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A MODEL FOR A CAI LEARNING SYSTEM

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Abstract

Over the past ten years, computer-assisted instruction (CAI) has had an impact on the educational system. In this paper, we discuss our view of a model for developing an integrated set of CAI modules for any given subject area. The model has been implemented and tested, with very favorable results, for the subject area of metrication.

Key Words

Computer Assisted Instruction, CAI, Learning Model, Metric System, Metrication.

I. Introduction

Computer-assisted instruction (CAI) systems have been available for use and evaluation by educators and computer scientists during the last two decades. However, until only recently such systems required large computers on which to run. With the advent of miniaturization, smart terminals and microcomputers, this may no longer be the case. In fact, it is now apparent that CAI should be revisited, in light of these technological developments, to determine the degree it can be utilized as a resource within the educational process. Our recent experiences indicate that the educational and industrial communities must consider using CAI on microcomputers as a viable approach to training.

As CAI is reevaluated and found to be an effective supplement to the educational process, what will be required is a well defined, structured approach to producing CAI modules for public dissemination. As pointed out by Nievergelt (3), CAI is now in the public domain. If basic models for CAI lessons are not provided, the public will be inundated with conflicting materials developed by dedicated people who have had little or no training in producing effective lessons. Software production must be constrained so as to insure effective CAI modules.

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In the remainder of this paper, we will discuss our view of a model for developing an integrated set of CAI modules in any given subject area. The model has been implemented and tested and the results of this implementation will be discussed. In addition, based on our experiences with this model, recommendations and conclusions are given regarding the future direction and production of CAI modules for microcomputer oriented systems.

II. A CAI Learning Model

The educational process essentially involves the determination of what should be taught, for whom the instruction is intended, and what resources are available to aid in the process. As mentioned earlier, the microcomputer, with its ever increasing availability must now be considered as a potentially valuable medium when determining instructional resources. The teacher must decide what material, if any, is best suited for and most effectively presented via the microcomputer.

Regardless of the original intention for the computer based learning system, whether it was to be a complete self-contained system replacing some traditional forms of education or a CAI system which supplements the learning situation, it is clear that the user becomes actively involved in learning. The involvement (CAI) can take many forms:

1. Individualized drill and practice exercises which reinforce a given concept,
2. Computer-based tutorials where the material presented is dependent upon the user's responses, and
3. A complete dialogue system where the student and the computer carry on a learning experience dialogue.

The model to be discussed utilizes the first two views of CAI, namely, drill and practice, and tutorial.

Given any subject area, the relevant material can be broken down into distinct but related con-

cepts. The task of the teacher is to present these concepts in an iterative manner in such a way that the learner proceeds to the next concept only after internalizing to some degree the previous ones. The final test of understanding on the part of the learner for the given subject area is that he or she can "live" the learned material. It is upon this common sense approach that we base our model for producing CAI modules for given subject areas.

The basic model for a CAI learning system is given in Figure 1. The model reflects the view that a given subject area can be broken into components called modules where the material in each module can be further delineated and presented in lessons. The diagram in Figure 1 depicts the user flow through a given module along with the process controls which direct and manage the learning activities. Upon completion of a module, the participant is either directed through remediation or, when successful, the participant proceeds to the next sequential module.

The flow, as depicted in Figure 1, through a given module is user response driven. The user enters the system by establishing what prior knowledge of the given subject area he or she already possesses. Upon completion of the pretest, the learning system will provide the user with a suggested lesson flow path through the module based on their pretest performance. The diagram indicates user input to the lesson flow is possible since it is labeled "suggested" lesson flow.

Once a suggested lesson flow path through the module has been established, the user enters an iterative loop until all lessons within that flow path are completed. Each iteration of the loop constitutes a lesson and its completion indicates the user's grasp of that lesson's concepts. As indicated by the dashed area of Figure 1, the material within a lesson is presented in a structured way, core material first, followed by drill and practice exercises to reinforce the concepts just presented. The user's understanding of the lesson is then tested to determine whether remedial work is required. Should the performance not be acceptable, the user is exposed to remedial material reflecting any deficiencies identified. Such activity is continued until mastery of the lesson is achieved.

Certainly within this major loop of the model, a substantial number of decisions relative to a variety of CAI aspects must be made by the developer of the module. The rate of presentation of the material, and whether it is to be core material or remedial, must be determined. This decision should be based on user responses to embedded questions within the material. In addition to the rate of presentation, the type of interaction required by the user and the kind of feedback (corrective, immediate and/or delayed) also play an important role in the effectiveness of the lesson. The model is general enough yet structured so as to allow individual training styles to be accommodated.

