SUMMARY

INTRODUCTION :

Educational technology has brought systematization in the instructional processes at all stages of education and since the early 1970's, computers seem to be almost an inseparable part of the modern system of education in developed countries and it has started penetrating itself into Indian education system as it can be seen from the priority measures during the VIIth plan.

The priority measures during the VIIth plan were :

1. Expansion of new programmes for computer man-power development.

2. Integration of Computer Education in professional and general education.

3. Introduction of elective computer science courses at higher secondary level.

4. Extension of computer literacy programmes to cover all higher secondary schools by 1955 and elementary schools in the long term.

As reported by CABE (1992) and Revised National Policy of Education (1992) that the ongoing programme of CLASS project needs to be revamped.

The use of computers as one of the educational tool would improve the quality of education and hence proper steps need to be taken for it's implementation. There are various

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ways of providing instruction in the classroom with the help of computers.

Computer Assisted Instruction (CAI) are used for providing instruction to the students. Early CAI programmes were designed either as drill and practice or tutorial mode. Such programmes were developed in highly structured disciplines like Mathematics (Mitzel et. al 1967) and in Chemistry (Smith 1970, and lower 1973).

REVIEW OF RELATED LITERATURE :

Most of the previous researches in this field tried to study the effectiveness of CAI. Here, an attempt has been made to present the summary of the studies conducted in the area of education through computers with regard to it's effectiveness.

(1) STUDIES CONDUCTED ON EFFECTIVENESS OF CAI :

Computer Simulated Instruction (CSI) and CAI accounts for much of the instructional use of computers in science. The following studies were to study the effect of CAI on students' learning. (Bennett (1956); Brasell (1987), Nachimias & Linn (1987), Linn et al (1987) and Rivers and Vockell (1987)). The aspects covered by these studies were :

(a) Effect of CAI on achievement and attitude of high school physics students.

(b) Effect of CBI on ability of students to translate between physical event and it's graphic representation.

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(c) Effect of computer simulation on problem solving performance of high school biology students.

Following conclusions are drawn based on their findings :

(1) Academic achievement and attitude are positively affected when regular activities were supplemented with computer based materials. In addition, it was found to be time effective.

(2) CAI in conjunction with review worksheets are effective in enhancing the performance of students.

(3) CAI helps students in translating physical events and it's graphic representation. In addition to this the student improved graph scaling with experimental variation.

(4) General problem solving performance is improved through computer simulation.

There are several other research evidences which show the effective use of computers in the classroom in India.

Findings of studies conducted by Rao and Shantha (1987), Raghavan & Dharmaraja (1991), Stella (1992), Stella (1993), Joshi and Mahapatra (1994), revealed that :

1) CAI produces significant difference in the achievement of students.

2) CAI helps students to understand the concepts of limit, continuity, derivative due to incorporation of graphical and numerical approach.

3)   CAI is an effective, individualised instructional technique.

4)   Students develop positive attitude towards CAI.

5)   With teachers' support, CAI was found to be superior in improving achievement of students than other mode of instruction.

All the above studies indicated that students' learning is affected in terms of instructional time, attitude and academic achievements. Further, it helps students' learning through interactive teaching-learning process and with teachers support.

(2)   **STUDIES RELATED TO THE TEACHING OF CHEMISTRY :**

Since hardly any study has been documented in India regarding effectiveness of CAI in the field of Chemistry teaching, findings of some of the studies done abroad are presented here. Studies conducted in this area were by Copolo (1992), William (1992), Ormer (1992) and Waddick (1994).

The observations recorded from the studies are as follows :

(1)   Students are found to be more attentive to visual instructional aid with the computers providing a focused and easily manipulated simulation for learning organic isomers.

(2)   As with computer graphics three dimensional presentations are possible, it increases the conceptual understanding by promoting the formation of dynamic mental images of phenomena.

(3)   Computer simulations and laboratory activities have same level of effect on students' achievement.

(4)   Computer based drill practice facilitates students in learning chemical formulas and names.

Thus, it can be concluded from the above findings that with the use of computer based simulation students can be made to learn the complicated structural formulas and concepts in Chemistry easily which require great deal of mental work on the part of students.

