CHAPTER VII

SUMMARY

INTRODUCTION

Educational system is a socially contrived system, which aims at enhancing the efficiency of social functioning. The core process that centres all activities in this system is the process of instruction. It is core for the reason that it is through this process of instruction individuals are initiated into the societal norms and thinking at a point of time. A little reflection on the other aspects of education, namely, curriculum construction, evaluation, administration, organization, management, etc., would reveal that they are only meant to be supportive to the core process of instruction.

The process of instruction refers to a series of events (instructional events) which can be controlled and manipulated to bring about desired behavioural changes in the learner. Defining the process technically, it is a process, whereby the environment of an individual (learner), who becomes a part of the environment, is deliberately manipulated to enable him to emit or engage in specified behaviours under specified conditions, or as responses to specified situations (Corey, 1967). What is essentially implied in the above definition is that the behaviours desired by those planning the instruction will be emitted

2 by the individual instructed as a response to the relevant situations - technically speaking to the learning conditions, which represent varied stimuli. Through his responses to these varied situations (environment), the individual learner would modify his behaviour, which constitutes learning. In such a context, the entire environment which includes the learner, the instructional planner or designer and the instructional medium would together constitute a complete system, namely, 'Instructional system', the working of which is geared towards one end, that is, improved learning on the part of the learner.

Persons concerned with educational system have been continuously proposing and adopting newer approaches and techniques for modifying instructional system, with a view to improving it in terms of its effectiveness and efficiency in achieving the desired instructional objectives. However, since middle of this century, the efforts have been more intensified in subjecting instructional system to greater scientific scrutiny, to understand the different aspects of it, and to systematise it further. The motive behind such efforts have always been enhancement of learning on the part of the individual learner. One such effort is the application of the principles of 'Systems Approach' to instruction.

Systems approach represents a set of procedures whereby a ~~ax~~ thorough analysis of the different parts of a system and their functions could be undertaken with a view to reorganize the system for its further improvement, Systems

approach to instruction would be viewing the process of instruction in all its aspects, specifying the output requirement in measurable terms, selecting appropriate inputs from the available alternative inputs, organizing the selected inputs for the effective realization of the output specifications, experimentally assessing the effectiveness of instruction and the validity of the different inputs, and making successive revisions for cumulative improvement. The outcomes of such a systematic and scientffic way of looking at instruction would be knowledge about the various inputs of the instructional system and their operation, which would contribute towards the systematisation of the instructional process. Systematisation of instruction would be in terms of designing, carrying out and evaluating the total process of instruction and bringing about more effective instruction through the optimal use of the findings of research in human learning and communication, and combination of human and material resources, and also through the coordinated functioning of the different components (parts) of the system working towards common goals.

In India, a few efforts have been made to systematise instruction at different levels of education. A review of these studies indicate positive trends in the achievement of instructional objectives to a larger extent through systematisation of instruction. In the light of the studies conducted in this area, and as a step further in the trend of systematisation incorporating some of the methodological

4 issues raised by the earlier studies, the present investigation has been undertaken with a view to developing a duly validated multimedia instructional strategy for teaching a course in science at secondary school level.

THE PRESENT STUDY

The present investigation, namely, 'Development of multimedia instructional strategy for teaching science (Biology) at secondary school level' was part of the institutional project undertaken at Centre of Advanced Study in Education (CASE), M.S.University of Baroda, Baroda. The project was an attempt towards developing duly validated multimedia instructional strategy for teaching the course 'General Science' of Gujarat Board Syllabus to students of Std. VIII. At this level, the course in science comprised of three parts, viz., Physics, Chemistry and Biology. For the present investigation, only Biology formed the content matter. Physics and Chemistry were taken up by another investigator working for her doctoral degree.

SIGNIFICANT ASPECTS OF THE STUDY

The present investigation has been an attempt towards systematisation of instructional process in science at secondary school stage. Systematisation has been attempted by developing a multimedia instructional strategy. The strategy being conceived of various components (methods and media), all identified and selected keeping in view the instructional objectives to be achieved, the potentialities

of these components in achieving the delineated instructional objectives, structure of the content, learner's characteristics and certain pragmatic considerations relating to feasibility of the components. The selected components have been validated for their effectiveness in terms of the achievement of the specified instructional objectives. Thus, it is a carefully planned and designed instructional system rather than a congregation of a few methods and media.

In the investigation, with science as the content matter having greater potential for developing affect attributes, a possibility was noticed to develop in students certain affect attributes such as curiosity, open-mindedness, etc. (components of scientific attitude). An aspect of significance is the attempt that has been made to develop scientific attitude in students through the strategy, and study empirically the extent of its development.

