Misconceptions about Mangaldosha, RakshasaGana, Kalasarpadosha and Sadesati have a lot of far reaching effects in the society full of superstitions, especially in marriage matters. Female infanticide, sooth saying, Deep-seated fear of hell fire etc are the social evils highly prevalent in India. The scientific age is riddled with intriguing contradictions and human-made follies. The technology-driven consumer culture and entertainment industry has fueled the growth of primitive superstitions, misconceptions about eclipse, myths and new age beliefs. The need to

promote a rational discussion on science, technology and equitable social development has never been so pressing.

'Human kill human'- although the quality of life has improved over the past decades due to new technological advances but the damages made to the earth weigh more. Damages included increase in pollution and change in climatic patterns. There can be drastic changes in the climatic pattern due to the increase in the carbon dioxide released into the atmosphere, which is the main cause of global warming. Human activities are comprised of many things which can destroy as well as endanger the environment and nature surrounding us. Humans have destroyed and endangered more species on the planet than any other species or group, with our continuous pollution and lack of respect for the environment. With the goal of teaching science are the unique development challenges and successes regarding a range of environmental problems, including climate change, waste management, unsustainable consumption, degradation of natural resources, and extreme natural disasters.

As Yashpal has noted, "science will also have to come forward in changing our thoughts and eradicating various social evils, including casteism, extremism…"One of the goals of the science education is to encourage students to have Scientific Temper for the effects of students' learning. The most important objective of school science instruction is to make the pupils aware of the scientific methods of the procedure and to inculcate Scientific Attitude of mind (Das, 1992). "Problem solving in science involves the use of scientific habits and attitudes which include, careful observations, accurate interpretation of these observations, and skillful recording and communicating of them. It includes the habit of withholding judgment, questioning sources of information, consulting many sources and other familiar aspects of Scientific Temper" (Narendra, 1971). Through scientific education, science has to penetrate societies and communities to get rid from age old traditional superstitions. Blind obedience to religious and judicial authorities is not only against the spirit of science and value education but also a great obstacle in achieving the constitutional goals of India as well as international peace and co-operation (Surendra, 2002). The scientific attitude encourages one to look at the universe without the distorting blinkers of superstition. Such a person can intelligently appreciate the wonders of nature with a sense of awe blended with humility, and yet understand that in the midst of incredible harmony and beauty in the universe, there is heart-rending ugliness and evil as natural by-products of cosmic evolution.

India, in Nehru's vision, could become a great country if the people adopted such a 'scientific temper.' In teaching science, it is more important to help students to understand the scientific approach to life and develop a Scientific Temper than it is to impart scientific knowledge or train them in specific scientific techniques. Scientific temper goes beyond objectivity and fosters creativity and progress. More of scientific temper would spread, and domain of religion would shrink, then the exciting adventure of fresh and never ceasing discoveries, of new panoramas will open out and new ways of living will emerge making it richer and more complete (Rakesh, 2003). The attributes of scientific temper like, honesty, truthfulness, humility, perseverance, positive approach to failure, are essentially some of universal human values which are as important for happiness of an individual as also for the society. Scientific Temper referred to a mentality or an outlook rather than a specialized body of knowledge. It addressed itself to Universalist concerns of "values of life" rather than to narrow and specialized questions of scientific research and application (Roy, 2007). Research study indicated that not only attitude toward science and scientific Temper are closely related to achievement in science, the relationship between students' attitudes and their achievement is not simply a correlation but causation in nature (Lee, 2013).Scientific temper is one human attitude which allows one seek and experience worldly matters, secular, religious and spiritual knowledge transcending one's own understanding, convictions, biases, and the like limited individual abilities and capabilities.

The activities include exposing students to the fascinating world of science through face to face interaction with eminent scientists, demonstration lectures by eminent experts from various fields and to provide opportunities for children to create science toys, watch fascinating experiments, science films and participate in delightful activities like aero modelling and sky watching. The teachers having critical thinking disposed to care that their beliefs be true and that their decisions be justified; that is, care to "get it right" to the extent possible. The aim of the teacher should be to build character and inculcate values that enhance the learning capacity of children, build confidence to be innovative and creative, which in turn will make them competitive to face the future. These qualities collectively constitute the essentials required to be an effective science teacher to shine like a full moon among the twinkling stars in the blue skies of knowledge. A thirsty man has a drive to dig a well not only for his personal benefits but also to cool the throats of numerous passers-by. In the same

way, a science teacher is expected to keep a tab on the scientific developments so as to be able to construe and answer the hard hitting questions of students born in this era of information explosion. The teacher's role in the present scenario is to ignite the young mind by eradicating the superstitious beliefs and deep rooted unscientific ideas still prevailing among the youth by exploring the scientific mysteries in the right path.

Clearly what the above meant was that science would not just play a role in building scientific expertise but also help reject superstition, prejudice and injustice. According to Viswanath (2011), "science education has an important role to play in the all-round cultural and societal development of human kind and for evolving a civilized society". Former President Kalam said, "Children must inculcate a Scientific Temper for pursuing knowledge to contribute towards making India one of the most developed countries in the world. An ignited mind is the most powerful resource on the earth, above the earth and under the earth. The current teaching methods need to be revamped with more practicals and experiments to inculcate Scientific Temper among students".

