A Design for Highly Interactive Automated Instructional System

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Abstract- A design for highly interactive automated instructional system involves users / students from multiple disciplines. Though user/ student interactions share similar information, often they do not collaborate. The lack of collaboration in the user/student interaction can yield to sub-divisional problems because design faults might be detected at a lower speed or not at all. The motivation towards the work in this study is to provide support in a high degree of interaction and generate its own instructional material and in a way emulates a good teacher. Firstly, this involves Intelligent Tutoring Systems (ITS)[7][8], ITS supports individualized instruction and it has been shown to lead to better learning than the normal classroom activities. Secondly, expert module, it also requires some form of teaching knowledge, all of which require a good knowledge representation technique. Thirdly, student diagnosis module, it detects the mistakes and errors in a systematic explanation. Fourthly, instructional module, it involves strategies for intervening in the course of a student's problem solving activity, offering advice and hints, answering questions and providing explanations. Fifthly, instructional environment, it consists of those elements of an ITS that support what the learner is doing, situations, activities and tools that provided by the system to facilitate learning. And finally, human computer interface, the Success in building the instructional environments will largely depend on how well designed the ITSs human computer interface is. An Automated Problem Solver (APS) has been designed and the prototype was developed for solving numerical problems with multiple goals in the domain of Mechanics. Furthermore, the concept of a generic cognitive model, in addition to the domain model of the student was developed. Finally, an authorizing system for interactive content has also been designed and developed.

Keywords – Highly interactive, Instructional system, Automated Problem Solver [4]

I. INTRODUCTION

In recent years, Computer have been used as a tool of instruction sometimes we call “Computer Based Education” which means using computers in education for all kinds of purposes. It is a teaching approach that integrates computer software programs with other teaching materials. Computer can also use as the interactive elements of the computer applications and software to present any type of media to the users in the purpose of education.

Since 1960s, computers have been used in education and in the 1970s, microcomputers were arrived, computer use in primary education through the university level and even in some preschool programs. Instructional computers are basically used in one of two ways. First, they had provided a straightforward presentation of data. Second, they had filled a tutorial role in which the student is tested on comprehension.[1] within the educational community there was not mainly use Computer Based Education as an important instructional tool. For many teachers and students, it was not yet realized.

In the present, Computer Based Learning is often seen as the most efficient and effective way in which to conduct distance education, as a lesson plan can be created that allows people to study at their own pace, either via the Internet or software installed on individual computers at various sites. There are many advantages to using computers in educational instruction. They provide one-to-one interaction with a student, as well as an instantaneous response to the answers elicited, and allow students to proceed at their own pace. Computers are particularly useful in subjects that require drill, freeing teacher time from some classroom tasks so that a teacher can devote more time to individual students. A computer program can be used diagnostically, and, once a student’s problem has been identified, it can then focus on the problem area. Finally, because of the privacy and individual attention afforded by a computer, some students are relieved of the embarrassment of giving an incorrect answer publicly or of going more slowly through lessons than other classmates. [2]The future of education technology is all about the cloud and anywhere access. In the future, teaching and learning is going to be social. Schools need to embrace cloud

technology to prepare for the future of learning. Teaching and learning will be globally accessing. Students can learn anywhere in the world with the massive open online courses (MOOCs).
Therefore, there are many technologies which can be applied in classroom. For example, [3] Programmed instruction was among the first, in historical significance for instructional developments and analytical processes, important to instructional design. This form of instruction is based on the behavioral learning theories. The early programmed instruction was often delivered by some form of 'teaching machine' but later it brought the concept of interactive text. The programmed instruction movement extended the use of printed self. Then, Computer-Based Training (CBT) involves the use of a personal or networked computer for the delivery and access of training programs. CBT can be synchronous and asynchronous, as well as online, web-based, mobile, and distance learning. Today CBT has grown to include nonlinear learning and collaborative communities for learners to connect with other learners. Moreover, the educators also use simulation to teach with scenarios where the learner is placed in a "world" defined by the teacher. They represent a reality within which students interact. The teacher controls the parameters of this "world" and uses it to achieve the desired instructional results. Students experience the reality of the scenario and gather meaning from it. Also, Web-based education (WBE) has been applied to encompass all aspects and processes of education that use World Wide Web as a communication medium and supporting technology. There are many other terms for WBE; some of them are online education, virtual education, Internet-based education, and education via computer-mediated communication. But as technology that mentioned above they all missed the objective of education these type of learning makes learners experience monotony and boredom. It takes too much time to teach a few points and the learner has no choice of his own to respond. No freedom for student to response and discovery. The main problem is there is no interaction, so it limited learner's imagination. Every learner has to follow the same path.