The third aspect which is of significance is the attempt made in the investigation to study the feasibility of the strategy in terms of time and cost required for regularising the developed instructional strategy.

Yet another significant aspect is the attempt that has been made in the investigation to develop alternative instructional components for teaching the same content and studying their effectiveness. This attempt in the investigation is of methodological significance, as it tries to demonstrate how developmental type of studies and strict laboratory type of studies should go hand in hand.

6 Besides, the study has a few more aspects which are significant from the point of view of science as the content matter. They have been highlighted below.

It may be recalled from what has been presented in the beginning that the present study was one part of the institutional project. The course considered for the project was VIII std. General Science, which comprised of Physics, Chemistry and Biology. As mentioned already, Physics and Chemistry were dealt by another researcher, and Biology by the investigator of the present study. Both the studies were tried out on the same group of students. This facilitated the aspect of bringing in integration among the three parts. An attempt has been made in the present study to link certain concepts of Biology with that of Physics and Chemistry and teach them in an integrated manner. This is another significant aspect of the study.

Yet another feature of the study is the attempt that has been made to enable the students imbibe the fact that science is not a finished product, but a process in itself of man's search for truth. This has been attempted through the strategy by exposing the students to literature related to historical development of man's thinking and experimentation through the ages to arrive at principles and concepts in science.

One more significant aspect of the study is the attempt made to relate scientific principles and concepts with the daily life situations. The objective has been to

7 bring home to students how science operates within their own physical and social environment. In the study, attempts have been made to achieve this objective through the utilization of resources available in the community and citing examples of scientific principles and concepts operating in their daily life.

The study had the following objectives in view:

1. To develop a duly validated multimedia instructional strategy for teaching the course Biology at VIII std. level.

2. To study the relationship between students' achievement and their intelligence.

3. To study the feasibility of the strategy in terms of (a) time and (b) cost.

4. To develop alternative instructional components for teaching a few concepts and studying their relative effectiveness.

Specific details related to how each of the above objectives have been studied in the investigation are presented below, objectivewise.

OBJECTIVE 1: To Develop a Duly Validated Multimedia Instructional Strategy for Teaching the Course Biology at VIII Std. Level

This objective included two aspects, viz., development of the instructional strategy and validation of the

8 same for its effectiveness. The developmental aspect included analysis of the course content, specification of the terminal behaviours, identification and sequencing of appropriate instructional components, development of learning experience (software) to be presented through the various components, and initial tryout and revision of the materials. The strategy has been validated in terms of students' performance on unit tests and comprehensive tests devised by the investigator, and the annual examination conducted by the school authorities, students' gain on scientific attitude test (pre-test to post-test), and also through their reactions towards individual components of the strategy and the strategy as a whole.

As a first step in developing instructional material, task analysis was carried out for the entire Biology course. This task analysis yielded 7 logically sequenced units. Flow charts were developed for the entire course content as well as for individual units to establish adequate sequencing of the concepts. An attempt was made to identify certain teaching points appropriate for integrating Biology with Physics and Chemistry. Besides the 7 units thus arrived at, an introductory unit was also developed with a view to bringing home to students the importance of studying science, and also orienting them as to how they would be studying it through the developed strategy. As a next step, terminal behaviours were specified for each unit and corresponding criterion tests were developed. Considering the terminal behaviours to be achieved, learner's -

characteristics, nature of the content, availability and feasibility of the media, different instructional components were identified for teaching the different units. The instructional strategy comprised of the following components: (1) Introduction by the teacher; (2) PLM and Deviated PLM; (3) Lecture method; (4) Team teaching; (5) Inquiry technique; (6) Pupil activities and teacher demonstrations; (7) Discussion sessions; (8) Audio-visual presentations; (9) Historical background of scientists and scientific inventions; (10) Summaries; (11) Criterion tests and feedback; and (12) Exercises and Assignments. In one of the units, viz., 'Unit IV', for a few concepts alternative instructional components were identified. The alternative instructional components identified were of two types of PLM, viz., PLM developed on the principles of inductive reasoning and deductive reasoning. The software material to be presented through the various instructional components of the strategy were developed following scientific procedures. The titles of the different units dealt through the strategy are presented below.

Unit 1: Importance of studying science.

Unit 2: Structure of a cell and its constituents.

Unit 3: Autotrophic Nutrition.

Unit 4: Heterotrophic Nutrition.

Unit 5: Transportation and circulation.

Unit 6: Respiration and production of energy.

Unit 7: Excretion.

Unit 8: Water economy.