Upon completion of all lessons within the module, remembering that the initial lesson flow path potentially could have been altered according to user performances within the learning loop, the user is required to live the module. The model accomplishes this through the role play component. Not only does this component of the module insure that the prerequisites for the next module have been attained, but it also enables and requires the user to put into practice his learning. Should a role play, which certainly can reflect the user's background, identify an unacceptable internalization of the module's concepts, user review lessons are indicated.

As can be seen, the model not only gives an overall framework for module development but also provides the flexibility to accommodate individual teaching strategies. Such strategies can be implemented using other aspects of CAI.

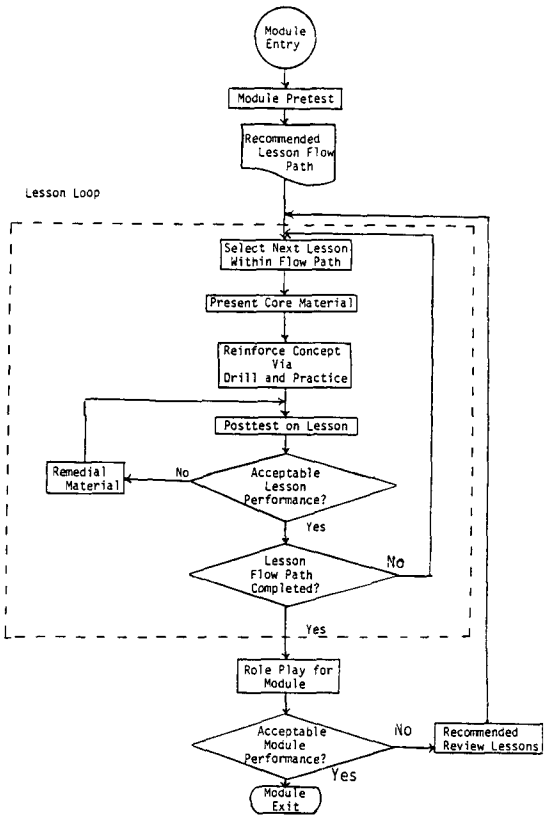

Figure 1 Model for CAI Learning System

III. A Model Realization

As with all models, the "proof is in the pudding". That is, its value is in the performance of given instances based on that model. With this in mind, the above model was utilized to develop a CAI learning system for the metric (SI) system of measurements. The CAI system, called CAISI, was used to train teachers in the use of the metric system. The results indicate that CAISI was very effective in not only teaching and/or reinforcing the metric system, but also in motivating the users to consider the computer and

CAI as a valuable educational resource to be utilized whenever and wherever microcomputers are available.

With the metric system as the subject area, a natural module division consisted of the four basic areas of masurements, namely, length, area and volume, mass, and temperature. Within a given module, the lessons were apparent. If one is to know any system of measures, they must acquire the vocabulary and be able to relate to it. Once this is accomplished, an ability to use these units in one's daily activities certainly is the next step to knowing the units. Finally, one has internalized the particular units if he can use them effectively. Perhaps the real indicator relative to this last step is if the participant can use the unit to estimate the real world around them. Thus the lessons within a given module were identified as (1) Vocabulary, (2) Reference Points, (3) Daily Living, and (4) Estimation.

As suggested by the model, the final test was to immerse the user in some familiar role where they have to deal with a world that is totally metric relative to the particular module being taken. One such role for length consisted of Monday Night Metric Football.

A view of the CAISI learning system developed from our model is given in Figure 2. For any given module (length, area and volume, mass or temperature), the user is sequenced through the associated lessons of vocabulary, reference points, daily living and estimation according to his performance within the core material. At any time within a module, should remedial work be required, the user and/or the program has several options. If after completing a test for a lesson a certain predetermined threshold is not reached, the program will cycle the user through remedial work. On the other hand, if short-term information is required the participants may page back through the material or they may ask for a "hint" for some of the ideas. Upon completing the four lessons, an appropriate role play based upon participants background/ interests is selected for module exit.

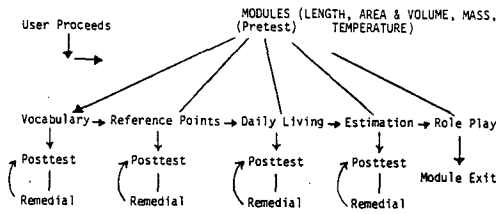

Figure 2 Lessons for SI modules within CAISI

The SI learning system, CAISI, was implemented on both a large-scale time sharing system, the DEC 1090, as well as on the PET microcomputer system. The language used was PILOT, a CAI oriented programming language. The DEC 1090 version of CAISI provided the following user capabilities:

1. A module to instruct the user how to:
   a. log onto the system through the terminal
   b. use the terminal,
   c. invoke CAISI,
2. The ability to go back to previous material before proceeding on to new material within the lesson,
3. The ability to ask for hints relative to embedded questions,
4. The ability to make comments and give input relative to the material being presented in the lesson, and
5. Accounting routines relative to individual users.

