CHAPTER VI

SUMMARY AND CONCLUSIONS

The field of intelligence testing grew from the soil nourished by the early experimental psychologists who were developing psychophysical methods (e.g., Weber, Fehner, Muller, and Urban), and by the pioneering efforts of Galton in England, Cattell in America, Kraepelin in Germany, and Binet and Simon in France. The focus on higher mental processes enabled Binet to develop a useful test of intelligence.

Theories of intelligence are beginning to show a coalescing of views, stressing the importance of both innate and developmental influences. Intelligence is viewed as being a central, "fluid" kind of genetically determined basic ability which is modified by experience. However, the ways in which people use their intelligence are determined by the unique learning history of the individual. Thus researcher interested to study Guilford’s Intellectual abilities (Convergent Production) associated with academic achievement of secondary students.

6.1 Re-statement of the Problem

A Study of Convergent Production of Figural, Symbolic, Semantic and Behavioural Abilities Associated with Academic Achievement in Science at Secondary Level.
6.2 Variables

6.2.1 Independent Variables

Based on the different type of contents suggested in Guilford's SI model. The following were considered as independent variables:

i. Figural Abilities
ii. Symbolic Abilities
iii. Semantic Abilities
iv. Behavioural Abilities

6.2.2 Dependent Variable

i. Academic Achievement in Science

6.3 General Objectives

The present study was undertaken with the following general objectives in view.

1. To study the association of Convergent Production of Figural abilities with academic achievement in Science.

2. To study the association of Convergent Production of Symbolic abilities with academic achievement in Science.

3. To study the association of Convergent Production of Semantic abilities with academic achievement in Science.

4. To study the association of Convergent Production of Behavioural abilities with academic achievement in Science.
5. To study the association of Convergent Production abilities with total four Content areas on academic achievement in Science.

6. To determine the cluster of Convergent Production factors in terms of their contributions to variation in academic achievement in Science.

7. To compare the academic achievement of student in Science at different levels of Convergent Production abilities.

6.4 Specific Objectives

The general objectives of the study are restated in terms of Specific Objectives. The first general objective is restated in terms of Specific Objectives 1 to 3, the second in terms of 4 to 6 Specific Objectives, the third in terms 7 to 9 Specific Objectives, the fourth in terms of 10 to 12 Specific Objectives, the fifth in terms of 13 to 15 Specific Objectives, the sixth in terms of 16th Specific Objective and the seventh in terms of 17 to 21 Specific Objectives. They are:

1. To study the relationship of Convergent Production of Figural abilities with academic achievement of students in Science.

2. To determine the relative efficiency of the Convergent Production of Figural abilities in predicting changes on academic achievement of students in Science.

3. To investigate the direct and indirect effects of Convergent Production of Figural abilities on academic achievement of students in Science.
4. To study the relationship of Convergent Production of Symbolic abilities with academic achievement of students in Science.

5. To determine the relative efficiency of the Convergent Production of Symbolic abilities in predicting changes on academic achievement of students in Science.

6. To investigate the direct and indirect effects of Convergent Production of Symbolic abilities on academic achievement of students in Science.

7. To study the relationship of Convergent Production of Semantic abilities with academic achievement of students in Science.

8. To determine the relative efficiency of the Convergent Production of Semantic abilities in predicting changes on academic achievement of students in Science.

9. To investigate the direct and indirect effects of Convergent Production of Semantic abilities on academic achievement of students in Science.

10. To study the relationship of Convergent Production of Behavioural abilities with academic achievement of students in Science.

11. To determine the relative efficiency of the Convergent Production of Behavioural abilities in predicting changes on academic achievement of students in Science.
12. To investigate the direct and indirect effects of Convergent Production of Behavioural abilities on academic achievement of students in Science.

13. To study the relationship of Convergent Production of total four content with academic achievement of students in Science.

14. To determine the relative efficiency of the Convergent Production of total four content areas in predicting changes on academic achievement of students in Science.

15. To investigate the direct and indirect effects of Convergent Production abilities with total four content area on academic achievement of students in Science.

16. To identify the clusters of Convergent Production of Figural abilities, Symbolic abilities, Semantic abilities and Behavioural ability in terms of their contributions to variations in academic achievement of students in Science.

17. To compare academic achievement of students in Science at different levels of Figural abilities.

18. To compare academic achievement of students in Science at different levels of Symbolic abilities.

19. To compare academic achievement of students in Science at different levels of Semantic abilities.

20. To compare academic achievement of students in Science at different levels of Behavioural abilities.
21. To compare academic achievement of students in Science at different levels of four content areas.

6.5 Research Hypotheses

In pursuance of the Specific Objectives, the following research hypotheses were set up:

1. There exists a significant relationship between Convergent Production of Figural abilities and academic achievement in Science among secondary school students.

2. There exists the joint direct and indirect effects of Convergent Production of Figural abilities on academic achievement in Science among secondary school students.

3. There exists a significant relationship between Convergent Production of Symbolic abilities and academic achievement in Science among secondary school students.

4. There exists the joint direct and indirect effects of Convergent Production of Symbolic abilities on academic achievement in Science among secondary school students.

5. There exists a significant relationship between Convergent Production of Semantic abilities and academic achievement in Science among secondary school students.

6. There exists the joint direct and indirect effects of Convergent Production of Semantic abilities on
academic achievement in Science among secondary school students.

