

Design, Development and Validation of Computer Aided Instructional Mathetic Problem Solving Approach (CAI-MPSA) Software

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Abstract

Present study has been conducted to design, develop of CAI-MPSA software and its validation. Behaviors of learners are not immediately reinforced in the present mathematics class rooms. This learning package is designed in such a manner that the learner more often gives a correct response. Maximum reinforcements are provided to the learner. In terms of class room teaching, mathetics is essentially an attempt to provide instruction that is more individualized more tailored to each learner unique learning abilities and needed and largely self instructional. The importance of this study was to develop the open source CAI-MPSA software for +2 level students' achievement in the Mathematics subject in terms of philosophical and psychological background and validation and the software usability, user-friendly, flexibility and its acceptance. The study was conducted in three stages; 1) Design and Development of CAI-MPSA Software 2) Internal and External Validation of the software. The findings were that the developed software is user-friendly and flexibility. Students and teachers were more positively opinion towards the software and accepted it.

Index terms:CAI-MPSA, Design, Development, Validation

I. INTRODUCTION

The Computer Aided Instructional Mathetic Problem Solving Approach(CAI-MPSA) Software is developed by the researcher understanding the learners difficulties in solving such problems.This instructional software is a lively creation and investigation tool that enables students to explore and understand mathematics in alternatives ways, which is not so easy with the traditional methods. This Softwareis an educational tool that is designed basically to support the mathematics problems teaching and learning activities. CAI-MPSA Softwareis created by considering basic teaching methods that respond to cultural, psychological and cognitive needs of target group, as well as the contemporary teaching and learning methods which help students to gain the positive attitudes towards mathematics. CAI-MPSA Softwareis oriented around the hard spot of the problem strategies, interactive exercises about mathematical problems and solutions based on inquiry. In addition to the learning sections, learn problems through support of text, ppt, video clips, and images provided.

Thus, the CAI-MPSA Software supports trigonometry content of the +2 level Mathematics subject and any similar content is suitable for below average, average and gifted students and those having difficulty with mathematics. To learn in each of the problems, solution "hints" are designed based on the inquiry learning principles and reinforcement theory. Students do problem solving through understanding. Besides, the Software hasnumber of interactive exercises for students in each phase of the program. Whenever students have difficulty with a specific task, the program directs students to the logical hint frames. CAI-MPSA Softwareis designed for using the dynamic nature of computers in laboratory environment together with teacher guidance. In addition to this, it can be used at home for individual learning purpose. Teacher can support the traditional instructional system by utilizing CAI-MPSA Softwarein specified lesson hours with interactive exercise. In this study, the researcher prepared and validated software.The main aim of the present CAI-MPSA software material is to assist and instruct +2 level students and teachers about the 'Trigonometric functions' chapter of the 'trigonometry' section of the subject Mathematics.This Software package is help to the teachers to encourage preparing trigonometric problems on their own ideas and styles. It also encourages the learners who aspire for self learning. This manual can be useful to the users for the clarity and better understanding of the programme.

II. OBJECTIVES

1. To Design and Develop the CAI-MPSA Software
2. To Validate the CAI-MPSA Software.
3. To study the opinion of teachers, Students, Educational Experts towards CAI-MPSA Software.

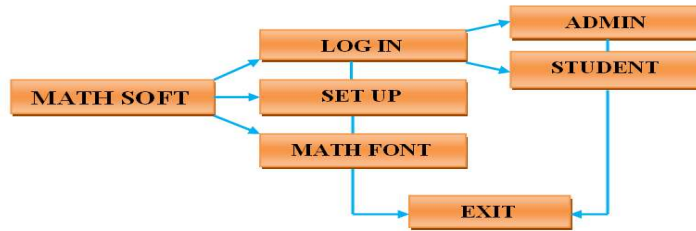
III. DESIGN OF THE CAI-MPSA SOFTWARE

The design of software is elaborated with three charts namely; Stage-1, Stage -2 and Stage-3;

Stage -I: Flow Chart of CAI-MPSA Software: Installation process

Mathsoft consisted three major parts.

