CHAPTER V

TRY OUT AND FINALISATION OF PROGRAMMED MATERIAL

After writing the entire programme in modern geometry for Std. IX, the next task before the investigator was to see analytically the programme from the view points of sequence and the coverage of the content. The second and major step was to try out the programmes on a small sample. The present chapter includes both the stages of research. Firstly, the investigator has discussed the analysis of the programme frames, view point of sequences and content, and secondly, the investigator has described the actual try out of the frames and finalisation of the programme frames.

5.1 Sequence of frames and programme characteristics

The modification of behaviour through instruction is usually brought about by many different, learning trials through the repetition of an increasingly more practice response in appropriate situations. Thus, the above stated 'learning traits' given at appropriate time, helps the learner to modify his behaviour.

In programmed learning, behaviour is modified through the entire sequences of frames. Different kinds of frame sequences are used for the purpose of behaviour modification.

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1. Taber, Glaser, Schaefer: Learning and Programmed Instruction; Addison-Wesley Reading, Massachusetts, New York: 1965, p. 119.
Hence frames were classified as (i) Introductory frame sequences (ii) Discrimination sequences (iii) Generalisation sequences, (iv) Concept formation sequences (v) Practice sequences, (vi) Terminal behaviour sequences.

The characteristics of the above stated sequences and occurrences in the present programme in 'Geometry' were as follows:

1. **Introductory Frame Sequences**

   They constitute the first building block of the programme. The student responds to them with that behaviour with which he is familiar. The purpose of introductory sequences was (a) to acquaint the learner with the way in which programme material has been written. (b) to provide a base upon which the further behaviour can be built.

   The introductory frames in the present programme were not used because the investigator thought that the introductory instruction in the beginning of each unit would serve the purpose.

2. **Discriminating Sequences**

   "The value of the discriminating sequences is that a learner remembers best what stands out most clearly in the subject matter context; what has been adequately discriminated".\(^2\)

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Therefore care should be taken to see that sufficient numbers of discrimination sequences are included in the programme.

In discrimination, appropriate responses must be elicited to appropriate stimulus. Simple response, already in repertoire was brought under the control of subtle stimulus. In present programme, for example (frame No. 5 and 6 unit one).

Programme : 1
Response : a triangle PQR

Just as union of three line segments sets \( AB, BC \) and \( CA \) is a triangle \( ABC \), the union of line segments sets \( PQ, QR \) and \( RF \) is also

The student must learn the response "a triangle PQR". The programme first made him respond to it more than once, aided first by formal prompts and then by thematic prompt. Following this, the programme discriminates it from "a triangle ABC". In general, the programme involved first establishing a response and then putting it under the discriminative control of an appropriate context. The operation was conducted some times simultaneously and sometimes sequentially. It could be interspread throughout the programme.

The illustrative sequences where the programmer wanted the response "Union of sets" to be brought under the control of the stimulus "\( A \cup B \cup C \)" and for this reason
response "Union of sets" was elicited in the presence of this stimulus.

Programme 1: In the language of set ΔPQR = PQR U QQR U
Frame No. 10: RRP, here the _____ of _____ of PQR, QQR
Response: and RRP is a ΔPQR.

Union of sets

Were the programme does not teach the definition of union of sets but teaches it as a symbolic way of representation of union of sets. Many illustrations of this type of frame sequences were observed in the present programmes.

3. Response differentiation Sequences:

In a sequence of frames, the response in one frame; prompts this response in the further frames. This is known as response differentiation sequences.

In programme 1, Frame No. 15, 17, 19 and 20 illustrate the response differentiation sequences. In the same programme the response differentiation sequences were used often.

4. Generalisation Sequences:

The term generalization refers to the fact that an individual trained to respond in a certain way to certain stimuli will also tend to respond in this way to similar stimuli.3

3. Ibid., p. 119.
The generalization is an important aspect of learning. Here, student learns to respond in the same way to similar stimuli. A rule or concept is only said to be well-learnt, not when he can recite it, but when the student can give examples of the rule. Thus identification of concepts involves discrimination and generalisation training. The student can define only after the stage of generalization he might have reached at. A generalization sequence starts and ends with the common properties of stimulus class-involved. The sequences were so arranged that the student would come to state and use the general concept by himself.

In the sequences, in the following examples taken from the programme - one - the definition of a triangle was generalised to facilitate the concept of "non collinear points" and "line segment".