10 The initial tryout was done during the year 1976-77 on a group of 45 VIII std. students belonging to an English medium school, viz., Shreyas Vidyalaya, Baroda. During this period, developed software material in a few units for the components such as PLM, Deviated PLM, Audio-visual presentations, etc., were administered to assess language suitability, smooth flow of the content matter and for feasibility aspects. Along with these, with regard to the other components too, e.g., discussion, team teaching, lecture method, etc., tryout was done to ascertain how these components would function without introducing major changes in the actual classroom situations. In the light of the experience gained, the software material for different components were suitably modified and made ready for the final tryout.

Besides the development of software, necessary tools were developed for measurement purposes. Details pertaining to them have been presented below.

Achievement Tests: Two types of achievement tests have been utilized in the investigation for measuring students' achievement through the strategy. One, unit tests and comprehensive tests developed by the investigator; and two, an annual examination conducted by the school authorities for promoting the students to the next standard. In all, 7 unit tests were developed for units 2 to 8. As the first unit was only an orientation unit, no unit test was developed for that. Besides the unit tests, two comprehensive tests

were developed; comprehensive test-I covered units 2, 3, 4 and 5, and comprehensive test-II, units 6, 7 and 8. All the unit tests and comprehensive tests included items related to instructional objectives knowledge, understanding, and application. Only unit tests 6 and 7 and the two comprehensive tests contained items related to the objective skill. As regards the annual examination, the question paper was developed by the regular school teacher in consultation with the investigator. It included contents of the units 2, 3, 4 and 5.

Scientific Attitude Test: Since no standardized test (standardized on an Indian sample) for measuring scientific attitude was available, a test for the same was developed. The test comprised of 8 components, viz., (a) empiricism; (b) curiosity; (c) freedom from bias; (d) open-mindedness; (e) criticality; (f) intellectual honesty; (g) seeking evidence; and (h) observation, with three items under each. Cronbach's alfa reliability value for the test ranges from 0.536 to 0.764. The test has been examined for its logical validity.

Reaction Questionnaire: Students' reactions towards working of the individual components of the strategy and the strategy were obtained through unstructured interviews and a reaction questionnaire. The developed reaction questionnaire comprised of both open-ended and closed type of questions.

For validating the strategy in terms of students'

12 achievement, four groups of VIII std. students from Shreyas Vidyalaya, Baroda, were utilized. Of the four groups utilized, two groups belonged to the year 1977-78, and the other two groups to the year 1978-79. The strategy was implemented on a group of 45 students belonging to the year 1978-79. In all, 90 students were admitted to VIII std. that year. As per the requirements of the experimentation, the total of 90 students were divided into 2 matched groups of 45 students each. Matching was done in terms of mean and S.D. The variable considered for matching was students' previous achievement on science in their VII std. One group was randomly assigned to experimentation. This group is referred to as experimental group. The other group not exposed to the strategy is referred as control group 1. Control group 1 and two more control groups - control group 2 and control group 3 each of 45 and 47 students respectively - of the preceding year (1977-78) have been utilized for validating the strategy in terms of students' performance on achievement tests. The sample utilized for validating the strategy in terms of gain on scientific attitude constituted of students belonging to the experimental and the control group 1. As regards validation of the strategy in terms of students' reactions, only experimental group has been utilized, since it was the ~~x~~ only group that was exposed to the strategy.

The instructional strategy developed through the initial tryout was implemented on the experimental group in the year 1978-79. Implementation began with the first unit,

13 viz., Importance of studying science. This was followed by rest of the units in the order shown earlier. Due to certain organizational constraints, by the close of the academic year, only 4 units (units 2, 3, 4 and 5) were covered. The rest of the units (units 6, 7 and 8) were administered in the beginning of the subsequent academic year (1979-80) to the same batch of students, that is, when they were in IX std. It may be noted that teaching of science course for IX std. for this group started only after these units were taught. At appropriate points in the course of experimentation, tests such as unit tests, comprehensive tests and scientific attitude test were administered. Students' reactions towards working of the individual components of the strategy and the strategy as a whole were obtained through interviews and a reaction questionnaire. At the end of the academic year 1978-79, the school authorities conducted the annual examination for promoting the students to the next standard. The test paper for this examination was set by the regular school teacher in consultation with the investigator.

Excepting unit tests, comprehensive test-II and reaction questionnaire, all the other tests were administered to the control group 1 also. As regards administration of comprehensive test-I to control groups 2 and 3, it was administered at the close of the academic year 1977-78. It may be mentioned that all the three control groups were taught by the regular school teachers.

