# Chapter 6

## SUMMARY AND CONCLUSIONS

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6.1 The Study in Retrospect

The present chapter outlines the major breakthroughs of procedure adopted for authenticating the newly developed learning designs in punching the pupils at secondary school level with reflective learning practices. Findings and conclusions extracted from the study and the recommendations and implications emanated for future practice and research in the domain of mathematics education are also discussed in this segment.

6.1.1 Statement of the problem

The hub of the present study was to evolve certain learning designs for habituating reflectivity and to establish the efficacy of the select designs in enhancing mathematics proficiency among the pupils at secondary level. Hence the problem under investigation is entitled, “Developing certain designs for promoting reflective learning practices at secondary level.”

6.1.2 Variables enacted for the study

The independent variables considered in the study are the select reflective learning designs namely, Reflective journaling design, Problem based learning design and Thinking maps design and the present activity oriented approach. The dependent variables selected for the study are mathematics achievement, level of reflective thinking and mathematics proficiency of the pupils at secondary school level.

6.1.3 Hypotheses of the study

The following hypotheses were formulated for the study:

1) The predominant pedagogical functions for transacting mathematics curriculum at secondary school level are inadequate in upbringing mathematics proficiency.
2) The select reflective learning designs are effective in enhancing reflective thinking level of secondary school pupils.

3) The select reflective learning designs are effective in improving the academic performance in mathematics of pupils at secondary school level.

4) The select reflective learning designs are effective in augmenting the set levels of mathematics proficiency of pupils at secondary school level.

5) There is significant difference in the performance among the subgroups of pupils at secondary school level [based on locale and ordinal state of pupils in mathematics achievement and reflective thinking level] with regard to:
   a) academic performance in mathematics and
   b) level of reflective thinking

6.1.4 Objectives of the study

The study mainly focused on attaining the following objectives:

1) To analyse the predominant pedagogical functions for transacting mathematics curriculum at secondary school level in upbringing mathematics proficiency.

2) To develop the select learning designs based on the strategies namely, Reflective journaling, Problem based learning and Thinking maps for promoting reflective learning practices among pupils at secondary school level.

3) To test the effectiveness of the select reflective learning designs in enhancing reflective thinking level of pupils at secondary school level.
4) To test the effectiveness of the select reflective learning designs in improving the academic performance in mathematics of pupils at secondary school level.

5) To explore the effect of the select reflective learning designs in augmenting the set levels of mathematics proficiency of pupils at secondary school level.

6) To compare the effect of each of the select reflective learning designs among the subgroups of pupils at secondary school level [based on locale and ordinal state of pupils in mathematics achievement and reflective thinking level] with regard to:
   a) academic performance in mathematics and
   b) level of reflective thinking

7) To analyse how the select reflective learning designs are effected to intensify the learning of mathematics in the experiential space among certain cohorts of pupils in an interactive set up at secondary school level.

6.1.5 Methodology in brief

The present study attempted to empower the student folk at secondary level with reflective learning practices pursuing advanced mathematics proficiency by developing the select learning designs namely Reflective journaling design, Problem based learning design and Thinking maps design. For attaining the set objectives of the investigation both quantitative and qualitative methodology were adopted for the study. The study was carried out in two sections.

The first section of the study investigated the prevalent status of mathematics learning space at secondary level by conducting a semi structured interview with the select sample of experts \( N = 81 \) in the field
of mathematics teaching. The investigator made use of an interview guide with three focus domains as: (a) predominant space of curriculum transaction modes in mathematics (b) impediments and challenges in the pedagogical functions of mathematics (c) affirmative trends in reinforcing mathematics learning scenario. Compiling the positive recommendations earmarked from the interview and the theoretical underpinnings of reflective learning practices the investigator prepared three learning designs namely, Reflective journaling design, Problem based learning design and Thinking map design and validated it among the select experts.

The second section of the study mainly conducted to test the effectiveness of the select reflective learning designs through experimental approach. As a prelude to the experimental procedure a select sample of 284 secondary school pupils were selected representing 8 schools from three central districts of Kerala. The pre test post test non equivalent group design was adopted for the experiment. Specific lesson designs for the select reflective learning designs were made use of the experimental intervention among the experimental groups. The control group was employed with present activity oriented approach. The effectiveness of the prepared reflective learning designs was established through the select instruments and techniques namely, achievement test in mathematics, scale of reflective action, analytic rubric for synchronized assessment of mathematics proficiency, strategy evaluation proforma and focus group discussions. The data thus procured were analysed statistically.

**6.1.6 Analytical supports and techniques employed.**

1) Interview guide

2) Judgment schedule

3) Analytic rubric for synchronized assessment of mathematics proficiency
The major findings and conclusions that have derived from the analysis of data are described in the following section.

### 6.2 Major Findings and Conclusions

The major findings and conclusions of the study reciprocating the objectives formulated for the same have been presented in the following sections:

**Section I**

This section depicts the findings and conclusions that emerged from the assessment of opinions of the select experts in mathematics, teacher educators and school practitioners regarding the prevailing stance of mathematics curriculum transaction modalities and the emphatic trends in nurturing mathematics proficiency among pupils at secondary school level. The major findings pertaining to this section are described below.

#### 6.2.1 Assessment of predominant pedagogical functions in conceptualizing mathematics proficiency

1) The analysis of the opinions tapped through the item that queries about the commonly practiced curriculum transaction
modes of the interview guide supported the finding that the majority of the teachers (95%) are practicing activity oriented approach and discussion oriented approach in actualizing the componential aspects of mathematics proficiency. Very negligible number of teachers are making use of progressive and dynamic instructional mechanisms, in tune with reflective thoughts and actions at secondary school level.

2) While responding to the item that queries about the efficacy of prevailing classroom practices in actuating the varied dimensions of mathematics proficiency, a large proportion of teachers (82%) were of the opinion that the prevailing teaching learning dynamisms are not at all adequate in propagating mathematics scholarship among pupils at secondary level.

3) The results obtained from Table 5.1 throws light into the functional dimensions of mathematics scholarship as perceived by the school practitioners. They are:

a) Explains mathematical problems
b) Integrates and functionalises mathematical concepts
c) Uses multiple representation of mathematical tasks
d) Formulates results accurately.
e) Estimates results accurately.
f) Selects and applies suitable mechanisms to solve mathematical issues.
g) Explains mathematical procedures.
h) Communicates mathematical ideas effectively.
i) Justifies conclusions.
j) Uses heuristic approaches.
k) Shows confidence in working with problems.
These activation dimensions enforced the learners to participate actively to bring embracing changes in the processing of all mathematical endeavors and to add a mathematical punch in all the routine actions so that they can become systematic and creative decision makers and problem solvers.