Objectives of the study

1. To analyse the perception of Teachers on
   a. Existing level of Scientific Temper of Secondary School Students.
   b. The need for enhancing Scientific Temper of Secondary School Students.
2. To identify the existing level of Scientific Temper of Secondary School Students.
3. To compare the existing level of Scientific Temper of Secondary School Students belonging to different subsamples based on
   - Gender: Boys/Girls
   - Locality of School: Rural/ Urban
   - Type of management of School: Aided/Government
4. To develop and validate a Scientific Temper Instructional package for 8th standard students following Kerala State Syllabus.
5. To find out the effectiveness of Scientific Temper Instructional package and Activity Oriented Method of Teaching for Secondary School Students with respect to
   - Self Regulation
   - Achievement in Biology
   - Scientific Creativity
   - Scientific Temper

- Science Interest
- Social Sensitivity

6. To compare the effectiveness of Scientific Temper Instructional package and Activity Oriented Method of Teaching for Secondary School Students with respect to

- Self Regulation
- Achievement in Biology
- Scientific Creativity
- Scientific Temper
- Science Interest
- Social Sensitivity

Hypotheses of the Study

The hypotheses formulated for the present study are:

1. There is no significant difference in the existing level of Scientific temper of Secondary School Students belonging to different subsamples based on

- Gender: Boys/Girls
- Locality of School: Rural/ Urban
- Type of management of School: Aided/Government

2. The Self Regulation of Secondary School Students taught using Scientific Temper Instructional package is significantly higher than that of those taught using Activity Oriented Method of Teaching.

3. The Achievement in Biology of Secondary School Students taught using Scientific Temper Instructional package is significantly higher than that of those taught using Activity Oriented Method of Teaching.

4. The Achievement in Biology of Secondary School Students taught using Scientific Temper Instructional package is significantly higher than that of those taught using Activity Oriented Method of Teaching with respect to the following Objectives

- Remembering
- Understanding
- Application
- Analysis
- Evaluation

5. The Scientific Creativity of Secondary School Students taught using Scientific Temper Instructional package is significantly higher than that of those taught using Activity Oriented Method of Teaching.

6. The Scientific Temper of Secondary School Students taught using Scientific Temper Instructional package is significantly higher than that of those taught using Activity Oriented Method of Teaching.

7. The Scientific Temper of Secondary School Students taught using Scientific Temper Instructional package is significantly higher than that of those taught using Activity Oriented Method of Teaching with respect to the Components

- Scientific Attitude
- Scientific Perception
- Scientific Habit
- Scientific Literacy
- Scientific Thinking
- Scientific Method

8. The Science Interest of Secondary School Students taught using Scientific Temper Instructional package is significantly higher than that of those taught using Activity Oriented Method of Teaching.

9. The Social Sensitivity of Secondary School Students taught using Scientific Temper Instructional package is significantly higher than that of those taught using Activity Oriented Method of Teaching.

Methodology in Brief

Methodology involves the procedure adopted for the realization of the objectives of the study. It is briefly described below.

For the study, survey and experimental methods were used. Using survey method, the perception of secondary school teachers on the existing level of Scientific Temper of secondary school students and their perception of the necessity of enhancing Scientific Temper of students were found out. The data was collected randomly from a sample of 120 secondary school teachers from different districts of

Kerala, using Teacher Perception Questionnaire (prepared by the investigator). Survey method was also used to find out the existing level of Scientific Temper of Secondary School Students based on gender, locality and type of management of schools. For this, a sample of 800 secondary school students were selected from three districts of Kerala viz, Kottayam, Alappuzha and Pathanamthitta using stratified random sampling technique. Scientific Temper Test (Prepared and Standardized by the investigator) was the tool employed for the purpose.

Experimental method was utilized for testing the effectiveness of the prepared Scientific Temper Package (STP). The development of STP was based on the Instructional System Design using the Dick and Cary's (2005) systems Approach Model. STP is a 40 hours teacher assisted package that includes 60 activities focusing different components of Scientific Temper and altogether meant for enhancing the Scientific Temper of secondary school students.

For the experimental study, five schools were selected from Kottayam, Alappuzha and Pathanamthitta districts of Kerala state, giving due weightage to gender, locality and type of management of schools. The sample for the experiment consisted of 328 students of standard VIII from ten divisions of the five secondary schools (two divisions from each school) selected for the study. Five divisions (one from each school) were considered as experimental group and the other five divisions (one from each school) were considered as the control group. Both the experimental and control group consisted of 164 students each, these students were selected by considering the gender, locality and type of management of schools.

Tools used for the study

1. Teacher Perception Questionnaire (Prepared by the Investigator)
2. Instructional package based on Scientific Temper (Developed and validated by the Investigator)
3. Lesson Transcripts based on Activity oriented Method (Prepared by the Investigator)
4. Scientific Temper Test (Prepared and Standardized by the Investigator)
5. Self Regulation Scale (Prepared and Standardized by the Investigator)

6. Scientific Creativity Test (Prepared and Standardized by the Investigator)
7. Achievement Test in biology (Prepared and Standardized by the Investigator)
8. Social Sensitivity Scale (Prepared and Standardized by the Investigator)
9. Science Learning Interest Inventory (Prepared and Standardized by the Investigator)

Before starting the experiment, pre tests were conducted by administering the Self Regulation Scale, Achievement Test in biology, Scientific Creativity Test, Scientific Temper test, Science Interest Inventory and Social Sensitivity Scale in both the groups. After that the investigator herself conducted classes in both the groups. The experimental group was taught using the Scientific Temper Instructional Package and the control group was taught using Activity oriented Method. After the treatment, all the tests given as pre tests were administered again to both the groups as post tests.