- i. Log in
- ii. Set up
- iii. Math font



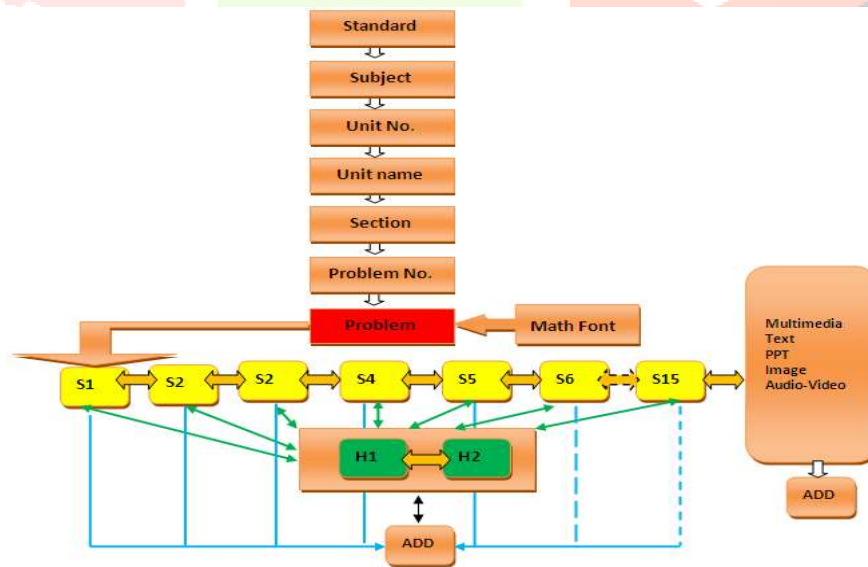
Flow chart-1: flow chart of CAI-MPSA Software installation process

Stage -II: Flow Chart: Admin process:

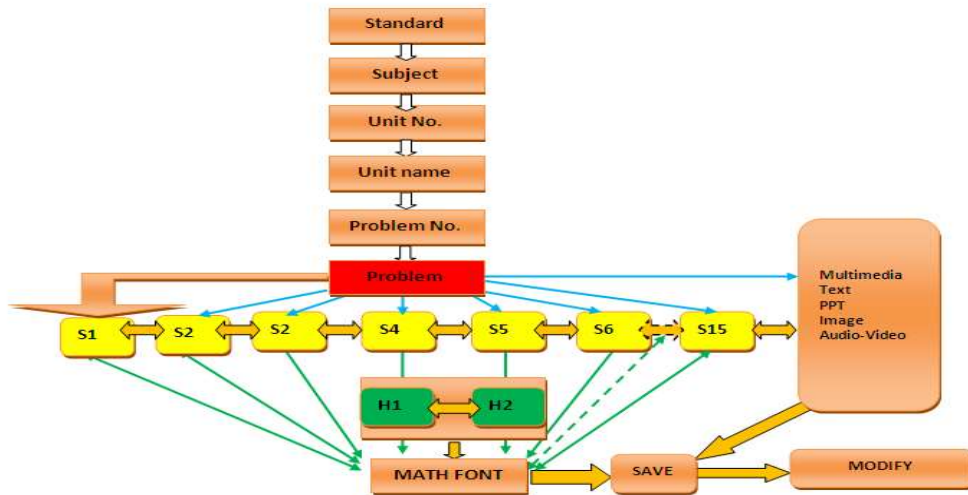


Flow chart -2: Flow chart of Admin process

Admin process consist log in form. Here the admin is teacher and makes entries and edits the problem data as per requisition.



