DOCUMENT RESUME

ED 077 250 EM 011 184

AUTHOR Wells, C. H.; And Others
TITLE Instruction in Renal Physiology on a Minicomputer-Based Educational System.
INSTITUTION Texas Univ., Galveston. Medical Branch.
SPONS AGENCY Esso Education Foundation.
PUB DATE Apr 73
NOTE 9p.; Paper presented at the American Physiological Society Symposium on Computer Aided Instruction, (Atlantic City, April 1973)

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Academic Achievement; *Computer Assisted Instruction; *Computers; Cost Effectiveness; Educational Programs; Educational Research; *Medical Education; *Physiology; Problem Solving; Student Attitudes
IDENTIFIERS Minicomputers; University of Texas Medical Branch

ABSTRACT

A prototypical minicomputer-based educational system was designed at the University of Texas Medical Branch to determine if it is possible to evolve complex educational programs which are effective and also flexible and of low cost. Freshman medical students using the minicomputer program substantially improved their problem-solving abilities in renal physiology, although this improvement in performance was not greater than that of a control group undergoing traditional large group instruction. The experimental group, however, required less time to complete the assignment and expressed a preference for the computer-based mode of instruction. It remains to be seen if such instruction can be made cost-effective and whether it can gain faculty acceptance. (PB)

# Instruction in Renal Physiology on a Minicomputer-Based Educational System*

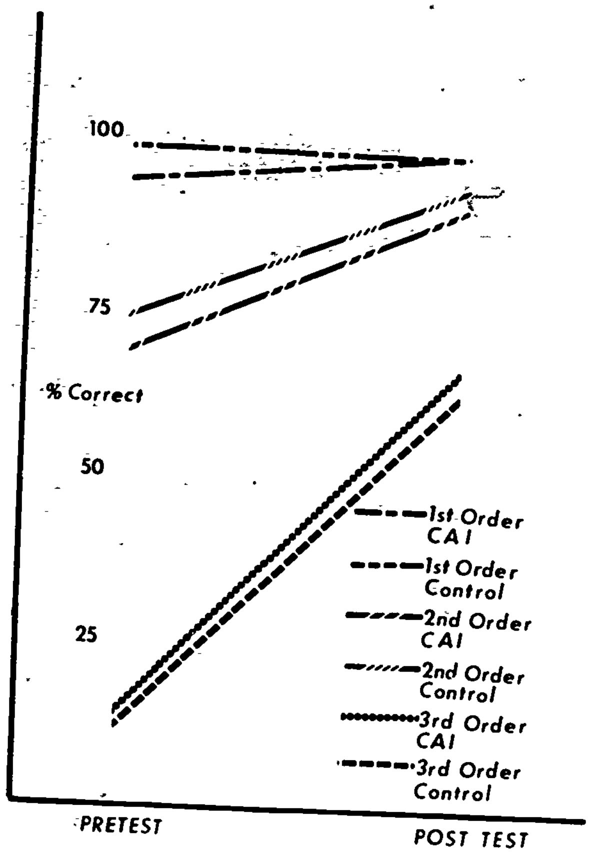
C. H. Wells,** Ph.D., W. M. Thompson,** Ph.D. and

C. S. Holm,** B. A.



* This study supported in part by the ESSO Education Foundation via National Fund for Medical Education Grant 95/69.

** Department of Physiology and the Educational Computation Center, University of Texas Medical Branch, Galveston, Texas 77550


100
75
% Correct
50
25
1st Order CAI
1st Order Control
2nd Order CAI
2nd Order Control
3rd Order CAI
3rd Order Control
PRETEST
POST TEST

It is well documented that Computer Aided Instruction (CAI) can be employed as a highly interactive, effective teaching tool. However both high systems costs and the inability of most faculty to quickly and simply assemble their own CAI material have contributed to the limited utilization of the concept. In an attempt to overcome these difficulties, and still retain the program flexability required of successful computer aided instruction, a minicomputer based system was designed at the University of Texas Medical Branch. A prototype version of this system was assembled and a simple user oriented language (CAISYS-8) prepared for use with it. The following program was one of a series developed to see if reasonably complex, educationally effective programs could be successfully assembled and executed by such a minicomputer-based system.