To supplement CAISI, computer metric games were available as concept reinforcement on the PET microcomputer. These games, including Metric Hangman and SI Clue, were not only instructive but also made learning fun and enjoyable. The users were shown a new dimension to education via CAI, namely, the graphical capabilities of microcomputers and their ease of use.

IV. Testing and Evaluation of CAISI

The testing and evaluation of CAISI was conducted during the summer 1980. During this period CAISI was an integral component of several workshops sponsored under a grant from the Department of Health, Education and Welfare for the in-service and pre-service training of teachers in the metric system. The results of these workshops clearly indicate that our model for CAI module production is certainly on the right track for producing effective computer based learning systems.

Five, two-week workshops were conducted to introduce elementary and secondary teachers of the local school district to an individualized, CAI approach to learning the SI system. During the course of a workshop, each of the participants was exposed to both traditional (hands-on experimentation) and non-traditional (CAI) means of becoming familiar with and understanding the metric system of measurements. A "class" consisted of the participants individually accessing the CAISI modules for approximately one hour, then they would leave the terminals and perform a prescribed set of experiments related to the material. This procedure was repeated twice in each four hour day.

Tables I and II provide basic results as to the effectiveness of the overall workshop format and, as can be seen from these tables, appreciable improvement occurred by comparing pre- and post-test scores. An even more dramatic improvement occurred for that group of participants who had a very low entry level knowledge of the SI system. The results as described in Tables I and II are encouraging, but by no means unexpected; what is more interesting is the qualitative information contained in Table III. The data contained in that Table indicate that for every group of participants, except one, the CAI approach had a greater impact on their learning than did the more traditional hands-on experimentation. Although additional test information is available, see (2), the emphasis here is on the need for an extensive reevaluation of CAI based on the availability of hardware and effective software modules.

WORKSHOP PERFORMANCE

Workshop #	Pretest Low	Pretest High	Pretest Mean	Posttest Low	Posttest High	Posttest Mean	Change Low	Change High	Change Mean
	Percents			Percents			Percents		
1	10	83	42.6	71	100	94.1	9.5	80	44.8
2	23	83	62.4	82	100	92.8	12	68	30.4
3	40	93	65.2	82	100	90.0	3.1	60	24.9
4	6	73	43.5	82	100	86.7	19	72	43.6
5	30	83	56.7	75	93	83.3	9	46	26.7

TABLE I

LOW SI ENTRY LEVEL*

Workshop #	Pretest Mean	Posttest Mean	Mean Change
1	16.6	80.3	63.7 (6)
2	26.7	87.2	60.6 (2)
3	----	----	---- (0)
4	14.1	79.5	65.3 (4)
5	30.0	75.0	45.0 (1)

*Pretest Score 30%

TABLE II

EFFECTIVENESS

Scale:

1	2	3	4	5
Poor	Fair	Average	Good	Excellent

A. Classroom Activities (Overall)

Workshop	Responses	
#1	4.43	
#2	4.13	
#3	4.00	4.00
#4	4.50	
#5	3.50	

B. Hands-on and Project

Workshop	Responses	
#1	4.23	
#2	4.26	
#3	3.45	4.00
#4	4.35	
#5	4.60	

C. CAI-Modules (CAISI) on Learning SI

Workshop	Responses	
#1	4.50	
#2	4.33	
#3	4.54	4.17
#4	4.42	
#5	4.60	

TABLE III

V. Issues, Recommendations and Conclusions

The potential currently exists for an explosion to occur in the production of CAI modules. The question is, how can the proliferations of such material be controlled so that only reasonable products are made available to the public in general? Certainly providing a model for CAI software production is a start. In addition, work by Nievergelt (3) and Chambers, et. al. (1) regarding a practical approach to CAI software will assist in producing good software. Other issues include such questions as where does the computer software specialist fit into this picture? Where do non-computer trained but creative educators fit? How do we address the portability and dissemination of such products across the many new families of personal computers? These and other challenges lie in the future for CAI proponents.

Regarding the production of CAI software, our experiences during the workshops would cause us to encourage team production of CAI systems. Interested people are creative. By coupling specialists in a given field with others who have computer programming skills, you have the making of a productive CAI team.

Finally, microcomputers have opened a whole new dimension to education as an adjunct to the teaching/training process. As such, CAI must be considered and evaluated as a component of the educational process of the future.

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