CHAPTER VI
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SUMMARY, CONCLUSIONS AND SUGGESTIONS

This chapter presents a brief summary of the in retrospect, conclusions Based on Findings of the study, educational Implications of the study and some suggestions for Further Research.

6.1 The Study in Retrospect

The main aim of the present study was to find out the effectiveness of Scientific Temper Package on certain cognitive and affective variables of students at secondary level.

6.1.1 Restatement of the Problem

The present study was entitled, 

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

6.1.2 Objectives of the Study

1. To analyse the perception of Teachers on
   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 Package for 8th standard students following Kerala State Syllabus.

5. To find out the effectiveness of Scientific Temper Package and Activity Oriented Method of Teaching for Secondary School Students with respect to
6. To compare the effectiveness of Scientific Temper Package and Activity Oriented Method of Teaching for Secondary School Students with respect to

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

6.1.3 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 Scientific Temper of Secondary School Students taught using Scientific Temper Package is significantly higher than that of those taught using Activity Oriented Method of Teaching.

3. The Scientific Temper of Secondary School Students taught using Scientific Temper Package is significantly higher than that of those taught using Activity Oriented Method of Teaching with respect to the Components
• Scientific Literacy
• Scientific Attitude
• Scientific Thinking
• Scientific Method
• Scientific Perception
• Scientific Habit

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

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

6. The Achievement in Biology of Secondary School Students taught using Scientific Temper 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

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

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

6.1.4 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 teacher assisted package developed and implemented for a duration of 1 ½ months that includes 62 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.

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

Before starting the experiment, pre tests were conducted by administering the Scientific Temper test, Self Regulation Scale, Achievement Test in biology, Scientific Creativity 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.

6.1.6 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 samples.

vi. Analysis of variance.

vii. Analysis of Covariance.

6.2 Major Findings of the Study

The major findings emerged from the study are given below.

6.2.1 Perception of Teachers on the Existing level of Scientific Temper of Secondary School Students

Teachers perceived that only a few students at secondary school level have proper ability to apply scientific knowledge ($\chi^2 = 64$, $P<0.01$), ability to utilize the process of scientific inquiry ($\chi^2 = 39.58$, $P<0.01$), interest in new developments ($\chi^2 = 52.75$, $P<0.01$), open mindedness ($\chi^2 = 73.33$, $P<0.01$), curiosity ($\chi^2 = 13.75$, $P<0.01$), ability to manage new situations ($\chi^2 = 57.41$, $P<0.01$), interest in future ($\chi^2 = 12.00$, $P<0.05$), skill of reasoning ($\chi^2 = 56.25$, $P<0.01$), ability of critical observation ($\chi^2 = 16.41$, $P<0.01$) and aversion to superstitious belief ($\chi^2 = 43.08$, $P<0.01$).

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

6.2.2 Perception of Teachers on the need 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, (89.17%), 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%).
Teachers also perceived that the number of students who need training for enhancing the Rationality, (40.0%) and Objectivity of intellectual belief, (35.0%) were less.

6.2.3 The existing level of Scientific Temper of Secondary School Students

The existing level of Scientific Temper of majority of secondary school students was average score of the test.

6.2.4 Comparison of the existing level of Scientific Temper of Secondary School Students based on gender

The test of significance of the difference between the mean Scientific Temper scores of girls and boys were significant at 0.01 level. ($M_{girls} = 89.98$, $M_{boys} = 91.70$; $CR = 2.91; p<0.01$). Findings show that Boys have high level of Scientific Temper when compared to that of girls.

6.2.5 Comparison of the existing level of Scientific Temper of Secondary School Students based on Locality of School

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 ($M_{urban} = 88.63$, $M_{rural} = 93.32$; $CR = 8.19; p<0.01$). This shows that 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.

6.2.6 Comparison of the existing level of Scientific Temper of Secondary School Students based on Type of management of School

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 ($M_{aided} = 92.11$, $M_{government} = 89.11$; $CR = 5.09; p<0.01$). This shows that students from aided schools are having high level of Scientific Temper when compared to that of students from government schools.