4) A critical evaluation of the level of mathematics expertise displayed by the secondary school pupils through the responses of the select teachers revealed that massive number of pupils is (81%) at Novice level. The details from Table 5.22, 5.23, 5.41 and 5.59 also corroborate this argument.

The above findings lead to the conclusion that the predominant space of pedagogical functions in actualizing mathematical scholarship among secondary schools pupils is insufficient and hence vibrant instructional mechanism for enriching the thinking processes are urgently needed.

6.2.2 The challenges and constraints if any, experienced by the student scape at secondary level in processing the pedagogical tasks in the prevailing classroom practices.

1) Table 5.2 shows the teacher responses with respect to the pedagogical impediments confronted by them in actualizing mathematics proficiency among the student folk at secondary level. The striking barriers faced by the teachers and pupils in mathematical task processing were existing negative attitude towards mathematics, lack of motivation in inspiring confidence, stereotype thinking of task analysis, approaching new task with the aim of performance rather than learning orientation, the hierarchical nature of mathematics, lack of independent practice, mismanagement of discourse around the mathematical task, ineffectual interaction in the classroom,
inability to link experience to abstractions, incapability to attend to the multiple approaches of problem solving and lack of self assessment by learners.

These findings lead to the conclusion that the pupils at secondary level are experiencing certain constraints and challenges in the mathematical task engagement in the present activity oriented approach. It is also concluded from the findings that these branded pedagogical imputations are to be outweighed while discerning the benchmarks of the new learning designs.

6.2.3 Affirmative dynamics credential to development of mathematics proficiency

1) The close analysis of the suggestive measures squeezed from the select sample of practitioners in mathematics throw light into [Table 5.3] certain pronounced designations resonating the pedagogical constructs of a dynamic and scintillating mathematics class warranting higher order thinking dispositions that unfolds optimum mathematical potentials.

2) The results detailing the designated elements of effective mathematics task engagement indicates that a marked proportion of teachers [80%] deemed it very essential to amalgamate the casted motifs in mathematics classes namely , real life task, visual transformation of learning, reflective writing, encouraging open mindedness to others, fostering objections as a way to examine new thoughts, timely reviewing and monitoring of learning process, and debriefing of actions leading to future modifications for articulating momentum to the mathematical thinking scenario.

3) Most of the teachers favoured the inclusion of progressive strategies like mapping strategies, journaling strategies and problem oriented strategies that are attuned to reflective
orientations for fortifying mathematics learning. By analyzing the preferences given by teachers in prioritizing the practices of the identified strategies most of the teachers advocated Problem based learning, Thinking maps and Reflective journaling for strengthening mathematics learning scenario (Figure 5.2).

4) Results shown in the Table 5.4 detailed the facilitators and constraints in practicing Problem based learning, Reflective journaling and Thinking map strategies as suggested by the select sample of teachers and experts in mathematics. The prominent positive elements earmarked are pathways to think at higher levels, sense of ownership in one’s own learning process, transform the role of learners as partners in the instructional process and the like. The most felt constraints put forward are dearth in the timely availability of resources and materials, inhibitions in practicing innovative strategies, deficit in institutional support for flexibility and the like.

5) As a concluding remark most of the teachers [around 60%] suggested reflective learning strategies as one of the best approaches in accentuating mathematics learning process.

The conclusion emanates from all these findings reveals that off beating instructional procedures embedded with reflective dispositions are essential in resurging mathematics learning scenario at secondary level of schooling.

Section II

The findings emerged while analyzing the test scores obtained through the conduct of the experiment and the administration of self assessment rubric, strategy evaluation proforma and the conduct of focus group discussions are detailed as follows.
6.2.4 Effectiveness of Reflective journaling design in shaping a culture of reflective practice among pupils at secondary level.

The effectiveness of the prepared Reflective journaling design over the prevailing activity oriented approach in shaping a culture of reflective learning practice among pupils at secondary level was established through both quantitative and qualitative approaches. During the initial phase, the effectiveness of Reflective journaling design was determined by analyzing the test scores of academic performance in mathematics and the level of reflective thinking of pupils. The augmentation in the set levels of the varied strands of mathematics proficiency was assessed through the self-assessment rubric of mathematics proficiency for authenticating the efficacy of the select Reflective journaling design. In addition to this, the impact of Reflective journaling design in strengthening mathematical competency in classroom situations was ascertained by the set strategy evaluation proforma administered to the experimental group I. The statistical results supporting these arguments are given below.

1) The results of the test of significance of the difference between mean pre scores of mathematics achievement of the experimental and control group of the total sample and locale wise and gender wise sub samples indicate that both groups were more or less similar in their initial performance (Vide Table 5.6; C.R = 1.18, 1.21, 0.13, 0.004, 1.78; Not significant at any level) where as the test of significance of the difference between mean post scores indicates that the two groups differ significantly (Vide. Table 5.7; C.R = 7.06, 4.82, 5.22, 4.97, 5.06; significant at 0.01% level). From the mean post test scores of mathematics achievement of total sample and locale wise and gender wise sub samples (Mean control: 19.69, 20.63, 19.20, 19.6, 20.15; mean experiment: 30.05, 30.44, 29.68, 30, 30.11) it is clear that the mean of the
experimental group is much higher than that of control group. While comparing the pre scores and post scores of experimental group I, it was observed that the post scores of the experimental group was noticeably higher than the pre scores. The effectiveness of the Reflective journaling design was statistically established through ANCOVA, wherein the F-ratios obtained were statistically significant at 0.01% level for the total sample and locale wise and gender wise sub samples (Vide Table 5.8 to 5.12; F-ratios: 262.238, 102.202, 107.788, 140.128, 105.973). The computation of the adjusted means for the post test scores of the total sample and locale wise and gender wise sub samples (Vide Table 5.13; Mean control: 19.69, 20.63, 19.20, 19.6, 20.15; Adjusted means experiment I: 29.99, 29.37, 29.52, 29.94, 29.94) showed that the adjusted mean of the experimental group is higher than that of the control group which implies better performance in mathematics achievement of the experimental group. Thus reflective journaling design is effective to a great extent in improving the academic performance in mathematics of secondary school pupils.