Following data were collected during experimentation

14 for studying the first objective of the study:

- achievement scores of experimental group students on unit tests and comprehensive tests.
- achievement scores of all the three control groups students (control groups 1, 2 and 3) on comprehensive test-I.
- achievement scores of experimental and control group 1 students on the annual examination conducted by the school authorities.
- pre-test and post-test scores of experimental and control group 1 students on scientific attitude test.
- experimental group's students' reactions towards individual components of the strategy and the strategy as a whole.

The data collected for studying the objective were analysed using both descriptive as well as inferential statistical techniques. Percentiles, mean and S.D. have been used to study the distributions of students' performance on unit tests and comprehensive tests. Students' performance on these tests have been analysed in terms of individual categories of objectives, viz., knowledge, understanding, application and skill, and all combined together. For comparing the performance of experimental group's students with that of the control groups (control groups 1, 2 and 3),

15 Student's 't' test has been used.

As regards analysis of students' performance on scientific attitude test, Student's 't' test has been used for finding out (1) significant difference between means of pre-test and post-test scores of experimental and control group 1 students separately, and (2) for comparing means of pre-test and post-test scores of experimental group students with that of control group 1.

Students' reactions obtained through interviews and reaction questionnaire were analysed for their content, and were categorised on the basis of the themes expressed. For each item, the number of students expressing a particular theme were pooled. The pooled number (frequency) thus arrived at were further converted into percentage.

The instructional strategy has been found effective to the extent that 70 per cent of the experimental group students have obtained 60 per cent and above on all the unit tests and comprehensive tests. It is worth mentioning that at least 30 per cent of the students have obtained a score of 75 per cent on all the tests, which is generally considered as distinction marks. About 50 per cent, 60 per cent, 40 per cent and 20 per cent of the students have secured 60 per cent and above as regards instructional objectives knowledge, understanding, application and skill respectively, on all unit tests and comprehensove tests.

The developed strategy has been found effective in

16 enabling students of experimental group to perform significantly superior in comparison to (a) students of all the three control groups on comprehensive test-I and (b) students of the control group 1 on the annual examination conducted by the school authorities.

So far as the effectiveness of the strategy in terms of developing scientific attitude is concerned, the strategy has been found effective in developing scientific attitude in the experimental group students to a significant extent in comparison to the control group 1 students.

As far as the effeftiveness of the strategy in terms of students' reactions, excepting the component team teaching, for all other components 70 per cent of the students have shown a positive reaction. Further, the strategy's appeal to the students is evident from the fact that they opted to learn IX std. science through such a strategy.

OBJECTIVE 2: To Study the Relationship Between Students' Achievement and their Intelligence

This objective included two aspects, viz., studying the relationship between students' achievement and their intelligence, and also studying how the experimental group students belonging to different levels of intelligence have performed on criterion tests. Data pertaining to students' intelligence were obtained through the utilization of an intelligence test. The first aspect of the objective has been studied through correlation, and the second through

17 finding out the significant difference in the mean achievement of students belonging to different levels of intelligence.

Dr.Madhukar Patel's Intelligence Test (MPIT) has been used to measure intelligence of students. It is a non-verbal test of intelligence, and has been standardized for 14* age group students in the schools of Gujarat. The reliability of the test varies between 0.82 and 0.97. Concurrent validity coefficient for the test ranges from 0.65 to 0.80.

The sample utilized for studying this objective constituted of all the 4 groups of students, namely, experimental, control group 1, control group 2 and control group 3, referred under objective 1.

Data in respect of students' intelligence were obtained by administering the MPIT on all the 4 groups of students. To experimental and control group 1, it was administered at the end of the academic year 1978-79. So far as control groups 2 and 3 are concerned, they were administered the test at the end of the academic year 1977-78.

As regards students' achievement, two sets of scores obtained during validation phase of the strategy have been utilized. They are (a) experimental group students combined comprehensive test scores (scores of comprehensive test-I and comprehensive test-II combined together), and (b) scores of experimental and all the three control groups on

18 comprehensive test-I.

Relationship between experimental group students' performance through the strategy (combined comprehensive test score) and their intelligence has been studied through Pearsons Product Moment Correlation.

The students of the experimental group were divided into three groups, viz., high, middle and low intelligence groups. Their corresponding scores on comprehensive test-I and combined comprehensive test were separated out. As the experimental group was categorized into high, middle and low intelligence groups, the students belonging to the control groups also were categorized into high, middle and low intelligence groups. Their corresponding scores on comprehensive test-I were separated out. The significant difference in the mean achievement of experimental group students belonging to the three levels of intelligence through the strategy has been studied using the statistical technique ANOVA. Similarly, the significant difference in the mean achievement of students belonging to experimental and control groups 1, 2 and 3, at each level of intelligence on comprehensive test-I have been studied using the statistical technique ANOVA.