6.2.7 Initial Comparison of Experimental and Control Group

Before starting the experimental treatment, there was no significant difference between the Experimental and Control group with respect to their Scientific Temper ($t=0.23, p>0.05$), Self Regulation ($t=0.12, p>0.05$), Achievement in Biology ($t= 0.06$, 0.06)
p>0.05), Scientific Creativity (t= 0.34, p>0.05), Science Interest (t= 0.08, p>0.05) and Social Sensitivity (t= 0.07, p>0.05).

6.2.8 Scientific Temper

a. The mean, Median and Mode of pre-test and post-test scores on Scientific Temper do not show much variation. 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.

b. The comparison of the posttest scores of the Experimental and Control groups with respect to Scientific Temper (CR= 12.61, p<0.01) revealed that the Experimental and Control group differ significantly at 0.01 level. The t value and the mean difference reveal that the Experimental group taught using Scientific Temper Package is better than the Activity Oriented Method in enhancing Scientific Temper of students.

c. When compared the gain scores of the Experimental and Control groups with respect to Scientific Temper to substantiate the above findings, it was revealed that the Experimental and Control groups differ significantly at 0.01 level. The value of critical ratio (CR =10.10, p<0.01) and the mean scores reveal that, instruction using Scientific Temper Package is better than the Activity Oriented Method in enhancing Scientific Temper of students.

d. The analysis of variance of the pre test and post test scores showed that there is no significant difference between the means of pre test scores of the Experimental and Control groups with respect to the Scientific Temper (Fₓ=0.06). But there is significant difference between the means of post test scores of the two groups (Fᵧ =156.64), which is significant at 0.01 level. This shows that the groups differ significantly in their post test scores on Scientific Temper.

e. Analysis of covariance of the pre test and post test scores showed that there is a significant difference between the means of the post test scores of the Experimental and the Control groups (Fᵧₓ = 162.52, p<0.01). When the
adjusted means of the post test scores of the Experimental and the Control groups were compared, the obtained t value \( t = 12.75 \) was found to be statistically significant at 0.01 level. Since the adjusted mean of the Experimental group is higher than that of the Control group, the students in the Experimental group are found superior on Scientific Temper than the students in the Control group. 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.

### 6.2.9 Scientific Temper with respect to Different Components

a. The mean, Median and Mode of pre-test and post-test scores on Scientific Temper with respect to each component do not show much variation. 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.

b. 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 Literacy - CR = 11.06, Scientific Attitude - CR = 10.74, Scientific Thinking - CR = 7.76, Scientific Method - CR = 5.14, Scientific Perception - CR = 9.38 and Scientific Habit - CR = 9.90). This shows that there is significant difference between Experimental and Control groups with respect to the post test scores on Scientific Temper under the components, Scientific Attitude, Scientific Perception, Scientific Habit, Scientific Literacy, Scientific Thinking and Scientific Method.

c. 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 Literacy - CR = 8.79, Scientific Attitude - CR = 7.95, Scientific Thinking - CR = 7.89, Scientific Method - CR = 6.23, Scientific Perception - CR = 6.79 and Scientific Habit - CR = 6.75). 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.

d. The analysis of variance of the pre test and post test scores showed that there is no significant difference between the means of pre test scores of the Experimental and Control groups with respect to Scientific Temper under the components. The obtained value of $F_y$ for the different components of Scientific Temper (Scientific Literacy - $F_y = 122.35$, Scientific Attitude - $F_y = 115.35$, Scientific Thinking - $F_y = 60.37$, Scientific Method - $F_y = 26.46$, Scientific Perception - $F_y = 87.21$ and Scientific Habit - $F_y = 98.17$) are significant at 0.01 level. This shows that the Experimental and control groups differ significantly on the post test scores on Scientific Temper under the components.

e. While computing ANCOVA, the obtained $F_{yx}$ ratio on Scientific Temper under the different components (Scientific Literacy - $F_{yx} = 124.27$, Scientific Attitude - $F_{yx} = 111.28$, Scientific Thinking - $F_{yx} = 76.96$, Scientific Method- $F_{yx} = 43.99$, Scientific Perception -$F_{yx} = 91.41$ and Scientific Habit - $F_{yx} = 100.81$) are greater than the table value and is significant at 0.01 level. The significant $F_{yx}$ 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. 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 $t$ values (Scientific Literacy - $t = 11.16$, Scientific Attitude – $t = 10.06$, Scientific Thinking - $t = 8.79$, Scientific Method- $t = 6.66$, Scientific Perception - $t = 9.57$ and Scientific Habit - $t = 10.04$) are 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.

