METHODOLOGY
CHAPTER - III

METHODOLOGY

3.1. INTRODUCTION

This chapter details the methodology of the present research. It contains the process of the research, design of the study, sample of the study, tools developed for the study, interventions for the groups, major objectives, hypothesis, research questions and statistical techniques used in data analysis.

The major objective of this study is to find the effectiveness of ICT Infused Instructional Design (IIID) in methodology of teaching mathematics on pre-service teachers’ techno-pedagogical competency in teaching mathematics. It also involves studying the impact of ICT infused Instructional Design in Methodology of Teaching Mathematics (IIID-MTM) on confidence in using ICT, attitude towards ICT, knowledge on ICT and ICT skills contributing towards the ICT pedagogy integration in teaching mathematics at secondary level. In order to carry out this study IIID in methodology of teaching mathematics was developed along with the tools namely ICT confidence scale, ICT knowledge scale, ICT attitude scale and observation schedule for ICT skills and techno pedagogical competency. This chapter clearly explains the flow of the study to give a complete picture of the study.

3.2. RESEARCH PROCESS

Research is understood as a systematic, controlled, empirical and critical investigation of hypothetic statements on supposed relationships among phenomenon. This study is a quasi experimental research that involves planning, developing, implementing and evaluating. The schematic expression of the process of this research is shown in Figure 3.1 and the process is explained phase wise in detail in this chapter.
Figure 3.1: Research Process of this Study
3.3. PHASE I – ANALYSIS

In this phase, the investigator started by analysing the researches that has been conducted in the areas of ICT in teacher education. Based on the identified gaps, the area of research was confined to training practices in teacher education program to prepare pre-service teachers to integrate ICT in their teaching of mathematics. To bring out the need and significance of this study, theoretical analysis, curriculum analysis and need analysis was done.

3.3.1. Theoretical Analysis

Firstly, to understand the recommendations of various policies towards training pre service teachers on use of ICT in teaching, various national and international policies were reviewed. A systematic and rigorous analysis on the researches done in the field of ICT and teacher education was performed to identify the psychological factors that contributes towards ICT infusion and also to analyse the current practice in various countries for preparing pre service teachers in use of ICT for teaching. This analysis is elaborated in chapter II.

This analysis contributed in developing the conceptual framework and identification of variables namely knowledge on ICT, attitude towards ICT, confidence in using ICT, ICT skill and techno pedagogical competency in teaching of mathematics. The title of the study, objectives and hypothesis of the study were also formulated based on this theoretical analysis and are elaborated in Chapter 1.

3.3.2. Curriculum Analysis

The curriculum for pre service teacher education offered by Tamil Nadu Teacher Education University (TNTEU) is termed in this study as the existing curriculum. Existing curriculum is given in Digital Appendix - 1 given in the attached DVD. In the lights of policy and recommendations discussed in Chapter I, the existing curriculum of B.Ed programme offered by TNTEU was analysed, to identify the ICT components and strategies used to prepare pre-
service teachers for ICT integration in teaching and learning. ICT component present in the existing curriculum is given in Digital Appendix - 2. The analysis of Methodology in teaching of mathematics course reveals that there is wide gap between the recommendations of the policies and the present curriculum. Elaborate information on the analysis of TNTEU curriculum is given in Chapter I.

3.3.3. Need Analysis

The ICT related instructional activities conducted in B.Ed colleges affiliated to TNTEU related to ICT were collected from teaching staffs of various colleges through informal interviews and discussion. It reflects that in most of the colleges ICT related trainings are conducted in two forms: one form is bridge course/stand alone course and the other is enhancement programmes. Bridge course mostly focuses on computer training on MS office and students were encouraged to make a power point presentation. This course is conducted by the computer faculty for duration of 3 to 5 days. When it is done as a standalone course the content extends to internet and the duration extends to 1 month. There is no link between the course and the practice in college. Even though a hand on experience is provided during this course, it does not add value in preparing pre-service teachers to use ICT in their teaching or learning. It only helps in developing the technical skill not the pedagogical skill.

When the enhancement programmes for developing pre-service teachers to use ICT is concerned, it is more of seminars, workshops and hand-on training during the course. From the reflections made by the students during the discussion, it revealed that this type enhancement program helps them to understand about the need for ICT, but do not help much towards integrating ICT in their teaching and learning. Moreover the pre-service teachers as well as the educators felt that the learning outcome of this training comes to an end by the end of the program itself. It is not followed up into professional learning. This is felt as a drawback of such enhancement programs. Only the demonstration of using ICT in teaching by the teacher educator or teachers
from schools helps them to understand the way in which ICT could be integrated in teaching. But such demonstration is not found in such enhancement or stand alone trainings or some time less exposure is provided. It was also observed that in most of the institutions, the practical aspect which is in paper is not transformed to practice itself. During discussion with a principal, it was noted that students are not even encouraged to use power point as they are not capable of developing it and if forced, they spend money and get it done through computer centers. Principal and the teacher educator itself feel this to be an unnecessary activity which doesn’t have any value.

When the use of ICT by teacher educator was discussed, it is prominent that most of them do not even use MS office for their personal or professional requirement. Very few of them use power point that too downloaded and used as it is without customization. This shows that there is a wide gap between the curriculum as well as the instructional activities that is found in the institutions. When these instructional activities were mapped against the recommendations by national policies and international standards, they both stand at two ends, where the gap between them is immeasurable. National policy on ICT defines ICT Literacy in terms of levels of competence. These levels are classified as basic, intermediate and advanced. The investigator studied the knowledge on ICT, confidence in using ICT and attitude towards ICT of the pre-service teachers undergoing the existing curriculum in order to:

- understand the impact of existing curriculum in preparing pre-service teachers for ICT and the level to which they are prepared in accordance to the level stated by national policy on ICT
- establish the need for ICT infused instructional design
- perform the need analysis based on which the IIID could be designed effectively
- nullify the college related variables like infrastructure, resources available with students.

In order to do the need analysis itself, tools were required. Though development of tools comes under designing phase, the investigator developed
the tools and standardized them at the analysis phase itself because of the requirement. The tools on knowledge on ICT, confidence in using ICT and attitude towards ICT were administered to 400 pre-service teachers from five colleges. Only the students present on the day of tool administration were selected for this analysis. Even if one tool is incomplete, the respective student data was eliminated from the sample. So the final number of pre-service teachers considered for need analysis is 371. The distribution of the sample for need analysis is given in Table 3.1.

Table 3.1: Details of the Distribution of the Sample for Need Analysis

<table>
<thead>
<tr>
<th>Name of the College</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.S.I College of Education</td>
<td>115</td>
</tr>
<tr>
<td>Penial College of Education</td>
<td>79</td>
</tr>
<tr>
<td>Thiagarajar College of Preceptors</td>
<td>36</td>
</tr>
<tr>
<td>Yadava College of Education</td>
<td>53</td>
</tr>
<tr>
<td>St.Justin’s College of Education</td>
<td>88</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>371</strong></td>
</tr>
</tbody>
</table>

Based on the data analysis it was found that the existing curriculum has not even prepared the pre-service teachers to be competent in the basic level according to national policy on ICT for school education. This in turn reflects that the existing curriculum do not prepare pre-service teacher sufficiently for integrating ICT in teaching and learning.

Based on the curriculum and need analysis it was found the there is a gap between the recommendations, curriculum and instructional activities. This gave the need for an ICT Infused curriculum that could align the instructional activities in accordance the recommendations and give a complete picture on the knowledge and skills to be developed among the pre-service teachers for better integration of ICT in teaching. Figure 3.2 shows the schematic representation of ICT infused instructional design.
3.4. PHASE II – DESIGN

In this phase, the investigator designed the study by identifying the appropriate research design. Due consideration was given in identifying the research design, as it is the base for the complete process of this research. Once the investigator identified the design, the appropriate sampling procedure was decided and the samples were drawn from the population for this particular study. The treatments for the groups were designed to according to the choice of sample. The tools for data collection were identified. This phase describes the nature of the study and the initial procedures followed for conducting the research.

3.4.1. Design of the Study

The present study is quasi-experimental in nature wherein a pre test-post test three group design is employed. Quasi-experimental design is different from true experimental design in a way that the samples are not selected randomly from a specified population nor they are randomly assigned as done
in a true experimental design. Since it was not possible to randomly assign subjects to groups in the present study, it was intended to use a quasi-experimental design. The design begins with the identification of naturally assembled three groups. The three curriculum models for ICT integration in pre-service teacher education as recommended by UNESCO was implemented in this study. First group was assigned with infused model second with the integrated model and third with the complementary model. The design of the present study is given in Figure 3.3.

3.4.2. Variables of the Study

Independent Variable:

An independent variable is the variable that has been manipulated. ‘The independent variable is the factor that is manipulated purposively under observation to ascertain its relationship with the dependent variable. During the experiment, the investigator attempts to keep all conditions the same for two groups expect the experimental variable which is manipulated. In the present study, the approach of training has been considered as manipulated to find out what kind of effect it can produce on the dependent variables. So, in this
study ICT Infused Instructional Design (IIID) in methodology of teaching mathematics at secondary level is the independent variable.

**Dependent Variable:**

A dependent variable is the measured or observed variable. By observing the dependent variable, the effect of the independent variable can be measured. The dependent variable is the phenomenon that appears, disappears or changes as the researcher applies, removes or varies the independent variable. It was tested whether the independent variable i.e., ICT Infused Instructional Design (IIID) would have an effect on the dependent variables like knowledge on ICT, Attitude towards ICT, Confidence in using ICT, ICT skills and Technop edagogical competency in teaching of mathematics. These dependent variables were observed to determine whether the independent variables had any effect.

**Moderate variable:**

It is a factor that is measured, manipulated or selected by the experimenter to discover whether it modifies the relationship of the independent variable to an observed phenomenon. The term moderate variable describes a special type of independent variable, a secondary independent variable selected to determine if it affects the relationship between the study’s primary independent variable and its dependent variable. In this study, elective course is considered as a moderate variable.

**Controlled Intervening Variables:**

Control variable is a variable that has the potential to have impact on the dependent variable as well as the independent variable, but its effects are removed or controlled by the research design or statistical manipulation. When variables are not amenable to physical or selective manipulation, they may be controlled by statistical techniques. Statistical controls can achieve the same precision as other methods when they are employed to evaluate a variable effect. Statistical techniques are particularly useful in a situation where multiple variables may be functionally related to a particular effect, as is often the case of Education. College chosen for the experimental treatment, course
chosen for the study, maturity and identified content for integration were all controlled in the study.