Flow chart -3: Flow chart of admin process:



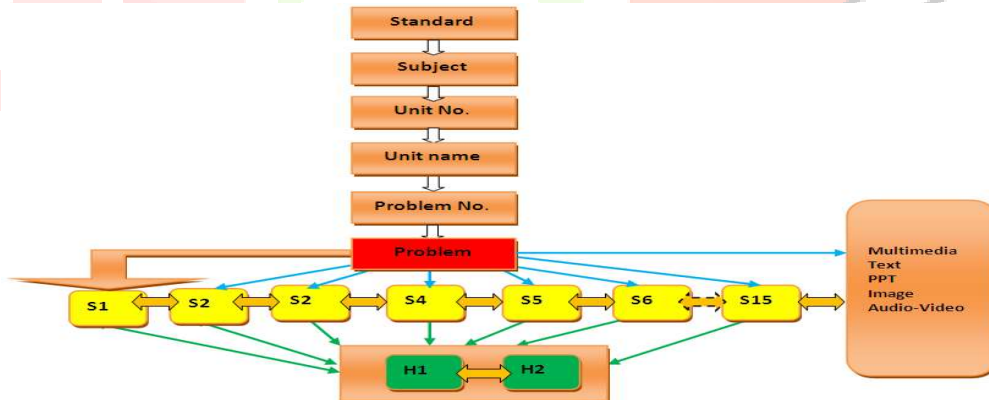
Flow chart -4: Flow chart of admin for modification process

Stage -III: Flow Chart: Student process:



Flow chart -5: Flow chart of Student process

Student process consists, log in form. Here the student is learner. He learns solutions through frames using small steps and hints along with multimedia approach.



Flow chart -6: Flow chart of learner process

IV. DEVELOPMENT OF THE CAI-MPSA SOFTWARE

Basic Platform of The Software

This CAI software is developed using visual basic 6.0 with Access back end platform. Word, Power point, Images in jpg format, audios in mp3 format and videos in windows media player/mp4 format are used for input of the software package. Math font and word are used for typing problems for input of the software package. This software supports both desktop and laptop operating system windows xp and higher version.

The main aim of the present CAI-MPSA software material is to assist and instruct +2 level students and teachers about the 'Trigonometric functions' chapter of the 'trigonometry' section of the subject Mathematics.

This manual is help to the teachers to encourage preparing trigonometric problems on their own ideas and styles. It also encourages the learners who aspire for self learning. This manual can be useful to the users for the clarity and better understanding of the programme.

Objectives of Software Development

1. To motivate and encourage teachers to develop their own programme in mathematical style.
2. To motivate teachers to show their own intellectual ability for preparing good lesson for the learner.
3. To clarify the concept of Trigonometry.
4. To instigate students to think logically while solving problems.
5. To instigate the students to become independent learner.
6. To motivate and encourage the learners to learn trigonometry by this innovative method.
7. To motivate to teachers and students to use of technology in their teaching and learning process.

The CAI-MPSA Software Material

It is Computer aided instructional software material developed on the principle of mathetic problem solving approach. Some selected trigonometry problems solved forward as well as retrogressive chaining consist three basic steps Demonstration, Prompts and Release frame along with different modes of multimedia support for mastery in solving problems. This software helps learner to learn problems repeatedly. Whenever the learner felt very difficult to understanding the steps followed and he did not know how to solve the next step he can use the logical hints frame for better understanding about the steps to go forward or reverse steps. If he wants more clear information he can also use the multimedia approach. Thus practices regularly the learner can mastery on every problem and it develops among self confidence.

Nature of Software

The instructional software is a lively creation and investigation tool that enables students to explore and understand mathematics in alternatives ways, which is not so easy with the traditional methods. Software is an educational tool that is designed basically to support the mathematics problems teaching and learning activities. Software is created by considering basic teaching methods that respond to cultural, psychological and cognitive needs of target group, as well as the contemporary teaching and learning methods which help students to gain positive attitudes towards mathematics. Software is oriented around the hard spot of the problem strategies, interactive exercises about mathematical problems and solutions based on adventure activities. In addition to the learning sections, the students learn problems through text, ppt, video clips, and images.