7. There exists a significant relationship between Convergent Production of Behavioural abilities and academic achievement in Science among secondary school students.

8. There exists the joint direct and indirect effects of Convergent Production of Behavioural abilities on academic achievement in Science among secondary school students.

9. There exists a significant relationship between Convergent Production of four Content area and academic achievement in Science among secondary school students.

10. There exists the joint direct and indirect effects of Convergent Production of four Content area on academic achievement in Science among secondary school students.

11. There is a significant difference between different levels of Figural abilities and academic achievement in Science among secondary school students.

12. There is a significant difference between different levels of Symbolic abilities and academic achievement in Science among secondary school students.

13. There is a significant difference between different levels of Semantic abilities and academic achievement in Science among secondary school students.
14. There is a significant difference between different levels of Behavioural abilities and academic achievement in Science among secondary school students.

15. There is a significant difference between different levels of four Content area and academic achievement in Science among secondary school students.

6.6 Scope of the Study

i. The present study is limited to students studying in IX Standard.

ii. The study is further restricted to academic achievement in Science.

iii. Academic achievement in Science is influenced by various intellectual operations. However, the present study is limited to Convergent Production abilities only.

6.7 Method of Research

The study is a descriptive and analytical study.

6.7.1 Tools Used

Since the available tests for the assessment of Guilford's Convergent Production factors were not found to be that satisfactory in terms of comprehensiveness and relevance, the tests covering all the 24 Convergent Production abilities were developed using the standard procedure.

The following tests were developed using scientific procedure:

i. Guilford's type tests of Convergent Production Abilities

ii. Academic Achievement test in Science
6.7.2 The Sample

In the selection of sample from IX Standard the method of random sampling technique was used. About 433 students studying 13 high schools belonging to Uttar Kannada district constituted the sample for the study. The sample involved 232 boys and 201 girls.

6.7.3 Collection of Data

In order to collect essential data for the purpose of the study, the investigator used the Guilford’s Type Test of Convergent Production Abilities, viz., Figural, Symbolic, Semantic and Behavioural, developed specifically for the purpose. The test was administered by the investigator personally in all the thirteen high schools with a view to control class teachers’ influence on the test performance. The testing was done in a normal classroom situation and during normal school hours only. The students were properly given instructions regarding the time allotted to each test and the marking procedure. The proper care was taken with regard to the seating arrangement, size of the class, ventilation, etc. The investigator collected the response sheets personally after the test.

6.7.4 Statistical Techniques

In pursuance of the Specific Objectives – 1, 4, 7, 10 and 13, the Pearson’s Product-Moment Coefficient of Correlation technique was used. In pursuance of the Specific Objectives – 2, 5, 8, 11 and 14, the Multiple Regression Analysis (normal) was used with the different independent variables fitted into a Regression equation. In pursuance
of the Specific Objectives – 3, 6, 9, 12, and 15, the Path Analysis was used in order to calculate the direct and indirect effects of independent variables on dependent variable. In pursuance of the Specific Objective–16, the Principal Component Factor Analysis was used. In pursuance of the Specific Objectives–17 to 21, One-way Analysis of Variance was used with a view to find out the variations in academic achievement scores in science when analyzed in terms of different levels of Convergent Production abilities.

6.8 Major Findings

Section – I

1. The Convergent Production abilities/factors like Figural – Units, Classes, Relations, Systems, Transformations and Implications are having positive relationship with the academic achievement of students in Science. These factors will act as boosters for the academic achievement of the students in Science.

2. The potency of NFU, NFC, NFR, NFS, NFT and NFI taken together in the prediction of academic achievement of students in Science, NFS makes the maximum contribution, and NFI and NFT makes considerable contribution for prediction.

3. The Convergent Production of Figural Units (NFU) has no direct positive and significant effect on academic achievement of students in Science. But its indirect positive and significant effect on academic achievement of students in Science is through NFR, NFS, NFT and NFI.
4. The Convergent Production of Figural Classes (NFC) has no direct positive and significant effect on academic achievement of students in Science. But its indirect positive and significant effects on academic achievement of students in Science is through NFR, NFS and NFI.

5. The Convergent Production of Figural Relations (NFR) has no direct positive and significant effect on academic achievement of students in Science. But its indirect positive and significant effects on academic achievement of students in Science is through NFU, NFC and NFT.

6. The Convergent Production of Figural Systems (NFS) has direct positive and significant effect on academic achievement of students in Science. Further, its indirect positive and significant effects on academic achievement of students in Science is through NFU, NFC, NFR and NFI.

7. The Convergent Production of Figural Transformations (NFT) has no direct positive and significant effect on academic achievement of students in Science. But its indirect positive and significant effects on academic achievement of students in Science is through NFU, NFR and NFI.

8. The Convergent Production of Figural Implications (NFI) has direct positive and significant effect on academic achievement of students in Science. Further, its indirect positive and significant effects on academic achievement of students in Science is through NFU, NFC, NFS and NFT.

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Section - II

1. The Convergent Production abilities/factors like Symbolic - Units, Classes, Relations, Systems, Transformations and Implications are having positive relationship with the academic achievement of students in Science. These factors will act as facilitator for the academic performance of the students in Science.

