Chapter V

SUMMARY, CONCLUSIONS AND SUGGESTIONS

- Study in Retrospect
- Variables
- Objectives of the Study
- Hypotheses of the Study
- Methodology
- Statistical Techniques
- Major Findings of the Study
- Tenability of Hypotheses
- Conclusions
- Educational Implications
- Suggestions for Further Research
SUMMARY, CONCLUSION AND SUGGESTIONS

This chapter provides a summary of the present study such as the statement, design, variables involved, objectives, hypotheses, methodology, statistical techniques adopted, findings of the study, conclusion arrived at, educational implications and suggestions for further research.

Study in Retrospect

In the present study the investigator constructed and validated the ‘Package on Geometry’ with a view to foster Mathematical Creativity of upper primary school students. The study was entitled as “DEVELOPMENT OF A PACKAGE ON GEOMETRY TO FOSTER MATHEMATICAL CREATIVITY AMONG UPPER PRIMARY SCHOOL STUDENTS”.

Variables

The treatment variable has two levels: use of Package on Geometry together with the usual class room experiences and the other usual class room experiences without any exposure to the Package on Geometry.

In the present study, Mathematical Creativity and its components viz., Fluency, Flexibility, Originality and Elaboration are the dependent variables. Mathematical Creativity is measured on the basis of scores obtained by students in the test of Mathematical Creativity developed by the investigator.
Two covariates considered are Intelligence as measured by Colored Progressive Matrices and pre-test score on Mathematical Creativity in order to get a clear picture of the effects of the ‘Package on Geometry’ to foster Mathematical Creativity among upper primary school students.

**Objectives of the Study**

The objectives of the present study are

1. To develop a ‘Package on Geometry’ of upper primary level to foster Mathematical Creativity among learners.

2. To find out the effectiveness of the ‘Package on Geometry’ on Mathematical Creativity and its components viz.,
   a. Fluency
   b. Flexibility
   c. Originality
   d. Elaboration

**Hypotheses of the study**

Following hypotheses were formulated for testing the effectiveness of the ‘Package on Geometry’ developed by the investigator to foster Mathematical Creativity among upper primary school students.

1) The post-test mean scores on Mathematical Creativity and its components of students using the Package on Geometry (experimental
group) will be significantly higher than that of students not using the package (control group).

2) The post-test mean scores on Mathematical Creativity and its components will be significantly higher than the pre-test mean scores for students using the Package on Geometry.

3) The post-test mean scores on Mathematical Creativity and its components will not be significantly higher than that in the pre-test for students who are not using the Package on Geometry.

4) The mean gain scores on Mathematical Creativity and its components of students using the Package on Geometry will be higher than that of students not using the package.

5) The mean difference in the gain scores on Mathematical Creativity of students using and not using the Package on Geometry will be significant when Intelligence scores measured through CPM and the pre-test scores on Mathematical Creativity are controlled statistically.

6) The mean scores on Mathematical Creativity in the pre-test and the successive tests will significantly differ for students using the Package on Geometry.

7) The Package on Geometry has a large effect on Mathematical Creativity among upper primary school students.
Methodology

Design of the Study

The study followed a quasi-experimental design in which experimental and control groups are formed not by assigning individuals randomly. One group of students was randomly taken as experimental group and the other as control group. A pre-test on Mathematical Creativity and Raven’s Coloured Progressive Matrices were administered to both groups. Then the experimental group was exposed to the treatment where as the control group was not assigned with any special treatment other than usual classroom experiences. Post-test on Mathematical Creativity was administered to both groups after treatment.

Pre-test scores on Mathematical Creativity and Intelligence scores obtained in Raven’s CPM were used to control the ceiling effect. Internal validity was ensured by selecting both schools from Government sector, same type of locality (rural) and same performance standard. After each module, successive tests on Mathematical Creativity were administered to the experimental group.

Participants

Seventy upper primary school students (sixth and seventh standard) from CMGHSS, Kuttoor were selected as the experimental group for testing the effect of the Package on Geometry on their Mathematical Creativity.
Seventy upper primary school students (sixth and seventh standard) from GVHSS, Machad were selected as the control group.

**Instruments**

The major instruments used in the present study are listed below.