This program was designed for use in our freshman medical curriculum at the end of the renal physiology lectures. At this time most of our students have acquired the facts necessary for calculation of clearances, Tm values, or the filtration, excretion or reabsorption rates of various substances. However, they generally have not integrated this material adequately to allow them to reliably execute these calculations. An additional period of individual consultation with an instructor or group conference is required before these calculations are adequately mastered. This program was designed to replace such conferences.

Successful completion of a complex calculation which required that the student employ a majority of the desired mathematic and conceptual manipulations was accepted as evidence of mastery of the material. Students able to perform these calculations at the onset were rapidly diverted to other tasks. Those who did not complete the calculation entered into a step by step analysis of the component calculations until the source, or sources, of their difficulties were determined.

The following is typical of student-machine interactions at the program's start.

Machine: Suppose you initiated renal clearance studies on a patient and obtained the following results:

Urine Production 2cc/minute

| | Glucose | Inulin | Osmolarity | PAH |
|---|---|---|---|---|
| Urine | 400 mg% | 0.6 mg/cc | 765 mOs/kg | 3.2 mg/cc |
| Plasma | 290 mg% | 0.01 mg/cc | 293 mOs/kg | .015 mg/cc |

Can you calculate the Tm for glucose for this individual?

Student: No

Machine: O.K., let's be sure we know what a Tm is. The Tm for glucose is the maximal amount of glucose that can be ____________ by the tubular cells each minute.

Student: Reabsorbed

Machine: Swell!

Did this give you enough of a hint for you to calculate the Tm for glucose now?

Student: No

Machine: O.K., let's take a look at this calculation. We've established that we are trying to calculate the maximum amount of glucose that tubular cells are capable of reabsorbing each minute. . .

After the student had demonstrated mastery of this concept he was again asked to perform the original calculation. If unable, his ability to execute each of the component calculations was in turn examined. Remedial information, which often incorporated practice calculations, was provided only as the student's performance indicated it to be necessary.

For example:

Machine: Can you calculate the rate of glucose excretion?

Student: Sure

Machine: O.K., he was excreting glucose at a rate of _________ mg/min.

Urine Flow: 2cc/min

| | Glucose | Inulin | Osmolarity | PAH | Na |
|---|---|---|---|---|---|
| Urine | 400 mg% | 0.6 mg/cc | 765 mOs/kg | 3.2 mg/cc | 43 meq/l |
| Plasma | 290 mg% | 0.01 mg/cc | 293 mOs/kg | 0.015 mg/cc | 142 meq/l |

Student: 4

Machine: No, you have an error somewhere. Take another look at the question and recalculate your answer.

Your patient's glucose excretion rate was _________ mg/min.

Urine Production 2cc/min

| | Glucose | Inulin | Osmolarity | PAH |
|---|---|---|---|---|
| Urine | 400 mg% | 0.6 mg/cc | 765 mOs/kg | 3.2 mg/cc |
| Plasma | 290 mg% | 0.01 mg/cc | 293 mOs/kg | .015 mg/cc |

Student: 1.2

Machine: No, that isn't right either. Let's take a look at the principles involved in the calculation.

Suppose you had collected the following data from a patient:

Urine Production Rate: 5cc/minute

| | Inulin | PAH | Glucose |
|---|---|---|---|
| Urine | 1.37 mg/cc | 4.80 mg/cc | 300 mg% |
| Plasma | 0.22 mg/cc | 0.37 mg/cc | 110 mg% |

This data tells us that your patient was producing 5cc of urine each minute, and each one of these 5cc's contained 3 mg of glucose.

(300 mg% = 3 mg/cc)

Therefore, he was losing 15 mg of glucose in his urine each minute.

(5 cc/minute) (3 mg glucose/cc) = 15 mg/min

Now, let's look at the original problem. Your patient was excreting _______ mg of glucose/minute.

Urine Production 2cc/minute

| | Glucose | Inulin | Osmolarity | PAH |
|---|---|---|---|---|
| Urine | 400 mg% | 0.6 mg/cc | 765 mOs/kg | 3.2 mg/cc |
| Plasma | 290 mg% | 0.01 mg/cc | 293 mOs/kg | .015 mg/cc |

This program may be viewed as an attempt to simulate a one-to-one instructor: student interaction. Although it is doubtful that such simulations would be as effective as live one-to-one interactions they might well be preferable to handling the same material in large group conferences. An attempt was made to evaluate the apparent effectiveness and acceptability of the program. Volunteers from the freshman medical class were divided into two groups. One group of 33 students served as a control and was given a large group conference covering this material by the author of the program. The other group (20 individuals) was given access to the computer terminal, and allowed to use as much time as they desired. Both conference and computer trained groups were given a pretest before conference or program exposure and a post-test afterward.