2. The potency of NSU, NSC, NSR, NSS, NST and NSI, taken together in the prediction of academic achievement of students in Science, NSS makes the maximum contribution and NSC and NST makes considerable contribution for prediction.

3. The Convergent Production of Symbolic Units (NSU) has direct positive and significant effect on academic achievement of students in Science. Further, its indirect positive and significant effects on academic achievement of students in Science is through NSC, NSR, NSS and NST.

4. The Convergent Production of Symbolic Classes (NSC) has direct positive and significant effect on academic achievement of students in Science at secondary level. Further, its indirect positive and significant effects on academic achievement of students in Science is through NSU, NSR and NST.

5. The Convergent Production of Symbolic Relations (NSR) has no direct positive and significant effect on academic achievement of students in Science. But its indirect positive and significant effects on academic achievement of students in Science is through NSU, NSC, NSS, NST and NSI.
6. The Convergent Production of Symbolic Systems (NSS) has direct positive and significant effect on academic achievement of students in Science. Further, its indirect positive and significant effects on academic achievement of students in Science is through NSU, NSR, NST and NSI.

7. The Convergent Production of Symbolic Transformations (NST) has direct positive and significant effect on academic achievement of students in Science. Further, its indirect positive and significant effects on academic achievement of students in Science is through NSU, NSC, NSR and NSS.

8. The Convergent Production of Symbolic Implications (NSI) has direct positive and significant effect on academic achievement of students in Science. Further, its indirect positive and significant effects on academic achievement of students in Science is through NSR and NSS.

Section – III

1. The Convergent Production abilities/factors like Semantic - Units, Classes, Relations, Systems, Transformations and Implications are having positive relationship with the academic achievement of students in Science. These factors will act improve the students performance in Science subject.

2. The potency of NMU, NMC, NMR, NMS, NMT and NMI, taken together in the prediction of academic achievement of students in Science, NMT makes the maximum contribution and NMR and NMI makes considerable contribution for prediction.
3. The Convergent Production of Semantic Units (NMU) has direct positive and significant effect on academic achievement of students in Science. Further, its indirect positive and significant effects on academic achievement of students in Science is through NMC, NMR, and NMS.

4. The Convergent Production of Semantic Classes (NMC) has direct positive and significant effect on academic achievement of students in Science. Further, its indirect positive and significant effects on academic achievement of students in Science is through NMU, NMR, NMS and NMI.

5. The Convergent Production of Semantic Relations (NMR) has direct positive and significant effect on academic achievement of students in Science. Further, its indirect positive and significant effects on academic achievement of students in Science is through NMU, NMC, NMS and NMT.

6. The Convergent Production of Semantic Systems (NMS) has direct positive and significant effect on academic achievement of students in Science. Further, its indirect positive and significant effects on academic achievement of students in Science is through NMU, NMC, NMR, NMT and NMI.

7. The Convergent Production of Semantic Transformations (NMT) has direct positive and significant effect on academic achievement of students in Science. Further, its indirect positive and significant effects on academic achievement of students in Science is through NMR, NMS and NMI.
8. The Convergent Production of Semantic Implications (NMI) has direct positive and significant effect on academic achievement of students in Science. Further, its indirect positive and significant effects on academic achievement of students in Science is through NMC, NMS, and NMT.

Section - IV

1. The Convergent Production abilities/factors like Behavioral - Units, Classes, Relations, Systems, Transformations and Implications are having positive relationship with the academic achievement of students in Science. This implies that these factors are responsible for improving the performance in Science.

2. The potency of NBU, NBC, NBR, NBS, NBT and NBI taken together in the prediction of academic achievement of students in Science at secondary level, NBC makes the maximum contribution, and NBS, NBI and NBR makes considerable contribution for prediction.

3. The Convergent Production of Behavioural Units (NBU) has no direct positive and significant effect on academic achievement of students in Science. But its indirect positive and significant effects on academic achievement of students in Science is through NBC, NBR, NBT and NBI.

4. The Convergent Production of Behavioural Classes (NBC) has direct positive and significant effect on academic achievement of students in Science. Further its indirect positive and significant effects on
academic achievement of students in Science is through NBU, NBR, NBS and NBI.

5. The Convergent Production of Behavioural Relations (NBR) has direct positive and significant effect on academic achievement of students in Science. Further, its indirect positive and significant effects on academic achievement of students in Science is through NBU, NBC, NBS, NBT and NBI.

6. The Convergent Production of Behavioural Systems (NBS) has direct positive and significant effect on academic achievement of students in Science. Further, its indirect positive and significant effects on academic achievement of students in Science is through NBC, NBR and NBI.

7. The Convergent Production of Behavioural Transformations (NBT) has no direct positive and significant effect on academic achievement of students in Science. But its indirect positive and significant effects on academic achievement of students in Science is through NBU and NBR.

8. The Convergent Production of Behavioural Implications (NBI) has direct positive and significant effect on academic achievement of students in Science. Further, its indirect positive and significant effects on academic achievement of students in Science is through NBU, NBC, NBR and NBS.

Section - V

1. The Convergent Production abilities/factors (Figural, Symbolic, Semantic, Behavioural and total) are having positive relationship with the academic achievement of
students in Science. These factors will act as boosters for the academic performance of the students in Science.

2. The potency of NFA, NSA, NMA and NBA taken together in the prediction of academic achievement of students in Science at secondary level NSA makes the maximum contribution and NMA and NFA makes considerable contribution for prediction.