- Raven’s Coloured Progressive Matrices (CPM)
- Tests of Mathematical Creativity (Jinu & Vijayakumari, 2014)
- Rating scale on different aspects of the package
- Package on Geometry (Jinu & Vijayakumari, 2014)

**Statistical Techniques**

Statistical techniques used for the present study are given below.

- Preliminary Analysis
- One-tailed test of significance of difference between two means for large independent groups
- One-tailed test of significance of difference between two means for large dependent groups
- Two-tailed test of significance of difference between two means for large independent groups
- Analysis of Covariance (ANCOVA)
- ANOVA with Repeated Measures
- The effect size of the treatment variable
Major Findings of the Study

Analysis was done to find out the effectiveness of ‘Package on Geometry’ in fostering Mathematical Creativity of upper primary school students.

Following are the major findings of the study.

1. The pre-test mean scores on Mathematical Creativity of experimental and control groups do not differ significantly ($t=1.22$, $p > .05$).

2. The pre-test mean score on Fluency of experimental and control groups do not differ significantly ($t=1.8$, $p > .05$).

3. The pre-test mean score on Flexibility of experimental and control groups do not differ significantly ($t=1.11$, $p > .05$).

4. The pre-test mean score on Originality of experimental and control groups differ significantly, the higher score for control group ($t=2.52$, $p \leq .05$).

5. The pre-test mean score on Elaboration of experimental and control groups differ significantly, the higher score for control group ($t=2.26$, $p \leq .05$).

6. The post-test mean score on Mathematical Creativity is significantly higher for the experimental group than the control group ($t=12.26$, $p \leq .01$).
7. The post-test mean score on Fluency is significantly higher for the experimental group than the control group ($t=13.33$, $p \leq .01$).

8. The post-test mean score on Flexibility is significantly higher for experimental group than the control group ($t=13.72$, $p \leq .01$).

9. The post-test mean score on Originality is significantly higher for experimental group than the control group ($t=9.42$, $p \leq .01$).

10. The post-test mean score on Elaboration is significantly higher for experimental group than the control group ($t=12.6$, $p \leq .01$).

11. The mean score on Mathematical Creativity is significantly higher in the post-test than the pre-test in the experimental group ($t=15.66$, $r = .64$, $p \leq .01$).

12. The mean score on Fluency is significantly higher in the post-test than the pre-test in the experimental group ($t=11.97$, $r=.58$, $p \leq .01$).

13. The mean score on Flexibility is significantly higher in the post-test than the pre-test in the experimental group ($t=12.74$, $r=.59$, $p \leq .01$)

14. The mean score on Originality is significantly higher in the post-test than the pre-test in the experimental group ($t=15.26$, $r = .4$, $p \leq .01$).

15. The mean score on Elaboration is significantly higher in the post-test than the pre-test in the experimental group ($t=13.99$, $r = .4$, $p \leq .01$).
16. The post-test mean scores on Mathematical Creativity of the control group is significantly higher than that of pre-test \((t=3.16, r = .93, p \leq .01)\).

17. The post-test mean scores on Fluency is significantly higher than that of the pre-test for the control group \((t=2.26, r = .96, p \leq .05)\).

18. The post-test mean score on Flexibility is not significantly higher than that in the pre-test for the control group \((t=.54, r = .83, p > .05)\).

19. The post-test mean scores on Originality is significantly higher than that of pre-test for the control group \((t=4.33, r = .87, p \leq .01)\).

20. The post-test mean score on Elaboration is not significantly higher than that in the pre-test for the control group \((t=.99, r = .82, p > .05)\).

21. The mean gain score on Mathematical Creativity is significantly higher for the experimental group than the control group \((t=19, p \leq .01)\).

22. The mean gain score on Fluency is significantly higher for the experimental group than the control group \((t=15.67, p \leq .01)\).

23. The mean gain score on Flexibility is significantly higher for experimental group than the control group \((t=17.06, p \leq .01)\).

24. The mean gain score on Originality is significantly higher for experimental group than the control group \((t=13.54, p \leq .01)\).
25. The mean gain score on Elaboration is significantly higher for experimental group than the control group (t=16.24, p \leq .01).