2) The results of the test of significance of the difference between mean pre scores in the level of reflective thinking of the experimental and control group of the total sample and locale wise and gender wise sub samples show that both the groups were more of less similar with respect to their level of reflective thinking [Vide Table 5.14; C.R: 0.98, 1.30, 0.2, 0.89, 0.13; Not significant at any level] whereas the test of significance of the difference between mean post test scores indicates that the two groups differ significantly [Vide Table 5.14; C.R: 12.68, 10.14, 8.02, 8.81, 9.17; significant at 0.01% level]. From the mean
scores obtained, vide Table 5.15; it is clear that the mean of the experimental group is much higher than that of the control group. While comparing the pre scores and post scores of the experimental group, it was observed that the post scores of the experimental group were remarkably higher than the pre scores. The effectiveness of the Reflective journaling design was statistically established through ANCOVA wherein the F- ratios obtained for total sample and locale wise and gender wise sub samples were statistically significant at 0.01% level [Vide .Table 5.16 to 5.20; F- ratios: 900.58, 102.202, 259.133, 392.922, 370.217; significant at 0.01% level]. The computations of the adjusted means for the post test scores of reflective thinking level of the total sample and locale wise and gender wise sub samples showed that the adjusted mean of the experimental group is higher than that of the control group which implies better performance of the experimental group I [Vide. Table 5.21; Mean control: 63.91, 63.47, 64.68, 65.17, 64.32; Adjusted means experiment: 99.23, 90.76, 95.34, 99.299, 99.3]. Thus the Reflective journaling design is effective in enhancing the level of reflective thinking of secondary school pupils.

3) In order to assess the impact of the select Reflective learning design in augmenting the set levels of varied strands of mathematics proficiency namely, conceptual understanding, procedural fluency, strategic competence, adaptive reasoning and productive disposition, the analytic rubric for synchronized assessment of mathematics proficiency was administered to the control group and experimental group I before and after the treatment of the select Reflective journaling design. The results indicate that there is considerable decrease in the percentage of
pupils of experimental group I coming under Novice level with regard to the total score, average score and strand wise scores of mathematics proficiency [Vide Table 5.23; average score: 71.4% to 23.8%]. It is also revealed from the table [Vide Table 5.23] that the number of pupils coming under Basic, Proficient and Advanced levels with regard to the total score, average score and strand wise scores of mathematics proficiency increased noticeably after exposing them to the select Reflective journaling design [Average scores: 22.4%, 5.6%, 0.6% to 51.2%, 17.4%, 7.6% respectively]. But there is no remarkable change in the percentage of pupils coming under Novice, Basic, Proficient and Advanced levels with respect to the total score, average score and strand wise scores of mathematics proficiency in the control group [Vide Table 5.22]. These results show that Reflective journaling design is effectual in uplifting the set levels of mathematics proficiency.

4) While analyzing the opinions of pupils tapped through the strategy evaluation proforma it was revealed that almost all pupils [Vide table 5.24] were greatly benefitted by the exposure to the select Reflective journaling design. The pupils of the experimental group could strengthen their ability to integrate the experiences with theory; demonstrate the growing self awareness and self development; self analysis of a liberating and self authenticating experience; highlight learning dysfunctions and their causes and to engage in intellectual exercise of experimenting with new world making perspectives through the experiences obtained through the phased implementation of the select Reflective journaling design. These results show that the select reflective journaling design
has strength in proliferating reflective dispositions among the pupils at secondary level.

Thus the findings mentioned above can conclusively point towards the fact that the select Reflective journaling design has tremendous effect in shaping a culture of reflective practices pursuing better performance in mathematics achievement and enriched proficiency in mathematics among secondary school pupils.

6.2.5 Effectiveness of Problem based learning design in radiating reflective dispositions among pupils at secondary level.

The effectiveness of the prepared Problem based learning design in radiating reflective dispositions among pupils at secondary level was established through both quantitative and qualitative research approaches. During the initial phase, the effectiveness of Problem based learning design was determined by analyzing the test scores of academic performance in mathematics and the level of reflective thinking of pupils. The augmentation in the set levels of the varied strands of mathematics proficiency was assessed through the self assessment rubric for authenticating the efficacy of the select Problem based learning design. In addition to these the impact of the select Problem based learning design in fortifying mathematical scholarship in classroom situations was accentuated by the set strategy evaluation proforma administered to the experimental group II. The statistical results supporting these arguments are described below.

1) The results of the test of significance of difference between mean pre scores of mathematics achievement of the experimental and control group of the total sample and locale wise and gender wise sub samples indicate that both groups were more or less similar in their initial performance [Vide
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Table 5.25; C. R: 0.97, 0.24, 0.53, 0.07, 1.12; not significant at any level] where as the test of significance of the difference between mean post scores of mathematics achievement of total sample and locale wise and gender wise sub samples indicates that the two groups differ significantly[ Vide Table 5.26; C.R: 6.08, 3.718, 4.784, 4.47, 4.15; significant at 0.01% level]. From the mean post test scores of mathematics achievement of total sample and locale wise and gender wise sub samples [Mean control: 19.69, 20.63, 19.20, 19.6, 20.15; mean experiment: 29.19, 29.06, 29.11, 29.33, 29.08] it is clear that the mean of the experimental group is much higher than that of control group. While comparing the pre scores and post scores of experimental group II, it was observed that the post scores of the experimental group II were noticeably higher than the pre scores. The effectiveness of the select Problem based learning design was statistically established through ANCOVA, where in the F-ratios obtained were statistically significant at 0.01% level for the total sample and locale wise and gender wise sub sample [Vide Table 5.27 to 5.31; F - ratios: 246.355, 132.305, 98.423, 80.287, 152.916; significant at 0.01% level]. The computation of the adjusted means for the post scores of the total sample and locale wise and gender wise sub samples [Vide Table 5.32; mean control: 19.69, 20.63, 19.20, 19.6, 20.15; Adjusted mean experiment: 29.19, 29.06, 29.11, 29.33, 29.08] showed that the adjusted mean of the experimental group is higher than that of the control group which implies better performance of the experimental group. Thus the select Problem based learning design is effective in improving the academic performance in mathematics of secondary school pupils.
2) The results of the test of significance of the difference between mean pre scores in the level of reflective thinking of the experimental and control group of the total sample and locale wise and gender wise sub samples show that both the groups were more or less similar with respect to their level of reflective thinking (Vide. Table 5.33; C. R: 0.44, 0.13, 0.49, 0.22, 0.52; not significant at any level) whereas test of significance of the difference between mean post scores indicate that the two groups differ significantly (Vide. Table 5.34; C. R: 13.30, 8.64, 9.66, 9.2, 9.71; significant at 0.01% level). From the mean scores obtained (Vide. Table 5.34) it is clear that the mean of the experimental group is much higher than that of control group. While comparing the pre scores and post scores of the experimental group II, it was observed that the post scores of the experimental groups II was remarkably higher than the pre scores. The effectiveness of the select Problem based learning design was statistically established through ANCOVA where in the F- ratios obtained for total sample and locale wise and gender wise sub samples were significant at 0.01% level (Vide. Table 5.35 to 5.39; F- ratios: 1128.493, 263.44, 339.387, 447.058, 626.745; significant at 0.01% level). The computation of the adjusted means for the post test scores of reflective thinking level of the total sample and locale wise and gender wise sub samples showed that the adjusted mean of the experimental group is higher than that of the control group which implies better performance of the experimental group II [Vide Table 5.40; mean control: 63.91, 63.47, 64.68, 65.17, 64.32; adjusted mean experimental: 106.17, 113.38, 90.91, 105.99, 116.33]. Thus select
Problem based learning design is effective in enhancing the level of reflective thinking of secondary school pupils.