Statistical Techniques Used

The major statistical techniques used for the study were the following.

i Descriptive statistics like mean, median, standard deviation, skewness and kurtosis of the selected variables.

ii. Percentage Analysis.

iii. Chi square test.

iv. Test of significance of differences between means of large uncorrelated samples.

v. Test of significance of differences between means of large correlated samples.

vi. Analysis of variance.

vii. Analysis of co variance.

Major Findings of the Study

The major findings that have emerged from the study are,

1. **Secondary school teachers perceive that the Scientific Temper of eighth standard students is at a low level.**

Teachers perceived that only a few students at secondary school level have proper ability to apply scientific knowledge ($X^2 = 64$, $P<0.01$), ability to

utilize the process of scientific inquiry ($X^2 = 39.58$, $P<0.01$), interest in new developments ($X^2 = 52.75$, $P<0.01$), open mindedness ($X^2 = 73.33$ $P<0.01$), curiosity ($X^2 = 13.75$, $P<0.01$), ability to manage new situations ($X^2 = 57.41$ $P<0.01$), interest in future ($X^2 = 12$, $P<0.05$), skill of reasoning ($X^2 = 56.25$, $P<0.01$), and ability of critical observation ($X^2 = 16.41$, $P<0.01$).

Teachers perceived that only some of the students, skill of reflective thinking ($X^2 = 23.08$, $P<0.01$) and aversion to superstition belief ($X^2 = 43.08$, $P<0.01$). Teachers also perceived that almost all students possess rationality ($X^2 = 56.58$, $P<0.01$) and objectivity of intellectual belief ($X^2 = 32.75$, $P<0.01$)

2. **Secondary school teachers perceive that there is an urgent need of training for enhancing Scientific Temper of secondary school students.**

   Teachers perceived that training is needed for secondary school students for enhancing their Ability to apply scientific knowledge, (90.0%), Ability to utilize the process of scientific inquiry, (85.0%), Interest in new development, (92.50%), Open mindedness, (86.67%), Curiosity, 70.0%), Ability to manage new situation, (91.66%), Interest in future , (81.66%), Reasoning, (75.0%), Reflective thinking, (63.33%), Observe everything as a critical thinker, (84.16%) and Aversion to superstition, (87.50%).

   Tachers also perceived that there is no need of training for students for enhancing the Rationality, (40.0%) and Objectivity of intellectual belief, (35.0%).

3. **Scientific Temper of secondary school students is at a low level.**

   The mean Scientific Temper score of the students was 90.81, which is 50% of the maximum score. This showed that the secondary school students have a low level of Scientific Temper.

4. **Boys are having high level of Scientific Temper when compared to that of girls.**

   The test of significance of the difference between the mean Scientific Temper scores of girls and boys was significant at 0.01 level. ($M_{Girls} = 89.98$, $M_{Boys} = 91.70$; $CR = 2.91$; $P<0.01$).

5. **Students from schools located in rural area are having high level of Scientific Temper when compared to that of students from schools located in urban area.**

The test of significance of the difference between the mean Scientific Temper scores of urban and rural school students was significant at 0.01 level (M_{Urban} = 88.63, M_{Rural} = 93.32; CR = 8.19; P<0.01).

6. **Students from aided schools are having high level of Scientific Temper when compared to that of students from government schools.**

   The test of significance of the difference between the mean Scientific Temper scores of aided and government school students was significant at 0.01 level (M_{Aided} = 92.11, $M_{Government}$ = 89.11; CR = 5.09; P<0.01).

7. **The implementation of Scientific Temper Package resulted in a marked enhancement in the level of Self Regulation of secondary school students**

   i. The mean, Median and Mode of pre-test and post-test scores on Self Regulation do not vary much. Narrow skewness and Kurtosis shows that the sample is approximately normal. The Standard deviations of the scores on Self Regulation of all the groups indicates that the scores are somewhat dispersed from the central value, so there are some deviant scores in both cases.

   ii. The analysis of the pre test scores on Self Regulation shows that the critical ratio obtained is 0.12, which is not significant at 0.05 level. When compared the mean post-test (CR= 6.68), and gain (CR= 11.12) scores of the Experimental and Control groups with respect to the Self Regulation, it was revealed that the Experimental and Control group differ significantly at 0.01 level. The value of critical ratio and the mean scores reveals that, for attaining total Self Regulation at Secondary Level, the Scientific Temper Package developed by the investigator is better than the Activity Oriented Method.

   iii. When comparing the groups using ANOVA, the obtained Fy value is 44.53, which is significant at 0.01 level. Then by using ANCOVA, the Fyx ratio is greater than the table value and it is significant (Fyx= 151.06, P < 0.01). The significant ratio for the adjusted post test scores on Self Regulation shows that the final mean scores of the students in the Experimental and the Control groups differ significantly after they are adjusted for the difference in the pre test scores.

   iv. The difference in adjusted means for the post test scores on Self Regulation of the experimental and control groups is significant at 0.01

level (t= 12.29), since 't' value from table D is 1.96 and 2.58 at 0.05 and 0.01 levels respectively. The above analysis revealed that for attaining total Self Regulation at Secondary Level, the Scientific Temper Package developed by the investigator is better than the Activity Oriented Method.