26. The experimental manipulation using ‘Package on Geometry’ has significant effect on the gain scores on Mathematical Creativity of the upper primary school students when Intelligence and initial level of Mathematical Creativity were controlled (F= 640.85, p \leq .01 for degrees of freedom (1, 139)).

27. The mean score on Mathematical Creativity is significantly higher in formative test 1 than in pre-test for the experimental group

$$\text{Mean}_{\text{pre-test}} = 10.97, \text{Mean}_{\text{Formative test 1}} = 34.93.$$ 

28. The mean score on Mathematical Creativity is significantly higher in formative test 2 than in formative test 1 for the experimental group

$$\text{Mean}_{\text{Formative test 1}} = 34.93, \text{Mean}_{\text{Formative test 2}} = 48.85.$$ 

29. The ‘Package on Geometry’ has very large effect on mean gain scores on Mathematical Creativity for the experimental group ($\Delta = 3.79, r = .79$).

30. Effect size of the ‘Package on Geometry’ on mean gain scores on Fluency is very large for the experimental group. ($d = 2.02, r = .71$)

31. Effect size of the ‘Package on Geometry’ on mean gain scores on Flexibility is very large for the experimental group ($d = 2.15, r = .73$).
32. Effect size of the ‘Package on Geometry’ on mean gain scores on Originality is very large for the experimental group ($\Delta = 3.99$, $r = .8$)

33. Effect size of the ‘Package on Geometry’ on mean gain scores on Elaboration is very large for the experimental group ($d = 2.36$, $r = .76$).

34. Effect size of the ‘Package on Geometry’ on the mean post-test scores on Mathematical Creativity is very large ($\Delta = 2.79$, $r = .72$).

35. Effect size of the ‘Package on Geometry’ on mean post-test scores on Fluency is very large ($\Delta = 3.12$, $r = .75$).

36. Effect size of the ‘Package on Geometry’ on mean post-test scores on Flexibility is very large ($\Delta = 3.24$, $r = .76$).

37. Effect size of the ‘Package on Geometry’ on mean post-test scores on Originality is large ($\Delta = 1.84$, $r = .6$).

38. Effect size of the ‘Package on Geometry’ on mean post-test scores on Elaboration is very large ($\Delta = 3.2$, $r = .73$).

**Tenability of Hypotheses**

The tenability of hypotheses was examined on the basis of analysis and its findings.

1. The first hypothesis is stated as ‘The post-test mean scores on Mathematical Creativity and its components of students using the Package on Geometry (experimental group) will be significantly higher than that of students not using package (control group)’. 
Findings of the study revealed that the experimental group has higher post-test mean scores on Mathematical Creativity and its components viz., Fluency, Flexibility, Originality and Elaboration than the control group. Hence the first hypothesis is substantiated.

2. The second hypothesis is stated as ‘The post-test mean score on Mathematical Creativity and its components will be significantly higher than the pre-test mean scores for students using the Package on Geometry’.

Findings of the study revealed that the experimental group has higher post-test mean scores on Mathematical Creativity and its components viz., Fluency, Flexibility, Originality and Elaboration than in the pre-test. Hence the second hypothesis is substantiated.

3. The third hypothesis is stated as ‘The post-test mean scores on Mathematical Creativity and its components will not be significantly higher than that in pre-test for students who are not using the Package on Geometry’.

Findings of the study revealed that the post-test mean scores on two components of Mathematical Creativity viz., Flexibility and Elaboration are not significantly higher than that in pre-test for students not using the Package on Geometry. However the post-test mean scores on the other two components of Mathematical Creativity viz., Fluency and Originality and Mathematical
Creativity itself are significantly higher than that in pre-test for students not using the Package on Geometry. Hence the second hypothesis is partially substantiated.

4. The fourth hypothesis is stated as ‘The mean gain scores on Mathematical Creativity and its components of students using the Package on Geometry will be higher than that of students not using the package’.

Findings of the study revealed that the experimental group has higher mean gain scores on Mathematical Creativity and its components viz., Fluency, Flexibility, Originality and Elaboration than the students not using the package. Hence the fourth hypothesis is substantiated.