<table>
<thead>
<tr>
<th>Programme : 1</th>
<th>If all the given points do not</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame : No. 1.</td>
<td>lie on a line, then these points</td>
</tr>
<tr>
<td>Response</td>
<td>are called ______ points.</td>
</tr>
<tr>
<td>(non collinear)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frame No. 2</th>
<th>Here the points, P, Q, and R, are</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response :</td>
<td>called ______ points.</td>
</tr>
<tr>
<td>(non collinear)</td>
<td></td>
</tr>
</tbody>
</table>
Frame No. 3  
\[ \overline{AB} \rightarrow \overline{BA} \]  
A line segment \( \overline{AB} \) is symbolically determined by the two end points \( A \) and \( B \).

Frame No. 4  
\[ \triangle ABC \]  
Three non collinear points \( A, B, \) and \( C \) symbolically determined the line segments \( \overline{AB}, \overline{BC}, \) and \( \overline{CA} \).

Frame No. 5  
The union set of three line segments \( \overline{AB}, \overline{BC}, \) and \( \overline{CA} \) is called a triangle. Here triangle ___ is formed.

Frame No. 6  
\( P, Q, R \) points.
non collinear \( \overline{PQ}, \overline{QR}, \overline{RP} \) \( \triangle \) The three line segments symbolically determined by these three points are ____ and _____. The union set of these three lines segments is called a __________.

Frame No. 7  
The union set of the three line segments determined by three non collinear points triangle is a __________.

It can be seen that, from the above stated sequence of frames, the behaviour requiring the definition of a triangle was shaped through the process of generalisation.
The definition of a triangle has three main elements, they are (1) Three non collinear points (2) three line segments (3) Union set. They were strengthened through stimulus response association frequently.

With the help of the frame No.2, 3, 4, 5, and 6 in programme one, the student is trained to respond in the same way to appropriate stimuli such as "non collinear", "line segments". In the seventh frame the student is required to define the term, which is generalized statement concept, all by himself. Similar other frames in the present programme are distributed wherever required. Examination of the chaining sequences are as follows.

5. Chaining sequence:

"Skilled or expert behaviours are frequently chains of previously learned responses, in which each member of the chain sets up the stimulus context for the following members of the chain."

A chaining sequence is a series of frames, which have been designed to establish a self sustained series of responses. It is a good instructional practice to begin the series with the end and work backwards which will be the first step in the sequence.

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4. Ibid., p. 122.
The chaining sequence used in the series from the programme is as follows:

Programme : 1 For a triangle XYZ, X, Y and Z are the
Frame No. 15 vertices of triangle XYZ.
Response :

Frame No. 16 For a triangle ABC, _____ and _____
Response the vertices of \( \Delta ABC \).
A, B, C

Frame No. 17 For a triangle PQR, PQ, QR and RP are the
Response sides of the \( \Delta PRQ \).

Frame No. 18 For a triangle XYZ, _____, _____ and _____
Response are the sides of \( \Delta XYZ \).
\( \overline{XY}, \overline{YZ}, \overline{ZX} \)

Frame No. 19 For a \( \Delta PQR \), \( \angle PQR \), \( \angle QRP \) and \( \angle RPQ \)
are the angles of the \( \Delta PRQ \).

Frame No. 20 For a triangle RST; _____, _____ and _____
Response : are three sides, whereas R, S and
\( \overline{RS}, \overline{ST}, \overline{TR} \) T are three _____ and \( \angle _____ \); \( \angle _____ \)
vertices and \( \angle _____ \) are the three angles of the
\( \overline{RST}, \overline{STR}, \overline{TRS} \) \( \Delta RST \).
Many examples of such chaining sequences are observed in the present programme. In the next paragraph concept formation sequences are discussed.

6. Concept Formation Sequences:

The formation of concept involves generalization within a class and discrimination between the class and other classes.

The concept of "included angle between the two sides of a triangle" and "opposite side of a given angle of a triangle" were taught by generalizing within a class and along with discriminative property of the classes.

The following series of frames, starting from Frame No. 29 to 33 in programme unit one, are the concept formation sequences.

