COMPUTER-BASED INSTRUCTION IN NUTRITION

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INTRODUCTION

A unique approach to the teaching of nutrition has been developed at the University of Illinois at Urbana-Champaign, College of Veterinary Medicine. It employs a computer-based system known as PLATO (Programmed Logic for Automatic Teaching Operation) to teach the fundamentals of nutrition and diet formulation. This new and effective teaching tool provides the student with individualized instruction. He may work at his own pace and actively participate in the learning process. The program uses a problem-solving format which permits the student to derive solutions to problems in nutrition through the use of concepts and mathematical operations. The computational and graphic capabilities of the PLATO system are particularly useful for this type of instruction.

THE PLATO SYSTEM

Hardware: PLATO is a computer-based system totally devoted to education. It has been under development at the Computer-based Education Research Laboratory of the University of Illinois at Urbana-Champaign since 1959 (Alpert and Bitzer, 1970). Several teaching programs have been described previously using the PLATO system (Grimes et al., 1972; Grossman, 1974). In the last 15 years, PLATO has progressed through various stages to its present sophisticated level of PLATO IV. The system uses a large scale Control Data Corporation Computer with a large number of PLATO IV terminals located at remote sites. It is expected that 1000 terminals will be in use before January 1975. Many of these terminals are located on the Urbana campus; however, others are in use at some 68 remote locations from Massachusetts to California, with one in Europe. These are connected to the computer either by voice grade or wide band communications channels. Each terminal communication line is linked to the computer through a network interface unit. This unit permits each student working at a terminal (Fig. 1) to be recognized as an individual. Therefore, he truly receives individualized instruction without regard to activities taking place at other terminals.

The student communicates with the computer mainly by means of a keyboard. This is similar to the ordinary typewriter, with conventional keys in the center, arithmetic keys (+, -, x, ÷) on the left, and control keys (NEXT, BACK, ERASE, etc.) on the right. The computer communicates with the student mainly by means of a display screen. Most students soon become accustomed to using the keyboard, and characters on the display screen have greater resolution than a television screen.

This unique teaching tool has a broad range of capabilities. Its computing power permits complex decision-making. The terminal itself can display alphabetic, numeric, and graphic characters on the screen. Computer generated graphs may vary according to the information provided by the student and the program with which he is working. These capabilities are used in the nutrition program.

Background: "Nutrition Problems" is one of more than 60 lessons developed under the College of Veterinary Medicine PLATO Project. This project was started in the summer of 1970 under the direction of Dean L. Meyer Jones on PLATO III. By 1974, a classroom had been remodeled and computer-based education for veterinary students was a reality. In the school year 1973-74, 4328 student-contact hours were taught veterinary students using PLATO, 187 of which were in the lesson on nutrition.

Philosophy: The objective of the PLATO nutrition lesson is to teach basic principles of nutrition and diet formulation using a problem-solving teaching strategy. Directed toward students at the college level in the fields of agriculture, animal science and veterinary medicine, its primary use has been in the teaching of first-year veterinary medical students.

Mechanics: The program is designed to flow as presented in Fig. 2. The student is first introduced to PLATO and to the objectives of the program. He is then presented with an index of problems which are organized according to subject area (Table 1). The student can choose problems of interest to coordinate his study in a timely manner with the lecture material. The problems are designed to illustrate specific basic concepts and employ nutritional terminology and mathematical operations necessary for solving feed cost relationships, diet formulation and nutritional values of feedstuffs. The Sample Problem exemplifies how problems are designed.

Although some problems are more highly structured than others, their basic design requires the student to select specific information from the problem presented and insert it into the appropriate mathematical equation or table necessary to solve the problem. In most cases, the students must select the correct units as well as the correct mathematical value. The computational capability of PLATO provides a calculator for some of the problems. However, computations are minimized to allow students to concentrate on the concepts being presented in the problem and to reduce frustration encountered with arithmetic computations.

For some problems, definitions of terms and mathematical equations are available upon request. In these cases, a note at the bottom of the display screen states that he may access certain definitions and expressions by pressing the "HELP" key on the keyset. This option allows the novice student of nutrition to develop terminology, whereas the more advanced student may step through the problems more directly. Consequently, the program can reach a broader spectrum of students and can be individualized to fit the student's needs.