3. The Convergent Production of Figural abilities/factors has direct positive and significant effect on academic achievement of students in Science. Further, its indirect positive and significant effects on academic achievement of students in Science is through NSA, NMA and NBA.

4. The Convergent Production of Symbolic abilities/factors has direct positive and significant effect on academic achievement of students in Science. Further, its indirect positive and significant effects on academic achievement of students in Science is through NFA, NMA and NBA.

5. The Convergent Production of Semantic abilities/factors has direct positive and significant effect on academic achievement of students in Science. Further, its indirect positive and significant effects on academic achievement of students in Science is through NFA, NSA and NBA.

6. The Convergent Production of Behavioural abilities/factors has no direct positive and significant effect on academic achievement of students in Science. But its indirect positive and significant effects on
academic achievement of students in Science is through NFA, NSA and NMA.

Section - VI

1. The key variable with respect to Symbolic ability with highest factors loading is 'Relations'. The next variables in the order of priority are Symbolic – Systems, Units, Transformations, Classes and Implications.

2. The key variable with respect to Behavioural ability with highest factors loading is 'Relations'. The next variables in the order of priority are Behavioural – Units, Systems, Classes, Implications and Transformations.

3. The key variable with respect to Figural ability with highest factors loading is 'Implications'. The next variables in the order of priority are Figural – Transformations, Units, Classes, Relations and Systems.

4. The key variable with respect to Semantic ability with highest factors loading is 'Systems'. The next variables in the order of priority are Semantic – Classes, Relations, Transformations, Units and Implications.

Section – VII

Figural Abilities

1. There is a significant difference between Above Average and Average; Average and Below Average; and Above Average and Below Average Convergent Production of
Figural Abilities of students and their academic achievement in Science.

2. The largest difference is between the means of Below Average (32.0860) and Above Average (43.1580) groups.

3. The smallest difference is between the means of Below Average (32.0860) and Average (38.3110) groups.

4. The means of the Above Average group (43.1580) clearly reveals that students who are Above Average in Figural ability scores are also Above Average in academic achievement in Science. Further, the secondary school students with different Figural abilities vary in their academic achievement in Science.

Symbolic Abilities

5. There is a significant difference between Above Average and Average; Average and Below Average; and Above Average and Below Average Convergent Production of Symbolic Abilities of students and their academic achievement in Science.

6. The largest difference is between the means of Below Average (31.6080) and Above Average (44.2190) groups.

7. The smallest difference is between the means of Below Average (31.6080) and Average (36.1890) groups.

8. The mean of the Above Average group (44.2190) clearly reveals that students who are Above Average in Symbolic abilities scores are also Above Average in academic achievement in Science. Further, the Secondary school students with different Symbolic abilities vary in their academic achievement in Science.
**Semantic Abilities**

9. There is a significant difference between Above Average and Average; Average and Below Average; and Above Average and Below Average Convergent Production of Semantic Abilities of students and their academic achievement in Science.

10. The largest difference is between the means of Below Average (31.6670) and Above Average (42.8990) groups.

11. The smallest difference is between the means of Below Average (31.6670) and Average (35.2220) groups.

12. The mean of the Above Average group (42.8990) clearly reveals that students who are Above Average in Semantic ability scores are also Above Average in academic achievement in Science. Further, the Secondary school students with different Semantic abilities vary in their academic achievement in Science.

**Behavioural Abilities**

13. There is a significant difference between Above Average and Average; Average and Below Average; and Above Average and Below Average Convergent Production of Behavioural Abilities of students and their academic achievement in Science.

14. The largest difference is between the means of Below Average (33.9340) and Above Average (41.6020) groups.

15. The smallest difference is between the means of Average (38.5590) and Above Average (41.6020) groups.

16. The mean of the Above Average group (41.6020) clearly reveals that students who are Above Average in
Behavioural ability scores are also Above Average in academic achievement in Science. Further, the Secondary school students with different Behavioural abilities vary in their academic achievement in Science.

**Total Convergent Production Abilities**

17. There is a significant difference between Above Average and Average; Average and Below Average; and Above Average and Below Average total Convergent Production Abilities of students and their academic achievement in Science.

18. The largest difference is between the means of Below Average (31.7370) and Above Average (44.4840) groups.

19. The smallest difference is between the means of Average (38.8700) and Above Average (44.4840) groups.

20. The means of the Above Average group (44.4840) clearly reveals that students who are Above Average in Convergent Production ability are also Above Average in academic achievement in Science. Further, the Secondary school students with different Convergent Production abilities vary in their academic achievement in Science.

6.9 Discussion and Conclusions

6.9.1 Discussion

1. **Figural Abilities**

   From the results obtained in the present study it is found that there is a positive and significant correlation of the factors NFU, NFC, NFR, NFS, NFT and NFI, with achievement in Science. It indicates
that these factors are closely associated with academic achievement in Science. The attainment of these factors enhances academic achievement in Science. The results obtained by other investigators, viz., Ball (1972), Tucker (1974), D'Errico, Albert Pusquale (1976), Komn, Richard Arnold (1978) and Bajtelsmit, Jhon Wernher (1978) are in line with the findings of the present study.