As Piaget [9] believed that children take an active role in the learning process, acting much like little scientists as they perform experiments, make observations, and learn about the world. As kids interact with the world around them, they continually add new knowledge, build upon existing knowledge, and adapt previously held ideas to accommodate new information. So, interactive teaching will be help instructing the students in a way they are actively involved with their own learning process. There are different ways to create an involvement as follows: 1) Teacher-student interaction 2) Student-student interaction 3) The use of audio, visuals, video, and 4) Hands-on demonstrations and exercises. It can encourage students to be active members of the class: Students are thinking on their own, using their own brains, resulting in long-term memory retention. Not only the students' knowledge will improve, but their interest, strength, knowledge, team spirit and freedom of expression will increase as well. Moreover, it can practice makes perfect: Interactive instruction enhances the learning process and measurable student accomplishments: Teachers making use of interactive teaching styles are better equipped to assess how well students master a given subject material. Also, flexibility in teaching: Applying training methods that involve two-way communications will enable you to make quick adjustments in processes and approaches.

The rest of the paper is organized as follows. Framework for the proposed system in section II. Scope are presented in section III. Design of authoring system for interactive content are mentioned in section IV. Concluding remarks are given in section V.

II A FRAMEWORK FOR THE PROPOSED SYSTEM

An Automated Problem Solver (APS)[4] has been designed and the prototype was developed for solving numerical problems with multiple goals in the domain of Mechanics. The problem solver incorporates the following features:
• Generate verbal problems that was prepared by the teacher, system, and the student, often accompanied by supporting diagrams and present these problems to the one student after the other for the solution. Student chooses the option of the either APS solving the problem or the student solving the problem.

In case the APS solves the problem
• The filter translates the problem into a parametric form, where the goal parameters, known parameters, the values of the known parameters, and the units of the known parameters are defined. In case of ambiguities in the problem, it resolves these ambiguities through a dialogue with the student. The filter classifies the problem into suitable sub-domain, which based on the principles of Physics and using the category information generated by the filter. Using this classification information, it generates a template based sketch of the problem. In case, the problem could not be translated or there were ambiguities in the interpretation, the system records the relevant information in appropriate files.
• The parametric values of the known parameters transformed such that the units of the parameters in SI units.
• The APS will solve the problem with multiple goals by using direct relationships provided in the knowledge base, if such a solution is feasible. In finding the values of multiple goals, it will sequence the multiple goals such that the value of the previously computed goal that used as known parameter in computing the next goal. The problem solver

engine makes use the problem classification information to retrieve the problem solving strategies specific to the sub domain and makes use of these strategies along with the general problem solving strategies. The information on whether the problem was solved or could not be solved due to gaps in the knowledge base will be recorded in suitable files. Similarly, the solution path is also recorded in suitable files. The system will generates alternative solutions, if the student desires such solutions.

• In the case of the problem's goal, parameters cannot be found directly in terms of the known parameters, the system generates intermediate goal parameters and makes the use of these parameters in progressive evaluation of its goal parameters.

• The concept of proximity, the graph was developed which will be used as a heuristic to find the intermediate goal parameters. The specific algorithms to generate the proximity map, generate intermediate goal parameters and the solutions to multiple goal parameters were developed.

• The APS generates the domain model of the student and keeps it updated dynamically. The model is used for guiding the student in the problem solving activity.

III SCOPE

The major objectives in the development of the problem solver are a) To provide an intelligent, automated numerical problem solving environment [10] to the users, namely the teachers and the students in the domain of Mechanics, a subset of undergraduate Engineering Physics, which could be subsequently expanded to include other domains in Engineering Physics by adding the relevant domain knowledge. b) To develop a design methodology and tools for a domain independent automated problem solver.

The current automated problem solver (APS), will present the student (user) one problem at a time on the screen from the set of the problems prepared by either the teacher or the computer. Alternatively, the problem solver may accept a problem from the student and display it on the screen. Once the problem is presented on the screen, the user has the option of solving the problem or asking the APS to solve the problem.