RATIONALE OF THE STUDY :

As Computer can be used in a variety of ways for providing instructions in the classrooms. The review of related studies reveals that hardly any study has been conducted in India related to the application of CAI for teaching of Chemistry at higher secondary level. Studies conducted abroad in the area of teaching of Chemistry through CAI have been found to be scattered over the subject matter. No study has been found by the researcher which would help to understand the area of Chemistry teaching through CAI and in particular the organic part of Chemistry which deals with very many three dimensional structural formulas. It has been found by some researchers that Computer simulation and CAI with graphics would be the most appropriate instructional media (Copolo 1992, Williamson 1992), for teaching of topics such as optical isomers, stereoisomers, chemical equilibrium etc. Thus CAI could be used effectively in such topics that

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require much of imagination for the students. Moreover, as the students are exposed to these topics for the first time in standard XI, they definitely need clarity and understanding of concepts as well as practice for attaining mastery over these concepts. Further, software packages have been found to produce a significant difference in the students' achievement (Raghavan and Dharmaraja 1991). Sahasrabudhe (1993) and Patadia (1993) studied the status of Computer Education in the secondary schools of Baroda city and reported that many computer teachers opined that there is a need to develop software packages for teaching of school subjects. It is because they have realised the usefulness of CAI packages in the teaching of school subjects.

The questions which still remain unanswered are :

1) How does computer based packages help students in bringing conceptual clarity in different topics of chemistry ?

2) If it helps in bringing conceptual clarity, then how does the varibale viz.,a) Intelligent Quotient level, b) Motivation level and c) Attitude of student affect learning of chemistry through computer based packages.

3) Whether CAI is time effective ?

To answer the above questions, the present study has been conducted.

TITLE OF THE STUDY :

"DEVELOPMENT OF COMPUTER SOFTWARE FOR LEARNING CHEMISTRY AT STANDARD XI".

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OBJECTIVES OF THE STUDY :

1. To develop CAI package in Chemistry for standard XI science students.

2. To study the effectiveness of the software package in terms of instructional time and achievement of students.

3. To study the effect of the software package on students achievement in relation to students'

a) Intelligence level of students

b) Motivation level of students and

c) Attitude of students towards the package.

4. To study attitude of the students and teachers regarding the effectiveness of the developed CAI.

OPERATIONAL DEFINITIONS OF THE TERMS :

1) **Motivation** : In this study motivation means academic motivation. According to Jack Frymier (1970), motivation towards school is assumed to represent an internalised state of being which manifests itself outwardly in particular ways of behaviour. Motivation to learn in the school is one which gives direction and intensity to students' behaviour in a school. Motivation is a construct inferred from behavioural observations.

2) **Attitude** : Attitude is generally used to denote the sum total of human being's inclinations, prejudices or bias, preconceived notions, ideas, feelings, threats and object.

Therefore attitudes are individual in nature having feelings about the psychological object in terms of favourable and unfavourable i.e., positive or negative feelings. Here in this study, students' feelings about the package are measured with the help of a three point attitude scale. Through it, dimensions like presentation of topic with the help of software package, comprehensiveness of the package, logical sequencing of the topics, examples and illustrations, figures and graphs, evaluation items and instructions given in the manual are measured.

3)   **Achievement** : Achievement means the marks obtained by the standard XI science students in the achievement tests constructed by the investigator for the three topics of chemistry from standard XI science textbook published by Gujarat State Textbook Board (GSTB 1994) for which CAI is developed.

4)   **Intelligence** : Intelligence of a student correspond to his IQ score as per Madhookar Patel's Intelligence Test (1970). It measures students' power of abstract reasoning and space perception, regardless of their cultural background.

Hypotheses :

1.   There will be no significant difference in the achievement of students between control group and experimental group.

2.   There will be no difference in the time taken by the control and experimental group for learning the three chapters of Chemistry. the three chapters

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3. There will be no significant difference in the achievement of the students in the experimental group with positive and negative attitude.

4. There will be no significant difference in the achievement of high intelligent and low intelligent students of experimental group.

5. There will be no significant difference in the achievement of experimental group students with high and low motivation level.