3) In order to assess the impact of the select Problem based learning design in augmenting the set levels of varied strands of mathematics proficiency namely, conceptual understanding, procedural fluency, strategic competence, adaptive reasoning and productive disposition, the analytic rubric for synchronized assessment of mathematics proficiency was administered to the control group and experimental group II before and after the treatment of the select Problem based learning design. The results indicate that there is considerable decrease in the percentage of pupils coming under Novice level with regard to the total score, average score and strand wise scores of mathematics proficiency [Vide. Table 5.41; average score: 72.2% to 20.8]. It is also revealed from the table [Vide Table 5.41] that the number of pupils coming under Basic, Proficient and Advanced levels with regard to the total score, average score and strand wise scores of mathematics proficiency increased noticeably after exposing them to the select Problem based learning design [Average score: 21.6%, 6%, 0.2% to 51.6%, 19.8%, 7.8%]. But there is no remarkable change in the percentage of pupils coming under Novice, Basic, Proficient and Advanced levels with respect to the total score, average score and strand wise scores of mathematics proficiency in the control group [Vide. Table 5.22]. These results show that the select Problem based learning design is effectual in uplifting the set levels of mathematics proficiency.
4) While analyzing the opinions of pupils squeezed through the strategy evaluation proforma it was revealed that a large majority of pupils [Vide Table 5.42] were greatly benefitted by the intervention of the select Problem based learning design. The pupils of the experimental group could participate in the learning actively and steer the learning process, manage challenging tasks, develop communication skills and interpersonal skills, make learning attuned to the world of work and enable the learner to monitor the adequacy of performance through the experiences obtained from the select Problem based learning design. These results concede that the select Problem based learning design has a logical inclination to frame a reflective mind set to the processing of mathematical tasks.

Thus the findings mentioned above conclusively point towards the fact that the select problem based learning design is effective in radiating reflective dispositions subsequently better performance in mathematics achievement and enriched proficiency in mathematics among secondary school pupils.

6.2.6 Effectiveness of Thinking maps design in attuning a reflective mind set among pupils at secondary level.

The effectiveness of the prepared Thinking maps design in attuning a reflective mind set among pupils at secondary level was authenticated through both quantitative and qualitative research approaches. During the initial phase, the effectiveness of Thinking maps design was determined by analyzing the test scores of mathematics achievement and the level of reflective thinking of pupils. The augmentation in the set levels of the varied strands of mathematics proficiency was assessed through the self assessment rubric for establishing the efficacy of the select Thinking maps
design. In addition to these the impact of the Thinking map design in gauging mathematical thinking in classroom situations was conceded by the set strategy evaluation proforma administered to the experimental group III. The statistical results supporting these arguments are described below.

1) The results of the test of significance of difference between mean pre scores of mathematics achievement of the experimental and control group of the total sample and locale wise and gender wise sub samples indicate that both groups were more or less similar in their initial performance [Vide. Table 5.43; C.R:1.55, 1.24, 1.92, 0.76, 1.65; not significant at any level]. The test of significance of the difference between mean post test scores of mathematics achievement of total sample and locale wise and gender wise sub samples indicates that the two groups differ significantly [Vide Table 5.44; C.R: 5.11, 3.81, 4.59, 4.73, 3.86; significant at 0.01% level]. From the mean post test scores of mathematics achievement of total sample and locale wise and gender wise sub samples [Mean control 19.51, 20.63, 19.20, 19.6, 20.15: Mean experiment: 29.03, 29.12, 28.93, 28.87, 29.17] it is evident that the mean of the experimental group is higher than that of control group. While comparing the pre scores and post scores of experimental group III, it was observed that the post scores of experimental group was noticeably higher than the pre scores. The effectiveness of the Thinking maps design was statistically established through ANCOVA, wherein the F-ratios obtained were statistically significant at 0.01% level for the total sample and locale wise and gender wise sub samples [Vide Table 5.45 to 5.49; F-ratios 239.016, 73.376, 78.468, 157.337, 66.259; significant at 0.01% level] The computation of the adjusted means
for the post scores of the total sample and locale wise and gender wise sub samples [Vide. Table 5.50; Mean control: 19.69, 20.03, 19.2, 19.6, 20.15; Adjusted mean experiment: 28.76, 30.35, 28.51, 28.76, 28.75] showed that the adjusted mean of the experimental group is higher than that of the control group which implies better performance of the experimental group. Thus Thinking map design is effective in improving academic performance in mathematics of secondary school pupils.

2) The result of the test of significance of the difference between mean pre scores in the level of reflective thinking of the experimental and control group of the total sample and locale wise and gender wise sub samples shows that both the groups were almost similar with respect to their level of reflective thinking [Vide. Table 5.51; C.R: 1.36, 1.43, 0.47, 0.25, 0.16; not significant at any level] the test of significance of difference between mean post scores indicate that the two groups differ significantly [Vide. Table 5.52; C.R: 14.44, 9.53, 11.11, 10.59, 9.48; significant at 0.01% level]. From the mean scores obtained [Vide. Table 5.52] it is clear that the mean of the experimental group is higher than that of the control group. While comparing the pre scores and post scores of the experimental group III, it was observed that the post scores of the experimental group III was remarkably higher than the pre scores. The effectiveness of the Thinking map design was statistically established through ANCOVA wherein the F -ratios obtained for total sample and locale wise and gender wise sub samples were significant at 0.01 % level [Vide. Table. 5.53 to 5.57; F- ratios: 1079.952, 257.136, 410.963, 612.886, 386.45; significant at 0.01% level]. The computation of the adjusted
means for the post test scores of reflective thinking level of the total sample and locale wise and gender wise sub sample show that the adjusted mean of the experiment group III is higher than that of the control group which implies better performance of the experimental group III [Vide Table 5.58; Mean control: 63.91, 63.47, 64.68, 65.17, 64.33; Adjusted mean experimental: 99.45, 101.31, 100.12, 99.39, 99.52]. Thus Thinking map design is effective in enhancing the level of reflective thinking of secondary school pupils.