**Uncontrolled Intervening Variables:**

Those variables that have an unpredictable or unexpected impact on the dependent variable were unable to control. Some of these variables are absenteeism of some students during experiment, exposure to ICT through other means outside the college, interaction of students with other related sources and students’ previous interaction with ICT.

All three groups were treated through three levels namely pre-testing, intervention and post-testing. Pre-testing and post-testing were done in the same manner for all the three groups, whereas the intervention differs for each group. The intervention for each group was planned differently to study the effectiveness of each intervention and to suggest the better way of preparing pre-service teachers of mathematics methods to integrate ICT in teaching and learning. The levels, variables and the intervention of the study are represented in Table 3.2.

**Table 3.2: Three group pre test- post test design showing levels, variables studied and intervention**

<table>
<thead>
<tr>
<th>Levels</th>
<th>Treatment for Group 1</th>
<th>Treatment for Group – 2</th>
<th>Treatment for Group - 3</th>
</tr>
</thead>
</table>
| Pre - testing| The level of the students on the following areas were tested for all the three groups before the intervention:  
* Knowledge on ICT  
* Attitude towards ICT  
* Confidence in using ICT  | The existing curriculum “methodology of teaching mathematics” is                      | The existing curriculum “methodology of teaching mathematics” is                      |
| Intervention | Infused Model - ICT infused instructional design throughout the year:              | Integrated Model – Standalone programmes across the academic year:                     | Complementary Model - Standalone bridge course at the starting of academic year:       |
|              | The existing curriculum “methodology of teaching mathematics” is                  | The existing curriculum “methodology of teaching mathematics” is                      | The existing curriculum “methodology of teaching mathematics” is                      |
infused with ICT components and with strategies to be used for implementing the same. IIID – MTM is the intervention for the complete academic year. integrated with enhancement programmes in the form of seminars/ workshops/hands-on training distributed across the academic year. 15 hours was allocated for this kind of programmes but not at a continuous stretch. complemented with stand – alone ICT training in the form of bridge course at the starting of the course, This bridge course is conducted for 15 hrs in 5 working days. 3 hours in invested for one day.

<table>
<thead>
<tr>
<th>Post Testing</th>
<th>The level of the students from all the three groups on the following areas were tested after the intervention:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Knowledge on ICT</td>
</tr>
<tr>
<td></td>
<td>• Attitude towards ICT</td>
</tr>
<tr>
<td></td>
<td>• Confidence in using ICT</td>
</tr>
</tbody>
</table>

Data related to ICT skills was collected through observation during the intervention. Techno pedagogical competency in teaching mathematics was collected through observation during internship practice.

3.4.3. Sampling Procedure

Sampling in educational research is generally conducted in order to permit the detailed study of part, rather than the whole, of a population. The information derived from the resulting sample is customarily employed to develop useful generalizations about the population. These generalizations may be in the form of estimates of one or more characteristics associated with the population, or they may be concerned with estimates of the strength of relationships between characteristics within the population. Provided that scientific sampling procedures are used, the selection of a sample often provides many advantages compared with a complete coverage of the population (UNESCO, 2005).

Population

A population is a group of elements or cases, whether individuals, objects, or events, that conform to specific criteria and to which we intend to generalize
the results of the research. This group is also referred to as the target population or universe. The population of the study is the pre-service teachers undergoing the methodology course in teaching of mathematics at secondary level in Tamil Nadu.

**Selection of sample**

The sample is the group of elements, or a single element, from which data are obtained. The sample for this study was obtained through random sampling procedure.

**Selection of College:**

There are 27 B.Ed colleges in Madurai district. 15 colleges were shortlisted based on the availability of infrastructure out of which three colleges were randomly selected for the study.

The colleges finally selected for the study are:

- Group 1 - C.S.I College of Education for implementation of IIID-MTM that follows Infused model
- Group 2 - Thiagarajar College of Preceptors for implementation of enhancement programs in the form of seminar/workshop/ hands-on training that follows the integrated model
- Group 3 - Penial College of Education for implementation of bridge course that follows the complementary model

Student teachers from mathematics stream of above three colleges were considered as the sample for this study. The details of the distribution of the sample are given in Table 3.3.

**Table 3.3 Details of the distribution of the sample of the present study**

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of student teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.S.I College of Education, Madurai</td>
<td>22</td>
</tr>
<tr>
<td>Thiagarajar College of Preceptors, Madurai</td>
<td>11</td>
</tr>
<tr>
<td>Penial College of Education, Madurai</td>
<td>25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>58</strong></td>
</tr>
</tbody>
</table>
3.4.4. Tools Used in the Study

The investigator developed and standardised tools namely ICT confidence scale, ICT knowledge scale, ICT attitude scale, and observation schedules for ICT skill and techno pedagogical competency in teaching mathematics. The details of the development of tool are given in 3.5.1 section of this chapter.

3.4.5. Designing the Interventions

The intervention planned for Group 2 and Group 3 i.e., complementary and integrated model reflects the type of ICT training that is happening in most of the B.Ed colleges in Tamil Nadu. The intervention for Group 1 was designed such that the ICT components are infused along with the content and activities in methodology of teaching Mathematics course. The intervention for group 2 was designed such that ICT related content and experiences are provided in the form of seminars, workshops and demonstration to enhance the methodology course. The intervention for group 3 was designed in the form bridge course where ICT components and applications were taught in isolation with the methodology course. The interventions designed for each group is elaborated here:

3.4.5.1. Complementary Model:

Bridge course is the nature of intervention for the group 3 in which complementary model is planned to be implemented. The college selected for this model has the entire necessary infrastructure. The college also provides laptop to all students at the starting of the year and collects it by the end of the year. The students are permitted to use the laptop for teaching and learning purpose. The intervention was planned to be a stand-alone bridge course at the starting of the academic year for 15 hours. i.e., 3 hours per day for 5 working days.

The mode of the bridge course was seminars, exposures and demonstration followed by hands-on practice in laptops.
1. Workshops (Demonstration with hands on practice):
   - Computer – Basic operation (1 hour)
   - Microsoft Word (1 hour)
   - Microsoft Excel (2 hours)
   - Microsoft Power Point Presentation (2 hours)
   - ICT tools for teaching mathematics (2 hour)
   - Internet (1 hour)

2. Seminar:
   - Recent trends in Teacher Education – Role of ICT (1 hour)
   - ICT in teaching and learning of mathematics (1 hours)
   - Use of internet in teaching of mathematics (1 hour)
   - Application of MS office in Education (1 hour)
   - Use of Interactive white board in Education (1 hour)

3. Exposure:
   - Teaching mathematics using power point (1 hour)

   An alternate seminar was planned by the faculty handling Educational
technology (Innovation) for other students when seminar was conducted
specifically in mathematics teaching for the students of mathematics stream.
Altogether the intervention for this group was planned for 15 hours at the
beginning of academic year.

3.4.5.2. Integrated Model

Enhancement programmes is the nature of intervention for the group 2 in
which integrated model was planned and implemented. The college selected for
this is well equipped with the infrastructure. The college has sufficient
computers and the internet access for students. Teaching staffs are provided
with computer at their workstations with internet access. The investigator
collected the list of planned programmes related to ICT from the college
administration. This list comprises of:

1. Workshops (Demonstration with hands on practice):
   - Computer – Basic operation (1 hour)
The investigator included the following seminars and workshop for pre-service teachers of mathematics stream.

2. Seminar:
   - Recent trends in Teacher Education – Role of ICT (1 hour)

3. Exposure:
   - Teaching mathematics through interactive board (1 hour)

The content coverage was equally maintained for Group 1 and Group 2. The enhancement programmes were conducted by the investigator, computer faculty and ICT experts. Workshops are conducted in the form of demonstration followed by hand-on practice. The Mathematics faculty handled the workshop on Interactive board. The students were given exposure to a real classroom teaching where teacher taught mathematics using interactive board in the model school attached with the college. Altogether the intervention for this group was planned for 15 hours across the academic year. Activities related to ICT integration was evaluated throughout the year.

3.4.5.3. Infused Model

ICT Infused Instructional Design in methodology of teaching mathematics was the intervention for Group 1 in which infused model is planned and implemented. The college selected for this intervention has the necessary infrastructure. ICT Infused Instructional Design (IIID) in
methodology of teaching mathematics at secondary level refers to the ICT infused content and methods of teaching mathematics course in B.Ed curriculum and the strategies to transact the same. ICT components were identified in terms of tools, concepts, application and software. These ICT components were infused along with the content in methodology of teaching mathematics through various strategies. An IIID-MTM framework was designed to act as a sketch for development of IIID-MTM in detail. The process for designing the IIID-MTM framework was formulated and given in Fig.3.4.

**Fig 3.4: Steps in Designing the IIID-MTM Framework.**

- Listing the objectives
- Designing the methodology
- Identifying the ICT components
- Identifying the plug points to integrate ICT components
- Identifying the pedagogical approaches and learning activities
- Designing the IIID-MTM framework

**Listing the objectives:**

Objectives are the guiding lines for developing a curriculum, methodology for transaction and evaluation. The objectives were listed out as a basement for developing IIID-MTM.

The objective of ICT infused instructional design in methodology of teaching mathematics is to:

- Improve the understanding of
  - Need for integrating ICT in teaching-learning of mathematics
  - Educational potentials of ICT in teaching and learning of mathematics
✓ Basic concepts and terminologies related to ICT
✓ Health, legal and ethical aspects of ICT

- Develop the skill in:
  ✓ Basic operations
  ✓ Finding, manipulating and communicating information
  ✓ Integrating ICT in teaching and learning of mathematics at secondary level
  ✓ Utilizing ICT based instructional materials and tools to support teaching of mathematics at secondary level

- Develop the ability to:
  ✓ Use ICT effectively in transacting the curriculum planned for secondary students
  ✓ Manage the use of ICT in the mathematics classroom
  ✓ Development of ICT based resource materials and content for teaching mathematics at secondary level
  ✓ Evaluate ICT tools and resources for teaching mathematics
  ✓ Apply the appropriate technology in teaching of mathematics at secondary level
  ✓ Judge the effective use of ICT tools and resources in teaching mathematics
  ✓ Evaluate the effect of ICT on their mathematics teaching and on their student’s learning of mathematics

- Develop the competence in working collaboratively to improve the quality of ICT enriched resources
- Develop positive attitude towards ICT and its use in teaching of mathematics
- Improve the confidence in using ICT for teaching mathematics
Designing the methodology:

Methodology for transaction of IIID-MTM was designed based on the recommended approach by UNESCO (2005) and the tested approach by Mishra and Koehler (2006). The methodology is a three stage approach:

**Figure 3.5: Methodology of IIID - MTM**

The techno pedagogical competency in teaching mathematics that is expected to be developed among the learners is first modeled by the educator. In this approach, the knowledge on ICT was transacted to the student teachers through modeling of educator and ICT competencies were observed by the student teachers. The same competency is put in practice through hands on practice by students in the form of activities, assignments, projects and daily classroom transaction. It is also practiced during internship. Attitude is intended to be developed alongside of the practice. The practice enhances the students to apply their knowledge and transform it to skills. So by the end, the competency in using ICT for teaching learning mathematics is achieved through this methodology.