IV. DESIGN OF AUTHORING SYSTEM FOR INTERACTIVE CONTENT

The Intelligent Authoring system (IAS)[5] provides environment to the Authors to create lessons or Tutors for any domain and supports all activities that are needed by authors to design and develop lessons or part of the lessons that could be used in Intelligent Instructional systems. The Tutor would support bi-directional interaction in lessons – ability to question and receive response in both directions, multiple instructional strategies, generate dynamically changing student models and use them in guiding/controlling the lesson flow and instruction.

The authoring system keeps track of the student progress and generates dynamic Domain student model using the course structure graph and content structure maps. The base cognitive model as described in section 6 would be implemented and the respective parametric values would be obtained by an agent and the model would be updated. The DM and the CM would be used to decide about the navigation and adaptive testing.

Appropriate SW components are invoked by the system as it guides the user to define course structure graph and content structure graph and at run time and these build the system in the background.

Main Components of the authoring system Software consist of 1) Course structure build: It is responsible to build the course in terms of units, unit structure, Domain modeler, Content structure build, Unit builder, Text & Graphic build , Practice build builds drill and practice and examples, Evaluator, Cognitive model build, Cognitive Agent, Web page build, Expert build, Simulation build, Question analyser-dialogue, Answer generator – simulation, Answer generator – Expert, Answer generator – database, Besides these there are additional modules as described below along with its functionality; **2) Content Manager**: CM keeps track of the basic resources, their modifications, usage by different users, maintains the necessary databases etc. **3) Structure Editor:** SE helps the author to define the structure of the lesson without putting the content into the lesson. This lesson structure may be used to represent the flow of the lesson, lesson plan/structure and the teaching strategy. The lesson may be one or more episodes supporting a single objective or a lesson spanning one to two hours. The lesson structure defined might be devoid of content or might incorporate content. It helps the teacher to view the lesson structure without going into the details. The lesson structure is built with the help of structure editor which may contain **executable** and mere **explanatory /non-executable** primitives. The explanatory primitives are used for documentation and also to incorporate certain off the computer based activities. **4) Content Creator** – This is a MM Editor that would help the author in putting the content into the lesson. In fact, the Content Creator might consist of a number of editors like text editor, graphic editor, animator, video & audio inserter etc. **5) Tools** - These are to be used by the teacher and the student. The access to these tools is provided through either the lesson screens or through the resources offered by the LMS. These tools include computation, graphing, graphic, database, Virtual laboratory, tools and also include simulation, and expert system builder tools and External professional tools.

Authoring process – roadmap

1. **Authoring Tool**: This screen is launched on request for the tool. Displays the title Intelligent Authoring System for a limited period of 5S and then next screen is displayed.
2. **Functionality:** This screen tells the user about the basic capabilities of the authoring system. The screen could be skipped using next button at any time. The screen would also provide a demonstration of the capabilities of the IAS. On completion of the demo, the control comes back to the functionality screen. Should there be a tutorial for initial start up?

   1) Information collection:

   This screen authenticates the user and collects the following details:

   a) Name of the author
   b) Target group
   c) Date & time (dat)
   d) Name of the lesson/unit to be created/accessed
   e) Suggested ways of using the course material/lesson
   f) External activity suggested to support the lesson and tools needed to support the activity
   g) Prerequisite knowledge of the student
   h) Relationship of the lesson with the rest of the material in the subject/course

   It creates appropriate metadata automatically, based on the information provided to the system.

   2) Define Objectives:

   a) *Prompts user to enter one or more objectives.* This step is optional and could be done at a later stage too if the user wishes. The window displays model objectives and suggests modifications to the written objectives, if required.
   b) *Prompts user to select class of Objectives and guide in the selection*- Use Blooms or any other classification. (e.g., Gagne, Merill, Mager etc..)
   c) *Provides Feedback* - Provides help through model examples. Feedback may be on the structuring of the objective or on the class of the objective.

   3) Select Instructional Strategy:

   - Some of the instructional strategies are listed below:
     - Listening to Lecture/reading
     - Discussion/interaction, brainstorming, group discussions, seminars
     - Watch films/video
     - Analyse case studies/situations
     - Problem solving /Design
     - Drill, practice
     - Calculate, compute
     - Laboratory activity
     - Simulations/explorations/discovery
     - Activity based learning – may be on the system and away from the system
     - Games, acting
     - Project work, group work
     - Narrating, story telling
     - Argue
     - Sketch, draw

     Each strategy might use a different media and helps in developing different abilities or objectives.
   - Each chosen class of objectives defines its own set of instructional strategies. The author can choose one of the displayed strategies or select a new one.
   - Instructional strategies may be displayed in terms of structures defined using structure chart.
   - Instructional strategies have their own characteristic words/ vocabulary.
   - Instructional strategy may not only depend on objective class, but also on classes of domain objects. Broadly 5 types of objects are defined – concepts, principles, procedure, problem solving and application.
   - Incase user selects his/her own strategy, the system should check for viability/suitability and appropriately provide advice.
   - The system must permit revision of strategy.