Some of the Indian studies, viz., Acharyalu (1978), Gupta (1978), Sharma (1982), Singh (1983), Rajeshwari (1998), Venugopal (1994) showed that there is a significant positive relationship between Figural abilities and academic achievement. The results of all these studies support the findings of the present study.

Further, in the present study it is found that out of six Convergent Production of Figural abilities prediction power of factors NFU, NFC, NER and NFT is negligible. Relative contributions of these factors to academic achievement of Science are relatively negligible (less than 10 %). This shows that the students at the secondary school are lacking in the ability of NFU, NFC, NFR and NFT. This may be due to the lack of presentation of scientific content through Figural form in secondary schools. It implies that there is a need to promote these factors among secondary school students to improve their performance in Science. Gupta (1978) found that visual mode of presentation was found to be significantly better for retention than auditory mode of presentation. This finding is in line with the finding of the present study.
Direct effect of NFU, NFC, NFR and NFT on academic achievement in Science is not significant. However, their indirect effects through other factors is significant. Direct effect of selected factors on academic achievement in Science is almost negligible. Only NFS and NFI factors are having direct effects on academic achievement in Science. This shows that the products like Systems and Implications have direct bearing on the academic achievement in Science.

The comparison of academic achievement in Science of secondary school students among different levels of Figural ability shows that the three groups with varying degrees of Figural ability differ significantly. This implies that the difference in the Figural ability is more prone to difference in achievement in Science. Therefore, there is a relationship between attainment of Figural ability and academic performance in Science.

Further, in the present study it is found that there is a close association between academic achievement in Science and Figural ability among different levels of secondary school students. This shows that students with higher Figural ability will be better in their academic achievement in Science. It implies that by promoting Figural abilities one can improve the academic achievement in Science.
As almost all the studies conducted in India and abroad support directly or indirectly the finding of the present study, the outcome of the study may be accepted at large scale.

2. **Symbolic Abilities**

The present study revealed that there is a positive and significant correlation between various symbolic abilities in Convergent Production area and academic achievement in Science. The attainment of these factors enhances academic achievement in Science. The results obtained by other investigators, viz., Tucker (1974); Komm, Richard Arnold (1978) and Bajtelsmit, Jhon Wernher (1978) are in line with the finding of the present study.

Some of the Indian studies, viz., Gupta (1978), Chouhan (1980), Sharma (1982), Singh (1983), Rajeshwari (1988), Venugopal (1994), Martha Pujar (2001), Shetti (2003) showed that there is a positive and significant relationship between attainment of Symbolic abilities and academic achievement. The results of all these studies are in agreement with the finding of the present study.

Further, in the present study it is found that out of six Convergent Production of Symbolic abilities, prediction power of NSR is negligible. Relative contribution of this factor to academic achievement in Science is relatively negligible. When compared to NSU, NSC, NSS, NST and NSI, the contribution of NSR to academic achievement in Science is not at all considerable (less than 3%). So,
the factor NSR is not a best predictor of academic achievement of Science. This shows that the students at the secondary school are lacking in the ability NSR. The reason may be due to the lack of relationships among different scientific concepts and principles in the Science content taught in secondary schools. This shows that there is a need to promote NSR factor among secondary school students to increase to facilitate Science learning.

As far as direct and indirect effects of Convergent Production of Symbolic factors on academic achievement in Science is concerned NSR has no significant direct effect on academic achievement in Science. However, its indirect influence through other factors is significant. Although the factors like NSU, NSC, NSS, NST and NSI are having direct effects on academic achievement in Science, the factor NSR is not influencing on the academic achievement in Science directly. This shows that the products like Units, Classes, Systems, Transformations and Implications in the Convergent Production of Symbolic abilities have direct bearings on the academic achievement in Science.

Students who are Above Average, Average and Below Average in their Convergent Production of Symbolic abilities differ in their academic achievement in Science. This shows that the difference in the Symbolic ability scores is responsible for bringing variation in performance in Science. Thus, a close association exists between Symbolic abilities and achievement in Science.
Further, in the present study it is found there is a positive and significant correlation between students with varying Symbolic abilities and their academic achievement in Science. This shows that students of higher Symbolic abilities score more in academic achievement in Science. It reveals that by promoting Symbolic abilities one can facilitate Science learning.

As almost all the studies conducted in India and abroad support directly or indirectly the finding of the present study, the outcome of the study may be accepted widely.

3. Semantic Abilities

From the results obtained in the present study, the findings clearly revealed that the factors NMU, NMC, NMR, NMS, NMT and NMI are closely associated with academic achievement Science. This shows that variation in the academic achievement in Science depends on the manifestation of these abilities among students. The results obtained by Williams (1969), boys with I.Q.'s over 120 showed a greater number of strength in 'Memory' and the 'Semantic' dimensions throughout the Structure of Intellect profile then those with I.Q.'s below 120. this study supported the findings of the present study. The other investigators viz., Fedman (1970), Tucker (1974), Komn, Richard Arnold (1978) and Bajtelsmit, John Wernher (1978) have found that Semantic abilities have significant relationships with academic achievement.
Some of the Indian studies, viz., Gupta (1978), Acharyalu (1978), Sharma (1982), Singh (1983), Tiwari (1986), Rajeshwari (1988), Venugopal (1994), Martha Pujar (2001) and Shetti (2003) showed that the coefficient of correlation between Semantic abilities and academic achievement is positive and significant. The results of all these studies are in agreement with the finding of present study.

