Commentary

Application of Computer-Assisted Instruction to Nuclear Medicine Technology

The impact of the computer on present day society is fairly obvious and symbolic of the current technological revolution. Progress in nuclear medicine computer applications in particular has been augmented by the acquisition and analysis of patient data. In addition, the computer is useful for instruction, research, and administration (record keeping, inventory control, and billing).

As an educational tool, the computer is Socratic in nature because it can be used as a questioning device to stimulate the student to apply adjunct knowledge. Computer-assisted instruction (CAI) includes a number of teaching techniques designed to enhance learning. It can take many different forms, such as drills, tutorials, simulations, and interactive situations (*1*). The purpose of drills is to increase familiarity and speed in a given area. An example of CAI is a mathematical drill given by the computer with immediate feedback as to the correctness of the solution. Tutorials, on the other hand, offer instruction by imitating an individual tutor. This is ideal for teaching concepts and principles. Tutorials include tests with immediate feedback providing the instructor and student insight into the weak areas of knowledge. Simulation is a more sophisticated form of CAI used to develop and practice reasoning, problem-solving, and decision-making skills. In medical education, the student may assume the role of the physician and the computer is programmed to simulate the patient (*2,3*).

Various medical, dental and pharmacy schools are using CAI regularly to instruct students (*4–7*). At the Upstate Medical Center, we have a PDP 11/34 time-share computer system or more whimsically, a "solid state Socrates." This amazing instructor is able to assist 16 students simultaneously seeking tutoring on as many topics or courses, and it speaks an author language called DECAL: *D*igital *E*quipment (*C*omputer Assisted Instruction) *A*uthor *L*anguage. This "foreign" tongue is designed specifically to provide individualized instruction for a large number of students. Its most attractive feature is its simplicity from the users' standpoint; i.e., students or staff can communicate easily, even though they may have no knowledge of computers or computer programming.

Interaction between the user and the computer occurs via a typewriter-like terminal and video display terminal. DECAL guides the instructor through creating, modifying, administering, and grading lesson material. It allows learning to be monitored and tested and it facilitates effective curriculum designed by maintaining statistics on student and lesson performance. The DECAL system is used by various departments in this medical center particularly in nuclear medicine to enhance the art of teaching in medical education.

Early in their training, nuclear medicine technology students must master voluminous factual material. In the beginning, there is a great need for refresher courses particularly in mathematics and chemistry. Since it is just this kind of material that can be shifted to the student's initiative and the machine's capability, CAI tutorials were implemented. Our

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approach in writing a tutorial has been to make it as personal, self-motivating, and flexible as possible. A typical example of an instructional package is the basic math tutorial, which consists of five main lessons:

- Number system/fundamental operations using numbers
- Fractions/ratios and proportions/equations
- Significant figures
- Scientific notation/exponents
- Logarithms

Each lesson has the same basic format. Each begins with a preface that includes the overall objectives for that lesson. This is followed by textual material pertaining to the subject, which is spiced with practice questions requiring recall and problem-solving. There are a number of (multiple choice) questions integrated within a lesson depending on the complexity of the topic involved. The final component is an exercise consisting of multiple choice questions designed to assess the objectives for that lesson.

Prior to taking the instructional package tutorial, the student takes a written pre-test to determine entry-level status. Each lesson in the package can be taken as many times as wished. When a student signs on, his name and I.D. number are stored. This is used to make the computer's responses more personal.

To simulate human tutorial response as much as possible, a variety of computer replies have been written in the program (Figs. 1, 2, and 3). In the event of a correct answer to a question, the computer will type out a message. For incorrect answers (Fig. 3), the message "wrong" is typed out followed by helpful hints or an explanation of the correct answer. If the student becomes confused, he or she may branch back to the initial part of the discussion or to a particular segment in the lesson for clarification.

During the last exercise (Fig. 4) of each lesson no help is provided. The student must show adequate proficiency or take the tutorial again. Once the student has gone through a lesson (on the average, 30–45 min) he or she is given the option of continuing with the next lesson or signing off the computer. As the student works through the course, the computer stores a record of his or her progress, enabling the instructor to monitor proficiency and identify deficiencies.

After completing the entire tutorial, the student is asked to evaluate this form of instruction and is given a written post-test. The post-test includes the same set of multiple choice questions as the pre-test to assess quality of instruction.

Our initial attempt at implementing the basic math tutorial has been successful. Results of the pre- and post-tests as well as the progress records stored by the computer indicate that the tutorial served not only as a refresher course but also led to the retention of the basic concepts involved. The students responded favorably to this form of instruction. They expressed the need for more "helpful hints" and clearer explanations of some answers. They found tiresome a standard message "right" repeated by the computer before continuing to the next segment of the text. This particular part of the tutorial is under revision as a result of this suggestion. Currently CAI tutorials are being developed for other courses in our nuclear medicine technology curriculum.