- The system should generate appropriate metadata based on the strategies adopted.

4) **Develop Test Items:**
   - This screen presents objectives, class and instructional strategy and allows the teacher to develop test items for the objective.
   - Each item on test is validated. Suggestions for modification provided.
   - Test may have one to many questions that are predefined or a link to Qbank with a TOS (Table of Specifications) is provided.

5) **Create Structure and Content:**
   - The screen presents objective, class, strategy and test items. Access to **structure editor** and **content creator** are provided. Teacher can use them to create structure and content.
   - Author could save the lesson/unit at any stage. Default saving of every content block after introduction of every frame.
   - Where strategy is identified system warns, if the strategy and structure differ. (Implementation is not clear – how??) Author could override the suggestions.

The User Interface:

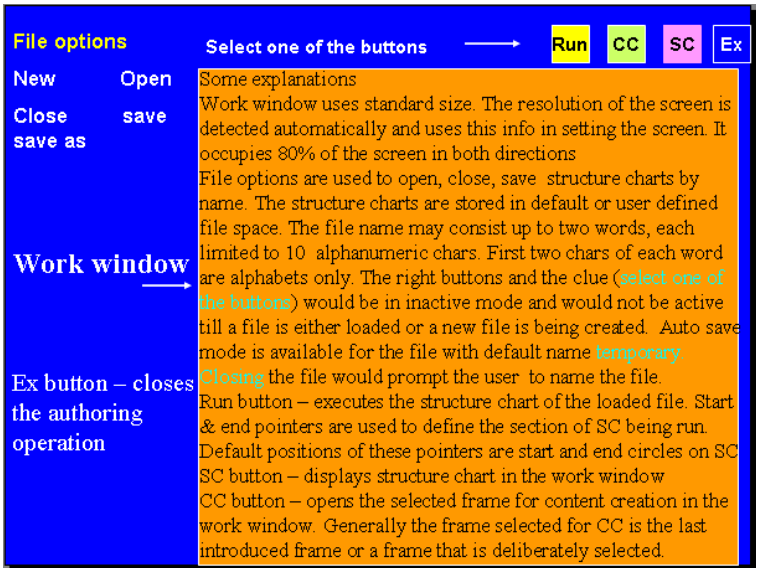

FIGURE 1 GUI of authoring system

Structure Chart Editor (SC): A structure editor is a graphical editor that can be used to model content structures and relationships. It helps to define the lesson structure and navigation from the start point to the end point while authoring content and also to get a view of the lesson plan. The structure editor has its own primitives, which could be used for adding the following types of elements to the diagram:

The start and end primitives are defaults and not shown below in the list of primitives and are included in every structure chart. *Start* represents the start of a structure chart and End, the end of structure chart

When one chart is embedded in another, these are removed from the inner chart. The primitive TOS generates the test using a Question bank and present the test it to the student during RUN.

- Display
- Interaction
- Comment
- TOS

Authoring system presents the lesson in terms of frames. Each frame may not exceed two screens.

The lesson is considered as a sequence of frames with time line running down. We may call it the **spine** of the lesson. Spine represents the main flow of the lesson.

