Interactions in Computer Aided Instruction Systems to Meet
The Changing Goals of Higher Education

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Abstract

Goals and challenges in higher education have been changing in recent years. There are more interests in employment-oriented majors such as computer science and bio-technology. More employers want their employees to go back to school to refresh their knowledge in fast changing fields. With these changes, our students are becoming more aware of the importance of developing specific skills and knowledge that employers require. I expect these changes to continue well into the future. This position paper discusses how Computer Aided Instruction (CAI) systems with “high-quality” interactions centered around a reasoning tool will help us meet the changing goals of higher education.

1: CAI: high-quality interactions = learning outcomes + assessment

Several years ago, the California State University system developed ten principles which were designed to form the basis of strategic planning for the University [1]. Teaching in an employment-oriented field in which students seek to advance their skills and knowledge, I was particularly struck with the first of the ten principles - “award the baccalaureate on the basis of demonstrated learning as determined by our faculty.” This involves defining the learning objectives for students and evaluating or assessing student learning. Although many feel that this principle should already be part of any education system, it is surprisingly difficult to enforce clear learning objectives as instructors change. University catalogues usually list a number of topics instead of learning outcomes. Assessment of student learning is also a difficult issue. I argue that we should be using assessment tools for two reasons: 1) to understand where the student is having problems so that we can remedy the situation, and 2) to determine whether he/she has mastered the material. Assignments and exams are designed mostly for the second goal. When there are more than ten students in a classroom, it is difficult to use exam results to help each student. Also, in order to cover the required topics within a term, instructors cannot slow down for a small group of students. Moreover, even when the instructor knows that a student has not mastered the material, the student passes the course with incomplete knowledge. The next course will try to build on top of this incomplete foundation.

What changes are required for us to focus on assessment of student learning for the right reasons? Are these changes feasible? I propose a certain kind of Computer Aided Instruction (CAI) as a possible solution. Not all CAI systems can address this problem. However, with CAI, we can embed the learning objectives into the material itself by constantly assessing the student’s skills and/or knowledge. Sequences of exercises can be tailored for each student based on the assessment results. No student will move onto the next material until the system is satisfied with her performance. Interactions that obtain enough information about the student to make such assessments are “high-quality” interactions.

2: Development, changing roles, changing reward systems

Is it feasible to create a “high-quality” CAI system for every course? Will it be possible to update it frequently? If we can develop an “authoring tool” that ensures high-quality interactions and little programmer involvement, the answer is “yes.” In fact, the Script Editor and Script Interpreter in the Irvine-Geneva strategy [2][3] were designed with this goal. However, more research is needed to allow a variety of pedagogical features.

How will the instructors’ roles change? Instead of preparing written documents for their courses, they will prepare pedagogical designs for their CAI systems. Instead of lecturing, they will be supplementing their systems through additional human-to-human interactions with the students. They will share their experiences and views which are not part of specific learning objectives.

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1 The author acknowledges that her views expressed in this paper do not necessarily represent those of the California State University.
They will also advise students based on the system’s evaluation of the students. Students will see their instructors more as mentors and advisors than as just a knowledge source.

Will reward systems need to change? Yes, although this is difficult, the administrators will have to develop criteria and tools to evaluate and reward the instructors not only for the hours they spend in their classrooms but for the quality of the systems they have designed and for their effectiveness as mentors and advisors.

3: Importance of reasoning tools

There is one essential ingredient that controls the success of these systems: the teachers who design the materials. The teachers themselves must have clear learning objectives, must be able to create interactive conversational exercises, must believe in assessing the students to help the students, and must know how to assess student learning.

In our experience in designing CAI systems with good teachers, we often hear anecdotes about some teachers not being able to explain to their students why something works the way it does. In many cases, they themselves learned the material through drill and practice without understanding the fundamental concepts. They can pass on the steps to their students but cannot explain why these steps work. This problem manifests itself in introductory Computer Science classrooms. The students know how to solve algebra problems as presented in math textbooks but do not know how to apply the knowledge to analyze computer algorithms. When the students understand only the steps but not the underlying concepts, they cannot apply the knowledge to new situations. With fast changing fields, it is more important than ever for our students to be able to apply knowledge to new situations.

I propose that we always give our students “reasoning models”, tools with which they can understand how something works the way it does. I have incorporated the use of reasoning tools in all of the recent systems I have developed. In DaRT (Diagrammatic Reasoning Tool for learning English articles), situational diagrams are used as reasoning tools to explain when to use definite versus indefinite articles [4]. In the ELM Preparation System, diagrams depicting situations as described in word problems are used as reasoning tools to explain how to solve distance-rate-time problems. In the C++ Tracer System, the memory content changes visibly as each line of a C++ program is executed [5], training the student to view a program as an executor of instructions. We are currently developing a reasoning tool to help ESL students learn countability of nouns: when an ESL student encounters a brand new word, how will she be able to tell whether it is countable or non-countable?

The reasoning tools were designed with the following goals: 1) We want the students to develop reasoning skills so that they can apply the skills in brand new situations they had not encountered before. 2) The reasoning tools can be used as common communication tools for students and teachers (or CAI systems) to discuss and explore their understanding of the material. 3) The CAI systems can assess not just the surface-level performance but the in-depth understanding of the material. 4) The students will be able to explain their understanding, or reasoning, to the next generation of students.

4: Conclusion

To focus on student learning outcomes for fast changing fields, future CAI systems for higher education must have the following ingredients 1) interactions to allow individualization, 2) assessment of mastery, and 3) interactions centering around reasoning tools. With reasoning tools, we can foster the next generation of teachers who will help us develop CAI systems with high-quality interactions.

5: References