**Identifying the ICT Components:**

The components of ICT that can be infused in the mathematics methodology curriculum of TNTEU were identified based on various reviews and the recommendations of the following:

- National policy on Information and Communication Technology
- Recommendations by several international, national and state bodies like UNESCO, NCTM, NCERT, NCTE etc., regarding ICT integration in pre-service teacher education programmes.
• Standards given by UNESCO, ISTE, BECTA, National policy on ICT etc on ICT competency
• UNESCO ICT syllabus for pre-service teachers at applying and infusing phase
• ICT integrated and infused curriculum in practice at various countries
• INTEL ICT infused curriculum
• European Pedagogy for ICT (EPICT) Curriculum
• Research findings of various training models for preparing pre-service teachers
• CIET diploma course on ICT in education for teachers

Opinion of the experts and practitioners were also considered while identifying the components. ICT components were of three categories namely ICT tools, applications and software and, pedagogical content. The identified components are listed below:

<table>
<thead>
<tr>
<th>Tools</th>
<th>Applications/Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computers</td>
<td>Online communication (Messaging &amp; chatting)</td>
</tr>
<tr>
<td>CD/DVD</td>
<td>Excel</td>
</tr>
<tr>
<td>Photocopier</td>
<td>Learning management software</td>
</tr>
<tr>
<td>Drivers</td>
<td>Access</td>
</tr>
<tr>
<td>Audio recorder</td>
<td>Search engines</td>
</tr>
<tr>
<td>Still camera</td>
<td>Word</td>
</tr>
<tr>
<td>Projector (OHP &amp; LCD)</td>
<td>Email</td>
</tr>
<tr>
<td>External CD writer</td>
<td>Blogs/ Forums</td>
</tr>
<tr>
<td></td>
<td>Movie maker</td>
</tr>
<tr>
<td></td>
<td>Bluetooth</td>
</tr>
<tr>
<td></td>
<td>Broadcasting tools</td>
</tr>
<tr>
<td></td>
<td>Tool</td>
</tr>
<tr>
<td></td>
<td>Content sharing tools</td>
</tr>
<tr>
<td></td>
<td>Typing and translation software</td>
</tr>
<tr>
<td></td>
<td>Web page</td>
</tr>
<tr>
<td></td>
<td>Assessment software</td>
</tr>
<tr>
<td></td>
<td>Online resources</td>
</tr>
<tr>
<td></td>
<td>Team viewer</td>
</tr>
<tr>
<td></td>
<td>Digital books</td>
</tr>
<tr>
<td></td>
<td>PowerPoint</td>
</tr>
<tr>
<td></td>
<td>Content sharing tools</td>
</tr>
<tr>
<td></td>
<td>Web page</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tools</th>
<th>Applications/Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computers</td>
<td>Online communication (Messaging &amp; chatting)</td>
</tr>
<tr>
<td>CD/DVD</td>
<td>Excel</td>
</tr>
<tr>
<td>Photocopier</td>
<td>Learning management software</td>
</tr>
<tr>
<td>Drivers</td>
<td>Access</td>
</tr>
<tr>
<td>Audio recorder</td>
<td>Search engines</td>
</tr>
<tr>
<td>Still camera</td>
<td>Word</td>
</tr>
<tr>
<td>Projector (OHP &amp; LCD)</td>
<td>Email</td>
</tr>
<tr>
<td>External CD writer</td>
<td>Blogs/ Forums</td>
</tr>
<tr>
<td></td>
<td>Movie maker</td>
</tr>
<tr>
<td></td>
<td>Bluetooth</td>
</tr>
<tr>
<td></td>
<td>Broadcasting tools</td>
</tr>
<tr>
<td></td>
<td>Tool</td>
</tr>
<tr>
<td></td>
<td>Content sharing tools</td>
</tr>
<tr>
<td></td>
<td>Typing and translation software</td>
</tr>
<tr>
<td></td>
<td>Web page</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tools</th>
<th>Applications/Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computers</td>
<td>Online communication (Messaging &amp; chatting)</td>
</tr>
<tr>
<td>CD/DVD</td>
<td>Excel</td>
</tr>
<tr>
<td>Photocopier</td>
<td>Learning management software</td>
</tr>
<tr>
<td>Drivers</td>
<td>Access</td>
</tr>
<tr>
<td>Audio recorder</td>
<td>Search engines</td>
</tr>
<tr>
<td>Still camera</td>
<td>Word</td>
</tr>
<tr>
<td>Projector (OHP &amp; LCD)</td>
<td>Email</td>
</tr>
<tr>
<td>External CD writer</td>
<td>Blogs/ Forums</td>
</tr>
<tr>
<td></td>
<td>Movie maker</td>
</tr>
<tr>
<td></td>
<td>Bluetooth</td>
</tr>
<tr>
<td></td>
<td>Broadcasting tools</td>
</tr>
<tr>
<td></td>
<td>Tool</td>
</tr>
<tr>
<td></td>
<td>Content sharing tools</td>
</tr>
<tr>
<td></td>
<td>Typing and translation software</td>
</tr>
<tr>
<td></td>
<td>Web page</td>
</tr>
</tbody>
</table>

111
Identifying the plug points to integrate ICT components into ten units and practicum component in methodology of teaching mathematics offered by TNTEU:

There is scope for ICT infusion in all ten units and the practicum components in methodology of teaching mathematics offered by TNTEU. It was further analysed to find out the exact places where the infusion can be done meaningfully. Table 3.4 shows the plug-ins in each unit.

Identifying the pedagogical approaches and learning activities:

The learning experiences were planned for each unit. The learning situations were visualized and created by planning several activities contributing towards attaining the objectives of IIID. Several pedagogical
strategies that lead to construction of knowledge, development of attitude and skill were incorporated appropriately for transaction of content. Constructivist learning approaches where learners are encouraged to participate in generative learning experience were included. Some of them are:

<table>
<thead>
<tr>
<th>Group discussion</th>
<th>Interviewing</th>
<th>Paired projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project based learning</td>
<td>Simulations</td>
<td>Peer Review</td>
</tr>
<tr>
<td>Field trip</td>
<td>Joint planning</td>
<td>Peer tutoring</td>
</tr>
<tr>
<td>Demonstration</td>
<td>Peer sharing</td>
<td>Hands on practice</td>
</tr>
<tr>
<td>Brain storming</td>
<td>Experimentation</td>
<td>Self learning</td>
</tr>
<tr>
<td>Multimedia presentation</td>
<td>Exploration</td>
<td>Debate</td>
</tr>
</tbody>
</table>

**Designing the IIID-MTM Framework:**

IIID-MTM framework consists of unit planning of methodology in teaching mathematics course that includes the instructional strategies to be followed by the teacher educator to transact the content and the student’s activity that contributes towards learning. It also contributes towards assessing the student’s ICT skill. The IIID-MTM framework that consists of the TNTEU syllabus, ICT components and planned strategies is given in Table 3.4. The materials to be prepared were noted down and the evidences to be collected were also identified for each unit.
Table 3.4 IID in methodology of teaching mathematics at secondary level - Framework

<table>
<thead>
<tr>
<th>C.No</th>
<th>Topic</th>
<th>Sub topic</th>
<th>ICT Component</th>
<th>Teaching activity (Strategy)</th>
<th>Learning activity (Strategy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Content</td>
<td>The syllabus for VI to X of Mathematics text books prescribed by the Text book of the Government of Tamil Nadu - time to time</td>
<td>Internet, Digital books, e-learning, downloading and saving book, online content</td>
<td>Demonstration on downloading resources Introducing the concept of Digital books, e-learning,</td>
<td>Self study using downloaded or physical books, self study materials from <a href="http://www.meritnation.com/">http://www.meritnation.com/</a> and other sites</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Internet, CD/DVD, Pdf, word, PPT, Flash/Movie, on line article, blog, interactive material, images, e-learning resources, downloading and saving content from internet, types of resources, validation of the resources</td>
<td>Demonstration on the use of different resources available for teaching and learning of mathematics using UNESCO- ICT resource CD and explanation on choosing a resource</td>
<td>Collection of five type of resources from internet Preparation of booklets on formula and definition, geometry note, graph note</td>
</tr>
<tr>
<td>2</td>
<td>Nature, Characteristic and Development of Mathematics and Logical Sequence, structure, precision, abstractness, symbolism</td>
<td></td>
<td>LCD, Laptop, Power point, USB, Word, Pdf, internet, printer. meaning of mathematics in the digital word, downloading files, Tamil typing tools, translation tool</td>
<td>Lecturing using a PPT covering the subtopic and the content on ‘Meaning of mathematics in the digital world’ Sharing notes through blog and</td>
<td>Preparing an album on &quot;Recent developments in Mathematics&quot; based on the internet resources</td>
</tr>
<tr>
<td>Mathematics Teacher</td>
<td>Mathematics as a science of measurement and quantification</td>
<td>Camera, mobile, tape recorder</td>
<td>as pdf file.</td>
<td>Group discussion</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------------------------------------------</td>
<td>-------------------------------</td>
<td>-------------</td>
<td>-----------------</td>
<td></td>
</tr>
<tr>
<td>Mathematics and its relationship with other disciplines</td>
<td>Video, audio recorder, camera, scanner, printer, photocopier, movie maker, USB, DVD/CD, computer, internet, mobile phone, blue tooth, format factory, antivirus, drivers, file formats, content sharing, knowledge management, converting files from one format to another, browsing, saving files from internet, maintaining folders, basic operations of computers</td>
<td>Video lesson by an expert on the subtopic using TV. Demonstration of using movie maker and exposing sample videos created using movie maker from you tube.</td>
<td>Making a movie on &quot;mathematics and its relationship with other disciplines&quot; Preparing album on &quot;Math in daily life&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Characteristics of a good mathematics teacher</td>
<td>Power point presentation, camera, video, video editing software</td>
<td>Video lesson by an expert on the subtopic. Introducing the concept on etiquettes of using ICT.</td>
<td>Seminar - I</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 3 | Aims And Objectives of Teaching Mathematics | The need and significance of teaching Mathematics | LCD, laptop, power point, USB, video, internet, emergence of ICT in teaching of mathematics | Explanation supported by a PPT covering the subtopic and the content ‘Emerging of ICT in teaching of mathematics’ | Discussion on "Need for teaching of mathematics"