Programme : 1

<table>
<thead>
<tr>
<th>Frame No. 29</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>In ( \triangle XYZ ), ( \angle Y ) is given. ( \overline{XZ} ) is the opposite side of it. If the ( \angle Z ) is given, then the opposite side of it is ( \overline{XY} ).</td>
<td></td>
</tr>
</tbody>
</table>

Frame No. 30

In $\triangle XYZ$, $\angle X$ is given, then the opposite side of it is ________

Response: ________

Frame No. 31

In $\triangle XYZ$, the included angle between the sides $\overline{XY}$ and $\overline{XZ}$ is $\angle X$. So the included angle between the sides $\overline{YX}$ and $\overline{YZ}$ is ________.

Response: ________

Frame No. 32

The side of a triangle, other than the sides of which a given angle is the included angle, is called the opposite side for the given angle.

Response: ________

Frame No. 33

In a triangle $\triangle XYZ$, the opposite angle of the side $\overline{XZ}$ is ________. $\angle Y$ is the included angle between the sides ________ and ________.

Response: ________

The first three frames from the sequences teaching, the concept "opposite side" of given angle, in a triangle and "included angle" between the sides of a triangle, show that a student discriminates the "included angle" and the "opposite side" in a triangle. In frame No. 32 and 33, the operant response, "opposite side" and "included angle" were asked from the students. The students read the definition and apply it to the example, which occurs simultaneously.
Here, after teaching the first concept, the second concept is taught with the help of the first concept learnt. The formation of concept is said to be established, if the student can find out the example from the other given data. To assess the conceptualization, Frame No. 34 is an example.

Programme : 1

In \( \triangle PQR \), the side \( PQ \) is given then the opposite angle of it is the included angle between \( QR \) and \( QF \).

If the student is successful in responding it can be said that he has successfully developed the concept of 'opposite side' and 'included angle', in a triangle.

7. Association:

Our learning is made possible by establishing the association with the proper stimuli. The stimulus 'S' associates with an individual response 'R' in such a way that occurrence of 'S' is followed by 'R'.

"Upon presentation of stimulus definable within narrow physical limits, and no other stimulus, makes a response". 6

The following is the example of the association behaviour displayed by a frame.

6. Ibid. p. 44.
Unit : 2

In a $\triangle PQR$, $\overline{FQ} \cong \overline{PR}$, sides $\overline{FQ}$ and $\overline{PR}$

Frame No. 1

Response :

$\therefore \triangle PQR$ is an isosceles triangle.

Congruent

Frame No. 2

If in $\triangle ABC$, $\overline{AB} \cong \overline{AC}$, then the $\triangle ABC$

is an _______ triangles.

8. **Multiple Discrimination**

In multiple discrimination or identification called by Gagne, the student makes several responses to equal number of responses, to differentiate two or more stimuli. Upon presentation of two or more potentially confusable stimuli makes an equal number of different responses which differentially identify these stimuli; and no other respond. The student can learn when associations of the individual S-R is previously established and if he can differentiate the responses. The conditions of instructional situation make the stimuli highly distinctive.

The following frames are examples of the behaviour "multiple discrimination" exhibited.

Unit: 2
Frame No. 11
In a \( \triangle PQR \), \( \angle Q = 90 \)°. \( \angle Q \) is a ___ angle, and side opposite to \( \angle Q \) is ___.
Response: Right, \( \overline{PR} \)

Frame No. 12
In a \( \triangle PQR \), \( \angle Q = 90 \)°. \( \triangle PQR \) is a right angled triangle, and side opposite to the right angle is called the hypotenuse.
Response:

Frame No. 13
In a \( \triangle ABC \), \( \angle B = 90 \)°.
Response:

The above frames exhibit the behaviour description, precondition of the learner and the conditions of instructional situations.

9. Principles:

To acquire 'principles' of 'rules' is the most common form of learning. Principle is the chain of two concepts, and it exhibits two links.

The act of using principles can be stated as follows. Upon presentation of situation containing stimuli classifiable as concept \(-a\), and instruction to produce concept \(-b\), performs the sequence \(-a-b\). The important condition for learning the
principle is that the concept which makes principle must be acquired previously, so the learning of the principle will be facilitated. The sequence in the programme is established, if one link is established, it becomes the occasion for another link. The frames devoted to the review can be used for two purposes.

Following is the example of such frame:

Unit: 5
Frame No. 20

A correspondence between two triangles (or a triangle and itself) is given, if two sides and the included angle of one triangle are congruent to the corresponding parts of the other triangle, then the given correspondence is a congruence.