The most important aspect of the educational software is the content of the software. The software is suited for trigonometry content of the +2 level Mathematics subject. These form a comprehensive system suitable for below average, average and gifted students, as well as for those having difficulty with mathematics. In each stages of the problems has "hints" that are designed based on the discovery learning principles and reinforcement theory to enhance students to go further steps for calculation. Besides, software provides number of interactive problems for students in each phase of the program. When students have difficulty with a specific task, the program directs students with logical hint frames.

The software is designed for use of computer laboratory environment together with teacher guidance. In addition to this, it can be used at home for individual learning purpose. The teacher can support the usual instructional strategies by utilizing software in specified lesson hours with interactive exercise. In this study, the researcher also, utilized the software in the proposed way. In addition to this, the researcher has prepared manual book for software.

Psychological Principles used for Development of CAI-MPSA Software

Computer aided instructional, 'mathetic problem solution approach' software is developed on the following psychological principles;

1. This software is developed based on Skinnerian principle of operant conditioning.
2. This software is developed based on connectivity theory of learning.
3. This software is developed with the principles of chaining, discrimination and generalization.
4. This software is developed also linearity, logical linkage at every steps and the solution path inverted from down to top.
5. This software is developed with reverse as well as forward chaining approach.

General Requirements of Software

The software has three modules namely admin module teacher module and student module. The software being generic form requires trained teachers to feed the content material in the processed forms. The requirement of content can be categorized into three stages i) unit requirement ii) teacher requirement ii) student requirement;

- i) **The subject unit requirements:** In this stage the teacher has to fill some of the basic information regarding course like subject unit, unit name and sub unit names. Here the teachers add subject names, unit names, and sub unit names sequentially and proceed to teacher frame.
- ii) **Teacher requirements:** The software has 'teacher entry form'. The teacher is an admin and needs different frames like problems entry frame, steps entry frame, hints entry frame and multimedia entry frames and also the support with MS word or math font software for entering the problems and solutions into the software. In addition, teachers have provision to modify or edit the problems, steps, hints or multimedia if required, also edit, add problems, steps, logical hints and multimedia like text, power point, images, audio and videos.
- iii) **Student requirements:** In this stage students are, lead to solution of problem with interactive steps and logical hints along with different modes like textual, ppt, image, audio and video forms. The student learns problem in methetic form through this stage.

For the security purpose the software has three major stages;

1. Log in section,
2. Admin section and
3. Learner/User section.

All users are compulsory, to log-in into the software. Log his section is used for both teachers and students individually. Everyone will have their own user name and passwords. This username and password help users to get into the software.

- iv) **Process of 'teacher module':** 'Teacher module' consist data entry form and edit or modify forms. Here the admin monitors the details of standards, subjects, unit numbers, unit names and sections. Then enter the problems into the demonstration frame. According to the problem, the solution steps frame is prepared. Each frame has two logical hint frames. The teacher loads hint which are links relation between two steps by giving clear information. The solution to the problem proceeds from each steps (up to fifteen) along with image, text, ppt and audio-video support. The admin has given facility for entering solution up to fifteen steps and two logical hints along with multimedia. Each problem can have fifteen steps and each step have logical hints along with multimedia modes. Here, the admin has given facility to swap the solution steps in both forward and reverse mode. The admin has another option that modifies the problem if needed for corrections. Here the teacher just click with modify button, opens the window of 'math font', use font to correct the problem steps, hints or even multimedia links.
- v) **Process of 'student module':** The 'student form' consist learner to click the option of standard, subject and unit of the mathematics content, go to the learning frame. In this section the learner interact with three frames, namely;
 - 1) demonstration frame,
 - 2) prompt frame and
 - 3) release frame

Student views the problem on the 'demonstration frame', reads carefully and goes to the steps frame (prompt frame). If he understands the step he proceed to the next step, otherwise takes support of the 'hint frame (release frame)' These hints motivate the learners to go to the next step confidently with methetical learning. Learner also has facility to view and learn the whole problem in different modes like text, ppt, audio-video and picture forms. This helps learner to master over the problems and is based Gardner's principles and multimedia exposition.