3) In order to assess the impact of the select Thinking map design in augmenting the set levels of varied strands of mathematics proficiency, namely, conceptual understanding, procedural fluency, strategic competence, adaptive reasoning and productive disposition the analytic rubric for synchronized assessment of mathematics proficiency was administered to the control group and experimental group III before and after the treatment of the select Thinking map design. The results indicate that there is considerable decrease in the percentage of pupils coming under Novice level with regard to the total score, average score and strand wise scores of mathematics proficiency [Vide Table 5.59; Average score: 72.2% to 22%]. It is also revealed from the table [Vide. Table 5.59] that the number of pupils coming under Basic, Proficient and Advanced levels with regard to the total score, average score and strand wise scores of mathematics proficiency increased noticeably after exposing them to the select Thinking map design [Average score: 23%, 4.4%, 0.4% to 49.4%, 20.2%, 8.4%]. But there is no considerable change in the percentage of pupils coming under Novice, Basic, Proficient and Advanced levels with respect to the total score, average score and strand wise
scores of mathematics proficiency in the control group [Vide Table 5.22]. These results show that Thinking map design is effective in upbring the set levels of mathematics proficiency.

4) While analyzing the opinions of pupils extracted through the strategy evaluation proforma it was revealed that a majority of pupils [Vide Table 5.60] were greatly benefitted by the intervention of the select Thinking map design. The pupils of the experimental group could increase memory of conceptual knowledge and deeper understanding in mathematics, learn ways to organize information, direct and construct networks of knowledge on the way to problem solution, unleash their visual strength in activating solution procedures and set forth a logical progression of ideas to reach at generalizations and conclusions through the experiences obtained from the select Thinking map design. These results prove that the select thinking map design has made a punch of reflectivity in strategizing solution routes of mathematical endeavors among secondary school pupils.

Thus the findings mentioned above conclusively point towards the fact that the select Thinking map design is effective in attuning a reflective mindset that culminates in better performance in mathematics achievement and heightened proficiency in mathematics among secondary school pupils.

6.2.7 Comparison of each of the select reflective learning designs among the subgroups of pupils classified according to locale and ordinal status in mathematics achievement and level of reflective thinking

The results obtained by analyzing the test scores of mathematics achievement and level of reflective thinking among subgroups of pupils classified according to locale and ordinal status of pupils by estimating predicted quartiles are consolidated in table 6.1.
Table 6.1 Consolidated Results of Predicted Quartiles of the Select Three Experimental Groups

<table>
<thead>
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<th>Group</th>
<th>Locale</th>
<th>predicted Quartile</th>
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<td></td>
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<td></td>
<td>Achievement in</td>
<td>Reflective thinking</td>
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<td></td>
<td></td>
<td></td>
<td>Mathematics</td>
<td>level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
</tr>
<tr>
<td>Experimental</td>
<td>Urban</td>
<td>29.81</td>
<td>29.15</td>
<td>28.73</td>
</tr>
<tr>
<td>group I</td>
<td>Rural</td>
<td>15.30</td>
<td>10.38</td>
<td>7.37</td>
</tr>
<tr>
<td>Experimental</td>
<td>Urban</td>
<td>29.94</td>
<td>32.12</td>
<td>33.67</td>
</tr>
<tr>
<td>group II</td>
<td>Rural</td>
<td>25.61</td>
<td>22.45</td>
<td>18.69</td>
</tr>
<tr>
<td>Experimental</td>
<td>Urban</td>
<td>28.80</td>
<td>30.84</td>
<td>31.33</td>
</tr>
<tr>
<td>group II</td>
<td>Rural</td>
<td>28.8</td>
<td>28.38</td>
<td>28.09</td>
</tr>
</tbody>
</table>

The results obtained from the estimation of predicted quartiles show that the prepared learning designs namely, Reflective journaling design, Problem based learning design and Thinking maps design influenced the secondary school pupils at varied ability levels and at different locale status with different intensities with respect to their academic performance and reflective thinking capacities. From the result obtained [Vide. Table 6.1] it is evident that Reflective journaling design is more effective to the backward pupils [pupils below Q1] than the average [between Q1 and Q3] or above average [above Q3] group of pupils in both urban and rural area. The result obtained from Table 6.1 also shows that the Problem based learning design and Thinking maps design are more beneficial to the below average [below Q1] group of pupils than the average [between Q1 and Q3] or above average [above Q3] group of pupils in both urban and rural area. But these Problem based learning design and Thinking maps design are more beneficial to the average [between Q1 and Q3] and above average [above Q3] group of pupils than the below average [below Q1] group of pupils in the urban area.
These findings lead to the conclusion that the select reflective learning designs namely, Reflective journaling design, Problem based leaning design and Thinking maps design have differentiated impact on secondary school pupils at varied ability levels and in the urban and rural locality.

6.2.8 The intensified effect of the select reflective learning designs in the experiential space among the identified cohorts of pupils through focus group discussions.

1) The findings evolved from focus group discussions A and B reveal that the heightened effect of the select Reflective journaling design to hone the mathematic competencies among the identified cohorts of pupils is mainly due to the following highlights of it as perceived by the pupils.

The exposure of Reflective journaling design could enable them to:

a) Induce self confidence and self respect among themselves that energize them in the better processing of mathematical tasks

b) Compare mathematical concepts and reconceptualise problems

c) Explore contradiction pursuing alternate strategies to maximize their learning

d) Planning, coordinating, monitoring and assessing the solution processes

e) Discover for themselves the creative ways to solve problems

f) Communicate mathematical idea coherently and clearly to peers and others

g) Promoting critical thinking, challenging assumptions, increasing personal growth and solidifying learning
h) Stimulate thinking and assist students in developing writing skills

i) Required them to be focused while reading and taught them to focus thoughts

j) Illuminate self assessment and self reflection in journaling.

k) Consolidate the thinking underpinned in the mathematical tasks

2) The discussion results entailed certain findings with regard to the constraints in practicing the select Reflective journaling design like the lack of availability of time and resources in the curriculum and institutions and the dearth of continuous monitoring of the journal entries by the respective mentors. The results of the discussion also point towards the significance of providing journaling prompts as it acts as a catalyst to initiate the reflection process and a device for structuring reflective writing.