8. The implementation of Scientific Temper Package resulted in a marked enhancement in the Achievement in Biology of secondary school students

i. The mean, Median and Mode of pre-test and post-test scores on Achievement in Biology do not vary much. Narrow skewness and Kurtosis shows that the sample is approximately normal. The negative value of Skewness for the Control group implies that the distribution is skewed negatively and majority of students have higher score than the average value, where as the positive value of Skewness for the Experimental group reveals that the distribution is skewed positively and majority of students possess lower score than the average value. The kurtosis of Experimental group is higher and Control group is lower than 0.263. Therefore the distribution is platykurtic for Experimental group and leptokurtic for Control group. The Standard deviations of the scores on Achievement in Biology of all the groups indicates that the scores are somewhat dispersed from the central value, so there are some deviant scores in both cases.

ii. When the pre test scores on Achievement in Biology were analysed, the CR obtained is 0.06, which is not significant at 0.05 level (CR = 0.06, P>0.05). This clearly proves that the experimental and control groups do not differ significantly on Achievement in Biology at secondary level. When compared the mean post-test (CR= 8.22), and gain (CR= 4.69) scores of the Experimental and Control groups with respect to the Achievement in Biology, it was revealed that the Experimental and Control group differ significantly at 0.01 level.

iii. When comparing the groups using ANOVA, the obtained Fy value is 194.76, which is significant at 0.01 level. Then by using ANCOVA, the Fyx ratio is greater than the table value and it is significant (Fyx= 328.21, P < 0.01). The difference in adjusted means of the Experimental and Control Groups is significant at 0.01 level (t= 18.12), since 't' value from table is 1.96 and 2.58 at 0.05 and 0.01 levels respectively. The above analysis inferred that teaching

through Scientific Temper Package helped the experimental group to achieve better than the control group taught through Activity Oriented Method.

iv. The mean, median and mode of pre-test and post-test scores on Achievement in biology with respect to each objective do not vary very much. Narrow skewness and kurtosis show that the sample is approximately normal. Standard deviation may also show that the sample is almost homogeneous with regard to objective-wise achievement in biology.

v. When the pre test scores on Achievement in Biology under the different objectives were analysed, the CR obtained is not significant at 0.05 level (Remembering- CR = 0.06, Understanding- CR = 1.42, Application- CR = 1.40, Analysis- CR = 1.14, Evaluation- CR = 1.81). This clearly proves that the experimental and control groups do not differ significantly on Achievement in Biology, under the different objectives prior to the treatment. When the mean post-test scores of the Experimental and Control groups were compared with respect to the Achievement in Biology under the different objectives, CR obtained is significant at 0.01 level (Remembering- CR = 4.22, Understanding- CR = 6.28, Application- CR = 11.17, Analysis- CR = 8.96, Evaluation- CR = 9.78). This shows that there is significant difference between the Experimental and Control groups with respect to the post test scores under the objectives, Remembering, Understanding, Application, Analysis and Evaluation. When the gain scores of the Experimental and Control groups were compared with respect to the Achievement in Biology under the different objectives, CR obtained is significant at 0.01 level (Remembering- CR = 5.40, Understanding- CR = 9.89, Application- CR = 8.98, Analysis- CR = 11.84, Evaluation- CR = 8.50). This revealed that there is significant difference between the Experimental and Control groups with respect to gain scores under the objectives, Remembering, Understanding, Application, Analysis and Evaluation. The mean gain scores of the two groups reveal that after the treatment the Experimental group achieved better than the Control group.

vi. When comparing the groups using ANOVA, the obtained value of Fy for the different objectives such as Remembering- Fy= 17.87, Understanding- Fy = 39.51, Application- Fy = 124.94, Analysis- Fy = 80.30 and Evaluation- Fy = 95.84 are significant at 0.01 level. While computing ANCOVA, the obtained

Fyx ratio on Achievement in Biology under the different objectives such as Remembering- Fyx= 34.62, Understanding- Fyx = 107.11, Application- Fyx = 135.19, Analysis- Fyx = 147.24 and Evaluation- Fyx = 110.33, which is greater than the table value and is significant at 0.01 level. The significant Fyx ratio for the adjusted post test scores on Achievement in Biology under the different objectives shows that the final mean (post test) scores of the students in the Experimental and the Control groups differ significantly after they were adjusted for the difference in the pre test scores.

vii. The difference in adjusted means for the post test scores on Achievement in Biology under the different objectives of the Experimental and Control groups were tested for significance for df 1/325. The obtained t value is Remembering- t = 5.88, Understanding- t= 10.38, Application- t = 11.66, Analysis- t= 12.16 and Evaluation- t = 10.56, which is significant at 0.01 level. It is clear that the Experimental and the Control groups differ significantly with respect to Achievement in Biology under the different objectives, Remembering, Understanding, Application, Analysis and Evaluation. Thus it is inferred that the students in the Experimental Group taught through Scientific Temper Package have better Achievement in Biology under the different objectives than the Control Group taught through Activity Oriented Method.