From the findings of the study all the selected Semantic abilities in the Convergent Production dimension are considered as best predictors of academic achievement in Science. The relative contributions of the factors NMU, NMC, NMR, NMS, NMT and NMI taken together accounts for maximum 37.4693 per cent of the variance in the academic achievement in Science. It means that Semantic abilities have positive impact on academic achievement in Science and the Semantic abilities are also the best predictors of academic achievement in Science. Further, it is noticed that two factors “Semantic Relations” and “Semantic Transformations” emerged as best predictors of academic achievement in Science.

The relative contributions of Semantic abilities as predictors accounts to maximum when compared to other predictors. The present study revealed that Convergent Production of Semantic abilities is the best predictor of academic achievement in Science, when compared to other Convergent Production abilities. This may be
due to the presentation of Science content through Semantic form in secondary school.

The factors NMU, NMC, NMR, NMS, NMT and NMI have direct effect on academic achievement in Science. This shows that the students at the secondary level have attained these Semantic abilities. The indirect effect of these factors on academic achievement in Science is also significant. It is noticed that academic achievement in Science to a greater extent depends on these Semantic abilities.

The findings of the comparison of three levels of Semantic abilities with respect to their achievement in Science revealed that the students who are Above Average, Average and Below Average differ significantly. This indicates that change in performance of the students in Science depends upon the Convergent Production of Semantic ability scores.

Further, in the present study it is found that there is a positive and significant correlation between academic achievement in Science and Semantic ability scores among different levels of secondary school students. This shows that students of higher Semantic ability scores more in academic achievement in Science. This implies that by promoting Semantic ability one can increase their academic achievement in Science.
As almost all the studies conducted in India and abroad support directly or indirectly the finding of the present study the outcome of the study may be accepted widely.

4. Behavioural Abilities

The study revealed that the Convergent Production of Behavioural Units, Classes, Relations, Systems, Transformations and Implications are having positive and significant relationship with the academic achievement in Science. This shows that attainment of these Behavioural abilities help in improving the academic performance of students in Science. The results obtained by other investigators, viz., Tucker (1974), Komn, Richard Arnold (1978) and Bajtelmsmit, John Wernher (1978) are in line with the findings of the present study.

Some of the Indian studies viz., Sharma (1982), Singh (1983), Rajeshwari (1988), Venugopal (1994) the results of these studies support the finding of the present study.

Since there are no studies conducted so far directly on Convergent Production of Behavioural abilities the findings of studies conducted in India and abroad on influence of Guilford's abilities on academic achievement in Science stand in support of the finding of the present study. Hence the outcome of this study may be accepted at large scale.

Out of the six Convergent Production of Behavioural abilities, NBU and NBT were proved to be poor predictors of academic
achievement in Science. The relative contributions of these two factors almost comes to 0.6329, which is less than 1 per cent. This shows that the students at the secondary school are lacking in the abilities of NBU and NBT. This may be due to the lack of presentation of scientific content through Behavioural Units and Behavioural Transformation forms in secondary school or teachers have failed to correlate the scientific facts with human behaviour in their daily work. This implies that there is a need to promote these factors among secondary school students to create interest in learning scientific concept.

From the results obtained in the present study, it is found that there is no direct effect of factors like NBU and NBT on academic achievement in Science. The reason may be attributed to the fact that the students are lacking in these two abilities. However, their indirect influence through other factors is significant. This shows that products like Classes, Relations, Systems and Implications have direct bearings on the academic achievement in Science.

It is revealed from the study that the students who are Above Average, Average and Below Average in their Convergent Production of Behavioural abilities differ in their academic achievement in Science. This implies that the difference in the scores on Behavioral abilities will result in difference in the achievement scores in Science subject. These findings clearly reveals that Convergent Production of Behavioural abilities are the best determinants of academic achievement in Science.
Further, in the present study it is found that there is a positive and significant correlation between academic achievement in Science and Behavioural ability scores among different levels of secondary school students. This shows that students of higher Behavioural ability scores more in academic achievement in Science. This implies that by promoting Behavioural abilities among students one can improve their performance in Science.

As almost all the studies conducted in India and abroad support directly or indirectly the finding of the present study, the outcome of the study may be accepted widely.

5. Total Convergent Production Abilities

Convergent Production of Figural abilities, Symbolic abilities, Semantic abilities and Behavioural abilities taken together shows that they have a positive and significant relationship with achievement of students in Science. The attainment of these factors enhances academic achievement in Science. The results obtained by other investigators, viz., Tucker (1974), found that there is significant and high correlation between the Structure of Intellect dimension scores and both M.A. and I.Q. Komn, Richard Arnold (1978) and Bajtelsmit, John Wernher (1978) are in line with the findings of the present study.

Some of the Indian studies, viz., Sharma (1982), found that the high achievers of only the scientific stream where significantly better
than the low achievers on both verbal and non-verbal intelligence. Singh (1983), Rajeshwari (1988), revealed that the pupils of higher grades were found to score higher than those of lower grades. Venugopal (1994), Martha Pujar (2001) showed that there is a positive and significant relationship between Convergent Production abilities and academic achievement. The results of all these studies support the findings of the present study.