Frame No. 25

For a given correspondence $ABC \rightarrow FQR$ between two triangles $ABC$ and $FQR$, if (i) $AB \cong FR$

(ii) $AC \cong FR$ and (iii) included $\angle A \cong \angle F$, then the correspondence is a congruence.

10. Strategies:

Individuals have their own strategies to solve the problems. The strategies are the mediating principles which do not appear in the performance of the task, but affect the
performance of the task. The behaviour description of
strategy is the chaining concepts. The concepts draw the
attention of the learner and make him to mediate responses.
Behaviour strategy is called for when the conditions of
instructional situation ensure availability of concepts and
encourages constructed responses. Thus, strategy can be
defined as in discovering content principles, applicable to
a series of novel situations, the student performs a mediating
sequence $a^* b^*$ in which $a^*$ is a class of concepts to be
selectively attended to, and $b^*$ is a class of sequences
intermediate to those required for completing the action.

Following is the example of the strategy.

Here, included angles are the concepts. To complete the
action, that angle $\angle B$ is the included angle between the
sides $\overline{BC}$ and $\overline{BA}$. Student mediates and his intermediate
action to apply the characteristics of included angle to the
$\angle B$ and $\angle C$ whichever fits, is selected as response.

5.2 Revision of the frames:

After writing the frames in sequential order, they were
revised. The first draft of the sequences was examined by the subject matter expert and the programme expert. They helped in finalising the programme for the first try out.

The programme expert examined the sequence of the programme with the behavioural objectives.

5.3 Initial try out of the frames:

Each frame was written on a paper sheet of 12 cm x 8 cm on one side of it, at the back of it, the correct answer was written. Initially six hundred and thirty five cards for seventeen units were prepared in the programme. Instruction cards were prepared for the experiment which covered the subject matter.

5.4 Pre-try out:

Taber, Glaser, Schaefer write, "This is very important stage, as at the heart of programme development are the data obtained on student performance".

"A programme works if the students can display the behaviour called for a succeeding step and can, at the end of the programme, perform the specified terminal behaviour. The will help student teachers the programmer what to do next."

In the beginning with the help of the three students, who had some background of the topic were selected, each

§. Ibid., p. 138.
frame was tried out. The students' comments and responses were the guides in revising the frame. Their comments were as follows:

"We don't understand what we have to write".
"We are not taught this before".
"To my mind, the answer cannot be what you say".
"Do the subsequent dashes require more than one sentence?"

Following are the examples of some of the questions which were revised and framed.

1. The union set of three line segments is a _______

   The students thought that they were taught the concept and were not able to respond it. "three line segments" stimulus did not prove to be so. The programmer noted that the term "three line segments determined by three non-collinear points" should be introduced. Three line segments are in the same line, then of course they cannot form a triangle.

2. In \( \triangle ABC \), (sides \( \overline{AB} \) and \( \overline{BC} \) are the parts of rays \( \overrightarrow{AB} \) and \( \overrightarrow{BC} \)) \( \triangle ABC \) is a union set of rays \( \overrightarrow{AB} \) and \( \overrightarrow{BC} \)

   \[ \overrightarrow{AB} \cup \overrightarrow{BC} = \ldots \]

   Here many students do not understand, how \( \triangle ABC \) is a union set of rays \( \overrightarrow{AB} \) and \( \overrightarrow{BC} \). For making this concept clear, the phrase "side \( \overline{AB} \) and \( \overline{BC} \) are the parts of rays \( \overrightarrow{AB} \) and \( \overrightarrow{BC} \)" was introduced in the frame. It is clear that \( \overrightarrow{AB} \subset \overrightarrow{AB} \) and
Ilk y aB8-C BC the ∠ABC of the triangle ABC is the union set of rays AB and BC.

The Programmer thought that as the ∠ABC did not prove to be the discriminative response and to make it discriminative response, a phrase, "Sides AB and BC are the parts of rays AB and BC," was introduced which was a discriminative stimulus for the student.

"You say that the answer is only one, but there can be more than one answer," etc., such comments were used to develop the first draft.

Then, all the frames were tried out on ten students. All the students were selected from one class of the same school on the basis of their scores in the last examination in Mathematics. They represented high, average and low ability groups in Mathematics. There were three students from high ability group, three students from average ability group and four students from low ability group.