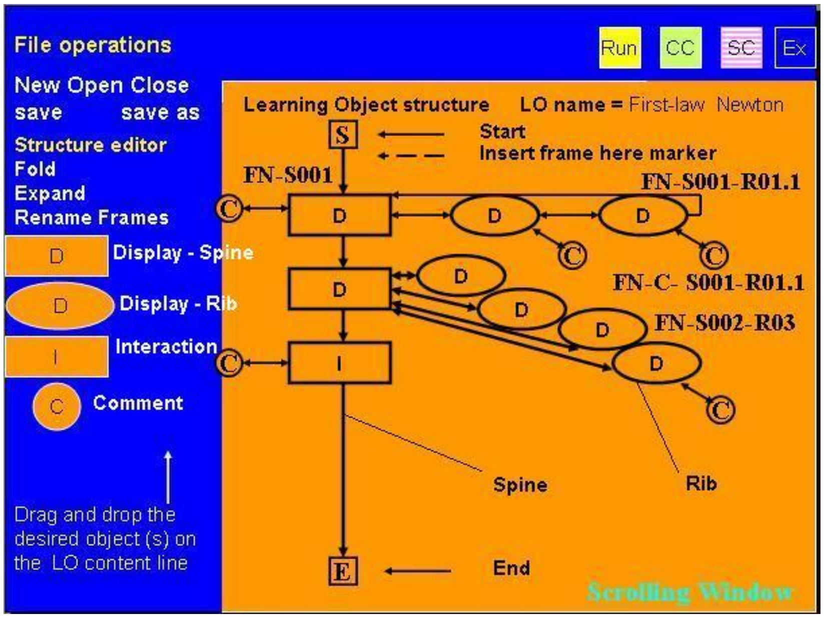

FIGURE 2 GUI of structure editor

Structure chart is composed of *Display* and *interaction* frames on spine and display frames on the ribs. **Rib** frames are connected to the spine frames through hyperlinks. Rib frames are explanations, additional support materials etc. Comment frames could be attached to spine frames and rib frames. *Comment* frames are provided such that the author can use it for further reference. These could be used by those authorised by the author and could be deleted once the author is through with content creation. Rectangular frames are spine frames; oval and circular ones are rib & comment frames respectively. we may use Dialogue/Interaction frames on the rib for the student questions

SC Editor allows rectangular frames only on the spine line and the oval frames only on the rib lines. The circular frames could be attached to frames either on the spine or on the rib. Ribs start from spine. A spine may have thus any number of rib frames attached to it. Rib length is by default limited to 2 frames. But this restriction can be modified by going into settings frame.

Each frame on the spine may have a number of horizontal frames attached to it. These are the explanation, further reading frames. These are accessed from the spine frame through hyperlinks. They are called rib frames. The spine generally comprises of display frames and interaction frames.

A display frame may display text, graphics, tables, animations, video and audio. Some of them need to be synchronized.

Interaction frame[6] is used whenever the author wants to put questions to the student. Interaction frame is a composite frame. Simulations, explorations and expert systems are considered to be Interaction frames.

The structure editor permits looping of the frames for repetition and this is done by using an interaction frame in a control mode.

The tools are generally accessed from interaction frames, even though they could be incorporated or called from display frames. Once the user clicks on the Structure Chart (SC) button, a new window opens with the start and the end button. A palette /tool bar would contain icons which would represent the display element, interactive element and the comment element. The user would have to drag and drop the elements in the structure chart. Once the elements are dropped on the structure charts, the CC button can be pressed once the display or interaction element is selected.

6.3.2 Content creation

The user selects the frame on the structure chart where content is to be created. Then the user clicks the CC button. Provide reminder to select the frame when CC button is pressed.

This leads to the CC view with relevant options and tools under the head MM editor, interaction builder, and tools. In the interaction builder one could use MM editor or tools and also provide tools for the use of the student.

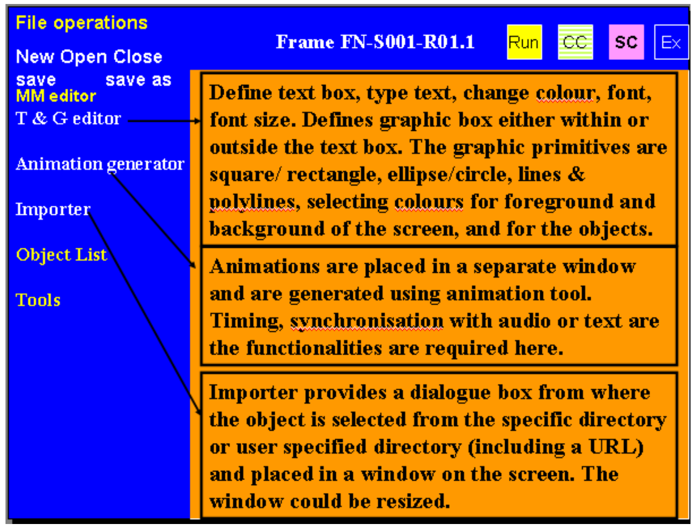

FIGURE 3 GUI of content creator

MM editor consists of Text & Graphic editor, Animation generator, and Import facility. Selection of each option opens either a tool set or a dialogue box to facilitate the operation.
Interaction builder provides facility to build Interaction frame. Interaction frame is a composite frame. It permits incorporation of Question and response, building exploration and simulation environment

6.3.3 Object List

As a result of using the MM editor, a number of objects are created/imported/ edited on the frame. The system stores these elements as Objects list and the frame is edited either by viewing and manipulating the objects on the frame or using the list.
Clicking on each object in the Object List will highlight the object on the spine/rib.