6. There will be no interaction effect of motivation and IQ level on students' achievement in the experimental group.

7. There will be no interaction effect of motivation level and attitude on students' achievement in the experimental group.

8. There will be no interaction effect of IQ level and attitude on students' achievement in the experimental group.

9. There will be no interaction effect of motivation level, IQ level and attitude on students' achievement in the experimental group.

METHODOLOGY :

This study being developmental cum experimental in nature was conducted in two phases.

Phase 1 :   Development of the software package: pilot study

Phase 2 :   Implementation of the package in the classroom to see it's effectiveness.

PHASE I

PILOT STUDY :

SELECTION OF CHAPTERS :

The Chemistry textbook of standard XI Science (published by GSTB 1st Edition 1994) contains in total sixteen chapters of three different branches of Chemistry namely, Organic, Inorganic and Physical. The selection of the three chapters was done on the basis of difficulty levels of chapters i.e. understanding the concepts which was expressed by seventy five students and five Chemistry teachers. The students and teachers were interviewed with the help of a structured interview schedule (appendix XI) for this purpose.

On the basis of the analysis of data collected from teachers and students', the following three chapters were selected for developing the software package.

1. Bonding and Molecular structure

2. Energy

3. Organic compounds

The software package was first developed for three chapters of Chemistry textbook for standard XI published by GSTB, 1994 namely Organic Compounds, Bonding and Molecular structure and Energy. For developing the software package, first of all, computer language was selected on the basis of requirements of chapter presentation, i.e., size of the letters required, types of figures, graphs, ease of

processing information and amount of information to be handled at a time. Therefore, Bortland C language was selected for developing the software package. The software package was developed on the basis of the concepts of branching programming, where in a concept is presented followed by the multiple choice questions. Students were given three chances for responding. If students fail to give a correct answer, they can refer home page for getting correct answer. Thus the package was developed for three chapters as mentioned above in the branching type of programming and using Bortland C language. The developed package was given to three experts in computer programming as well as five school teachers teaching Chemistry at higher secondary level for judging the comprehensiveness of content, and presentation of the software. Then it was subjected to field try out. For field try out, fifteen students of standard XI science stream were taken and the difficulties faced by these students were noted, as well as students' & teachers' attitude were collected and on the basis of comments and attitude of the students and teachers about the software package, it was duly modified on the following points :

1. Examples related to Hess's Law of Constant Heat Summation were added.

2. Examples of energy changes during chemical reaction were added.

3. Explanation related to functional groups was modified.

4. Test, items related to topic of Nomenclature of organic compounds were increased in number and simple test items were deleted.

5. Figures related to isomerism and the spelling mistakes were corrected.

Thus after making the necessary changes in the software package. The software was finalized for studying it's effectiveness.

PHASE II

The actual experiment : Control group students were taught by their regular school Chemistry teacher, while experimental group students were learning with the help of software package. The following tests were administered to both the groups before starting the experiment.

a) Pretest   b) IQ test (MPIT)

c) Motivation scale (JIM scale)

The students of the experimental group were told to take their own time to learn through the software and the time required was noted for both the groups. After completion of the experiment, the students of both the groups were administered post-test based on the three chapters which they have learned. In addition to this, the students of the experimental group were given an attitude scale to know their attitude about the package. To know the attitude of the students an unstructured interview schedule was implemented as well as a structured interview schedule was administered

to the Chemistry teacher to know her reactions, opinion and suggestions regarding students learning through software package.

SAMPLE FOR THE STUDY :

Out of hundred and twelve secondary schools in Baroda city, one English medium school was selected on the basis of having facility for providing computer education. Out of seventy students from standard XI science, thirty students were selected randomly for the experiment.

TOOLS FOR THE STUDY :

1)   IQ TEST :

For measuring the intelligence level of the students, Madhookar Patel's Intelligence Test (MPIT, 1972) was used. It is a non-verbal group test of intelligence having total of eighty items. The test requires 45 minutes and it has been developed for the age group of 14+. Reliability estimated by different methods ranges between 0.922 and 0.979. The test has been proved valid, the correlation of test score with total school marks varies from 0.54 to 0.69 with a mean value of 0.61. The score on the test was converted to the mental age as per values presented in the manual of the test.