Progress of the student is continuously monitored and he receives immediate feedback after each input. If he cannot achieve the correct answer, he can use an "answer option" by pressing the "ANS" key and see the answer to that particular step. The answer option reduces the frustration level, helps maintain an atmosphere of interest and productivity and serves as a convenient option for students to review problems.

The graphic display capability of PLATO has a distinct advantage over more conventional methods of teaching. In one problem the student derives algebraically the amounts of soybean meal and corn to provide a required level of protein. This is followed with a graphic display. The graph is presented in sequential steps until a completed graph appears on the screen (Fig. 3). This graphic solution reinforces the concept relating protein content to feed composition. A more complex example allows the student to select the values he wants to use and uses the computer to graph the result. This format is used in a problem on daily basal energy requirement. The student is given coordinates displayed on the screen and labeled Weight in Pounds (abscissa) vs. Energy in Grams of Sugar (ordinate). He selects a weight, which may approximate his own, or that of an animal; and then by pressing the "LAB" key, the computer graphically derives the basic metabolic energy needs (in grams of sugar) followed in se-

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quence by the active metabolic needs as 175% of basal needs (Fig. 4). In this example, the student personally interacts with the computer in developing his concept of BMR, metabolic size and the energy value of sugar.

DISCUSSION

Effectiveness of the PLATO system was tested by comparing performance of 41 students who worked through the PLATO problems with performance of 19 who did not. As students "signed in" to the program using their name, the PLATO system accumulated records of which students worked which problems. Scores of students who worked more than two-thirds of the problems were compared with scores of other students on a "practical" examination, which consisted of problems of the same concepts but differing in format from the PLATO problems. Secondly, a similar comparison was made using three three-hour examinations. Scoring comparison is listed in Table 2.

Results of this comparison suggest that overall ability of students using PLATO, adjudged from the grades on the other three exams, did not differ from those not using PLATO. Yet, students who had used PLATO appeared to be more able to tackle problems involving routine calculations relating to nutrition.

Although comparison of classes from year to year is difficult to quantify, the general level of performance on the "practical" exam appeared to be considerably better in 1974 than in 1973 even though less time in formal class time was devoted to problem-solving when PLATO became available.

PLATO has certain advantages for the student and the teacher. First, timing is improved. The student can learn at his own pace and review problems at will. The teacher avoids the dilemma of presenting routine material at a pace too slow for the advanced or experienced student or too fast for the slower student. Course lecture time on routine problems can be curtailed at no detriment to the student. This opens class time for informal discussion with individuals, making instruction more personal. Or, more advanced or other material may be taught to give the student a higher quality of instruction.

Secondly, teaching methods and tools are modernized and extended. Due to the effort involved in programming, much more time is devoted to organizing realistic problems in a sequential fashion than would be true otherwise. Novel ways to present problems as well as to solve them are often discovered. Developing such a program refines and distills both thought and teaching methods of an instructor. Parallel to this lesson, a series of self-teaching exercises presenting general information on proximate analysis, energetics and nutrient requirements were developed to further aid student progress. The immediate feedback of answers to questions in these programmed learning exercises, like the PLATO system, simplified grading and avoided the student discouragement of undiscovered errors early in the sequential problems.

Criticisms of the PLATO system are of three major types. First, according to some critics, student interaction with a machine rather than an instructor could lead to impersonalized teaching. This opinion has been disproven by an extensive survey (Siegel, 1974) of 584 students in 23 separate University of Illinois courses using PLATO. Some 79.7% of the students surveyed disagreed with the statement that "computer-based education dehumanizes the student" and 87.6% disagreed that "computer-based education is nothing but an expensive gimmick."

Secondly, mechanical or electronic factors may inhibit progress. Students who do not type may hesitate to use the typewriter-style keyboard. Occasionally, computer failure halts all programs and may discourage the time-pressured student.

Finally, the program construction can be unduly restrictive in terms of precision of answers or of forcing the student to progress through problems in a preset, stepwise fashion. The independent student who prefers to modify the sequence of steps or use a novel approach may feel restricted. Use of a calculating subroutine, which can be called for during various problems, and of branch points to allow students to bypass specific problems or jump from sequential problem solving to a direct question-answer series helps reduce these limitations. The very limited dissatisfaction with the nutrition problem series concerned these difficulties. The overall satisfaction with the nutrition instruction with PLATO, presented in Table 3, appears quite favorable.