6.2.10 Self Regulation

a. The mean, Median and Mode of pre-test and post-test scores on Self Regulation do not show much variation. 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.

b. The comparison of the post test scores of the Experimental and Control groups with respect to Self Regulation (CR= 6.68), revealed 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 is better than the Control Group taught using Activity Oriented Method in developing Self Regulation among secondary school students.

c. The comparison of gain scores of the Experimental and Control groups with respect to Self Regulation, revealed that the Experimental and Control groups differ significantly at 0.01 level (CR= 11.12, p<0.01). The value of critical ratio and the mean difference reveal that the instruction using the developed Scientific Temper Package helped the students in the Experimental group to enhance their Self Regulation compared to the students in the control group.

d. The analysis of the variance of the pre test and post test scores showed that there is no significant difference between the means of pre test scores of the Experimental and Control groups with respect to Self Regulation ($F_x = 0.01$). But there is significant difference between the means of post test scores of the two groups ($F_y = 44.53$), which is significant at 0.01 level.
This shows that the groups differ significantly on Self Regulation in post test scores.

e. When computing Analysis of covariance, as the $F_{yx}$ ratio is found to be greater than the table value, it is significant at 0.01 level ($F_{yx}= 151.06$, $p < 0.01$). 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. 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 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.

62.11 Achievement in Biology

a. The mean, Median and Mode of pre-test and post-test scores on Achievement in Biology do not show much variation. The Standard deviations of the scores on Achievement in Biology of all the groups indicates that the scores are not dispersed much from the central value. Narrow skewness and Kurtosis shows that the sample is approximately normal.

b. The comparison of the post test scores of the Experimental and Control groups with respect to Achievement in Biology (CR= 8.22), revealed 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 achieved better than the Control Group taught using Activity Oriented Method.

c. The comparison of gain scores of the Experimental and Control groups with respect to total Achievement in Biology, revealed that the Experimental and Control groups differ significantly at 0.01 level (CR= 4.69, $p<0.01$). The value of critical ratio and the mean scores reveals that
instruction using Scientific Temper Package helped to achieve better than the instruction using prevailing Activity Oriented Method.

d. The analysis of the variance of the pre test and post test scores showed that there is no significant difference between the means of post test scores of the Experimental and Control groups with respect to the Achievement in Biology Fx (0.01). But there is significant difference between the means of post test scores of the two groups (Fy =194.76), which is significant at 0.01 level. This shows that the groups differ significantly on their post test scores on Achievement in Biology

e. Analysis of covariance of the pre test and post test scores showed that there is a significant difference between the means of the post test scores of the Experimental and Control group (Fyx= 328.21, p < 0.01). When the adjusted means of the post test scores of the Experimental and Control groups were compared, the obtained t value (t= 18.12), was found to be statistically significant at 0.01 level. Since the adjusted mean of the Experimental group is higher than that of the Control group, the students in the experimental group are found superior on Achievement in Biology than the students in the Control group. The above findings inferred that teaching through Scientific Temper Package helped the Experimental group to achieve better than the Control group taught through Activity Oriented Method.

6.2.12 Achievement in Biology under the Category of Objectives

a. The mean, median and mode of pre-test and post-test scores on Achievement in biology with respect to each objective do not show much variation. 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.

b. 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 on Achievement in Biology under the objectives, Remembering, Understanding, Application, Analysis and Evaluation.

c. When the mean 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 mean gain scores of Experimental and Control groups with respect to Achievement in Biology under the objectives, Remembering, Understanding, Application, Analysis and Evaluation. The mean gain Achievement scores of the two groups in each category of objectives states that after the administration of the package, the Experimental group taught using Scientific Temper package achieved better than the Control group under the category of objectives.