The finding clearly reveals that all the Convergent Production abilities except the Behavioural abilities were proved to be the best predictors of academic achievement in Science. Since majority of the studies conducted in India and abroad stand in support of the present study, the outcome of study may be accepted at large scale.

The relative contributions of Convergent Production of Figural abilities, Symbolic abilities and Semantic abilities accounts for maximum 51.6975 per cent of variance in achievement in Science when compared to the other potential predictors of criterion variable. It implies that the contents like Figural, Symbolic, Semantic have positive impact on achievement in Science. This also further implies that the students of the secondary school are poor in Behavioural abilities. This may be due to the lack of presentation of Scientific content through Behavioural form in secondary schools. This implies that there is a need to promote Behavioural abilities among secondary school students to create interest in learning scientific concepts.
The direct effects of Figural abilities, Symbolic abilities, Semantic abilities are significant when compared to the effects of Behavioural abilities. However indirect effect of Behavioural abilities through other factors is significant. This shows that the academic performance of the students in Science, at present, is solely determined by only Figural, Symbolic and Semantic contents.

All four contents, viz., Figural, Symbolic, Semantic and Behavioural when considered together revealed that the difference in these contents resulted in difference in the achievement in Science. This implies that there is a close relationship between 4 content areas of the Convergent Production abilities and academic achievement in Science at the secondary levels. Thus, variations in performance in Science may be attributed to the variations in the scores of 4 content areas.

As almost all the studies conducted in India and abroad support directly or indirectly the findings of the present study, the outcome of the study may be accepted at a large scale.

In case of the findings emerged through path analysis and principal component factor analysis, no parallel studies of exact nature can be quoted here for comparison of results.

6.9.2 Conclusions

Based on the discussion of findings of the study the following conclusions could be drawn:
1. The Convergent Production of Figural ability of students studying in secondary schools –
   a) has positive and significant correlation with their academic achievement in Science;
   b) is a third potential predictor among the four predictor's variables of academic achievement in Science;
   c) accounts for 32.1653 per cent contribution to academic achievement in Science;
   d) has direct significant effect on academic achievement in Science;
   e) reserved its place in the third factor with more factor loading than any other factors; and
   f) the scores of academic achievement in Science differ significantly between different levels (Above Average, Average, Below Average) of Figural abilities.

2. The Convergent Production of Symbolic ability of students studying in secondary schools –
   a) has positive and significant correlation with their academic achievement in Science;
   b) is a best potential predictor with maximum amount of variations among the four predictor variables of academic achievement in Science;
   c) accounts for 47.1336 per cent contribution to academic achievement in Science;
   d) has direct significant effect on academic achievement in Science;
   e) reserved its place in the first factor with highest factor loading than any other factors; and
f) the scores of academic achievement in Science differ significantly between different levels (Above Average, Average, Below Average) of Symbolic abilities.

3. The Convergent Production of Semantic ability of students studying in secondary schools –
   a) has positive and significant correlation with their academic achievement in Science;
   b) is a second highest predictor variable of the variance in the academic achievement in Science;
   c) accounts for 37.4693 per cent contribution to academic achievement in Science;
   d) has direct significant effect on academic achievement in Science;
   e) reserved its place in the fourth factor with least factor loading; and
   f) with varying degrees of Semantic Abilities differ in their academic achievement in Science.

4. The Convergent Production of Behavioural ability of students studying in secondary schools –
   a) has positive and significant correlation with their academic achievement in Science;
   b) is a fourth predictor variable of the variance in the academic achievement in Science;
   c) accounts for 26.7520 per cent contribution to academic achievement in Science;
   d) has no direct significant effect on academic achievement in Science, however, it has indirect
significant effect through other factors on academic achievement in Science.
e) reserved its place in the second factor with more factor loading than any other factors and
f) with varying degree of Behavioural abilities differ in their academic achievement in Science.

6.10 Educational Implications

The present study has made an attempt to look at the academic achievement in Science from the angle of Guilford's Convergent Production abilities as put forth in the Structure of Intellect model. SOI has been known to be a model useful for teaching reading and remedial work in classrooms (Meeker, 1992). Considering the potential of this model for developing academic achievement in Science, this study was undertaken to probe into the correlation between Guilford's Convergent Production abilities and academic achievement in Science. The study has proved quite useful and developed many insights into the processes of academic achievement in Science. The implications of the study are listed below.

1. The Convergent Production abilities have shown significant correlations with academic achievement in Science. Convergent Production abilities should become an integral part of school education. Understanding the achievement in Science in terms of SOI factors has now become more precise nowadays.

2. The precision achieved in the process of the study is helpful in identifying problem areas for the learner and
remedy the same. The SOI factors have already been defined and factor analysed. The study establishes correlation between selected intellectual factors and academic achievement in Science. The abilities which show a high correlation only mean that they have a significant bearing on academic achievement in Science. In other words, a person good at a particular competency relating to Convergent Production abilities could be equally good at academic achievement in Science too. Similarly, a student who faces problems in attainment of Convergent Production abilities could be trained in specific abilities of intelligence which influence academic achievement in Science. Convergent Production abilities could be analysed very specifically in terms of these intelligence abilities. Convergent Production abilities open up 24 different possibilities of tackling the problem. A student who is not able to perceive the 'cause and effect' relationships is actually deficient in just one dimension that is in seeing Implications (Meeker, 1969). Tracing down a problem to such specific abilities makes remedial work in Science more meaningful to the teacher as well as the taught.