Learning Material Preparation and Teacher Module

Software content has to be prepared by teacher and needs to be fused in the software. The teacher should have the competency to analyze evolve the step by step logistic conversion with mathematical rationale and explain with supportive information, theories, laws, and proofs. The researcher prepared the content material for validation purpose.

i) Discipline of study selection

The present problem for the study has its origin from the field, especially the difficulty of the X, XI, XII standard students learning mathematics. The researcher reviewed events and discussed with the students and identified the subject content difficulty based on their opinions and other mathematics teachers in the field the content.

ii) Selection of the subject

For the validation of the software, content has to be infused to the software. For this purpose the researcher selected trigonometric part of the Pre University course of the PU board, Govt. of Karnataka. This is selected because students feel it to be one of the hard spot.

The concept of trigonometric functions and its different kinds are the main parts. Explanation of the problems with each steps and its logical hints are formed. The following unit and sub units are selected for the study;

Trigonometric Functions:

- i) Identities
- ii) Compound angles
- iii) Multiple and sub multiple angles
- iv) Transformation of angles.

iii) Drafting of the Text Content

On the basis of story board, the text is prepared for the software. - Various prescribed text books, materials and software are from internet are referred for the purpose of the trigonometric content. The prepared trigonometric functions content is then computerized using a suitable type font using Word, PowerPoint with animations, pictures, audio and videos format. However, Word software is extensively used for making the drawings and diagrams and then those were incorporated into the software. Mathematical Equation Editor Software and math font software for Windows are extensively used for making the equations which are then inserted into the appropriate position in the software presentation.

iv) Development of ppt and Graphic Files

To make the programme more effective for the students, graphics and initial forms, i.e., photographs are collected from internet. Pictures are saved in .jpeg file format as they can be customized to size and faster to load. Trigonometric figures are created by the researcher using trigonometric fonts. All animations are created using PowerPoint programme animation facilities. 'Appear and Wipe' effects are utilized appropriately. All the graphics files are linked to the appropriate position of the problem into the software. The problems developed are linked in forward and reverse chain with the help of animation along with the power point presentation.

The researcher prepared the slide show utilizing PowerPoint application tool of Office software based on the flow chart, story board, content matter and animation effects. The developed slide shows are linked to the software for effective use.

v) Development of Audio and Video Files

To make the programme effective for the learner the researcher used number of videos, on related contents of trigonometric functions and recorded his/her own videos with the expert guidance. All videos are linked to the appropriate position of related problems.

vi) Development of Images or Pictures Files

To make the programme effective and attractive for the learner, the researcher prepared number of coloured images related to the trigonometric content into the jpeg format. All pictures were linked to the correct position of related sub units and problems.

vii) Construction of Storyboard

The researcher prepared the storyboard on the basis of the instructional objectives. While selecting the subject matter, the level of the learners, and also the expected knowledge were kept in mind. Based on the analysis of the content, its style of presentation is evolved. Basically the approach is mathetic problem solving with ppt, audio videos, pictures, graphics or a combination of more than one. Presentation of content is in the form of facts, rules, principles or concepts, with supportive information. For active involvement of the learners some exercises are given. All these aspects together build a story board.

In the present study the researcher created the flow chart to get related information and then prepared the story board on the basis of the flowcharts. The flow chart is as shown below.