Expansion of the program to include a series of self-examination test questions is now underway. Plans to employ PLATO in other animal science courses are being developed. Use of the existing programs in continuing education courses is anticipated. A computer does not criticize or intimidate the absent-minded, dated or timid students, but serves as an unbiased tutor.

Currently, 24 instructors in 21 courses in Veterinary Medicine at Illinois, use PLATO programs, and considerable expansion is expected.

SUMMARY

A program for teaching principles of nutrition to veterinary medicine students using PLATO IV was developed. Students who used the program were more capable of solving general nutrition problems than students not using PLATO. Student satisfaction with the programmed instruction was high. Advantages and disadvantages for students and teachers of the system are presented.

LITERATURE CITED

Alpert, D. and D. L. Bitzer. 1970. Advances in computer-based education. Science 167:1582.

Grimes, G. M., H. E. Rhoades, F. C. Adams and R. V. Schmidt. 1972. Identification of bacteriological unknowns: A computer-based teaching program. J. Medical Education 47:289.

Grossman, M. 1974. PLATO: Computer-Assisted Instruction in Animal Genetics, NACTA Journal 17:20.

Siegel, M. A. 1974. PLATO student attitude survey. Unpublished.

TABLE 1. Problem Index

Subject area	No. of problems	Concepts
Problem index		
1. Food composition	2	Physiological fuel values Total digestible nutrient calculation
2. Energy expenditure	3	Metabolic size Energy needs (graphic) Feed needs for BMR
3. Added energy needs	1	Feed need for exercise
4. Energy costs and feed prices	3	Cost per unit of energy Relative costs of cereal grain energy Value and cost of fat
5. Dry matter	2	Value of high moisture corn Silage vs. hay intake
6. Protein digestibility	2	Digestibility of dog food Digestibility of various proteins
7. Nitrogen balance	2	N balance of growing lambs N balance at various protein levels and protein requirements
8. Protein supplementation	3	Soybean meal supplementation of corn for poultry by simultaneous equations Urea supplementation of diet with non-protein additives Formulating a dog food for protein and energy content
9. Calorie:protein ratio	1	Protein need changes when fat is added to a diet
10. Protein supplementation cost	1	Cost of lysine from various feeds
11. Mineral supplementation	2	Dical and lime additions to a feed Copper sulfate addition calculations

TABLE 2. Student Scores

Type of student	Practical exam	Overall course score
Users of PLATO (n=41)	84.4%	88.0%
Nonusers (n=19)	81.6%	86.9%
Probability of difference being random chance	P<.10	P>.50

TABLE 3. Summary of student questionnaire (n=51)

	Responses (%)
Did you use the PLATO program?	73% All problems
	19% Some problems
	7% None of the problems
Were the problems helpful to your understanding?	81% Yes
	11% No
	8% Omit
How can the program be improved?	14% Have PLATO accept interchangeable units (kg, g)
	8% Rigid structuring does not allow student independence in problem solving
	6% Expansion in number of problems
	4% Make answers accessible after several attempts
	3% Mathematically menial