Aims - Practical, social, disciplinary and cultural | OHP projector, word, printer, pdf, camera, mobile, editing software | Lecture using OHP sheets | Assignment "Interview – Utility purpose of Mathematics" | 116 |
<p>| 4 | Teaching Skills | Instructional Objectives – General Instructional Objectives (G.IOs) and behavioural or Specific Learning Outcomes (S.L.Os) relating to the cognitive, affective and psychomotor domains based on Bloom's Taxonomy of Educational Objectives | LCD, laptop, power point, USB, internet, browsing and download, pdf, printer, taxonomy for use of ICT, NCF 2005, Teaching of Mathematics- focus paper | Presentation on Revised Bloom's Taxonomy by Anderson, explanation and practice on writing objectives supported with downloaded study materials | Downloading from internet - NCF 2005 and position paper and discuss the objectives of teaching mathematics at different levels |
| 4 | Teaching Skills | Micro teaching – origin, need, procedure, cycle of operation and uses | PPT, printer, PPT formats | Presentation on the subtopic supported with printed notes (PPT printed as notes) | |
| 4 | Teaching Skills | skill emphasis - explaining, questioning, Probing and fluency in questioning, using black board, reinforcement, stimulus variation, introduction, closure-Link lesson | Mobile, video, bluetooth, DVD/CD, computer, video sharing, audio recorder, digital camera, video editing, Format factory, PPT, PDF, file formats, etiquette | Explanation of the subtopic with PPT followed by demonstration. Introducing the concept file format during recording by students and editing tools during peer sharing. | Self learning using the recorded videos on micro teaching. Practicing the skills with video recording done. Discussion based on the feedback on recorded video/audio files in mobile |
| 4 | Teaching Skills | | | | Preparation of micro teaching file |</p>
<table>
<thead>
<tr>
<th>5</th>
<th>Lesson planning and its uses</th>
<th>Macro teaching</th>
<th>Explanation</th>
<th>Preparation of unit plan, year plan using word</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lesson plan and unit plan &amp; year plan</td>
<td>Power point, word</td>
<td>Explanation using power point on subtopic and scanned copy of the model year plan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Herbartian steps</td>
<td>OHP, printer</td>
<td>Presentation on the concept using OHP sheet (Modeling)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Format of a typical lesson plan - teaching aids – G.I.O's &amp; S.I.O's. teaching aids - motivation, presentation, application, recapitulation and assignment</td>
<td>LCD, laptop, power point, USB, instructional designing, ICT integrated lesson plan, instructional strategies, internet, use of ICT to develop lesson plans and teaching materials</td>
<td>Explanation of model lesson plan in word doc Browsing and explaining different lesson plans from internet. Explanation on the topics Instructional designing, ICT integrated lesson plan and instructional strategies using PPT</td>
</tr>
<tr>
<td></td>
<td>Psychological Theories and factors influencing the Learning</td>
<td>Psychology of learning Mathematics - Gagne’s types of learning, the ideas of Piaget and Bruner – appropriateness</td>
<td>Pdf, internet, psychological theories related to the use of ICT in education, Learning theories that supports the</td>
<td>Writing a model lesson plan and submitting it in the form of word doc Identifying sites for lesson planning Preparation of at least five lesson plans using ICT tools and practice during internship Preparation of lesson plan file</td>
</tr>
</tbody>
</table>

118
<table>
<thead>
<tr>
<th>of Mathematics</th>
<th>of these types in learning mathematics.</th>
<th>use of ICT</th>
<th>support the use of ICT’ Sharing notes in pdf format.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychological aspects – interest, attention</td>
<td>Demonstration the Potentials of ICT using simulation and GSP</td>
<td>Seminar – I</td>
<td></td>
</tr>
<tr>
<td>Formation of mathematical concepts</td>
<td>Mind map tool</td>
<td>Demonstration on the use of mind map tool (Edraw)</td>
<td>Seminar – I</td>
</tr>
<tr>
<td>Factors influencing the learning of Mathematics - motivation, maturation, perception, special abilities, attitude and aptitude</td>
<td></td>
<td>Seminar - I</td>
<td></td>
</tr>
<tr>
<td>Divergent thinking in Mathematics – creative thinking in Mathematics.</td>
<td></td>
<td>Seminar –I</td>
<td></td>
</tr>
<tr>
<td>Identification of Individual differences</td>
<td>Individual differences in mathematics</td>
<td>Learning management tool</td>
<td>Explanation on the use of ICT for remedial teaching tool</td>
</tr>
<tr>
<td>8</td>
<td>Methods and Teaching Aids</td>
<td>Inductive, deductive, analytic, synthetic, heuristic, project, problem solving and laboratory methods of teaching mathematics</td>
<td>DVD, applets, Games, GSP, Geogebra, Mathematics 4.0, Tablet, math lab kit</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------</td>
<td>-------------------------------------------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>activity based learning (ABL), active learning method (ALM), applications of ABL and ALM-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Simulation software, virtual laboratory tools, ICT integrated lab, cloud computing</td>
<td></td>
</tr>
<tr>
<td>Problem</td>
<td>Action</td>
<td>Discussion</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>--------</td>
<td>------------</td>
<td></td>
</tr>
<tr>
<td>Format of a typical lesson plan based on ALM - Introduction, Evacuation, Recall, Survey - Understanding: Concept, teacher and individual solving problems - Group work, Presentation - Evaluation: Reinforcement, Homework, Remedial measures</td>
<td>Computer assisted instruction, e-learning, mobile learning</td>
<td>CAI/CAL</td>
<td></td>
</tr>
<tr>
<td>Sharing the scanned copy of ALM-Lesson plan format and allocation of topics for lesson plan writing through mail</td>
<td>Seminar - II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sharing the scanned copy of ALM-Lesson plan format and allocation of topics for lesson plan writing through mail</td>
<td>Downloading the lesson plan from mail and writing a lesson plan in ALM format for the assigned topic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer assisted instruction, e-learning, mobile learning</td>
<td>Seminar on creating CAI package followed by hands on practice</td>
<td>Seminar – II Preparation of CAI package</td>
<td></td>
</tr>
<tr>
<td>Importance of teaching aids – projected and non-projected aids – improvised aids : Paper folding and paper cutting etc.</td>
<td>Workshop on preparing teaching aids. Demonstration on various ways of using ICT tools as a teaching aid. Demonstration on applet, games, GSP, Geogebra, Mathematics 4.0, Math lab kit. Introducing the social,</td>
<td>Seminar -II Preparation of Improved teaching aids and Preparation of overhead transparencies Preparation of GSP sketches for the lessons taken during internship with</td>
<td></td>
</tr>
<tr>
<td>LCD, OHP, movie maker, software packages, snipping tool, team viewer, Power point, Laptop, USB, Computer peripherals , various methods of adopting ICT for teaching and learning, National and international recommendation , internet, use of ICT in teaching and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Criteria for selection of appropriate teaching aids</td>
<td>Word, excel, rubrics, Validation of ICT tools</td>
<td>Demonstration on web analysis using the format in word. Introducing the content ‘validation of ICT tools’</td>
<td>Preparing a web analysis document by analyzing 3 websites. Seminar – II</td>
</tr>
<tr>
<td>Use of mass media in teaching mathematics</td>
<td>Decision making, evaluating, basic concepts of ICT</td>
<td>Introducing the content ‘Importance of decision making and criteria to be considered’ using the UNESCO module.</td>
<td>Online learning using UNESCO module and getting certified. Seminar – II</td>
</tr>
<tr>
<td>Field trip as a teaching technique</td>
<td>Virtual tour</td>
<td>Arranging for a field trip</td>
<td>Seminar – II</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>construction of achievement test</td>
<td>Word, equation editor, typing tool, translation tool, pdf, hot potatoes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous and comprehensive evaluation - Formative assessment - Grading pattern</td>
<td>Camera, mobile</td>
<td>Presentation on writing questions. Introducing the concept of online assessment and tools for assessment. Demonstration on creating question paper using word and software hot potato</td>
<td>Test construction – (Hands on experience) preparation of question paper in word to be used during internship Preparation mcq booklet and question paper using hot potato</td>
</tr>
<tr>
<td>Statistical measures- mean, median, mode, range, average deviation,</td>
<td>Excel, statistical tools</td>
<td>Seminar by a school practitioner</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Analysis of Textbooks</td>
<td>Analysis of content available in Mathematics textbooks of IX to XII standards prescribed by Government of Tamil Nadu.</td>
<td>Concept of digital textbooks and interactive books, internet, pdf, file formats, mobile, accessing books through mobiles, Aldiko (sample tool) File format compatibility, Word</td>
</tr>
</tbody>
</table>

**Internship** – Out of 20 lesson plans during internship, 5 lessons are expected to be ICT infused lesson plans based on which the techno pedagogical competency in teaching mathematics is evaluated. Based on the activities listed in the framework, ICT skills are evaluated. Seminars were evaluated using Rubrics. IIID framework is given in Digital Appendix – 3.

(Note: Practicum based activities are marked in italics and bold)
Identifying the assessment strategies:

The rating scale to measure knowledge, attitude and confidence was planned to be used to assess the pre service teachers on the construct for which the tools are developed. Observation schedules were planned to be used to record the observation of ICT skills of pre-service teachers and the techno pedagogical competency in teaching mathematics. The indicators of the standards in the observation schedule and activities were planned to be mapped. And wherever it is not possible to find situation to assess an indicator, a simulated situation was planned to be created. The student log was planned to be maintained by all pre service teachers and anecdotal record by the teacher educator that could contribute to evaluate the student.

3.5 PHASE III – DEVELOP

This phase consists of development of the tools, intervention, assessment techniques and the materials required for implementing the intervention. This phase plays a very important role as the development and validation takes place. The investigator has provided due importance to this stage.

3.5.1 Development of Tools

In experimental studies, two things are important - the nature of the sample and the measurement of desirable behavioral changes in the sample because of treatment. In order to measure these changes valid tools are required. The tools used in this study are given in Table.3.5.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Variable</th>
<th>Type of tool</th>
<th>Developer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Confidence in using ICT</td>
<td>Rating scale</td>
<td>Developed by the Investigator</td>
</tr>
<tr>
<td>2</td>
<td>Knowledge on ICT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Attitude towards ICT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>ICT skills</td>
<td>Observation schedule</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Techno pedagogical competency in teaching mathematics</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The process followed in tool development is given in Figure 3.6.
1. Identifying the dimensions:

The tool is designed to measure a particular construct. Before constructing the tool, the dimensions of the construct need to be identified, so that the items can be constructed such that it measures all the attributes of the construct.