In the investigation, a positive and significant correlation between experimental group students' achievement through the strategy and their intelligence has been found. The strategy has differential effect on students' achievement within the experimental group, and it has

19 influenced the achievement of students belonging to high, middle and low groups of intelligence consistently.

OBJECTIVE 3: To Study the Feasibility of the Strategy in Terms of (a) Time and (b) Cost

For realizing this objective, a detailed account of time and cost involved during the implementation of the strategy was maintained, from which the feasibility of the strategy in terms of time and cost were discerned.

During implementation of the strategy, data in respect of the time required to administer the learning material for each of the unit in the course along with the tests was maintained in terms of number of class periods utilized. As regards cost, from the learning material and tests developed during the implementation of the strategy, the total number of stencils and other stationery required for duplicating them were calculated. Details in respect of labour charges for stencil cutting and duplicating the learning material and tests, stationery required etc., were also obtained.

Feasibility of the Strategy in Terms of Time:

A total of 10 periods would be required as extra in addition to the 60 regular periods prescribed by the State Department of Education, Gujarat, to regularise the strategy in a school. When this total of 10 periods is spread over the complete academic year, it amounts to taking almost one period as extra in a month. This could be accommodated by

making use of such periods as library periods, free periods that arise due to absence of teachers etc. As this arrangement could be adjusted in the normal functioning of the school without causing undue disturbance, it can be argued that the strategy is feasible in terms of time.

Feasibility of the Strategy in Terms of Cost:

As regards the feasibility of the strategy in terms of cost, the net amount that would be required for regularising the strategy is Rs.3,355. The cost that would be incurred for duplication and preparation of one set of learning material and tests - the amount when calculated for preparing 100 sets of learning material and tests - would be Rs.30.63. The net amount of Rs.3,355, though appears rather on the higher side, however, when seen in terms of the utilization of the learning material and tests over a period of years (materials being provided in reusable form) appears to be manageable by the school, thereby, reflecting the feasibility of the strategy in terms of cost.

OBJECTIVE 4: To Develop Alternative Instructional Components for Teaching a Few Concepts and Studying their Relative Effectiveness

For fulfilling this objective, alternative instructional inputs were identified for a few concepts in one of the units and software material were developed. The relative effectiveness of the alternative instructional inputs has been studied by administering them on the experimental group, which was divided into two matched groups for this

21 purpose.

Through task analysis, it was identified that a few concepts in unit IV (Heterotrophic Nutrition) could be presented through two types of programmed learning material (PLM), namely, PLM developed on the principles of inductive reasoning (Inductive PLM) and deductive reasoning (Deductive PLM), without bringing in any change in the sequencing of the concepts. For the concepts identified, PLM was developed in both inductive and deductive approaches. The developed software were examined by methodology and content experts for frame sequence and content respectively. The material were modified as per their suggestions. The PLM developed on the principles of inductive reasoning contained 62 frames, and the other contained 50 frames.

To study the relative effectiveness of the two types of PLM in terms of students' achievement, a criterion test was developed. The test included 7 items with a maximum score of 12. Out of the 7 criterion items, 3 items belonged to the objective knowledge, and the rest to the objective understanding.

The sample for studying this aspect included all the 45 students of the experimental group. The group was divided into two matched groups of 23 and 22 students each. Matching of the groups was done in terms of mean and S.D. The variable considered for matching was students' achievement on unit test III.

22 In the beginning, both the groups were informed about the purpose of the experiment, and also the method through which they would be learning the concepts. The material was distributed to the groups. As the learning material was self-instructional, students were asked to read the material at home and come prepared for the criterion test, which was held in the subsequent science period.

To study the performance of students exposed to inductive and deductive PLM on the criterion test, statistical techniques such as percentiles, mean and S.D. have been used. The significant difference in the mean achievement of the two groups on the criterion test has been studied using Student's 't' test.

The two groups, groups exposed to inductive and deductive PLM, did not differ with regard to their mean achievement on the individual categories of objectives, namely, knowledge and understanding, and also when the scores on these objectives were combined. The findings indicate that both the types of PLM are equally effective and hence could be utilized as alternative instructional components.

OUTCOMES OF THE STUDY

The study has resulted in the development of a duly validated multimedia instructional strategy. The strategy is found to be feasible if it is to be regularised in a

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school. Besides, the study has also paved the way for structuring alternative approaches of instruction within the strategy through the results obtained in respect of the relationship between students' achievement through the strategy and their intelligence, and also through the experiment with the alternative instructional inputs.