9. **The level of Scientific Creativity of secondary school students has enhanced significantly after the implementation of the Scientific Temper Package**

i. The mean, Median and Mode of pre-test and post-test scores on Scientific Creativity do not vary much. Narrow skewness and Kurtosis shows that the sample is approximately normal. The Standard deviations of the scores on Scientific Creativity of all the groups indicates that the scores are somewhat dispersed from the central value, so there are some deviant scores in both cases.

ii. After comparing the pre test scores the critical ratio obtained is 0.34, which reveals that there is no significant difference between the Experimental and Control groups with respect to Scientific Creativity at 0.05 level (C R =0.34, P>0.05). The critical ratio obtained after comparing the post test scores (CR= 8.55, P<0.01) and gain scores (CR =12.65, P<0.01) of the Experimental and

Control groups with respect to Scientific Creativity shows that the Experimental and Control groups differ significantly at 0.01 level. The value of critical ratio and the mean scores reveals that the Experimental Group taught using Scientific Temper Package showed more Scientific Creativity than the Control Group taught using Activity Oriented Method.

iii. From the analysis using ANOVA, the obtained value of Fy is 72.72, which is significant at 0.01 level. This shows that the groups differ significantly in their post test scores on Scientific Creativity. From the analysis using ANCOVA, the Fyx ratio 193.55 is greater than the table value, it is significant at 0.01 level (Fyx = 193.55, $P<0.01$). The significant ratio for the adjusted post test scores on Scientific Creativity shows that the final mean scores of the students in the Experimental and the Control groups differ significantly after they are adjusted for the difference in the pre test scores.

iv. The difference in adjusted means for the post test scores on Scientific Creativity of the Experimental and Control groups were tested for significance for df 1/325. The obtained t value is 13.91, (t =13.91) which is significant at 0.01 level. After treatment there is significant difference between the Experimental and the Control groups with respect to Scientific Creativity. Thus it is inferred that the Scientific Temper Package developed by the investigator is better than the Activity Oriented Method in enhancing Scientific Creativity among secondary school students.

10. The implementation of Scientific Temper Package resulted in a marked enhancement in the level of Scientific Temper of secondary school students

i. The mean, Median and Mode of pre-test and post-test scores on Scientific Temper do not vary much. Narrow skewness and Kurtosis shows that the sample is approximately normal. The Standard deviations of the scores on Scientific Temper of all the groups indicates that the scores are somewhat dispersed from the central value, so there are some deviant scores in both cases.

ii. After comparing the pre test scores, the critical ratio obtained is 0.23, which reveals that there is no significant difference between the Experimental and Control groups with respect to Scientific Temper at 0.05 level (C R =0.23,

P>0.05). The critical ratio obtained after comparing the post test scores (CR= 12.61, P<0.01) and gain scores (CR =10.10, P<0.01) of the Experimental and Control groups with respect to Scientific Temper shows that the Experimental and Control groups differ significantly at 0.01 level. The value of critical ratio and the mean scores reveals that, for attaining total Scientific Temper at Secondary Level, the Scientific Temper Package developed by the investigator is better than the Activity Oriented Method.

iii. From the analysis using ANOVA, the obtained value of Fy is 156.64, which is significant at 0.01 level. This shows that the groups differ significantly in their post test scores on Scientific Temper. While computing ANCOVA, the Fyx ratio162.52, is greater than the table value, it is significant at 0.01 level (Fyx = 162.52, P<0.01). The significant ratio for the adjusted post test scores on Scientific Temper shows that the final mean scores of the students in the Experimental and the Control groups differ significantly after they are adjusted for the difference in the pre test scores.

iv. The difference in adjusted means for the post test scores on Scientific Temper of the Experimental and Control groups were tested for significance for df 1/325. The obtained t value is 12.75, (t =12.75) which is significant at 0.01 level. After treatment, there is significant difference between the Experimental and the Control groups with respect to Scientific Temper. Thus it is inferred that the Scientific Temper Package developed by the investigator is better than the Activity Oriented Method in enhancing Scientific Temper among secondary school students.

v. The mean, Median and Mode of pre-test and post-test scores on Scientific Temper with respect to each component do not vary much. Narrow skewness and Kurtosis shows that the sample is approximately normal. The Standard deviations of the scores on Scientific Temper of all the groups indicates that the scores are somewhat dispersed from the central value, so there are some deviant scores in both cases.

vi. When the pre test scores on Scientific Temper with respect to each component were analysed, the CR obtained is not significant at 0.05 level (Scientific Attitude- -CR = 1.85, Scientific Perception - CR = 0.63, Scientific Habit - CR = 0.53, Scientific Literacy - CR = 0.74, Scientific Thinking - CR = 1.06 and Scientific Method- CR = 1.59). This clearly proves that the experimental and

control groups do not differ significantly on Scientific Temper with respect to each component prior to the treatment. When the mean post-test scores of the Experimental and Control groups were compared with respect to the Scientific Temper under the different components, CR obtained is significant at 0.01 level (Scientific Attitude- -CR = 10.74, Scientific Perception - CR = 9.38, Scientific Habit - CR = 9.90, Scientific Literacy - CR = 11.06, Scientific Thinking - CR = 7.76 and Scientific Method- CR = 5.14). This shows that there is significant difference between the Experimental and Control groups with respect to the post test scores under the components, Scientific Attitude, Scientific Perception, Scientific Habit, Scientific Literacy, Scientific Thinking and Scientific Method. When the gain scores of the Experimental and Control groups were compared with respect to the Scientific Temper under the components, CR obtained is significant at 0.01 level (Scientific Attitude- -CR = 7.95, Scientific Perception - CR = 6.79, Scientific Habit - CR = 6.75, Scientific Literacy - CR = 8.79, Scientific Thinking - CR = 7.89 and Scientific Method- CR = 6.23). This revealed that there is significant difference between the Experimental and Control groups with respect to gain scores under the components, Scientific Attitude, Scientific Perception, Scientific Habit, Scientific Literacy, Scientific Thinking and Scientific Method. The value of critical ratio and the mean scores reveals that the Experimental group taught using Scientific Temper Package showed more Scientific Temper than the Control group taught using Activity Oriented Method.