5. The fifth hypothesis is stated as ‘The mean difference in the gain scores on Mathematical Creativity of students using and not using the Package on Geometry will be significant when Intelligence scores measured through CPM and the pre-test scores on Mathematical Creativity are controlled statistically’.

Findings of the study revealed that the experimental group has significantly higher mean gain scores on Mathematical Creativity than that of the students not using the Package on Geometry, when the variation due to Intelligence scores measured through CPM and the pre-test scores on Mathematical Creativity are removed by taking them as covariates. Hence the
fifth hypothesis is substantiated.

6. The sixth hypothesis is stated as ‘The mean scores on Mathematical Creativity in the pre-test and the successive tests will significantly differ for students using the Package on Geometry’.

Findings of the study revealed that the mean score on Mathematical Creativity is significantly higher in formative test 1 than in pre-test and formative test 2 than in formative test 1 for the experimental group. That is the mean scores on Mathematical Creativity in the pre-test and the successive tests are significantly different for students using the Package on Geometry. Hence the sixth hypothesis is substantiated.

7. The seventh hypothesis is stated as ‘The Package on Geometry has very large effect on Mathematical Creativity among upper primary school students’.

Findings of the study revealed that the Package on Geometry has very large effect of the gain scores on Mathematical Creativity and its components viz., Fluency, Flexibility, Originality and Elaboration for the students using the Package. The effect size of the ‘Package on Geometry’ on the mean post-test scores on Mathematical Creativity and its components viz., Fluency, Flexibility and Elaboration, except Originality are very large. For Originality the effect size is large. Hence the seventh hypothesis is partially substantiated.
Conclusions

Students using the Package on Geometry has significantly higher post test mean scores on Mathematical Creativity and its components viz., Fluency, Flexibility, Originality and Elaboration than that of students not using the package which implies that Mathematical Creativity and its components have significantly increased by the implementation of the package. The prevalent education system is good in developing Mathematical Creativity especially for two components Fluency and Originality but only to a smaller amount. However the implementation of ‘Package on Geometry’ has far reaching impacts in fostering Mathematical Creativity and all its components among upper primary school students. The Flexibility and Elaboration components of Mathematical Creativity are not much influenced by the existing school curriculum. ‘Package on Geometry’ can be utilized for fostering of all the four components of Mathematical Creativity among the upper primary school students.

The experimental manipulation using ‘Package on Geometry’ has significant impact on the mean gain scores on Mathematical Creativity and all its components among upper primary school students. The effect of ‘Package on Geometry’ on the mean scores on Mathematical Creativity of upper primary school students was tested when the Intelligence and initial level of Mathematical Creativity were controlled and found that the model is explaining more variance between the groups. Intelligence is a significant
predictor of Mathematical Creativity, whereas the initial level of Mathematical Creativity is not. That is the post-test mean scores on Mathematical Creativity have significantly improved for all upper primary school students who used the package irrespective of their intelligence and initial level of Mathematical Creativity, even though Intelligence is a correlate of Mathematical Creativity. The mean scores on Mathematical Creativity have significantly increased in the first formative test than that of pre-test. The mean difference between first and second formative tests on Mathematical Creativity is also significant. Hence it may be concluded that the level of Mathematical Creativity is gradually increasing among the students who used the package.

The ‘Package on Geometry’ has very large effect on the mean gain scores on Mathematical Creativity and its components. The effect size of the Package on Geometry on the mean post-test scores of Mathematical Creativity and its components viz., Fluency, Flexibility and Elaboration is very large whereas that for Originality is large. Hence the package is highly effective in fostering Mathematical Creativity and all its components among upper primary school students.

**Educational Implications**

The present study has educational implications in various dimensions especially for parents, teachers, educational administrators and curriculum
developers. The implications as noted by the investigator based on the findings are mentioned below.