d. The analysis of variance of the pre test and post test scores showed that there is no significant difference between the means of pre test scores of the Experimental and Control groups under the category of objectives. The obtained $F_y$ values in each category of objectives (Remembering – $F_y = 17.87$, Understanding - $F_y = 39.51$, Application - $F_y = 124.94$, Analysis - $F_y = 80.30$ and Evaluation - $F_y = 95.84$) are significant at 0.01 level. This shows that the Experimental and control groups differ significantly on the post test scores on Achievement in Biology under the category of objectives.

e. From the analysis using ANCOVA, the obtained $F_{yx}$ ratio on Achievement in Biology under the category of objectives (Remembering - $F_{yx} = 34.62$, Understanding - $F_{yx} = 107.11$, Application- $F_{yx} = 135.19$, Analysis - $F_{yx} = 147.24$ and Evaluation - $F_{yx} = 110.33$) are greater than the table value and is significant at 0.01 level. The significant $F_{yx}$ 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. 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 values (Remembering - t = 5.88, Understanding - t = 10.38, Application - t = 11.66, Analysis - t = 12.16 and Evaluation - t = 10.56) are 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 category of objectives than the Control Group taught through Activity Oriented Method.

6.2.13 Scientific Creativity

a. The mean, Median and Mode of pre-test and post-test scores on Scientific Creativity do not show much variation. 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.

b. When the post test scores of the Experimental and Control groups with respect to Scientific Creativity (CR = 8.55, p<0.01) were compared, it is revealed 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.

c. When compared the gain scores of the Experimental and Control groups with respect to Scientific Creativity to substantiate the above findings, it is
revealed that the Experimental and Control groups differ significantly at 0.01 level (CR =12.65, p<0.01). 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.

d. The obtained value of $F_x$ (0.11), is not significant at 0.01 level. It shows that there is no significant difference between pre test scores of Experimental and Control groups with respect to their Scientific Creativity. The obtained $F_y$ value is 72.72, which is significant at 0.01 level shows that the groups differ significantly in their post test scores on Scientific Creativity.

e. When computing ANCOVA, as the $F_{yx}$ ratio is found to be greater than the table value, it is significant at 0.01 level ($F_{yx} = 193.55$, $p<0.01$). 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. 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, which is significant at 0.01 level. It shows that the Scientific Temper Package developed by the investigator is better than the Activity Oriented Method in enhancing Scientific Creativity among secondary school students.

6.2.14 Science Interest

a. The mean, Median and Mode of pre-test and post-test scores on Science Interest do not show much variation. 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 not much dispersed.

b. When the post test scores of the Experimental and Control groups with respect to Science Interest ($CR= 9.15$, $p<0.01$) were compared, it is
revealed that the Experimental and Control groups differ significantly at 0.01 level. The t value and the mean scores reveal that the instruction using Scientific Temper Package is better than instruction using Activity Oriented Method in enhancing Science Interest of students.

c. When compared the gain scores of the Experimental and Control groups with respect to Science Interest, it is revealed that the Experimental and Control groups differ significantly at 0.01 level (CR =13.04, p<0.01). 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.

d. The obtained value of $F_x$ (0.004), is not significant at 0.01 level. It shows that there is no significant difference between pre test scores of Experimental and Control groups with respect to Science Interest. The obtained $F_y$ value 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.

e. While computing ANCOVA, the $F_{yx}$ ratio 202.20 is found to be greater than the table value, which is significant at 0.01 level ($F_{yx} = 202.20$, 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. 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.
6.2.15 Social Sensitivity

a. The mean, Median and Mode of pre-test and post-test scores on Social Sensitivity do not show much variation. 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.

b. The comparison of the post test scores of the Experimental and Control groups with respect to Social Sensitivity (CR= 9.62, p<0.01) revealed that the Experimental and Control group differ significantly at 0.01 level. The t value and the mean difference reveal that the Experimental group taught using Scientific Temper Package is better than the Activity Oriented Method in enhancing Social Sensitivity of students.

c. When compared the gain scores of the Experimental and Control groups with respect to Social Sensitivity, it was revealed that the Experimental and Control groups differ significantly at 0.01 level. The value of critical ratio(CR =13.16, p<0.01) and the mean scores reveal that, instruction using Scientific Temper Package is better than the Activity Oriented Method in enhancing Social Sensitivity of students.