vii. When comparing the groups using ANOVA, the obtained value of Fy for the different components of Scientific Temper such as Scientific Attitude- - Fy = 115.35, Scientific Perception - Fy = 87.21, Scientific Habit - Fy = 98.17, Scientific Literacy - Fy = 122.35, Scientific Thinking - Fy = 60.37 and Scientific Method-Fy = 26.46 are significant at 0.01 level. While computing ANCOVA, the obtained Fyx ratio on Scientific Temper under the different components such as Scientific Attitude - Fyx = 111.28, Scientific Perception - Fyx = 91.41, Scientific Habit - Fyx = 100.81, Scientific Literacy - Fyx = 124.27, Scientific Thinking - Fyx = 76.96 and Scientific Method- Fyx = 43, which is greater than the table value and is significant at 0.01 level. The significant Fyx ratio for the adjusted post test scores on Scientific Temper under the different components shows that the final mean (post test) scores of

the students in the Experimental and the Control groups differ significantly after they were adjusted for the difference in the pre test scores.

viii. The difference in adjusted means for the post test scores on Scientific Temper under the components of the Experimental and Control groups were tested for significance for df 1/325. The obtained t value is Scientific Attitude - t= 10.60, Scientific Perception -t = 9.57, Scientific Habit - t = 10.04, Scientific Literacy - t = 11.16, Scientific Thinking - t = 8.79 and Scientific Method- t = 6.66, which is significant at 0.01 level. It is clear that the Experimental and the Control groups differ significantly with respect to the Scientific Temper under the components, Scientific Attitude, Scientific Perception, Scientific Habit, Scientific Literacy, Scientific Thinking and Scientific Method. Thus it is inferred that the students in the Experimental Group taught through Scientific Temper Package have better Scientific Temper under the different components than the Control Group taught through Activity Oriented Method.

11. The level of Science Interest of secondary school students has enhanced significantly after the implementation of the Scientific Temper Package

i. The mean, Median and Mode of pre-test and post-test scores on Science Interest do not vary much. Narrow skewness and Kurtosis shows that the sample is approximately normal. The Standard deviations of the scores on Science Interest of all the groups indicates that the scores are somewhat dispersed from the central value, so there are some deviant scores in both cases.

ii. After comparing the pre test scores, the critical ratio obtained is 0.08, which reveals that there is no significant difference between the Experimental and Control groups with respect to Science Interest at 0.05 level (C R =0.08, P>0.05). The critical ratio obtained after comparing the post test scores (CR= 9.15, P<0.01) and gain scores (CR =13.04, P<0.01) of the Experimental and Control groups with respect to Science Interest shows that the Experimental and Control groups differ significantly at 0.01 level. The value of critical ratio and the mean scores reveals that the Experimental Group taught using Scientific Temper Package showed more Science Interest than the Control Group taught using Activity Oriented Method.

iii. From the analysis using ANOVA, the obtained value of Fy is 80.38, which is significant at 0.01 level. This shows that the groups differ significantly in their post test scores on Science Interest. While computing ANCOVA, the Fyx ratio 202.20 is greater than the table value, it is significant at 0.01 level (Fyx = 202.20, P<0.01). The significant ratio for the adjusted post test scores on Science Interest shows that the final mean scores of the students in the Experimental and the Control groups differ significantly after they are adjusted for the difference in the pre test scores.

iv. The difference in adjusted means for the post test scores on Science Interest of the Experimental and Control groups were tested for significance for df 1/325. The obtained t value is 14.22, (t =14.22) which is significant at 0.01 level. After treatment, there is significant difference between the Experimental and the Control groups with respect to Science Interest. Thus it is inferred that the Scientific Temper Package developed by the investigator is better than the Activity Oriented Method in enhancing Science Interest among secondary school students.

12. The implementation of Scientific Temper Package resulted in a marked enhancement in the level of Social Sensitivity of secondary school students

i. The mean, Median and Mode of pre-test and post-test scores on Social Sensitivity do not vary much. Narrow skewness and Kurtosis shows that the sample is approximately normal. The Standard deviations of the scores on Social Sensitivity of all the groups indicates that the scores are somewhat dispersed from the central value, so there are some deviant scores in both cases.

ii. After comparing the pre test scores, the critical ratio obtained is 0.07, which reveals that there is no significant difference between the Experimental and Control groups with respect to Social Sensitivity at 0.05 level (C R =0.07, P>0.05). The critical ratio obtained after comparing the post test scores (CR= 9.62, P<0.01) and gain scores (CR =13.16, P<0.01) of the Experimental and Control groups with respect to Social Sensitivity shows that the Experimental and Control groups differ significantly at 0.01 level. The value of critical ratio and the mean scores reveals that, for attaining total Social Sensitivity at