2. Construction of test items:

Identifying or constructing items relevant to measure each dimension of the construct is the main step in tool development. Items should be constructed keeping the end users in mind. An exhaustive list of test item is made related to each dimension and forms a pool of test items. The test items are arranged in the required order for a better understanding.

3. Establishing the validity:

The validity of an instrument is the extent to which it measures what it is supposed to measure. Face validity can be established during the construction of the test items. In evaluating a psychological test, there is particular concern with construct validity and criterion validity. Construct validity is the degree to which the instrument measures the theoretical variable or construct that it was intended to measure. It can be assessed by expert panel review. Sampling validity ensures that the measure covers the broad range of areas within the
concept under study. Not everything can be covered, so items need to be sampled from all of the domains. This may need to be completed using a panel of “experts” to ensure that the content area is adequately sampled (Colin and Wren, 2006).

Content validity is defined as the extension to which a measurement reflects the specific intended domain of content. Content validity is established through item analysis where item difficulty index and discriminative power are calculated. In this study only discriminative power is calculated as difficulty level is not applicable to these tools. It was carried out based on the guidelines of Ebel and Frisbie. The total scores are arranged in descending order and the upper twenty seven percent of the subjects (27%) and the lower twenty seven percent of the subjects (27%) are taken as the upper and the lower group respectively. This is called as extreme group method. Paired t test is applied to find whether each item differentiate between the upper and lower. The item that does not differentiate is rejected or taken for modification.

4. Establishing the reliability:

The reliability of a measure is the extent to which it is unaffected by random influences. Two types of reliability are usually identified: temporal stability (or test-retest reliability) and internal consistency. Temporal stability is estimated by correlating scores obtained on two separate occasions from the same group of people while internal consistency is indicated by the degree of inter-correlation between the items of which the measure is comprised. Both types of reliability are expressed in terms of a correlation coefficient.

The most widely used indicator of internal consistency is the alpha coefficient (Cronbach, 1951) which is, in effect, the average of correlations that are computed between the scores on two halves of the instrument when the full set of items is split in half in every possible way. Nunnally’s (1976) criterion of acceptable internal consistency is an alpha coefficient of 0.7 or above.

5. Translation of the tool

Based on investigators’ past experience with the pre-service teachers of that locale, translating the tools to the mother tongue i.e., Tamil was felt to be a
necessary work. The tool for knowledge and skill had technical terms, that if translated may be difficult for learners to understand. So the competency tools were not translated.

6. Standardization of translated tool

Validity and reliability of the translated tool can be established in the same way as it was established for the original tool. This makes the translated tool validated.

7. Finalisation of the tool:

The final list of items that crosses the content validation and the process of rejection based on item analysis form the final tool. The final tool comprises of the test items, instructions for administering the tool, instruction for scoring and interpretation.

3.5.1.1 ICT Confidence Scale

ICT confidence refers to student teachers’ perception of their own confidence in handling ICT operations, managing to use ICT for teaching and learning and solving the issues during the use. Confidence also encompasses creating trust, safety and security in the use of ICT. This tool aims at measuring the level of confidence of the pre-service teachers in using ICT for teaching and learning. It is a 5 point Likert Scale.

Development of tool:

1. Identification of dimensions:

   Confidence in using ICT includes handling ICT tools and resources, managing the use of ICT to learn and teach, and solving the issues rising during the use of ICT.

2. Construction of test items:

   Investigator constructed 20 items to measure the confidence in using ICT. After self review, the investigator eliminated 5 items. The remaining 15 items were pooled together to form Draft-1 of the rating scale. Instruction for filling the rating scale was also included in the draft. The five point rating was given
as below and the respondent should rate themselves by encircling the respective score.

- No confidence – 0
- Very less confidence – 1
- Less confidence – 2
- Confident – 3
- Highly confident - 4

3. Validity and Reliability:

Draft – 1 was given to 6 experts for item validation. These experts include professors, Associate professors and Assistant professors in the field of Education. Based on the recommendations by the experts, 5 questions were eliminated. Remaining 10 questions were retained with suggested corrections. After making necessary corrections, the Draft – 2 was redesigned. Thus the construct and sampling validity was established.

Item Analysis:

Draft – 2 was administered to 120 pre-service teachers as a try out. After rejecting 5 incomplete ones, data of 115 pre-service teachers was considered for item analysis. Item analysis was done by extreme group method. The total scores were arranged in ascending order and 27 % (i.e., 31) of the upper score and 27% of the lower scores were considered. To establish discriminating power of the item, paired t test was applied between the upper scores and lower scores. Test item with significance value greater than 0.05 has to be rejected. Since all the items values falls below 0.05, all the items were accepted. So, all the 10 items were retained. Thus content validity was established.

Establishing Reliability:

To establish reliability, Cronbach’s alpha was also found. The reliability coefficient was found to be 0.799.

4. Translation of the Tool:

The tool was translated to the mother tongue Tamil for the reader’s convenience and Draft-1 was prepared.
5. Validity and Reliability:

The translated tool was given for technical review to the experts. These experts include Associate professor and Assistant professor in English and Tamil. Based the recommendations, the tool was modified and incorporated in Draft – 2. Thus construct and sampling validity was established.

Item Analysis:

Draft – 2 was administered to 115 pre-service teachers as a try out. As all 115 scales were filled completely, entire was considered for item analysis. The total scores were arranged in ascending order and 27% (i.e., 31) of the upper score and 27% of the lower scores were considered. To establish discriminating power of the item, paired t test was applied between the upper scores and lower scores. Test item with significance value greater than 0.05 has to be rejected. Since all the items values falls below 0.05, all the items were accepted. So, all the 10 items were retained. Thus content validity was established.

Establishing Reliability:

To establish reliability, Cronbach’s alpha was also found. The reliability coefficient was found to be 0.787.

6. Scoring and Interpretation:

The scoring and interpretation was also included in Draft – 2. Confidence of the learner is scored as follows:

- No confidence – 0
- Very less confidence – 1
- Less confidence – 2
- Confidence – 3
- High confidence – 4

The cumulative score for all the items is considered as ICT confidence score.

7. Finalisation of the Tool:

The tools were finalized in both English and Tamil. The final tool has 10 items. This tool will help to identify the level of confidence of a pre-service
teacher to use ICT in teaching and learning mathematics. The final English tool is given in Appendix – 1 and Tamil tool in Appendix - 2.

3.5.1.2 ICT Competency

The term “competency” stands for a desirable quality or behaviour, or, rather, what a person will be able to do after a period of instruction or training – a performance indicator as it is sometimes called. The accepted level of this desirable quality/competency will be referred to as “standards” (UNESCO, 2003). A competency is a set of attributes covering knowledge, skill and attitude for enabling one to effectively perform the activities of a given occupation or a function to the standard expected in employment. The four main groups of competencies are content and pedagogy, technical issues, social issues, collaborating and networking (UNESCO, 2005).

The investigator reviewed the following ICT standards recommended at National and International level. Investigator could not find any evidence of the competency standards recommended at national level in India. Only the National Policy on Information and Communication Technology for School Education was evident with respect to ICT in Education. The following standards were reviewed and formed the basis for developing the tools.

- ICT Competency Standards for Teacher by UNESCO
- National Educational Technology Standards for Teachers by ISTE
- ICT Competencies by ICT Professional Development Services (ICT – PD)
- National ICT Competency Standards (NICS) for Teacher by Commission on Information and Communication Technology
- ICT Competency Standards for Rwanda Teachers
- DepEd ICT Competency for teachers
- NC Technology Competencies
- UNI Preservice Teacher Technology Competencies

As per UNESCO, competency was considered to be a single attribute with three dimensions: knowledge that is related with cognitive domain, attitude that
is related with affective domain and skill that is related with psychomotor domain. So investigator developed 3 tools related with this variable.

- ICT Attitude Scale to measure the Attitude dimension.
- Knowledge on ICT rating scale to measure Knowledge dimension.
- ICT skill Observation schedule to measure Skill dimension.

### 3.5.1.3 ICT Attitude Scale

Attitude towards ICT refers to positive or negative evaluation of the capabilities of ICT use in teaching learning process, skill of using ICT and social aspects related to use of ICT in education.

#### Development of tool:

1. Identification of dimensions:

   Attitude towards technical aspect of handling ICT, pedagogical usability of ICT, social and ethical aspects related to ICT and professional use of ICT constitutes the attitude towards ICT.

2. Construction of test items:

   Investigator constructed 30 items. The constructed items were pooled together to form Draft-1 of the rating scale. Instruction for filling the rating scale was also included in the draft.

3. Validity and Reliability:

   Draft – 1 was given to 5 experts for item validation. These experts include professors, Associate professors and Assistant professors in the field of Education. Based on the recommendations by the experts, 10 questions were eliminated. Remaining 20 questions were retained with suggested corrections. After making necessary corrections, the Draft – 2 was redesigned.

#### Item analysis:

Draft – 2 was administered to 100 pre-service teachers as a try out and all the data was considered for item analysis. The total scores were arranged in ascending order and 27 % (i.e., 31) of the upper score and 27% of the lower scores were considered. To establish discriminating power of the item, paired t
test was applied between the upper scores and lower scores. Test item with significance value greater than 0.05 has to be rejected. Out of 20 items, 17 are significant as the values falls below 0.05 and they are accepted. Three items have t values that are not significant. When the item was analyzed, it was related to time factor, ethical and social factor. Due to the importance and necessity of that item, these items were also considered for the final tool.

Establishing Reliability:

The tool was administered to a representative sample of 100 pre-service teachers. Cronbach’s alpha is measured to find the internal consistency of the tool. Alpha value was found to be 0.821 which is an accepted value. This proves the tool to be reliable.

4. Translation of the Tool:

The tool was translated to the mother tongue Tamil for the reader’s convenience and Draft-1 was prepared.

5. Validity and Reliability:

The translated tool was given for technical review to the experts. These experts include Associate professor and Assistant professor in English and Tamil. Based the recommendations, the tool was modified and incorporated in Draft – 2. Thus construct and sampling validity was established.

Item analysis:

Draft – 2 was administered to 100 pre-service teachers as a try out and all the data was considered for item analysis. The total scores were arranged in ascending order and 27 % (i.e., 31) of the upper score and 27% of the lower scores were considered. To establish discriminating power of the item, paired t test was applied between the upper scores and lower scores. Test item with significance value greater than .05 has to be rejected. Out of 20 items, 17 are significant as the values falls below 0.05 and they are accepted. Three items have t values that are not significant. When the three items were analysed, it was related to time factor, ethical and social factor. Due to the importance and necessity of that item, these items were also considered for the final tool.
Establishing Reliability:

The tool was administered to a representative sample of 100 pre-service teachers. Cronbach’s alpha is measured to find the internal consistency of the tool. Alpha value was found to be .842 which is an accepted value. This proves the tool to be reliable.