2)   JUNIOR INDEX OF MOTIVATION (JIM) SCALE :

The scale developed by Jack Frymier (1970) was used for measuring academic motivation of the students. The test

consisted of eighty agree-disagree statements. Out of eighty items only fifty items are to be scored, the others are filler items. It takes 30 minutes for students to complete the items. Frymier (1970) has reported a split-half reliability coefficient of 0.67 for the test.

Higher scores on the scale indicate higher motivational level and lower score indicates lower motivational level.

3. ACHIEVEMENT TESTS :

Students were given two achievement tests :

(1)   Pre-test : This test was prepared with regard to the topics on chemistry which students have studied in standard 8th, 9th and 10th science text books. The pre-test was administered to the students to see whether students' of experimental and control group were initially different in terms of their previous knowledge or not. The test was of 30 minutes duration having 25 marks and all the items in the test were objective in nature.

(2)   Post test : This was administered to the students to measure achievement of students in three units viz (Organic Compounds, Bonding and Molecular structure and Energy) of chemistry textbook for standard XI science published by GSTB (1994). This test was of 100 marks and it is for three hours duration. Items of this test were objective as well as descriptive in nature.

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After preparing the first draft of these tests they were given to five experts. On the basis of their comments the necessary modifications were done and the final version of the tests were made ready for implementation.

ATTITUDE SCALE : The attitude scale was administered to the students of experimental group to know their attitude regarding different aspects of the software package as well as about it's implementation. The different aspects covered were as follows :

Content of the software, Presentation of the software, Examples and illustrations, Figures and graphs, Evaluation items, Instructions given in the manual, Learning through the software, and Utility of the software package.

The attitude scale contained twenty five items related to the above aspects and the statements were put on three point scale i.e. agree, undecided and disagree. The first draft was prepared and given to the experts for validation and accordingly it was modified and the final draft was prepared.

UNSTRUCTURED INTERVIEW SCHEDULE FOR STUDENTS :

This was implemented further to know the attitude of the experimental group students towards the software package for the three chapters of chemistry, in relation to certain aspects like i) comprehensiveness of the package, ii) content covered, presentation of the software, examples and illustrations, logical sequencing test items.

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STRUCTURED INTERVIEW SCHEDULE FOR CHEMISTRY TEACHER :

This was administered to collect the attitude of Chemistry teacher of standard XI Science of the school in which the experiment was conducted. The tool contains questions on different aspects of the software e.g. presentation of the content, language used, adequacy and appropriateness of examples and illustrations and any significant change in students learning behaviour which they have noticed. This tool was administered after the experiment was over.

DATA COLLECTION PROCEDURE :

The experiment, was conducted in one English medium school of Baroda city having facility of computer laboratory. All the students of standard XI science were administered the Motivation scale and IQ test and based on the average scores of Motivation & IQ two groups were made i.e. experimental and control group. Afterwards, the students of both the groups were given pre-test. Then the students of experimental group were taught three units of Chemistry with the help of software package, while the students of the control group were taught by their regular school teacher. Time taken by both the groups to learn three chapters was also noted. After completion of three units, students of both the groups were administered post-test. In addition to this the students of experimental group were administered attitude scale and

unstructured interview schedule to know their attitude, observations and suggestions about the software package. The chemistry teacher was also administered structured interview schedule after completion of the experiment. After the completion of data collection, the data were analysed objectivewise as follows :

DATA ANALYSIS :

Data collected was analysed objective wise :

1. For objective no. 1; first of all the chapters were selected on which CAI was to be developed. After selecting the chapters the content analysis was carried out and using a suitable computer language CAI package was developed. Then the package was ready for final experiment after conducting a pilot study and suitably modifying it.

2. For objective no. 2, the mean time required for experimental and control group was compared & to find out effectiveness of software package in terms of achievement of students of experimental group, analysis of variance was employed and to see the effectiveness of software package alone by nullifying the effect of intervening variables like IQ, motivation level and previous knowledge, an analysis of covariance was applied.