Their co-operation was sought for in every zero period of their school time table and they used to sit with the programmer for 45 minutes on every week day.

The purpose of the Pre-try out was to find out the following things:

- Workability of frames i.e. to examine bad frames that did not teach.
- Workability of the sequences.
- Achievement in the programmed subject matter.
- Interest of the pupils in programmed learning.
- Time taken by each pupil for one unit.

Following are the examples that show how the frames were represented in programme of unit 2.

<table>
<thead>
<tr>
<th>Unit: 2</th>
<th>A B C</th>
<th>Points ______ and ______</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame No: 1</td>
<td>1 2 3</td>
<td>are given on the line segment AC</td>
</tr>
<tr>
<td>Response:</td>
<td>A, B, C</td>
<td></td>
</tr>
</tbody>
</table>

Frame No: 2
A set of given points on a line AC is
((A, B, C)). Three natural numbers 1, 2 and 3 corresponding to each of them are given.
The set of natural numbers given. The set of natural number given on a line AC is \{1, 2, 3\}.

Frame No: 3
Now if we associate point A with 1, B with 2 and C with ______ then this correspondence 3
is called one to one correspondence. And it is symbolically represented as A \rightarrow 1, B \leftarrow 2, C \rightarrow 3, we can read it, as A corresponds to 1, B corresponds to 2 and C corresponds to 3.

Frame No: 4
The correspondence between the elements of set
Response: \{A, B, C\} and set \{1, 2, 3\} is ______ one-one correspondence
Thus a set of given points on a line and a set of corresponding real numbers to them one - one has ______ correspondence

As the students failed to respond to the frame No. 5 frame No. 4 was introduced.

The frames and sequencing of the programme on the congruence of triangle.

Unit: 4

Frame No: 1 In $\triangle ABC$ and $\triangle PQR$ for a given correspondence $ABC \leftrightarrow PQR$ (i) $AB \cong PQ$ (ii) $BC \cong QR$ (iii) $CA \cong RP$, (iv) $\angle A \cong \angle P$, (v) $\angle B \cong \angle Q$ and (vi) $\angle C \cong \angle R$, then correspondence $ABC \leftrightarrow PQR$ is said to be congruent.

Response : $\triangle ABC \leftrightarrow \triangle PQR$ between $\triangle ABC$ and $\triangle PQR \angle A \cong \angle P$ and $\angle B \cong \angle Q$; $\angle C \cong \angle R$ and $BC \cong \ldots \cong RP$.

Frame No: 3 For a given correspondence between two triangles (or a triangle and itself). If all the pairs of corresponding sides are congruent and if all the pairs of corresponding angles are also congruent, then the given correspondence is _______.

Response : Congruence
Frame No : 4  For a given correspondence AEC\(\rightarrow\)PQR between triangles ABC and PQR, the corresponding side of AB is ____ and that of BC is ____.

Frame No : 5  For the given correspondence in frame No. 4 the corresponding angle of \(\angle A\) is ____ and that of angle \(\angle Q\) is ____.

Frame No : 6  If the congruent correspondence ABC\(\leftrightarrow\)XYZ is given between the two triangles ABC and XYZ, then the correspondence ABC\(\leftrightarrow\)XYZ will not be congruence.

The above frames teach conditions for the given correspondence to be congruence. Frames No. 3 and 5 were introduced to make the concept more clear.

The following were the instances when the learners asked for the help of the programmer. The programmer noted the difficulties, for further improvement in the programme on Unit 4.

1. Some of the learners could not answer correctly the frame No. 2 and 5.

2. They could not give the corresponding angle to a given angle of a \(\text{triangle}\).
3. They could not give the corresponding side to a
given side of a triangle.

The above mentioned points were some of the examples
which were considered at the time of second draft of the
programme.

The outcome of the first draft was the achievement on
the test. The result was 99% on the test. The test was
an objective test, and was designed to measure all the
previously laid down objectives. The test items were all
from the frames, either fill in the blank type 'or' multiple
choice type with only two distractors. The high result was
due to, easy test, so it was found necessary to add more
difficult test items.

Another outcome was the interest of the learners; which
was not measured by interest inventory, but measured through
the following observation of the behaviour of the learners.
(i) All the learners remained present during the try out
periods. (ii) They said that they liked programmed
learning. (iii) Some learners asked for all the programmes
for showing them to their parents. All the frames were
examined by the subject matter expert, who had helped to
finalise the programmes for the first try out.