6. Scoring and Interpretation:

   The scoring and interpretation was also included in Draft – 2.

   1, 2, 3, 6, 7, 9, 10, 12, 17, 18 – Favourable items. Take scores as it is.

   4, 5, 11, 13, 14, 15, 16, 19, 20 – Unfavourable items. Replace the scores as follows: 1 as 5; 2 as 4; 3 as 3; 4 as 2; 5 as 1.

7. Finalisation of the Tool:

The tools were finalized in both English and Tamil. Number of items in the final tool was 20 items and this tool will help to identify the pre-service teacher attitude towards ICT. The final English tool is given in Appendix – 3 and Tamil tool in Appendix - 4.

3.5.1.4 ICT Knowledge Scale

Knowledge on ICT refers to the level of knowledge pre-service teacher have about ICT concepts and its use in teaching and learning. According to UNESCO (2005), the ICT competencies are organized into four groups. Pedagogy is focused on teachers’ instructional practices and knowledge of the curriculum and requires that they develop applications within their disciplines that make effective use of ICTs to support and extend teaching and learning. Collaboration and Networking acknowledges that the communicative potential of ICTs to extend learning beyond the classroom walls and the implications for teachers development of new knowledge and skills. Technology brings with it new rights and responsibilities, including equitable access to technology resources, care for individual health, and respect for intellectual property included within the Social Issues aspect of ICT competence. Finally, Technical Issues is an aspect of the lifelong learning theme through which teachers update skills with hardware and software as new generations of technology emerge.
This tool is a five point Likert rating which aims at measuring the knowledge of the pre service teachers on ICT.

**Development of tool:**

1. Identification of dimensions:

   The dimensions of knowledge on ICT are Basic computer operations and issues, Application software, Internet Resources, ICT peripheral, and ICT in teaching learning process. These dimensions were selected based on the research studies and recommendations given by UNESCO on knowledge part. This tool was planned to be administered at the starting of the academic year to understand the entry level of the pre-service teachers. It also contributes to the planning of activities.

2. Construction of items:

   Items were framed by the investigator in reference with the existing tools used by several researchers during their study. Investigator consolidated the list of items selected from other sources and constructed by self. The distribution of the items is shown below in Table 3.11.

3. Validity and Reliability:

   Draft – 1 was subjected to experts’ scrutiny. Based on the opinion, criticism and suggestions obtained from the experts the items were rejected, accepted and modified. Thus the construct and sampling validity was established. Draft 2 was prepared with modifications and the dimension-wise distribution is given in Table 3.6.

**Table 3.6: Distribution of Items constructed for ICT knowledge scale**

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Initial No of Items</th>
<th>Final No of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic computer operations and issues</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Application software</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Internet Resources</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>ICT peripheral</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>ICT in teaching learning process</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>45</td>
</tr>
</tbody>
</table>
Item analysis:

Draft –1 was administered to 120 pre-service teachers as a try out and all the data was considered for item analysis. The total scores were arranged in ascending order and 27 % (i.e., 32) of the upper score and 27% of the lower scores were considered. To establish discriminating power of the item, paired t test was applied between the upper scores and lower scores. Test item with significance value greater than 0.05 has to be rejected. Since all the items values falls below 0.05, all the items were accepted. So, all the 45 items were retained. Thus content validity was established.

Reliability:

To establish reliability, cronbach’s alpha was also found. The reliability coefficient was found to be 0.938 which shows that the tool is highly reliable.

4. Scoring:

0 - Not aware of the components
1 – Aware of the components
2 – Familiar with the use of the components
3 – Knowledgeable about the components
4 – Highly knowledgeable about the components

5. Finalisation of the Tool:

The tools were finalized and the number of items in the final tool is same as it is shown in Fig.3.8. This tool will help to identify the level of knowledge pre-service teacher has have ICT and its use. The final tool is given in Appendix 5.

3.5.1.5 Observation Schedule for ICT skills

ICT skill refers to skills of pre-service teachers in using ICT. This tool is developed to observe the performance skill for the student teachers in using ICT during the intervention. As standards were available at National and International level, investigator analysed all the standards mentioned earlier. National ICT Competency Standards (NICS) for Teacher developed by Commission on Information and Communication Technology mostly suits the
Indian context. So investigator selected NICS for this study. The NICS is given in Digital Appendix –4. The structure of NICS standard is shown in Fig.3.7.

**Fig 3.7: Schematic Representation of the Structure of NICS**

The four main areas represent the domains of competency followed by standards. Each standard is described by a set of indicators and the number of indicator per standard is mentioned in the Fig 3.9. Investigator developed an observation schedule based on NICS. It is a five point Likert rating scale used to measure the ICT skill of pre service teachers’. The development of this tool is explained below.

**Development of tool:**

1. Identification of dimensions:

   Investigator considered the four domains suggested by UNESCO as the dimensions. That is, Technology, Pedagogy, Social and Networking and Collaboration. The dimensions are renamed as per NICS standard as technology operations and concepts, social and ethical, pedagogical and professional.
2. Construction of the tool:

The domains of NICS were mapped with the domains of competency stated by UNESCO. The investigator consulted with 5 experts about NICS. After a thorough analysis of the standards and the indicators, experts approved NICS for conversion to a rating scale. Then the indicators were converted to a 5 point rating scale. On approval from the experts Draft – 1 was prepared. Instruction for filling the rating scale was also included in the draft.

3. Validity and Reliability:

The items in Draft – 1 were once again gone through by 5 experts for suitability of language and the technical words. As the items were of simple language and the technical terms suited the context there was no change made in Draft -1. Thus construct and sampling validity was established.

Item analysis:

Draft –1 was administered to 50 pre-service teachers as a try out and all the data was considered for item analysis. The total scores were arranged in ascending order and 27 % (i.e., 14) of the upper score and 27% of the lower scores were considered. To establish discriminating power of the item, paired t test was applied between the upper scores and lower scores. Test item with significance value greater than 0.05 has to be rejected. Since all the items values falls below 0.05, all the items were accepted. So, all the 76 items were retained. Thus content validity was established.

Establishing Reliability:

To establish internal consistency, cronbach’s alpha was also found. The reliability coefficient was found to be .986 that shows the tool to be highly reliable. The tool was used by three teacher educators to observe 5 pre service teachers and the inter rater reliability was found to be 0.90 which is highly reliable. Inter rater reliability is a measure of reliability used to assess the degree to which different judges or raters agree in their assessment decisions. Inter-rater reliability is useful because human observers will not necessarily interpret answers the same way; raters may disagree as to how well certain
responses or material demonstrate knowledge of the construct or skill being assessed.

4. Scoring:
   
   0 - Don’t know
   1 - Know very little and not able to perform
   2 – Perform only with guidance
   3 – Perform with some guidance
   4 – Perform independently

5. Finalisation of the Tool:

   The tools were finalized and the number of items in the final tool is same as it is shown in Fig.3.6. The final tool has 76 items where 39 is to measure skill towards technology operations and issues, 17 for social and ethical, 12 for pedagogical and 9 for professional domains. This tool will help to identify the pre service teachers’ level of ICT skill. The final tool is given in Appendix 6.

3.5.1.6 Observation Schedule for Techno Pedagogical Competency in Teaching Mathematics

Techno pedagogical competency refers to the pre-service teachers’ competency in infusing ICT in teaching of mathematics. This tool was developed to observe the techno pedagogical skills of the student teachers practiced during their internship. This tool address technological and pedagogical skill required for teaching mathematics. It is a five point Likert rating. The development of this tool is explained below.

Development of tool:

1. Identification of dimensions:

   The two major dimensions are lesson design and lesson implementation. The sub skills required for each of this dimension were considered to frame the items in the observation schedule. Due focus was given to the skills required for teaching of mathematics

2. Construction of the tool:
The main skills to be observed during teaching practice and the indicators of the main skills were areas. The items cover a wide range of competence in teaching of mathematics like listing objectives in the lesson plan, resource selection, preparation and validation, planning instructional activities and learning activities, planning assessment techniques, transactional skills, classroom management and ICT infusion competency. Totally there were 20 areas in which the competence need to be assessed and the indicators of each area were listed in the guidelines. Draft 1 was prepared taking this 20 main competency.

3. Validity:

The items in Draft – 1 were evaluated by a group of teacher educators and modification was made according to the suggestions. Expert validation was done.

4. Scoring:

1 – Not competent
2 – Very less competent
3 – Less competent
4 – Competent
5 – Highly competent

5. Finalisation of the Tool:

The final tool contains 20 main areas of competency which reflects the techno pedagogical competency in teaching of mathematics. The final tool is given in Appendix – 7 and the guidelines are given in Appendix - 8.

3.5.2 Development of ICT Infused Instructional Design in Methodology of Teaching Mathematics (IIID-MTM)

Development of IIID involves developing and validating the resources required for transaction of IIID and the evaluation technique. Only when the resources are developed appropriately, it can be used effectively. Considerable importance was given to level of the student teachers, cultural background, language competency and objectives of this design while developing the
materials. Development of the material was followed by a try out and validation of the materials.

3.5.2.1 Development of materials

Based on the IIID-MTM framework, the materials to be developed were listed. The materials required for IIID-MTM were collected, developed and downloaded. The materials were developed following the development cycle as shown in Figure 3.8.

Figure 3.8: IIID-MTM Resources Development Cycle

The developed resources were shared with the experts and practitioner for content validation. Based on their feedback, modifications were made. The list of resources is as follows:

1. Free resources (interacts, simulations, applets, games etc) downloaded from internet (E.g.: Meritnation) on the mathematics content covered in class 6 to 10 according to Tamil Nadu syllabus to be used as samples.

2. Sample resources collected through demo disc from:
   - Meta Learn –Flash module on fraction, virtual trip to a saloon cash counter, games on percentage, fraction and basic statistics
Interactive video skill builder for elementary and intermediate algebra by Brooks/Cole, a division of Thomson Learning

Cambridge Hitachi – Multi e-math strand, Multi e-math toolbox, Mathematics dictionary

3. Tamil Nadu Digital Textbooks for mathematics from class 6 to 10 in pdf format

4. UNESCO resources on the following
   - Directory of ICT resource for teaching and learning of science, mathematics and language
   - E-learning series on ICT in Education - Module on ICT essentials and decision making
   - Web tools for educators
   - Multimedia resources
   - Free software for windows

5. Power point presentation covering the following subtopics:
   - Meaning, characteristics and definition of Mathematics
   - Logical Sequence, structure, precision, abstractness, symbolism
   - Meaning of mathematics in the digital world

6. Video lesson by an expert covering the following subtopics:
   - Need and importance of mathematics
   - Mathematics and its relationship with other disciplines
   - Characteristics of a good mathematics teacher

7. Notes in pdf format and in blog covering the following subtopics:
   - Meaning, characteristics and definition of Mathematics
   - Logical Sequence, structure, precision, abstractness, symbolism
   - Mathematics as a science of measurement and quantification
   - Mathematics and its relationship with other disciplines

8. Sample movies on Mathematicians and Mathematics in Nature done using movie maker downloaded from YouTube and TeacherTube

9. Power point presentation covering an introduction about the contributions of eminent mathematicians.
10. List of web address of web pages and blogs on the topic ‘Mathematicians’.