Both the pretest and post-test contained questions of three levels of difficulty. The simplest of these required only that the student perform a calculation described previously in text and lecture, (i.e., given a urine production of 1 cc/minute, a plasma inulin concentration of 0.01 mg/cc and a urine inulin concentration of 1.20 mg/cc calculate the individuals glomerular filtration rate). For ease of identification these were called first order questions (figure 1).

Questions of intermediate difficulty (second order questions) were those requiring that the student recognize a relatively simple relationship, and perform the necessary calculation, without having been told expressly how to do so, (i.e., given plasma and urine inulin and glucose concentrations and the urine production rate, calculate the amount of glucose filtered each minute).

The more difficult questions (third order questions) were those requiring still more conceptual and mathematic manipulations, (i.e., given the urine production rate, plasma and urine $PO_4$, inulin and PAH concentrations calculate this individual's Tm for phosphate).

A synopsis of the pretest and post-test scores of conference and computer trained students is depicted in figure 1. Neither conference nor computer program exposure improved performance on the simplest questions, (first order questions). Both groups of students handled these calculations with a high degree of accuracy on both the pretest (99% for conference, 93% for CAI group) and on the post-test (98% for each group). The incorrect answers occasionally seen probably indicate random mathematical and data transposition errors, not a lack of comprehension.

The scores for questions of intermediate difficulty did, however, differ between the pretest and post-test for both groups. The conference group scored 73% on the pretest second order questions, with 93% on corresponding post-test questions. This difference was statistically significant ($p < .05$). The CAI group correctly answered 67% of the pretest questions and 90% of the post-test second order questions. This difference too was statistically significant ($p < .05$). No difference was demonstrable between the magnitude of change in performance observed in the conference group and that of the CAI group. The greatest change between pretest and post-test performance was found with the more difficult (third order) questions. The conference group executed 11% of these correctly on the pretest and 62% on the post-test.[1] The CAI group correctly answered 15% of the corresponding pretest questions and 65% of the post-test questions. The improvements in performance between the pretest and post-test were statistically significant ($P < .05$) for both groups. Again, no significant difference could be found between the performance improvements exhibited by the two groups. We interpret these results to indicate that both the conference and computer program exposure significantly increased student performance, but there was no discernable difference between the performance changes produced by the two experiences. The group conference required 55 minutes for all students. Those using the computer expended an average of 32 minutes.

While this difference in exposure time might be greater than anticipated, a substantial difference could be expected. Certainly a large part of any large group conference is devoted to discussion of material already perfectly well understood by a large segment of the student body. The computer program individually tailored the course content to the student's indicated needs and th spent minimum time reviewing material already mastered.

The students who used the computer program were asked to indicate their preference for this, or conference modes of instruction. All had previously attended numerous conferences of the type experienced by the control group and were familiar with their format. A 5 point scale was used: 1 indicating a strong preference for conference teaching, 3 a neutral position and 5 a strong preference for computer aided instruction. The mean score of this evaluation was 4.70.

This program was prepared to evaluate the capability of our minicomputer-based CAI system, and its user oriented language (CAISYS-8) for the preparation and execution of reasonably complex, educationally effective CAI programs. The program appears to be successful. Students using it substantially improved in their renal problem solving abilities. This improvement in performance was not demonstrably different than that of a control group given a group conference, although the performance modification was accomplished in substantially less time. The students who were allowed to use the CAI program indicated a strong preference for this to traditional large group conference instruction.

These results, as well as preliminary results from subsequent tutorial and patient management simulation programs suggest that educational programs such as this, in which the machine serves as a program logic controller and student evaluation device, not as a data processor, are well within the capabilities of minicomputer-based CAI. These results also suggest that computer aided instruction can be effective and well received at this educational level. Although the outlook appears favorable it remains to be demonstrated that such computer aided instruction will realize its apparent cost-effectiveness, and that the faculty acceptance necessary for it to become a practical adjunct to our current teaching methods can be generated.