Present study establishes the effectiveness of the Package on Geometry in fostering Mathematical Creativity among upper primary school students. It is also effective in developing four major components of Mathematical Creativity viz., Fluency, Flexibility, Originality and Elaboration. The package is for instructional purpose but can be managed by parents too regardless of their educational status. The modules are based on the basics of Geometry, but presented in a multimedia approach with a variety of life related activities. The environment during the implementation of the package is student friendly, interactive and challenging. The activities involved are interesting for the proposed population and according to their age level. The present school mathematics curriculum is found to be successful in increasing Mathematical Creativity to some extent but not the flexibility and elaboration. That is, mathematics class room experiences are not helping students think divergently and meaningfully. Hence mathematics teachers must try to follow such an environment in the class room which will make the student think openly, interact freely and participate actively in mathematics learning. Instead of mere drill works, creative ones are to be assigned for home learning. Variety of methods to approach the concept or problem should be encouraged in the class. Mathematics teachers should adopt a flexible approach by bringing novelty to their day-to-day teaching and come up with problems from daily life related
concepts. Students must be encouraged to solve them and develop such problems and exchange it with other students. Also allow them to solve mathematical problems by their own methods. Then they will start playing with mathematical concepts which will lead to the development of Mathematical Creativity.

For this, challenging problems with wide scope for generating divergent solutions are to be planned. Also challenging creative life-related tasks are to be planned and learners must get enough opportunities for constructing knowledge. Students are to be encouraged to make still and working models on various mathematical concepts. Other recreational activities such as mathematics quiz, creative work shops, exhibitions, math-lab, etc. to be arranged at schools and students must get opportunities to invent and construct knowledge.

Teachers and parents should not over stress on academic achievement of students; instead they should be allowed to enjoy exploration, innovation and discovery. Obeying elder’s decisions silently without questioning sometimes restricts children’s choices, harms their interest and kills curiosity.

Teaching method based on technology can sustain students’ interest in learning. Multimedia modules can be used for concept clarification and support classroom learning by clarification of difficult topics in various subjects. It saves time and effort in the present scenario of over-loaded syllabus. Creative thoughts can occur in a situation where individuals are thorough and
comfortable with respect to the subject matter. Teachers and parents must ensure mastery learning in mathematics among the students at each level. Special programmes for interested students must be organized by the school which is either in the form of self learning or supervised learning that make students think flexibly and with originality.

In the present system, group works are given much importance, along with collective activities; more creative meaningful and participative activities are to be included for the development of creative components in the children. Mishandling of creative, talented buds, inside and outside the classrooms by the adults, especially teachers leads to student violence and misbehaviors. They are not permitted or encouraged to express their original ideas but are forced to keep the strict path followed by all. Package on Geometry can be introduced in classrooms which help to nourish the creative components and to develop better study methods. Similar packages can be developed by the teachers as a collective effort. Ready-made materials and multimedia packages are also available in the market which can be purchased at schools if affordable.

Instead of using such instructional packages separately, these aspects can be included in the school mathematics curriculum and creative tasks can be included as follow up. Enough expertise among teachers for handling these activities must be given through in-service and pre-service training. Adequate references have to be added in the teacher texts.
The classroom experiences make the learner think innovatively and divergently and hence teachers and administrators must be vigilant about the environment in the classroom and school as a whole.

**Suggestions for Further Research**

The findings of the study and the limitations encountered made the investigator suggest the following for further research in this area.

1. The Package was prepared only on geometrical concepts of upper primary level. This can be prepared for other topics in Mathematics such as algebra, arithmetic, statistics etc.

2. Similar instructional packages based on multimedia approach can be attempted for other disciplines such as physics, chemistry, language etc.

3. The Package on Geometry was prepared exclusively for the students of upper primary level. The study can be conducted to students of different levels such as lower primary, high school and higher secondary.

4. Packages can be developed using online platforms like ‘moodle’ for higher standards.

5. Comparison based on gender, religion, socio economic status, locality of residence, locality of school, type of school management, parental involvement etc. can be executed.
6. Other techniques to foster Creativity such as positive learning environment, other innovative learning materials, brain related exercises, techniques, etc. can be experimented in the same way.

7. Different approaches to Mathematical Creativity such as sensitivity, making associations, imagination etc. can be made for the study.

8. In the present study all participants were classified into two levels viz., students using the package and students not using the package. The study can be conducted to investigate the effectiveness of the package at various levels of Creativity such as high, average and low.

9. A survey on the attitude of teachers and students in incorporating similar multimedia packages in classroom learning can be carried out.