The above findings lead to the conclusion that the select Reflective journaling design link mathematics theory and practice as well as integrate personal, intrapersonal, interpersonal, private, public, intellectual and professional aspects of pupils during all mathematical endeavors subsequently supports the movement of learners towards becoming reflective practitioners.

3) The findings derived from focus group discussions C and D show that the registered supremacy in the effect of the select Problem based learning design to enculture mathematical thinking in resolving problematic tasks among the identified cohorts of pupils is mainly due to the following leading punches of it as perceived by the pupils.
a) Learning is considered as an active and meaningful enquiry where knowledge is built by learners.

b) Learning of knowledge in an embedded context which informs a need for that knowledge.

c) Learners could themselves engage in questioning, revising and entertaining various dimensions of the issues they uncovered within the mathematical task.

d) Learners could create a rich foundation for solving problems and prepares them to be competent enough for future learning

e) Familiarizing with the use of more than one resource and to deal with more than one perspective.

f) Responsible and independent learning habits are nurtured.

g) Enhancing skill of analysis and proposing well grounded solution.

h) Dynamic and interactive nature of the process

i) Learning activities are designed and conducted in integrated teaching – learning – assessment framework.

j) Improve the individual, group, personal awareness and communication skills.

k) Maximize competency development at individual levels.

4) The discussion results rubricated a set of findings with regard to the impediments in practicing the Problem based learning design like the timely scaffoldings and facilitations to be rendered by their mentors and the problem of using multiple resources for in depth inquiry. The results also throw light into
certain affirmative trends like allocation of more time for data collection and class discussions, more attention to organization of ideas, use of evidence in advancing arguments in discussions, and employment of range of cognitive tools involving enquiry and dialogue for embellishing Problem based learning design in the experiential space.

The above findings lead to the conclusion that the select problem based learning design could move through an organizational structure of reflectivity that authorize the pupils’ development in all spheres enacting self authentication, existential self realization, empowerment and transformation.

5) The findings extracted through focus group discussions E and F indicate that the marked ascendance in the effect of the select Thinking map design to make upswings in mathematics expertise among the identified cohorts of pupils is mainly due to the following benchmarks of it as demarked by the participants. Learning through Thinking map design provides:

a) An informational context for greater understanding and meaning.

b) Provide new pathways to think at higher levels.

c) Develops the disposition for creativity and flexibility.

d) Could justify and explain interesting patterns and relationship.

e) Create intense proggammic focus to structure and accomplish mathematical task.

f) Depict relationship between main idea and sub ideas.

g) Create a frame work onto which future information can be added.
h) Demonstrate development and achievement in learning.

i) Can provide the focus for reflection, target setting and action planning by the student.

j) Confusion and error are embraced as opportunities to deepen mathematical understanding.

k) Able to consolidate their thinking and communicate the mathematical ideas coherently and clearly to their peers.

6) The discussion results calibrated certain barriers in practicing the Thinking map design in the experiential domain like hold of Thinking map primitives in correctly transforming the networks of their thinking, the analytical scaffolding to be extended by the facilitators in incorporating primitives into learning process and the timely feedback to be rendered by the facilitators in the strategic management of mathematical tasks and the pursuing formulation of maps. The results also throw light into the need for providing more intelligent, creative, varied and appropriate mapping probes as a preferred comfort level in reifying the select Thinking map design.

The above findings lead to the conclusion that the select Thinking maps design enabled the secondary school pupils to gain valuable skills of reflection in organization, evaluation and management ensuing a concrete system and model for proceeding through a problematic exercise.

6.3 Summary of Conclusions

The present study emphasizes the acute urgency of exercising progressive instructional dynamisms for resurging the student folk with reflective dispositions that culminates to embrace advanced mathematics proficiency. It is revealed from the study that the select learning designs
namely, Reflective journaling design, Problem based learning design and Thinking maps design could enhance the reflective thinking level of the pupils at secondary level. The study also found that the exposure of the select learning designs acted as a support to steer the learning endeavors within a reflective culture that leads to improved academic performance of learners in mathematics. The radiance of reflectivity penetrated through the intervention and exploration of the select learning designs induced a momentum to the upbring ofing of the proficiency level of mathematics with respect to the varied strands. The study also proved that the experiential facet of the reflective mind set is influential in strategizing and designing the solution pathways of mathematical tasks fruitfully. The distinctive characteristic of the select learning designs in optimizing the performance of the set special cohorts of learners in practice domains were also discussed and proved that the metalearning awareness squeezed through self analyzing, self monitoring and self management of mathematical tasks energizes them to embark on better out comes enabling the backward learners to lift their levels of achievement as well as maximizing the potentials of the forward pupils in processing of mathematical endeavors.

The most demarcating contribution of the study is that sharpening the thoughts of the young adolescents in a reflective tune could empower the learners with a philosophical mind who has self control and command over their own thinking and beliefs.

6.4 Implications of the Study

Mathematics Education has become a full-fledged interdisciplinary field of research and analysis with a mission of appraising and amplifying the practices of mathematics learning at all levels. It is also aiming at a better understanding of the processes underlying the acquisition and development of mathematical knowledge, skills, beliefs, attitudes and
dispositions applied to the design of valuable tools and powerful environments for teaching and learning of the subject.