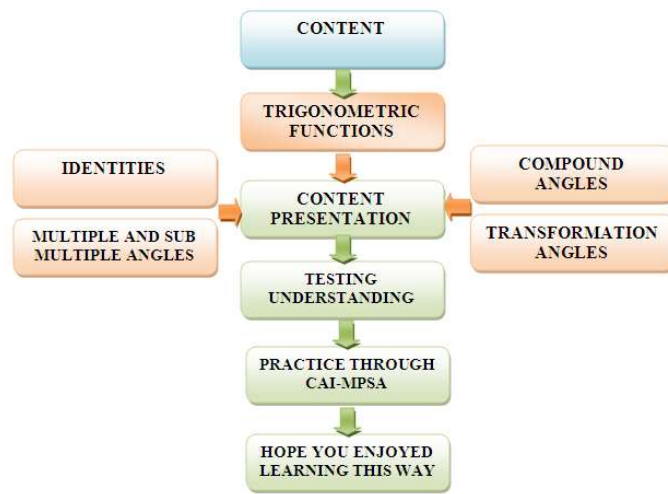


Fig-15: Story board

Researcher at +2 level and a computer application trained person was able to prepare story board. The researcher also had support in the form of guidance and suggestions with research guide.

SOFTWARE INSTALLATION PROCEDURE:

The procedure of software installation is very simple as follows;

- Insert cd into the cd: drive
- Copy mathsoft folder in c:/drive
- Open mathsoft folder
- Click on mathsoft exe file
- Click on set up button for software installation
- Click on math font button for installation of math font software

The whole software installation takes few seconds.

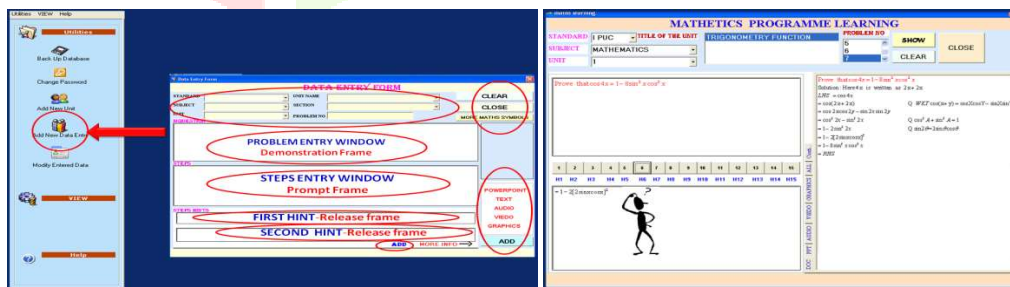
NEED FOR MINIMUM REQUIREMENT:

CAI-MPSA Software required the following system software and operating software.

1. Operating System: Windows XP and higher version
2. Office application
3. Media player

This user manual has two parts;

1. Admin/teacher user
2. Learner/student user



V. VALIDATION OF SOFTWARE:

The validation of the software is conducted in five stages;

- i) **Validation of software by learners Achievement test:** The software in this stage is tried out with learners with experimental design. The effectiveness in terms of achievement score gain compared with conventional technology is the criteria for testing
- ii) **Validation of Software by Computer Expert:** The original copy of the instructional package of software was given to five computer experts who taught to MCA and M.Sc. Computer science, to go through for their assessment, suggestion and

criticism. Their responses are qualitatively analysed and necessary corrections are done, producing the final version of the instructional material.

iii) Validation of software package by Mathematics Teacher: The original copy of the instructional software is given to five mathematics teachers who taught at the +2 level. Their responses are qualitatively analyzed and necessary corrections are taken into consideration in producing the final version of the instructional material.

iv) Validation of software by Mathematics Expert: The original copy of the instructional software is given to five mathematics experts provided the material, to go through for their appraisal, suggestion and criticism. Their responses are qualitatively analysed and necessary corrections are done, producing the final version of the instructional material.

v) Validation of software package by Educational Technology Expert: The copy of the instructional software package is given to five educational technologists educational technology. They were provided the material, to go through for their assessment, suggestion and criticism. Their responses are qualitatively analysed and necessary corrections are made in producing the final version of the instructional material.

PHASE II: INTERNAL VALIDITY OF THE SOFTWARE

The second phase is the internal validity design where in the software developed is tested for its expected nature, characteristics and functioning.