Secondary Level, the Scientific Temper Package developed by the investigator is better than the Activity Oriented Method.

iii. From the analysis using ANOVA, the obtained value of Fy is 92.18, which is significant at 0.01 level. This shows that the groups differ significantly in their post test scores on Social Sensitivity. While computing ANCOVA, the Fyx ratio 225.81, is greater than the table value, it is significant at 0.01 level (Fyx = 225.81, $P<0.01$). The significant ratio for the adjusted post test scores on Social Sensitivity shows that the final mean scores of the students in the Experimental and the Control groups differ significantly after they are adjusted for the difference in the pre test scores.

iv. The difference in adjusted means for the post test scores on Social Sensitivity of the Experimental and Control groups were tested for significance for df 1/325. The obtained t value is 15.03, (t =15.03) which is significant at 0.01 level. After treatment, there is significant difference between the Experimental and the Control groups with respect to Social Sensitivity. Thus it is inferred that the Scientific Temper Package developed by the investigator is better than the Activity Oriented Method in enhancing Social Sensitivity among secondary school students.

Educational Implications

The main objective of the study was to find out the effectiveness of Scientific Temper Package on certain Cognitive and Affective Variables of students at secondary level. The findings of the study point out some important facts that require the attention of the educational practitioners. The implications of the study are outlined below.

The initial survey study conducted as a part of the investigation revealed that the Scientific Temper of secondary school students is at low level. Efforts to create an objective, open-minded, logical approach with a respect to accuracy in reasoning among children are still not adequate. This is a matter of serious concern. Scientific Temper involves the application of logic and the avoidance of bias and preconceived notions, which is behind the method of acquiring reliable and practical knowledge. Scientific Temper requiring solid information and incontrovertible data, and then suitable analysis before accepting anything. If a person uses the scientific method in

his/her daily life decision making process knowingly or unknowingly then we can say that he/she has Scientific Temper. Nehru first defined and elaborated the concept of Scientific Temper in 'The Discovery of India', points out that scientific approach should be an integral part of social interactions, as expressed by the quote "The scientific approach and temper are, or should be, a way of life, a process of thinking, a method of acting and associating with life, a process of thinking, a method of acting and associating with our fellowmen". Thus Scientific Temper is important in our life, this kind of attitude enable general public for making their decisions rational. Therefore the development of Scientific Temper among the citizens is essential for the overall development of the nation. For the overall development and growth of the country and society, Low Scientific Temper causes many adverse effects on the well being of an individual. The lack of Scientific Temper weakens our ability to take rational decisions. Development of Scientific Temper among the people was an important part of Nehru's vision of India. He recognized, however, the extent of the transformation required of contemporary Indian society before his vision could materialize, and this was sufficient to despair even an optimist like him, for a scientific temper is conspicuously lacking in the country, even among those with an ostensibly scientific training. Development of Scientific Temper among the people could, in fact, bring into focus the essence of all religions-the universal laws governing the inner world of human beings and thus, promote communal harmony in a multilingual, muti-religious and multiracial country like India. Therefore, it is high time for all the concerned authorities including the government, curriculum developers, teachers and parents to think on ways to enhance the Scientific Temper of students. India is one of the leading nations in the world in terms of science and technology. India has the second largest pool of scientists and engineers in the world. In terms of technological advancements and scientific achievements India is second to none. India belongs to the select group of countries who have developed indigenous nuclear technology. India is among the few countries which have developed ballistic missiles. In the field of space science India is among the few countries which have the capability to launch GSLV satellite. India's achievements in the field of IT and software are acknowledged all over the world. India's successful stories are on the move now. It gets a new momentum by the giant leap of Mangalyaan to the red planet. Not only in the scientific arena, but also many gradual positive changes are happening around every strata of life. There is no doubt that 'Make in India' will

create a new India. Still, there are some loopholes in the changing face of India. On one hand, the country has the much hailed glory of Mangalyaan which enabled India to set a mark in the history of the world, but on the other hand the same 'incredible' India is in the grip of false beliefs and misconceptions, simply pass the right of making decisions to astrologers who don't even know our dreams and caliber.

Blind beliefs are making us blinds. India has been conventional societies which faithfully believe in old beliefs and miracles happening in the community. A genuine faith in conventional beliefs and in miracles means living on hope for all the time. The drinking of milk by the Ganesh idols in India, Nepal, London, U S A and other places on September 21, 1995 has presented a picture of miracle promoting credulity and straining credibility. This miracle strengthens the conventional faith of supernatural powers in people and taking scientist's explanation phony. The rationalist who refuses to accept miracles was reduced to minority. These immature superstitions are accumulated in our social consciousness due to the immature teaching-learning atmosphere which is prevalent in the present system. It is high time to think about a change in the existing system, unless it will devour the dreams of children to fly. Science related environmental issues and faith in traditional beliefs necessitates scientifically literate citizens, who understand science and use Scientific Temper for quality living. It has far reaching educational implications.A common science curriculum needs appropriate content which is relevant, adequate, accurate and contemporary. It should be related to real life situations.