3. For objective no. 3 i.e. to study the effectiveness of the software package on student's achievement in relation to student's intelligence level, motivation

level and attitude. For studying this a qualitative analysis was carried out by dividing the students of the experimental group into two groups one having low IQ, low motivation level and another group with high IQ, high motivation level, and their attitude towards the package.

Further the data was subjected to three way analysis of variance inorder to find out the interaction effect of these three variables on the academic achievement of the students.

4. For objective no. 4, the percentage analysis of data was carried out to study the attitude of students and teachers.

FINDINGS OF THE STUDY :

1. It was found by the investigator that the software package developed for teaching three units of standard XI Chemistry textbook of Gujarat State Textbook Board was effective in terms of students achievement. This was reflected in the performance of experimental group students which showed that the experimental group were having significantly higher academic achievement than control group.

2. It was found in the present study that CAI was found to be time effective. The experimental group took 45 hours time in average to complete the three units in Chemistry. This was due to the reason that learning through software was more interesting & concrete

whereas the control group took 60 hours time in average to complete the three units.

3. It was found that the academic achievement of students of experimental group was found to be affected by the variables like IQ, academic motivation and attitudes. It was found that attitude as a separate variable did not have any significant effect on student's academic achievement but together with IQ and motivation attitude had an interaction effect on academic achievement of students.

Further IQ and motivation as separate variables did have an effect on students academic achievement but the there was no interaction effect of these two variables on academic achievement. Also attitude together with either IQ or motivation showed an interaction effect on students academic achievement.

4. It was found that majority of the experimental group students had positive attitude about various aspects of software package especially regarding presentation of content logical sequencing and language used for understanding the content. However, some students found that the number of illustrations and examples were not sufficient. The school subject teacher also had positive attitude about the various aspects of the package.

EDUCATIONAL IMPLICATIONS OF THE STUDY :

As it was found that the students learn in a limited time at their own pace and achieve better as compared to the students who learned through the traditional method. This implies that such packages should be developed and used in all the schools at higher secondary level. Moreover, in all the school subjects there is a possibility of developing CAI packages which are not available today. For the development of such packages both subject teachers and software experts should be involved. It is felt that there is some inhibition from the subject teachers for using such packages and therefore they should be oriented to use CAI package.

As the students can learn at their own pace, it is expected that all the students will attain mastery level. However, it is seen that computer laboratories are not accessible to the students when they require it. The implication that can be derived from this is that students should have access to the computer laboratory and should be allowed to use it as per their requirement. For this the mode of operation and charges can be worked out.

As the classrooms today are becoming overcrowded there is a need of alternative system of education in addition to the open school education. As computer technology is coming up in a big way students can learn complicated topics by being at their own. Therefore, there is a need to train teachers in the teachers training colleges to use such packages in alternative system of education.
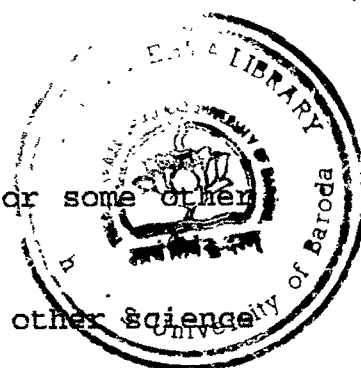
SUGGESTIONS FOR FUTURE STUDIES :

1. Software package needs to be developed for some other units of Chemistry at standard XI.

2. Software package needs to be developed in other science subjects like Physics & Biology at higher secondary level.

3. Software package needs to be developed for training of teachers to teach various science subjects.

4. Since computer education is going to be important in teacher education institutions also, the software package needs to be developed for training of teacher educators.

CONCLUSION : This study clearly indicated that the CAI developed and implemented by the investigator for teaching of Chemistry at higher secondary level was effective. The effectiveness was found in terms of academic achievement of the students of experimental group and the time taken by them to complete the learning of three units.

It was also found that the academic performance of experimental group was effected by the variables like IQ, Motivation and Attitude taken separately and together showed an interaction effect. The findings of this study implies that there is a dire need to develop CAI packages in different subjects at higher secondary level. This package can be used by researchers and Chemistry teachers of higher secondary schools and effectiveness can be further judged.