A) Compatibility and Installation testing [IQ or QD experts]: The programme is tried for installation into different make computers with different window version for its correct installation, hard disk setting, the base management and other requirements. The programme is debugged by using demo content.

B) Admin comfort testing with mathematics teachers and experts: The developed material is taken for lab try out with few mathematics teachers and computer experts who have exposure of using the CAI. They are asked to use the software to upload sample lines with various types of problems on mathematics and multimedia files and find out the comfort level of operation. The reactions in the form of suggestion are taken to the software specialist for further needed modification. This is repeated till a satisfactory level is reached for external validity. The following tools are used for internal validation.

i) Subject Content Treatment Questionnaire (SCTQ): This questionnaire consist twelve statements having four choices in terms of strongly agree, agree, disagree or strongly disagree. This scale is administered to twenty Mathematics teachers to ascertain the adequacy of the content of the software with regards to the officially prescribed content of the Karnataka State PU Board of Mathematics curriculum. Mathematics teachers responded to statements regarding the adequacy and appropriate sequencing of the trigonometric problem, steps hints and multimedia support, appropriate language use among others.

ii) Computer Experts Response Questionnaire (CERQ): this questionnaire consist sixty statements. It is administered to ten computer experts. The questionnaire contains four categories (user friendly, usability, flexibility and acceptability) statements to which respondents are required to state whether they strongly excellent, very good, good and normal. They are expected to write freely about their views about the typography, legibility, navigation, the simulation, etc., properties among others, of the instructional software package.

iii) Educational Technology Experts Response Questionnaire (ETERQ): This questionnaire consist sixty two statements and is administered to ten educational technology experts for the purpose of finding out whether the software confirms to acceptable standards of educational technology. The respondents were to express their opinions on software user friendly, usability, feasibility and acceptability. These opinions are recorded in terms of strongly agreed, agreed, disagreed or strongly disagreed choices.

iv) Mathematics Expert Response Questionnaire(MERQ):

This questionnaire consist fifty two statements and the questionnaire is administered to ten mathematics experts who are experienced in teaching at higher education used for the purpose of finding out whether the software confirms to acceptable standards subject correctness. This contained four categories (user friendly, usability, flexibility and acceptability) statements to which respondents are required to state whether they strongly agreed, agreed, disagreed or strongly disagreed.

PHASE-III: EXTERNAL VALIDATION OF SOFTWARE:

This is the third phase, involves of experimenting the software against conventional mode of teaching mode to the learners by creating a parallel group design with students. In this phase, the researcher designed content on Trigonometry and developed the content inputs for the software as elaborated earlier.

A. Validation of content design:

The researcher validates the design of content using 'content validation tool' prepared. This tool contained twelve statements to which respondents are required to state whether they strongly agree, agree, strongly disagree or disagree. This tool is administered to ten Mathematics expert teachers after they used software to ascertain the adequacy of the content for the software with regards to the officially prescribed content of the Karnataka State PU Board of Mathematics curriculum. Respondents responded to statements regarding the adequacy, appropriate sequencing of the trigonometric problem, steps hints and multimedia support and appropriate language. Researcher also validated the design regarding the content in the form of text, ppt, image, audios and videos.

The researcher has developed problems on a unit of 'Trigonometric Functions' for specific type of trigonometric situation with detailed steps, and are feed to the software. Supporting multimedia files are developed and linked to the software.

Findings of the Study

The following are the findings of the present study.

- i) The computer aided mathetic problem solving software is effective generic and pleasant software that can be used during teaching learning of mathematics.
- ii) The learners reactions are significantly positive towards use of CAI-MPSA software in terms of acceptance, user friendly and flexible
- iii) The teachers' reactions are significantly positive towards use of CAI-MPSA software in terms of user friendly, flexibility and acceptance.
- iv) The students' academic achievement is significantly improved by using this software.
- v) The CAI-MPSA software programme can fulfill the need of the students' interest. It helps to grasp the content easily for prolong period. According to their observation it increases concentration, and its leads to self learning.