To try out the frames, initially, they were written on
paper sheets, at the back of which the responses to the frames
were written.
Instruction cards were prepared for the theorems which were to be included in the programmes. The first draft was tried out on ten students of the IXth class of the same school. The students were of higher, average and low ability group in Mathematics. The initial try out helped to find out weak frames, workability of all the frames, students' interest and the time needed to complete the programme unit.

Following are the points which were considered when second draft was prepared.

Here, care was taken to give clear instruction in short sentences. The request words used were 'Friends, be careful', 'please write carefully', 'Answer peacefully'; 'please do not make haste', 'Read carefully the frames', etc. Students were asked to study the figures carefully.

In the frames of the programmes on theorems, the students have to study the figures carefully and have to write data to prove and the proof of the theorems. So the frames which were sequenced wrongly were resequenced with the addition of a new frame or frames to facilitate the learning.

Revision of the second draft of the programme by the expert, for the approval was made. The revised draft was again tried out with the three students, one with high ability, one with the low ability and one with the average ability in Mathematics.
5.5 Preparation of Programmes for field testing:

After this, the programme was prepared for field testing.
- The new draft has more frames.
- More frames with figure as thematic prompts.
- Rearranged sequences.
- The sequences were grouped under appropriate sub-topics.

They were as follows, and cyclostyled in seventeen units:

Unit 1: Triangle: Definition, vertices of triangle, sides and angles of triangle.

Unit 2: Types of triangles: Isosceles triangle, Equilateral triangle, scalene triangle, Equiangular triangle, Right angled triangle. Hypotenuse.

Unit 3: One-one correspondences, definition.

Unit 4: Congruence of triangle: Definition.

Unit 5: The congruence postulate.

Unit 6: A consequence of SAS postulate - Theorem 1 and 2.

Unit 7: Bisector of an angle, Definition, Theorem 3A, 3B.

Unit 8: Congruence Theorems: ASA Theorem 4, 5, and 6.

Unit 9: SSS Theorem: 7

Unit 10: Perpendicular lines: Theorem 8, 9A, 9B.

Unit 11: Inequalities in triangle.
Unit: 12  Linear pair of angles, Exterior angle, interior opposite angles in a triangle. Theorem 10, 11, 12, 13 and 14.

Unit: 13  Parallel lines: Definition Theorem 15, 16 and 17.

Unit: 14  Intercepts, A pair of alternative angles, A pair of corresponding angles, A pair of interior angles of one side of a given intercept. Theorem, 18, 19 and 20.

Unit: 15  The parallel lines postulate: Theorem: 21, 22, 23, 24 and 25.

Unit: 16  Measures of angles of a triangle Theorem 26 and 27.

Unit: 17  Some more theorems about triangle, Theorem 28 and 29.

Before cyclo-styling, the material was examined by the language expert, he added necessary commas, semi colons and full stops, over and above the language structure.

Subject matter expert had also examined the material.

The terminal objective tests were also reconstructed, where the items were not only of 'fill-in the blank type', and the 'multiple choice' with only two-distractors. But in the new tests, 'short-answer-questions' and the 'multiple choice-tests' with more than two distractors were included, and the questions were also on the application of knowledge i.e. on
transfer. The test was not broad spectrum test but narrowly focussed test comparable to teacher-made test.

5.6 Try out on a large sample:

One class of the IXth standard was chosen for field testing. The number of the students in the class was fifty. The purpose of the field testing was to improve the programmes and tests, hence the elaborate statistical calculations were not done.

The experiment was conducted by the investigator. The pre-tests were administered prior to each programmed unit, given for learning through the programme. The post-test was also administered after the students have completely gone through the programme. The post test had the different formats.

The results of the field testing are given below.

<table>
<thead>
<tr>
<th>Class</th>
<th>No. of students</th>
<th>Correct responses on the Test Test</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>IX</td>
<td>50</td>
<td>85 %</td>
<td>40 %</td>
<td>80 %</td>
<td>40 %</td>
</tr>
</tbody>
</table>

TABLE 5.1

No. of students, % of correct responses and % of scores on pre and post test

In the class

programmed units in percentage
Above results showed that 15 percent of the frames were to be improved, and the post tests revealed that it was still harder to do so. Total time spent was sixty-two periods i.e. 137.76 hours. This included the hours spent on pre-testing and post-testing.