Computer-assisted instruction is a very useful adjunct in the educational sphere of a training program. It alleviates the burden of regularly scheduled classes. It provides individualized, self-paced tutorial assistance. The student is free to repeat any segment of a tutorial

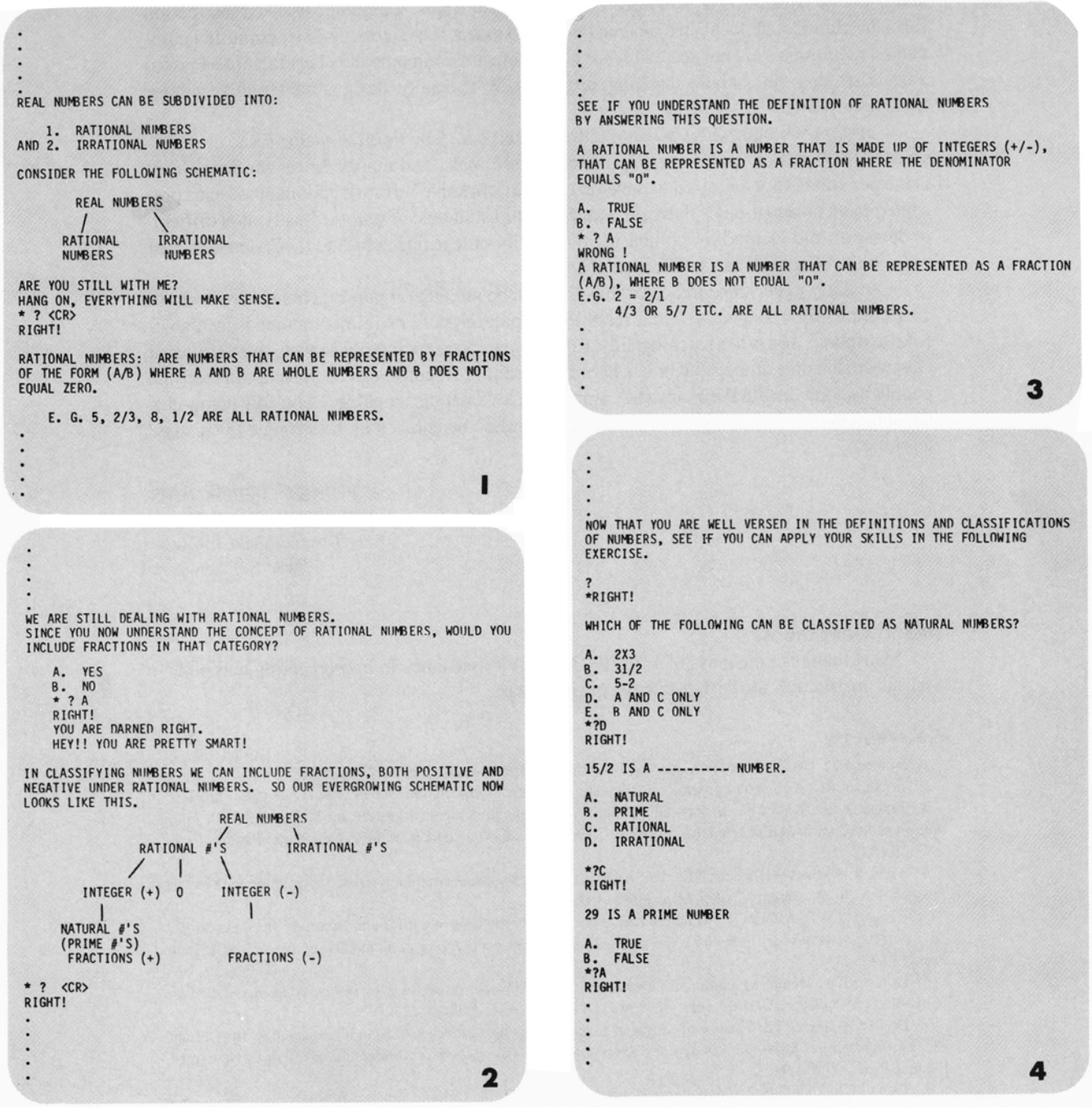

FIG. 1. Text segment of basic math tutorial (lesson: number system). **FIGS. 2 and 3.** Computer responses to correct and incorrect answers. **FIG. 4.** Example of a proficiency exercise (lesson: number system).

and is not penalized for lack of speed in grasping concepts. Computer-assisted instruction furnishes immediate feedback and can be used to assess the quality of instruction. If a computer and terminals are not accessible for CAI, there are minicomputers (available at a reasonable cost) that can handle teaching programs by specially designed interactive author languages (*8,9*).

Certain problems with CAI should be pointed out. One limiting factor is the cost. Besides the obvious expenses of computer time, terminals, and maintenance, the major cost is the personnel time required to develop clear, informative self-instructional packages presented in a conversational, dynamic mode to avoid students' boredom. Lastly, it is difficult to devise a valid method for comparing the quality of learning achieved by CAI and its cost with those of traditional teaching methods.

Our early experience indicates that CAI can be an integral part of a health profession's curriculum, providing access to a reliable computer system or minicomputer is available. Like textbooks and other teaching aids, CAI may supplement but not replace the traditional classroom lectures or the student-teacher relationship. Computers can be fun and can motivate people by appealing to their cultural compulsion to "beat the machine." Thus the computer, the subject of endless science fiction fantasy, can also be enlisted in the struggle to enhance learning.

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