3. An initial training in the Convergent Production abilities could enhance the academic achievement in Science of students at later stages. Such training could be the forerunners for academic achievement in Science later on. Training in these abilities will bring students out of the stereo-type environment of the learning situation and fill them with new vigour and enthusiasm. It would be easy for a teacher to plan activities in Science for enhancing these intellectual abilities as they are specifically defined.
4. Standardised training material could be made available to teachers for enhancing the abilities related to Convergent Production. As these abilities are universal, standardisation would remain meaningful to all. However, this is not possible with academic achievement in Science straightaway because the processes of understanding Science differ significantly from individual to individual.

5. Evolving of a standardised training programme in intelligence abilities which relate to academic achievement in Science has many implications for improving the quality of education. Science Education is the most important aspect of any educational endeavour. However, science programmes have not seen much success inside the classrooms, in regular teaching hours because classroom teachers are not so very well qualified to give their students individualised science programmes and activities. Even if this is possible, it would require huge amount of time, well established laboratory and complicated planning. The present study opens up a different possibility in this area. It goes a little deeper into the subject and tries to tackle the very factors that influence the academic achievement of students in Science at secondary level. The essence of intelligence factors remain the same in individuals though their outward manifestations could be different. Understanding science or Science Education is the outward manifestation of the deeper structures of intelligence. Probing into such deeper structures helps educational planners to arrive at more universal strategies for training. This can reduce the training botheration to a large extent and enable the simple
classroom teacher to take on the challenge of developing Science Education/skills more meaningfully.

6. The deeper structures of the convergent production abilities could have bearing on the learning of other subjects too. There is close relationship between Science and Agriculture, Industry, Health and Hygiene etc. Demonstration, experiments and laboratory investigations should reflect the agricultural and industrial interest of the local community. This would make Science teaching more realistic to the pupils and interesting and useful. If such studies are undertaken, probably it would be easier to arrive at an integrated curriculum in Science for school education that has been the talk of the day.

7. This study has also opened new vistas in the study of intelligence in general and convergent production abilities in particular. Understanding intelligence and understanding intelligence for a definite purpose are two different concerns. The teaching of science should be built round 'home technology' or the maintenance and study of gadgets commonly used at home, agriculture and industry. The latter is very pragmatic and useful in social contexts. There is a need to develop application oriented scientific knowledge so that whatever knowledge is discovered becomes useful to the society directly.

8. Application level analysis of convergent production abilities in terms of their influence on academic achievement in Science integrates knowledge and provides for a more holistic understanding of both intelligence and Science Education. This programme can become meaningful and useful only if the science
curricula are reorganized and brought up-to-date the methods of teaching are vitalized and proper facilities are provided for the teaching of the science subject. The changing character of the science should be the major factor in curriculum development.

6.11 Suggestions for Further Research

While conducting the present study, a need for a few specific research studies relating to the field was felt. The suggestions for such studies are enumerated below under two categories: one studies that arise out of the limitations of the present investigation; and the other, studies that are related to the field.

Studies Arising out of the Limitations of the Present Investigation

1. Studies could be undertaken to develop valid, reliable and standardized tool for assessing Convergent Production factors among secondary school students with norms for Indian children.

2. Development of Audio-Video computer programme for the assessment of Convergent Production factors among primary school children may be taken up.

3. Studies may be conducted to investigate the relationship between scores of Convergent Production factors and Cattell's 16 Personality Factors.

4. Studies may be undertaken to investigate the relative contributions of the Content variables - Figural, Symbolic, Semantic and Behavioural to Convergent Production.
5. Interaction studies could be undertaken involving different Operations – Cognition, Divergent Production, Evaluation in relation to academic achievement.

6. Studies may be conducted to investigate the relationship between scores of Convergent Production factors and General Mental ability scores.

7. Studies exploring the association of Convergent Production of Figural, Symbolic, Semantic and Behavioural abilities with academic achievement in Language, Social Studies and Mathematics may be undertaken.

8. Studies may be taken up to investigate the association of Cognitive, Memory, Divergent Production and Evaluation factors with academic achievement in Science.

9. Studies may be conducted to cross validity the findings of the present study.

Studies Related to the Problem

1. Comparative study could be undertaken to find out the attainment of Convergent Production factors among students studying in Central Schools, Jawahar Navodaya Vidyalayas, Sainik Schools, Morarji Residential Schools and Private Schools.

2. Similar study may be undertaken to investigate the Convergent Production factors among Primary School children, Secondary School children and Pre-University College students.
3. Studies could be undertaken to measure Convergent Production factors among Secondary School students when they are classified according to age, sex, locality, educational qualifications, etc.

4. Study may be undertaken to investigate the relationship between the various Content areas – Figural, Symbolic, Semantic, and Behavioural.

5. Studies may be undertaken to evolve strategies to develop Convergent Production abilities among Primary and Secondary School students.

6. Longitudinal studies based on age-wise, educational background-wise and IQ-wise analysis of Convergent Production factors could be undertaken among school students.

7. Studies may be undertaken to compare Convergent Production factors among students studying in Engineering Colleges, Medical Colleges, Agricultural Colleges, Home Science Colleges, and other Academic Colleges.

8. Studies could be undertaken to compare Convergent Production factors among Arts, Science, and Commerce graduates.