11. Self learning material and video on plagiarism downloaded from internet.

12. Power point presentation covering:
   ✓ The need and significance of teaching Mathematics
   ✓ Emergence of ICT in teaching of mathematics

13. OHP sheets on aims of teaching mathematics and the same content in word document

14. Power point presentation covering:
   ✓ Blooms taxonomy
   ✓ Taxonomy for use of ICT.

15. NCF 2005 and position paper on teaching of mathematics downloaded from internet

16. Resources related to Bloom’s taxonomy downloaded from internet:
   ✓ Verb list
   ✓ Poster
   ✓ Self study materials
   ✓ Planning sheet
   ✓ Worksheet

17. Sample micro teaching recorded videos

18. Power point presentation on Lesson plan and unit plan

19. Scanned copy of year plan and unit plan

20. OHP sheets on Herbertian steps and the same content in word document

21. Model lesson plan in word document

22. Power point presentation on instructional designing and instructional strategies

23. Power point presentation covering the following:
   ✓ Gagne’s types of learning
   ✓ Piaget – appropriateness in learning mathematics.
   ✓ Bruner – appropriateness learning mathematics.
24. Notes in pdf format covering:
   - Gagne’s types of learning
   - Piaget – appropriateness in learning mathematics.
   - Bruner – appropriateness learning mathematics.

25. Video on ICT integrated math lab

26. Video of real mathematics classroom conducted by school teachers

27. Video on ABL and ALM – Concept and real mathematics classroom session

28. Scanned copy of ALM lesson plan for mathematics

29. Software downloaded from internet or borrowed from others:
   - Mathematics related software
     i. Geogebra
     ii. Mathematics 4.0
     iii. Virtual math lab
     iv. Tux math
     v. Propriety software Geometer’s Sketch Pad (GSP) borrowed from Key Curriculum Press
   - Equation editor to be used to type maths equations and symbols
   - Aldiko to be used in mobile phone for reading epub format files
   - Tux paint to create the background for power point and other teaching resources
   - Hot potato to create online question papers
   - Kyplot for analysis of test scores
   - Movie maker for creating a movie
   - Format factory to convert the file formats according to the requirement
   - Editing tools to edit video and audio
   - Edraw for creating concept map and mind map
   - Analyse –it trial version to be used with excel from analysis purpose
✓ Alaghzi software for typing in Tamil
✓ Free antivirus to be installed in laptops and computers for security
✓ Snipping tool to select content and images from scanned files and pdf files
✓ Acrobat reader for editing pdf files
✓ iSpring trial version for converting PPT to flash
✓ Team viewer for monitoring the learning of GSP and to teach GSP online
✓ CCE tool

30. Web analysis format in word
31. Digital books in different formats
32. Sample concept map created using edraw
33. Sample question paper created using hot potatoes
34. Power point presentation on types of test and writing questions
35. Sample question created using hotpotato
36. Sample interactive textbooks (E.g.: http://www.mathigon.org/)
37. Power point presentation on digital books
38. Text book review format in word

3.5.2.2 Pilot Study and Integration of Feedback:

The developed activities based on the IIID-MTM framework was tried out in Christian College of Education, Perambalur to study the feasibility, time taken and other difficulties faced during implementation. Few components which were not feasible during pilot study due to constrain in the institution, were tried in other colleges to understand the issue. Based on the pilot study, certain materials were prepared in Tamil and once again implemented to check the feasibility. Improvements were done based on feedback of the pilot study and finalized to be used for experimentation. The resources used for this study are given in the Digital Appendix - 5 in the attached DVD.
### 3.5.2.3 Development of Observation Technique

ICT skill of pre-service teachers was planned to be assessed based on the indicators in the observation schedule for ICT skills. So each indicator was mapped to the planned activities as given in Table 3.7.

**Table 3.7: Mapping of learning activities and indicators on observation schedule**

<table>
<thead>
<tr>
<th>C.No</th>
<th>Topic</th>
<th>Learning experience</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Content</td>
<td>Self study using downloaded or physical books, self study materials from <a href="http://www.meritnation.com/">http://www.meritnation.com/</a> and other sites</td>
<td>1.4 – 1 to 3, 1.3 – 6, 4.1 -1, 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Collection of five type of resources from internet, Preparation of booklets on formula and definition, geometry note, graph note</td>
<td>1.3 – 6, 1.4 – 1 to 3, 2.1 – 1 to 3, 4.1 -1, 4</td>
</tr>
<tr>
<td>2</td>
<td>Nature, Characteristics and Development of Mathematics and Mathematics Teacher</td>
<td>Preparing an album on &quot;Recent developments in Mathematics&quot; based on the internet resources</td>
<td>1.4 – 1 to 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Making a movie on &quot;mathematics and its relationship with other disciplines&quot; Preparing album on &quot;Math in daily life&quot;</td>
<td>1.1– 1 to 10, 1.2 - 11 to 16, 1.3– 1 to 7, 1.4 – 1 to 5, 2.1 – 1 to 3, 2.2 – 2 to 5, 2.3 – 1 to 5, 2.4 – 3, 3.2 – 1,2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seminar - 1</td>
<td>1.2 – 7 to 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Self learning with the document and video on plagiarism.</td>
<td>4.2 – 2, 2.1 – 1 to 3, 2.2 – 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Preparing album on mathematicians and history of symbols.</td>
<td>1.4 – 1 to 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Self learning by using video to use 'word'.</td>
<td>4.2 – 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assignment on ‘Contribution of Mathematicians’ submitted as word doc and created as a blog.</td>
<td>1.2 – 1 to 3, 1.3 – 1 to3, 1.4 – 1 to 5, 2.2 – 1, 2</td>
</tr>
<tr>
<td>3</td>
<td>Aims And Objectives of</td>
<td>Discussion on &quot;Need for teaching of mathematics&quot;</td>
<td>3.1 – 2</td>
</tr>
<tr>
<td>Teaching Mathematics</td>
<td>Assignment &quot;Interview – Utility purpose of Mathematics&quot;</td>
<td>1.2 – 11 to 16</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>----------------------------------------------------------</td>
<td>----------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Downloading from internet - NCF 2005 and position paper and discuss the objectives of teaching mathematics at different levels</td>
<td>1.3 – 6</td>
<td></td>
</tr>
<tr>
<td>4 Teaching Skills</td>
<td>Self learning using the recorded videos on micro teaching. Practicing the skills with video recording done. Discussion based on the feedback on recorded video/ audio files in mobile</td>
<td>1.2 – 10 – 16 2.4 – 1 to 4 3.2 – 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Preparation of micro teaching file</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Lesson planning and its uses</td>
<td>Preparation of unit plan, year plan using word</td>
<td>1.2 – 1 to 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Writing a model lesson plan and submitting it in the form of word doc</td>
<td>2.3 – 1 to 5 2.4 – 1 to 4 2.2 – 1 to 4 3.1 – 1, 2 3.2 – 1, 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Identifying sites for lesson planning</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Preparation of at least five lesson plans using ICT tools and practice during internship</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Preparation of lesson plan file</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Psychological Theories and factors influencing the Learning of Mathematics</td>
<td>Seminar – I</td>
<td>1.2 – 7 to 10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Creating concept maps for the lessons taken during internship</td>
<td>3.1-1</td>
<td></td>
</tr>
<tr>
<td>7 Identification of Individual differences</td>
<td>Seminar – II</td>
<td>1.2 – 7 to 10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Group discussion and presentation based on the researches on ‘enrichment programmes for the gifted’ found in e-articles, e-journals and e-publications</td>
<td>1.3 – 1,2,6 1.4- 1 to 3</td>
<td></td>
</tr>
<tr>
<td>8 Methods and Teaching Aids</td>
<td>Preparation of game booklet</td>
<td>1.3 – 1,2,6 1.4- 1 to 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Downloading the lesson plan from mail and writing a lesson plan in ALM format for the assigned topic</td>
<td>1.3-3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Preparation of CAI package</td>
<td>1.2 – 7 to 16 1.3 – 3, 5 2.2- 4,5 2.3-1 to 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Preparation of Improvised teaching aids and Preparation of over head transparencies</td>
<td>2.2 – 1 to 5 2.4 – 1 to 4 3.1 – 1, 2</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Evaluation and Analysis of test scores</td>
<td>Conducting action research. Preparation of diagnostic report based on the test conducted during internship.</td>
<td>4.2 – 1, 4.3 – 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test construction – (Hands on experience) preparation of question paper in word to be used during internship Preparation mcq booklet and question paper using hot potato</td>
<td>1.7 – 1 to 3, 3.4 – 1, 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Preparation of test and measurement file using the software kyplot</td>
<td>1.2 – 4 to 6, 3.4 – 3, 3.6 – 2</td>
</tr>
<tr>
<td>10</td>
<td>Analysis of Textbooks</td>
<td>Critical analysis of content course of standard IX to XII syllabus</td>
<td>1.2 – 1- 3</td>
</tr>
</tbody>
</table>

The techno pedagogical competency was assessed based on the observation done during internship using the observation schedule for TPC-TM. Each component in the schedule was rated based on the guidelines. During internship, at least 3 ICT infused mathematics classes were planned to be observed for collecting data on techno pedagogical competency in teaching mathematics.

### 3.6 PHASE IV – IMPLEMENT

This phase focused on conducting the pre test for all the three groups, implementing the interventions for each group, observing the ICT skills during
intervention and techno pedagogical competencies in teaching mathematics during internship and conducting post test. Before the implementation, the study was explained to the principal, teacher educator and computer faculty of respective colleges and necessary permissions were obtained. In the implementation phase, there were three main stages:

- Administration of pre tests
- Intervention
- Administration of post tests

3.6.1 Administration of Pre Test

The developed tools to measure knowledge on ICT, confidence in using ICT and attitude towards ICT were administered during pre-test for all the three groups. The tools were distributed and the instructions were clearly stated before starting the pre test. After the test, the scoring was done and the pre test scores were calculated. By analysing the pre test scores it was found that the three groups are non equivalent groups.