d. The analysis of variance of the pre test and post test scores showed that there is no significant difference between the means of pre test scores of the Experimental and Control groups with respect to the Social Sensitivity (Fx=0.01). But there is significant difference between the means of post test scores of the two groups (Fy = 92.18), which is significant at 0.01 level. This shows that the groups differ significantly in their post test scores on Social Sensitivity.

e. Analysis of covariance of the pre test and post test scores showed that there is a significant difference between the means of the post test scores of the Experimental and the Control groups (F_{yx} = 225.81, p<0.01). When the adjusted means of the post test scores of the Experimental and the Control groups were compared, the obtained t value, (t =15.03) was found
to be statistically significant at 0.01 level. Since the adjusted mean of the Experimental group is higher than that of the Control group, 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.

6.3 Tenability of Hypotheses

The Tenability of Hypotheses is stated below.

Hypotheses

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

Finding numbers 6.2.4, 6.2.5 and 6.2.6 indicate that there was a significant difference in the mean scores of Scientific Temper of secondary school students based on gender, locality and type of management of schools. Hence the first hypothesis is rejected.

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

   The finding 6.2.8 shows that the Scientific Temper of Secondary School Students taught using Scientific Temper Package is significantly higher than that of those taught using Activity Oriented Method of Teaching. Hence the second hypothesis is accepted.

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

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

The finding 6.2.9 shows that the Scientific Temper of Secondary School Students taught using Scientific Temper Package is significantly higher than that of those taught using Activity Oriented Method of Teaching under the different components. Hence the third hypothesis is accepted.

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

The finding 6.2.10 indicates that the Self Regulation of Secondary School Students taught using Scientific Temper Package is significantly higher than that of those taught using Activity Oriented Method of Teaching. Hence the fourth hypothesis is accepted.

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

The finding 6.2.11 indicates that the Achievement in Biology of Secondary School Students taught using Scientific Temper Package is significantly higher than that of those taught using Activity Oriented Method of Teaching. Hence the fifth hypothesis is accepted.

6. The Achievement in Biology of Secondary School Students taught using Scientific Temper 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
The finding 6.2.12 shows that the Achievement in Biology of Secondary School Students taught using Scientific Temper Package is significantly higher than that of those taught using Activity Oriented Method of Teaching under the category of objectives. Hence the sixth hypothesis is accepted.

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

The finding 6.2.13 indicates that the Scientific Creativity of Secondary School Students taught using Scientific Temper Package is significantly higher than that of those taught using Activity Oriented Method of Teaching. Hence the seventh hypothesis is accepted.

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

The finding 6.2.14 shows that the Science Interest of Secondary School Students taught using Scientific Temper Package is significantly higher than that of those taught using Activity Oriented Method of Teaching. Hence the eighth hypothesis is accepted.

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

The finding 6.2.15 shows that the Social Sensitivity of Secondary School Students taught using Scientific Temper Package is significantly higher than that of those taught using Activity Oriented Method of Teaching. Hence the ninth hypothesis is accepted.

6.4 Conclusions of the Study

The major conclusions are emerged from the study are given below.

1. Secondary school teachers perceived that majority of secondary school students have low Scientific Temper.
2. Secondary school teachers perceive that there is an urgent need of training for enhancing Scientific Temper of secondary school students.

3. The existing level of Scientific Temper of secondary school students is at average level.

4. The Scientific Temper of Secondary School Students taught using Scientific Temper Package is significantly higher than that of those taught using Activity Oriented Method of Teaching. It can be concluded that instruction based on Scientific Temper Package helped the students to show more Scientific Temper.

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

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

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

8. The Achievement in Biology of Secondary School Students taught using Scientific Temper Package is significantly higher than that of those taught using Activity Oriented Method of Teaching under the category of objectives.

9. The Scientific Creativity of Secondary School Students taught using Scientific Temper Package is significantly higher than that of those taught using Activity Oriented Method of Teaching. It can be concluded that instruction based on Scientific Temper Package helped the students to show more Scientific Creativity.