The present study is intended to develop certain learning design tools grounded in reflective actions for upscaling the new perspectives on mathematics learning at secondary school level. The major implications of the study are described below:

1) At the outset of the study the investigator enquired about the prevalent stance of mathematics education at secondary school level by conducting a face to face interaction with select experts and practitioners in this field. The conclusions derived in this respect evinced that a realignment of mathematics learning scenario is inevitable now in order to bridge the gap between what the learners acquire from the mathematics classroom environment and what knowledge and skills they are expected to have to meet the demands of 21st century communities. Educational institutions are struggling to keep pace with the astonishing rate of change in the learner’s life outside the school due to the inception of innovative trends in social media technology. They have to spend their lives in a multitasking, multifaceted, technology driven, diverse, and vibrant and globalize world and they must arrive at equipped to do so. This situation demands the symbiosis of multipronged pedagogical modes to fabricate a culture of higher order thinking in every mathematical task engagements. In the prevalent scenario of mathematics learning the learners experience certain barriers and hindrances in the effective processing of information and knowledge production. They are often constrained by mental habits, biases, presuppositions and preset standards of
operations that tend to close off new ways of perceiving and interpreting their experiences. The results of public examinations of standard X and higher secondary in mathematics reveal that a large proportion of pupils are still struggling to deal with the subject fruitfully even though some potential improvements in the pedagogy of mathematics like activity oriented approach were introduced into the curriculum. A major reason behind this observable fact can be the dearth of innovative and reflective instructional designs which enforces the learners to think deliberatively, and articulate the rationale that underlies their learning decisions. These reflective mechanisms evolved from reflective learning designs can make perpetual problem solvers who can synthesize experiences integrating information and feedback, uncover underlying reasons and discover new meaning. All the practitioners in mathematics education need to be made aware of and be disposed to constructive pedagogical instruments involving reflective journaling, portfolio writing, PBL, graphic organizers, inquiry approaches and the like to upgrade the landscape of mathematics learning. The curriculum framers, policy makers and teacher educators should allocate plethora of educational resources to bring about the needed critical changes in both in-service and pre-service course of teacher education.

2) Mathematics education should broadly embrace the view that learning is not a solo and internal activity; rather learning efforts are distributed over the individual learner’s mindful and effortful involvement. Engaging one with mathematics tasks requires frequent opportunities to make sense of it and to recognize the benefits of perseverance. Success in mathematics
learning requires being positively disposed toward the subject. If students are to learn, act, and apply mathematics expertise effectively, they should see it as a subject in whom things fit together logically and sensibly and they need to believe that they are capable of figuring it out. Students who are proficient in mathematics become more confident of their expertise to learn the subject. They need to believe that they can develop understanding of the mathematical concepts, strategize solution procedures, reason out propositions and be positively disposed towards the subject. To be cautious in arranging every pedagogical endeavors that should address the integrated strands of proficiency to make knowledge stronger more durable more adaptable more useful and more relevant.

3) A reflective model of learning experience enables the learners to have meaningful learning by making visible both teachers’ and learners’ thinking processes. Facilitators should employ a range of cognitive tools involving enquiry, dialogue, discussion, regulation, documentation, presentation to provide students with strategic road maps that assist them in their line of analysis they employed that led to their final decision. The experiential space embedded with the pedagogical task grounded in reflective dispositions requires students to play the role of decision makers in being able to evaluate different perspectives and take multiple views into account so as to make an informal decision. In this stance of reflective culture cognitive patterns and networks of knowledge structures are incrementally constructed by drawing linkages between the fundamental base of prior knowledge and the body of new knowledge gathered from current learning activities. The facilitation should provide
a variety of resources and recursive set of activities to acquire and integrate new knowledge schemes. Learner’s prior mathematical content knowledge levels have to be assessed and adequate mediation need to be done to acquaint students with the foundation of expertise before plugging them into reflective endeavors.

4) The study acclaimed that learning through PBL has improved the learners’ social interactive and public communication skills. In PBL classes students present the solutions in a systematic and well organized way, showing thorough understanding of subject matter, speak clearly and confidently and explain learning idea using simple terms. They are able to present ideas logically and smoothly without excessive dependence on the original plan and respond properly to questions or ideas raised. The positive symbiosis between effective communication and competent problem solving spurs both cognitive and intellectual growth in learners. Since the task of conducting presentation is consigned to individual team members on a rotational basis even reticent and shy students are forced to articulate their ideas in class openly and this gradually boosts their confidence in public speaking. Thus the study underscores the positive impact of incorporating pedagogical tools blended with PBL design elements into the curriculum development.

5) A significant implication of the study is the specific emphasis given to the collaboration dimension of mathematics learning embedded within the PBL design. Learning is inherently social in nature and the interchange of ideas and multiple perspectives from team members enhance this process. Learners should be
encouraged to work collaboratively in teams to seek solution by integrating other participants’ outlooks and opinions to form viable solution yet maximizing individual talents. Dialogue between learners and facilitators and among learners themselves drives the quest for knowledge instead of the monologues in the form of teacher talk and hence it should be encouraged. By such instructional conversations, the facilitators build understanding among the students by mediating student dialogue so that students are actively co-constructing their knowledge through posing questions and redirecting responses of peers. Learners need to be reinforced to work as active problem solvers and discussants as mutual exploration, meaning making through discourses and feedback from peers and facilitators cause to arise germination of ideas. Through this study the investigator emphasizes the need to develop a collaborative learning environment wherein learners could expand their horizons of all strands of mathematics scholarship by forging critical openness in collaborative activities. Faculty members are to be enforced to make an executive decision to use social synergy as a silver bullet to pierce the armour of secondary school mathematics education.

6) The present study underscores the use of learning journals as a method of engaging mathematics learners in the exercise of reflective actions and their transcripts and in relating classroom theory to situations of practice outside the classroom. Not only the enthusiastic benefits namely the untapped potential of journals were highlighted in the study but also it points towards the numerous constraints embedded within the dominant culture of educational system that limit the full potential of journal
writing. The study participants indicated that they got a rare opportunity to reflect upon their own experiences and were able to share their journal entries regarding what has worked and has not worked; and were able to learn innovative ideas for using journals in their own learning. This implies the need of transacting an ambience of journal writing among the school practitioners as well as all levels of learners so that effective learning takes place.

7) The findings of the study set the stage for more ambitious exploration of the role of Thinking maps for activating habits of mind in the entire realm of school education as well as higher education. Thinking maps is a significant educational reform measure since it marks a departure from prevailing activity oriented pedagogical model to cartographic mode of knowledge processing and accommodation. The enculturation process into this new design of instruction requires both cognitive and psychological realignment of the contextual constructs of the set task. Learners have to call upon to become more open minded and receptive of cognitive networks and patterns of the exercise tasks. In order to adapt to this new design implementation facilitators should assume a multifaceted guiding role and create an interactive classroom learning culture through discussion and discourses. When learners combine the use of visual tools with the habits of mind to crystallize their thinking, they could see their own accommodating ideas and thus gain new sense of themselves as efficacious thinkers and problem solvers. Educators and instructional facilitators need to ensure that learners consciously apply Thinking maps into their daily learning by redesigning the materials they already use in their
classrooms. Educational administrators, policy analysts, scenario planners and knowledge managers should promote appropriate training programme for all the stake holders of this innovative pedagogical tool is another indispensable condition for the implementation of thinking maps design.