The pre test scores in Knowledge on ICT, attitude towards ICT and confidence in using ICT were analysed by performing one-way ANOVA. The result revealed that there was a significant difference in the mean pre test scores in knowledge on ICT among the groups with F=21.181 at 0.05 level of significance. As there was significant difference among the groups, Post Hoc range Scheffe test was performed to do pair wise comparison. The test revealed that Group 2 differed from Group 1 as well as Group 3, but there was no significant difference between Group 1 and Group 3 in knowledge on ICT before the intervention.

A significant difference was found in the mean pre test scores in attitude towards ICT among the groups with F= 4.422 at 0.05 level of significance. The Post Hoc range Scheffe test result revealed that Group 3 does not differ from Group 1 and Group 2 whereas a significant difference was found in between Group 1 and Group 2 in attitude towards ICT before intervention. A significant difference was found in confidence in using ICT among the groups with
F=3.901 at 0.05 level of significance. The Post Hoc range Sidak test result revealed that Group 1 differed from Group 2 and Group 3 and also Group 2 from Group 3 in attitude towards ICT before intervention.

This shows that the groups are non equivalent groups.

3.6.2 Interventions

The treatments were implemented as per the plan. All the three groups were treated differently to observe the effectiveness of the treatment. The intervention for each group is detailed in the following paragraphs.

Bridge course:

All the students were provided with a laptop by the college management at the starting of the course. The bridge course was conducted for 15 hours i.e., 3 hours per day for 5 days as soon as the orientation was done by the college administration. The schedule of the bridge course is given in table 3.8

Table 3.8: Schedule of bridge course for group undergoing bridge course

<table>
<thead>
<tr>
<th>S.No</th>
<th>Nature of the course</th>
<th>Course title</th>
<th>Time duration</th>
<th>Handled by</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Workshop</td>
<td>Computer – Basic operation</td>
<td>1 hour</td>
<td>Computer faculty</td>
</tr>
<tr>
<td>2</td>
<td>Workshop</td>
<td>Word</td>
<td>1 hour</td>
<td>Computer faculty</td>
</tr>
<tr>
<td>3</td>
<td>Workshop</td>
<td>Excel</td>
<td>2 hours</td>
<td>Computer faculty</td>
</tr>
<tr>
<td>4</td>
<td>Workshop</td>
<td>Power Point Presentation</td>
<td>2 hours</td>
<td>Investigator</td>
</tr>
<tr>
<td>5</td>
<td>Seminar</td>
<td>Use of Interactive White Board in teaching of mathematics</td>
<td>1 hour</td>
<td>Investigator</td>
</tr>
<tr>
<td>6</td>
<td>Workshop</td>
<td>Internet</td>
<td>1 hour</td>
<td>Investigator</td>
</tr>
<tr>
<td>7</td>
<td>Seminar</td>
<td>Recent trends in Teacher Education – Role of ICT</td>
<td>1 hour</td>
<td>Investigator</td>
</tr>
<tr>
<td>8</td>
<td>Workshop</td>
<td>ICT tools in teaching of mathematics</td>
<td>2 hours</td>
<td>Investigator</td>
</tr>
<tr>
<td>9</td>
<td>Seminar</td>
<td>Use of internet in teaching of</td>
<td>1 hour</td>
<td>Investigator</td>
</tr>
</tbody>
</table>
After the bridge course, the investigator handled the methodology course throughout the academic year with the support of the course teacher for 180 hours. Use of ICT was not modeled by the investigator while handling the methodology course. A choice was given for the students to select ‘computer in education’ course as their elective paper. The activities which were planned for evaluation was executed and the observations were recorded in the observation schedule and sometime as anecdotes. A careful observation was made such that no other ICT related programmes happens during the intervention. The observation made by the teacher educator and the computer faculty were discussed for clarification and for the investigator to understand the process. During internship, pre service teachers’ skill techno-pedagogical competency in teaching mathematics was observed and recorded.

Enhancement programmes:

The enhancement programmes were conducted for 15 hours distributed across the course by using all the ICT facilities available in the college. The planned programmes were handled as given in the table 3.9

Table 3.9: Programme schedule for semi control group

<table>
<thead>
<tr>
<th>S.No</th>
<th>Type of Programme</th>
<th>Programme</th>
<th>Time duration</th>
<th>Handled by</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Workshop</td>
<td>Computer – Basic operation</td>
<td>1 hour</td>
<td>Computer faculty</td>
</tr>
<tr>
<td>2</td>
<td>Workshop</td>
<td>Word</td>
<td>1 hour</td>
<td>Computer faculty</td>
</tr>
<tr>
<td>3</td>
<td>Workshop</td>
<td>Excel</td>
<td>2 hours</td>
<td>Computer faculty</td>
</tr>
<tr>
<td>4</td>
<td>Workshop</td>
<td>Power Point</td>
<td>2 hours</td>
<td>Investigator</td>
</tr>
<tr>
<td>No.</td>
<td>Type</td>
<td>Title</td>
<td>Duration</td>
<td>Facilitator</td>
</tr>
<tr>
<td>-----</td>
<td>-----------</td>
<td>------------------------------------------------------------</td>
<td>----------</td>
<td>----------------------</td>
</tr>
<tr>
<td>5</td>
<td>Workshop</td>
<td>Interactive white board</td>
<td>1 hour</td>
<td>Mathematics faculty</td>
</tr>
<tr>
<td>6</td>
<td>Workshop</td>
<td>Internet</td>
<td>1 hour</td>
<td>Investigator</td>
</tr>
<tr>
<td>7</td>
<td>Seminar</td>
<td>Recent trends in Teacher Education – Role of ICT</td>
<td>1 hour</td>
<td>Investigator</td>
</tr>
<tr>
<td>8</td>
<td>Workshop</td>
<td>ICT tools in teaching of mathematics</td>
<td>2 hours</td>
<td>Investigator</td>
</tr>
<tr>
<td>9</td>
<td>Seminar</td>
<td>Use of internet in teaching of mathematics</td>
<td>1 hour</td>
<td>Investigator</td>
</tr>
<tr>
<td>10</td>
<td>Seminar</td>
<td>Application of MS office in Education</td>
<td>1 hour</td>
<td>Investigator</td>
</tr>
<tr>
<td>11</td>
<td>Seminar</td>
<td>ICT in teaching and learning of mathematics</td>
<td>1 hour</td>
<td>Investigator</td>
</tr>
<tr>
<td>12</td>
<td>Exposure</td>
<td>Teaching of mathematics through interactive board</td>
<td>1 hour</td>
<td>Practioner</td>
</tr>
</tbody>
</table>

The methodology course was handled by the teacher educator of that college itself due to the time constrain for the investigator to manage teaching between all the three colleges. The teacher educator is also qualified and experienced person to handle the classes. As he has completed doctoral degree it was easier to make him understand the nature of the group and intervention. The methodology course was conducted for 180 hours. It was made sure that the teacher educator is implementing the course as planned by the investigator. Frequent visits were made and also discussed over phone about the intervention. It was made sure the investigator visits the college twice in the week. The course teacher used power points on three topics namely Blooms taxonomy, inductive and deductive approaches in teaching mathematics, and analytic and synthetic approaches in teaching mathematics using laptop and LCD projector. These were downloaded directly from internet and not customized and contextualized. All type of resources like interactive board, software, hardware and applications were available in the educational
technology lab. Students of this group were encouraged to use the facilities available in the college and a time slot was provided to use educational technology lab to prepare teaching materials using ICT. A choice was given for the students to select ‘computer in education’ course as their elective paper. The observation made by the teacher educator and the computer faculty were discussed for clarification and for the investigator to understand the process. During internship, pre service teachers’ techno-pedagogical competency in teaching mathematics was observed and recorded. Most of the students from this group had opportunity to use ICT during internship as the schools had the facilities.

**ICT Infused Instructional Design (IIID) in methodology of teaching mathematics:**

ICT Infused Instructional Design in methodology of teaching mathematics was implemented as planned in the IIID-MTM framework using the respective resources. The methodology course was conducted for 180 hours along with the 10 hours allotted for computer literacy. The investigator modeled the use of ICT in education while transacting the course. Pre service teachers were given activities where they practice the ICT integration with the guidance of the investigator. The performance of the pre service teachers were carefully observed with the help of the teacher educator and the computer faculty. A choice was given for the students to select ‘computer in education’ course as their elective paper. It was made sure that no other ICT intervention takes place other than IIID-MTM. (A sample activity is discussed in Appendix – 9)

The students teachers belonging to all the three groups were instructed to maintain a log book to record their activities related to ICT. They also wrote about their experiences once they complete a task. During the intervention, the observation schedule on ICT skill was used to record the skills of student teacher in using ICT. It was done according to the planned techniques. The students of all the three colleges understand the internship at the same timing almost within the same set of schools. The regular observation was done by the
teacher educators of the college, whereas the ICT infused lesson were observed only by the investigator. Out of 20 lessons, 5 lessons were instructed to be ICT infused lessons. Out of 5 lessons, three were observed by the investigator and the techno pedagogical competency in teaching mathematics was rated in the observation schedule. All the output of the activities was maintained by the students for the purpose of practical exam. Students were also encouraged to use ICT infused lesson for their practical. It was also counted for rating their skill and techno-pedagogical competency.

3.6.3 Administration of Post Test

At the end of the intervention, the post test was administered to the pre-service teachers of all three colleges to test the dependent variables: knowledge on ICT, confidence in using ICT and attitude towards ICT. ICT skill and techno pedagogical competency in teaching mathematics were consolidated at the end of the intervention by all the three observers.

3.7 PHASE V - EVALUATE

Throughout the intervention formative evaluation was conducted and the feedback acted as impetus for the student teachers’ to reflect and learn. For example, Feedbacks provided during the seminar on power point presentations used by student teachers helped them in improving the technical as well as presentation skills. But the summative assessment gives as knowledge on what is the gain at the end. At this phase, firstly scoring was done based on the scoring instruction of each tool and the consolidated data was entered in an excel file.

Keeping in view the objectives, and the design of the study, different statistical techniques were employed to analyse the data. Investigator used the statistical software SPSS Version20 for analyzing the data. Descriptive statistics like mean, median and standard deviation were used wherever needed to describe the data. Inferential statistics like ANOVA, ANCOVA, paired t-test and sample t-test were employed to study the effectiveness of the independent
variable on the dependent variable. Regression analysis was used to study the
predictor of a dependent variable. The data is also described qualitatively based
on the observations made during intervention.

The details of the analysis carried out along with the findings and
discussion is presented in Chapter – IV