5.7 Final version of the Programmes:

The frames which were not responded were reframed, resequenced. They are as follows:

Unit: 1 Frame No. 2 was introduced between the frame No. 1, and 3. In frame No. 2 figure of three non-collinear points was introduced to clarify the idea of three non-collinear points.

Unit: 2 Frame No. 3 was introduced to stress the idea of isosceles triangle.

Unit: 3 Newly introduced frame No. 3 seemed to be helpful to teach one-one correspondence. Instead of six different frames only one frame i.e. frame No. 11 was framed to give the six different one-one correspondences between the vertices of two different triangles.

Unit: 4 One difficult frame was omitted.

Unit: 5 Frame No. 17 was introduced to give the pictorial concept of the congruence postulate, i.e. SAS postulate. The sequence was strengthened by the frame No. 17 and four difficult frames were omitted.
Unit: 6
Frame No. 7, 8 and 9 were introduced, so give 'the data' and 'to prove'. These frames were very easy to answer, and very helpful for the concept of theorem No. 1. This sequence was very helpful to give the proof of the theorem. Five difficult frames were omitted.

Unit: 7
Frame No. 6 was introduced to give the clear idea of the intersection of two half plans 'H' and 'G' which was the interior part of the given angle \( \angle AOG \). One frame was taken out from between the frame No. 17 and 18. It had no effect on the responses of frame No. 18 and 19.

Unit: 8
Between frame No. 6 and 7 three figures of triangles were introduced to facilitate the responses of follow up frames. In this unit instruction to take rest was given, that helped the pupils to respond to the remaining frames without mistakes.

Unit: 9
Frames No. 2 and 3 were newly introduced for introductory sequence. In Frame No. 4 figs. 1, 2 and 3 were introduced to lay the stress upon the introductory frame sequences.
Unit: 10  Frame No. 1 was introduced to clarify the concept of right angle. Frames No. 4, 5 and 6 were newly introduced to give the generalization sequences. Seven difficult frames were omitted. Frame No. 3 in theorem \( \theta \) was introduced to facilitate the responses of the follow up frames.

Unit: 11  In this unit some difficult frames were dropped out and introductory sequences were strengthened. Students responded to the remaining frames correctly.

Unit: 12  In the beginning two frames defining the linear pair of angles were omitted and frames 3 and 4 were introduced to strengthen the generalization sequence. After finishing the theorem No. 10, students were requested to take rest for few minutes and again requested to proceed further so they were quite able to respond to the follow up frames correctly. Here the unit was divided into five parts.

Unit: 13  In this unit Frames No. 5, 6 and 7 were newly introduced for strengthening the concept formation sequence. This unit was also divided into three parts and students were requested to take rest for some time and then they were asked to proceed to the next part.
Her© the investigator merited that students responded to the follow-up frames correctly and with interest.

Unit 15 In Frame No. 1 and 2 figures were introduced to give the prompt. Frame No. 6 was introduced to generalize the concept of intercept of two co-planer lines. This unit was divided into three parts. Frames No. 35, 36 and 37 were newly introduced for strengthening the concept of alternate and vertically opposite angles. Two frames which were difficult to respond were omitted.

Unit 15 This unit was divided into five parts. Each part deals with one theorem. In part one two frames after Frame No. 5 were omitted. They were difficult to respond.

Unit 16 Frames No. 1 to 8 were newly introduced for generalization sequence. The generalization is an important aspect of learning. Here a student learns to respond in the same way to similar stimuli. The sequences were so arranged that the student would come to state and use the general concept by himself. In part two of this unit, figure of a ΔABC from frame No. 2 was omitted, as it was not required to make response easy.
Unit : 17  This is the last unit of the programme. In this unit the investigator had omitted three difficult frames and instead of them only frame No. 23 was introduced which was easy to respond. This had no effect on the sequence of the frames.

Thus the programmes were reconstructed by reframing the frames which had non-critical verbiage, non-critical art work and which had no prior strengthening.

The total frames in the programmes in the beginning were 705 which were finally reduced to 635 after try out and revision. Final production was printed. It contains seventeen programmes attached with tests. The programmes were ready to be used in the seven experimental schools in the IXth class. The next chapter deals with the actual experiment, carried out in seven schools.