8) The findings of the study suggest that educators should concern themselves more with the development of a reflective environment and practice of reflective scaffoldings than teaching students how to reflect. This might account for a slow adoption of reflection within the curricula and the stake holders should be encouraged to examine the fruit of reflection in many contexts and arenas. When students reflect on their work, become more adept at describing the skills and strategies they use to solve complex problems and apply those same strategies in a variety of contexts consequently discover their metacognitive process for learning. They transform their roles as a learning community by joining as partners in the instructional process. These impressions of reflective designs under the present study affirm that practitioners in all disciplines should find new dynamisms and tools synchronized with reflective orientations to expand their repertoire of pedagogical mechanisms for a better learning community. Hence it is high time to orient the educational practitioners at all levels to habituate reflective learning practices in their daily classroom transactions for building productive learning population as well as for their professional development by the educational planners and administrators.

9) The present study emphasizes the core competencies necessary for the good practice of reflective activities as observation of
critical moments, communication, judgment, decision making and collaborative work. These competencies are important in that they allow the learners engaging in learning conversations where meaning is being constantly negotiated and hence cope better with the complexities of mathematics learning. It enables the learners to make deliberate and intentional decisions for further actions as it promotes analysis and evaluation of mathematics task engagement at a deeper level. This implicates broadly to the role of reflective conversations in all the pedagogical functions claiming that it can encourage access to diverse range of opportunities and activities bringing improvement forward. It is the quality of the conversation that is important and so the curriculum framers, teacher educators and practitioners at various levels need to design a structure for better use of reflective conversations into the routine of classroom practices.

10) A powerful contribution to self initiated learners who continue to pursue learning as a life long endeavor is the activation of self assessment mode of evaluating learning gains. It enables them to clarify their own goals, establish their own personal learning and to energize self initiated changes in their effort for continual self enhancement. In the present study, the investigator made use of certain self-assessment modalities namely rubrics and strategy evaluation proforma for collecting data in a qualitative perspective. These self assessment strategies that are intended to help students to be self referring, self monitoring and self modifying that provides timely feedback about their behavior and can determine for themselves how to improve. As one of the self assessment modes, rubrics
provide a concrete vision and explicit language for goal setting and personal mastery. It is a systematic way to chart growth and improvement of the behavior anchors of the learning output and empowers them to analyse where they need to focus to improve. Hence, the study implies a systematic orientation, development and practice of distinct self-assessment modalities in the educational sector by all the practitioners at all levels.

### 6.5 Limitations of the Study

The present study has the following limitations.

1) The validity and reliability of the study are limited by the sample of secondary school pupils from eight schools of three central districts of Kerala namely, Alappuzha, Ernakulam and Trichur due to feasibility constraints.

2) The sub stratification of secondary school pupils other than locale, gender and ability groupings could not have considered as it makes the study more elaborated.

3) Though many reflective learning strategies are there, the investigator could focus only on the select strategies namely, Reflective Journaling, Thinking maps and Problem based learning because they are experienced to be the most appropriate strategies for secondary school pupils.

4) The study was conducted only on pupils following the curriculum framework set by the S. C.E. R. T.

In spite of the aforesaid limitations, the study has great implications in wider contexts as mentioned in section 6.4. Though the select reflective learning designs are not holistic therapy for the handicaps and hurdles in shaping the intellectual as well as emotional landscape of mathematical
thinking, they could illuminate the portrayals of self analyzing, self referring, self correcting, self monitoring and self managing. This would capacitate the aspirants to configurate mathematical concepts, use algorithms properly, strategize solution routes, finds logical relationships, reflects and explains the procedures and to indulge in challenging mathematical tasks.

### 6.6 Suggestions for Further Research

A radical analysis of the research conducted in the manifold domains of the present study has opened the new avenues of which further investigations ought to be done. A few of the set problems in the select areas namely, mathematics education, reflective practices and progressive instructional dynamism are cited below:

1) A critical enquiry into the impact of reflective practices for boosting 21st century skills among the student folk at varied levels.

2) An investigation into faculty dispositions toward instructional dynamics blended with reflective practices at higher education level using focus group discussions.

3) A study on the effect of reflective practices in activating sustainable professional development among school practitioners – A case study.


5) Effective educational leadership and reflective practices – An investigative study.

6) Invoking reflective practices through web enhanced design tools at higher education level.
7) Impact of reflective practices for effective classroom management among pre service and in service teachers.

8) An enquiry into design centered models of teaching and learning for facilitating higher order thinking skills.

9) Scaffolding for success in reflective pedagogical tools – A qualitative enquiry.

10) Instructional designs for reflective learning practices supporting multiple learning styles – An experimental study.

11) A study on the effect of web enhanced learning packages for promoting reflective thinking among learners at varied levels.

12) A study on the effect of ICT enabled instructional designs for developing mathematics proficiency.

13) An investigation into other reflective learning mechanisms for improving higher mathematics competencies at all levels of schooling.

14) A study on the impact of reflective mode of curriculum transaction at higher education scenario for uplifting mathematics expertise.

15) Effect of reflective learning practices in enhancing academic performance in other disciplines other than mathematics – An investigative enquiry.

16) A comparative study on the prospect of reflective practices among mathematics practitioners at various levels using focus group discussion.

17) Influence of reflective practices in empowering in-service teachers with sustainable professional development at various levels.
18) Effect of reflective learning practices on mathematics achievement among pupils of varied learning styles.

19) An investigative enquiry into the impact of self-assessment modes on academic performance among student folk at varied levels.

20) A case study on the effect of online journaling on academic achievement in mathematics.

21) Identification and experimentation of innovative pedagogical tools other than reflective practices like e-learning kits, online learning packages and the like in enhancing mathematics proficiency.

22) Discourses in mathematics education through collaborative knowledge representations – An empirical study.

23) Reflective Journaling to improve professional practice in teacher education.

24) Investigation into the impact of visual tools for activating habits of mind at varied levels of schooling.


26) The need for designing tools for virtual learning communities – An investigative enquiry.


28) Impact of knowledge based cartography on pupil’s mathematics performance – an in depth investigation.

30) Graphical knowledge representations to support pedagogical expertise among mathematics practitioners – a qualitative study.

31) Use of reflective diary among teacher educands – a case study.

32) ICT supported mapping methodology among teacher educands – An empirical study.

A perfect amalgamation of the vintages of the researches in the suggested arenas can nurture the learning faculties with authenticated, accountable and responsible caliber and prowess.