10. The Science Interest of Secondary School Students taught using Scientific Temper Package is significantly higher than that of those
taught using Activity Oriented Method of Teaching. It can be inferred that instruction based on Scientific Temper Package helped the students to show more Science Interest.

11. The Social Sensitivity of Secondary School Students taught using Scientific Temper Package is significantly higher than that of those taught using Activity Oriented Method of Teaching. It can be inferred that instruction based on Scientific Temper Package helped the students to show more Social Sensitivity.

6.5 Educational Implications of the Study

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 average level. Efforts to create an objective, open-minded, logical approach with 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 pre-conceived 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, multi-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, USA 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 in order 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 classroom. 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 (2005) has noted, “science will also have to come forward in changing our thoughts and eradicating various social evils, including casteism, extremism…”. 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.”

6.6 Suggestions of the Study

1. The findings of the study revealed that the Scientific Temper Package is effective than the Activity Oriented Method in enhancing Scientific Temper at secondary level. Therefore Scientific Temper Package should be introduced at secondary level for the attainment of Scientific Temper and for the development of related cognitive and affective variables.

2. The infrastructural facilities and other technological facilities in schools are not sufficient for implementing innovative methods and strategies in science education. Therefore more facilities should be provided in all secondary schools for effective science learning.

3. Teaching secondary level should be experience based. Therefore games, activities based on experience, brainstorming etc, are more appreciable at secondary schools for effective science learning.
4. Most of the teachers are very reluctant to change the method of teaching which they have studied or followed. So they develop a negative attitude towards implementing any type of new instructional strategy. But without a positive attitude from the part of teachers, new instructional techniques and strategies cannot be adopted. Hence some measures may be taken to develop positive attitude for adopting effective and interesting instructional strategies and techniques.

5. One of the factors that determine the achievement in biology is Scientific Temper of students. So while teaching biology the components of Scientific Temper must be taken in to an account.

6. The achievement in biology of students also depends on Science Interest and Scientific Creativity. Thus teachers should take substantial efforts to develop the Interest and Creativity of students towards science.

7. Even though Activity Oriented Method is implemented at secondary school level, it is just in theory not in practice. Utilizing the advancements in the field of ICT, the activities at secondary level should be restructured, such that importance should be given to the Scientific Temper.

8. Research should be conducted to develop effective and feasible instructional strategies for teaching biology.

9. The elements of convergent and divergent thinking should be continuously stressed and applied to the solution of the problems in classroom and school regularly.

10. Pre-service and in-service teacher training programmes should focus on the importance of Scientific Temper Package, in order to make our schools better and more advanced in future.

11. Appropriate steps should be taken by NCERT, SCERT and other agencies related to the quality of education regarding the development of Scientific Temper Package for all subjects. With slight modification, these kinds of packages can engage the students even in the absence of teachers and thereby prevent wastage of time.
6.7 Suggestions for Further Research

The present study brings to light a number of new areas to be covered by future researchers. Some suggestions for the possible lines in which further research can be carried out are given below.

1. The study can be repeated for a large sample for longer duration representing all districts in the state to ensure the validity of the results.
2. This study can be extended to find out the effectiveness of Scientific Temper Package on other variables like self reliance, moral intelligence, spirituality, personality correlates etc
3. Attitude of educational practitioners, administrators, curriculum framers, teachers and students towards inclusion of this package in school and college curriculum may also be studied.
4. Experimental studies can be conducted to find out the effectiveness of Scientific Temper Package with other innovative teaching learning techniques, models, mastery learning, small group technique etc.
5. A study on the relationship between the Scientific Temper of children and the socio economic status of parents can be carried out.
6. By including more advanced activities, this package could be made more beneficial to children with specific abilities.
7. An attempt could be made to prepare a Scientific Temper Package considering some additional components of Scientific Temper except the six components taken for the present study.
8. Studies can be conducted with different experimental designs to collect more reliable data.
9. Instructional package based on Scientific Temper can be prepared and tested in other subjects also.
10. Studies can be conducted to find out the effectiveness of Scientific Temper Package on Scientific Temper of students at different levels of intelligence.