The present educational system focuses only on the academic outcomes of students leaving behind their social, cultural, cognitive and affective developments. Bondey (1984) stated that, we cannot possibly provide school children with enough information to ensure their lifelong success in an ever changing world. Preparing children to meet the demands of an uncertain future, however, may require a shift in educational focus from the content to the process of learning. Science education is still far from achieving the goal of revamping the curriculum inorder to make an attempt to link teaching of scientific principles with daily life experiences of the learners, enough opportunities to learners to attain some basic levels of scientific literacy, and ample opportunities to the teachers to try and apply a variety of methods of teaching to suit the needs of learners of different backgrounds.

At present there is no special attention paid in the school to develop Scientific Temper among students. Since the lack of scientific awareness and Scientific Temper are the topics for discussion for long in the educational scenario, the present educational institutions are not adequately equipped to handle the challenges in a scientifically advanced society. Hence it is necessary to incorporate the relevant aspects of Scientific Temper in the curriculum of secondary school students. Teaching science should be in such a way that helps students to develop scientific approach to life. Inculcation of values like spirit of inquiry, courage (to question), objectivity, honesty and truthfulness, which are precursors to the development of good citizen in the society. Educational materials like Scientific Temper Package may be used to serve the above purposes.

The aim of the study was to develop Scientific Temper Package that could be used by the Secondary students. This study contributed to education under the *Research and Development Category*, which is described by Gay (1987) as research that is directed at the development of effective products that can be used in schools. Findings of the study proved that the Scientific Temper Package was far superior to the present Activity oriented method in enhancing Scientific Temper of secondary school students. This Package should be introduced at Secondary level for the attainment of and also for the enhancement of Achievement in Biology, Science Interest and Social Sensitivity. The importance of such learning packages should be emphasised in the teacher education curriculum and teacher educators should be equipped to translate the importance of learning packages in their practice.

The package has provision to help the students to understand their own learning process. This understanding helps to improve the self regulation of students and to regulate their learning process in a positive direction. The package provides opportunity for the learners to actively participate in group discussions while learning so that they are not passive listeners. Scientific Temper Package enhances the Scientific Creativity of students and helps to retain the achievement for long. So the teacher should assist parents to encourage the creative experiences of their children by discussion, experimenting, discovering and constructing, by being tolerant to divergent ideas for themselves and by sharing stimulating experience with them. The child's striving for independence, for recognition and for reward are some of the assets of creative personality that the parents should realize. The self evaluation

aspect and immediate feedback provided in the package helped students to know whether the desired goal has attained. Scientific Temper Package provides students ample opportunities to plan and practice monitoring of their learning. The combination of multimedia elements such as texts, graphics, animations, simulations, audios and videos in one digital environment created an interesting and interactive learning environment that motivated the students in their learning. The student's perception and attention spans also get improved by utilizing the technology based presentation.

Teachers should be encouraged to apply Scientific Temper Package while teaching the subject and also teachers should be oriented to the theory and practice associated with STP to implement it in the class room. Hence the use of this type of instructional package should be incorporated in the syllabi for teacher training and in-service training programmes. The STP can be introduced to teach biology in the whole class since the students have scored significantly higher scores while teaching through this package. So the authorities should take necessary steps to introduce this package for teaching biology. Pre service and in service teacher training programmes should focus on the importance of instructional package based on Scientific Temper in order to make our schools better institutions. Teachers should be given orientation as to how an instructional package based on Scientific Temper can be developed by making use of the resources locally available to teach biology both at school and college level. This will pave the way for optimum human resources development.

One of the most important contributions of the study, in addition to its wider theoretical and practical implications is that, it has come out with a set of standardised instruments for measuring the variables of the study, viz., Scientific Temper, Self Regulation, Scientific Creativity, Science Interest and Social Sensitivity. These tools can be further used widely in the fields of Education and particularly science Education. Keeping the results of the study in mind, the agencies responsible to improve the quality of education should take up the task of developing an instructional package based on Scientific Temper for all the subjects. For the development of an instructional package by integrating Scientific Temper, the NCERT and the SCERT can make use of the services of outstanding teachers at the national as well as the state level so that the expertise of the meritorious teachers can be made available even to the students in far flung areas. Preparing children to meet

the demands of an uncertain future however may require a shift in educational focus from the content to the process of learning. Not only do children need to be able to think, but they need to exercise control over their own thinking.

The country needs people with the capacity to think independently, logically and critically and also to create knowledge. This need can be fulfilled if Scientific Temper based teaching is introduced along with other modern methods. This process of teaching and learning create in children an urge to learn new developments and motivate them to acquire information and knowledge about new techniques. The results of the present study have very significant value in the field of education. The findings of the study can bring about revolutionary changes from the perspective of the learner, the teacher, the educational system and the society at large. Science would not just play a role in building scientific expertise but also help reject superstition, prejudice and injustice. As Yashpal has noted, "science will also have to come forward in changing our thoughts and eradicating various social evils, including casteism, extremism…" (Times of India, 2005). India, in Nehru's vision, could become a great country if the people adopted such a 'Scientific Temper.

The father of India's nuclear bomb, the architect of space and missile technology and the eleventh president of India, Kalam points out that, science education is the foundation to ensure the creation of enlightened citizens who will make a prosperous, happy, and strong nation. To quote him,

"When learning is purposeful,
Scientific Temper blossoms,
When Scientific Temper blossoms,
Thinking emanates,
When Thinking emanates,
Knowledge is fully lit,
When Knowledge is fully lit,
Economy flourishes."