CONCLUSION

Researcher concluded that CAI-MPSA software material offers teachers and students an opportunity to be actively engaged in the teaching and learning process, to receive instruction through a variety of multimedia, to choose the place and time to learn, to work at their own pace, and to receive immediate and accurate feedback and also study the effectiveness of using CAI software in teaching and learning mathematics. In the current study judging from overall response of the students and teachers and from observations of the investigators, it is found that students and teachers are having positive attitude towards learning mathematics through CAI software. So it can be concluded that CAI software is one of the effective ways to teach and learn mathematics.

REFERENCES

- [1] Adhikari, R. (1992) "Development of Computer Aided Instruction Material on cell and cell reproduction for class IX". In Goel, D. R. (2000). Educational Media in India. Delhi: Bharatiya Kala Prakashan, India.
- [2] Ambasana, Anil (2004). Effectiveness of Computer Aided Programmed Instruction as compared to Print Media Programmed Instruction in developmental challenges and educational technology. (Edited by Goel, D.R.), pp 23-26. CASE, Faculty of Education and Psychology, MS University, Baroda.
- [3] Ambasana, A.D. (Ed.).(1998) Computer in Research and Education. Rajkot: Saurashtra University.
- [4] Best.J.W.(1996) "Research Methodology" Prantic Hall Publishers, New Delhi 1996.
- [5] Bhatia & Bhatia (2001) "A Text Book of School Psychology" Douba House, New Delhi
- [6] Costa, A.P., Loureiro, M.J., Reis, L.P., (2009) - "Development Methodologies for Educational Software: The Practical Case of Courseware SERE" - International Conference on Education and New Learning Technologies (EDULEARN09)
- [7] Evans, Chris; Gibbons, Nicola J. (2007). The Interactivity Effect in Multimedia Learning. Computers & Education, 49 (4) :1147-1160.

Articles Referred:

- [1] Joshi, Anuradha and Mahapatra, B.C. (1997) conducted a study on, "Effectiveness of computer software in terms of reasoning ability in science", Indian educational Abstracts.
- [2] Issue 5, July 1998; p.39
- [3] Jothiokani, N. and Thiagarajan, A.P. (2004). "Effectiveness of Computer Assisted Instruction in Mathematics among B.Sc. Degree Students", Ph.D. Edu., Algappa University, Indian Educational Abstracts, NCERT, Vol. 4, No.2, July.
- [4] Khirwadkar, A. (1998) "Development of Computer software for learning chemistry at standard XI." An unpublished Ph.D, Thesis, Vadodara: CASE, The M.S. University of Baroda, India,
- [5] K. Sampath .A.Panneerselvam.S.Santhanam (1987) "Introduction to Educational Technology", Sterling Publishers Pvt. Ltd. New Delhi.
- [6] Mukhopadhyay, M., Khanna K. & Parhar M. (eds.) (1989). Educational Technology: Year Book 1988. New Delhi: All India Association for Educational Technology.

- [7] Sharma R.A .(1982) “Programmed Instruction” International Publishing House, Meerut (U.P)
[8] Trotter, A. (2007). R&D Project on Algebra Software Seen to Show Promise. Education Week, 27 (5) : 10-14.

Software Referred:

- [1] Algebra Problem Solvers [Computer software]. (2000 +)
[2] Apex Learning Math [Online software]. (2007+).
[3] Britannica SmartMath [Online software]. (2010+)
[4] Mathematica [Computer software]. (2011+)

Website referred:

- [1] <http://www.eric.ed.gov> (database search service exclusively for educational research)
[2] <http://www.google.com/scholar>
[3] <http://www.princetonuniv.org/education>
[4] <http://www.wikipedia.org>
[5] <http://www.mit.org/ed>
[6] <http://www.aplusmath.com/> — The A+ Math site helps students learn mathematics interactively with a mathematics game room, flashcards, and practice sheets.