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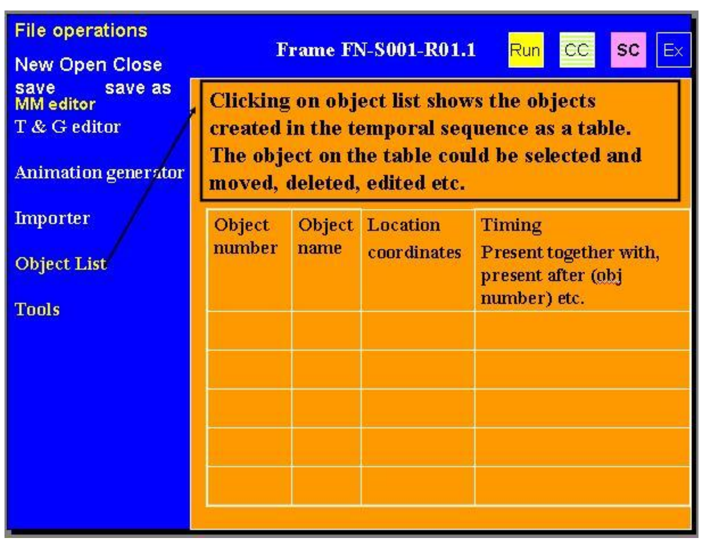

FIGURE 4 GUI of object list

Tools: such as Computational tool, Database tool, Graph tool, Graphic tool, Simulation, Expert system, are made available and these are dragged on to the CC window for making them available to the student when using the frame. The external tools when placed on the screen would connect the student to appropriate tools existing on application servers.
Importer facilitates import of Video, audio, image, text, graphics from the predefined location or from user specified location including a URL.

Components of MM editor and tools are existing in some form or the other.

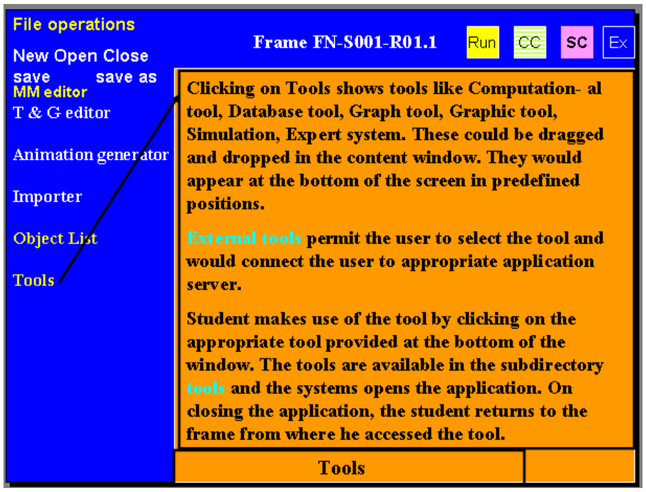

FIGURE 5 GUI of tools selector

Run:

After the structure chart for a lesson is made and the content is inserted into the frames, the lesson/ or learning object is executed providing the student view of the CW. Though the actual execution occurs in the user space – user system, user environment, browser, testing the system in the developer's environment provides useful feedback.
This is done through Run option. Thus to run the learning object, we need to have a valid lesson structure chart (ie content ready lesson) on the system. We may have to set the start and end points of the run with appropriate pointers. The default is the start and end boxes of the chart.

V.CONCLUSION

The parameters for the areas of knowledge acquisition, cognition, work habits and attitudes are weighted for obtaining the value for the area The weights for the parameters for each area may be assigned on the basis of research study For the purpose of the study each parameter is given equal weightage Though there is substantial justification for treating cognitive model as a separate entity from the domain model, the validation for the cognitive model may have to come from its usefulness in the instructional systems The generic cognitive model developed could also be used for modelling general human behaviour besides being used for modelling student cognition.
The current work provides a schema for simple cognitive model for incorporation in the computer based educational environments. More complex and powerful cognitive models may be built by improving the parameters, the attributes of the parameters and the interpretation of the scores. The schema could be used by cognitive scientists and educators. The concepts and the design developed during the current work will help in developing software tools for future work in automating cognitive model.

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