FIGURE 1. PLATO IV terminal

FIGURE 2. Flow chart of nutrition program

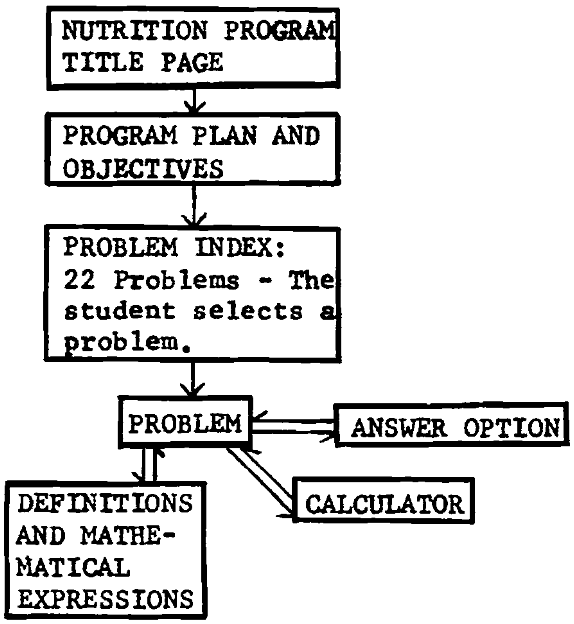


FIGURE 3. Graphic display of protein problem

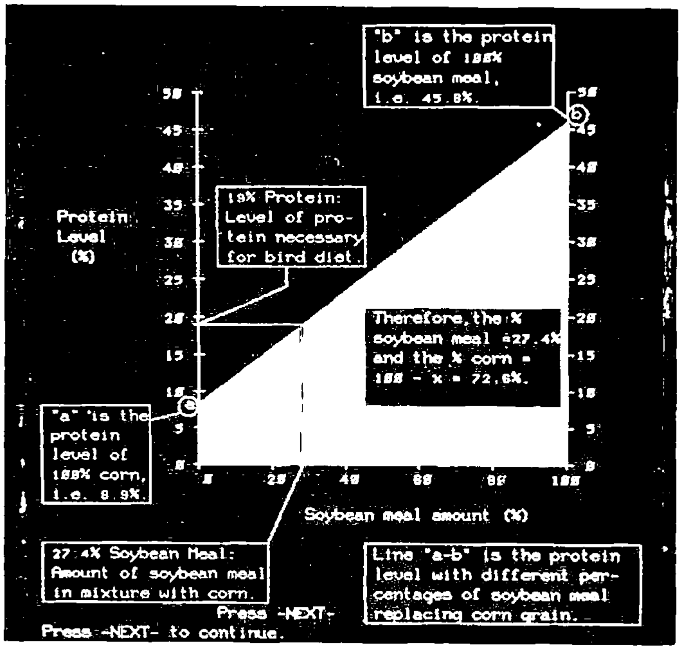
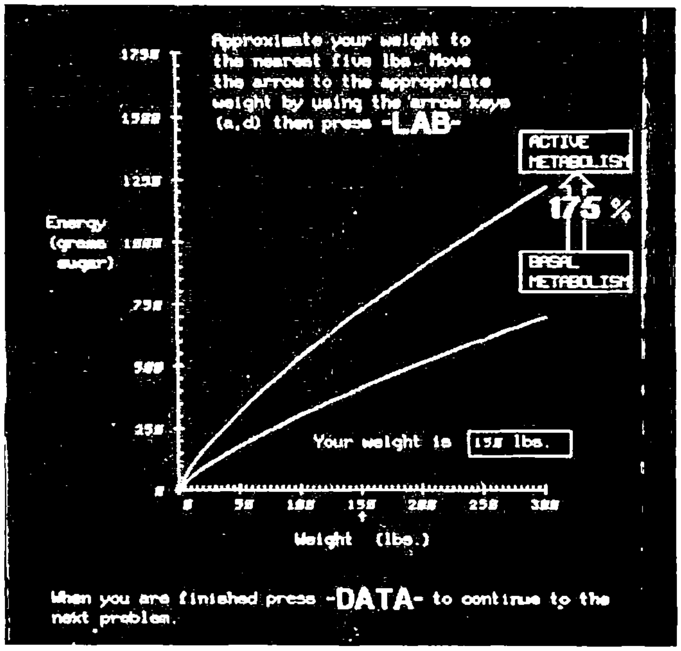


FIGURE 4. Graphic display of energy requirements



SAMPLE PROBLEM

III. A. Energy costs and feed prices

EXAMPLE 1: If corn grain sells for $1.68 per bushel (56 lb), what is a reasonable price to pay for a ton (2000 lb) of a high-quality alfalfa hay as a substitute for corn as a source of energy?

EXPLANATION: Cost and values are to be compared on an energy basis. Total digestible nutrient (TDN) content is a good estimator of available energy. The feeds table lists TDN content of several feeds. TDN for corn and alfalfa hay may be obtained from that table.

CALCULATIONS:

Corn energy cost – 56 lb of corn costs $1.68, or 1 lb costs

>1. $1.68

>2. 56 lb = 3¢/lb

TDN of corn is 81% (from feeds table)

Thus, 1 lb of TDN from corn costs $\frac{3¢}{0.81}$ = 3.75¢ per lb TDN

Energy content of alfalfa hay – TDN of alfalfa hay is
>3. 55% (from feeds table)
1 ton or 2000 lb contains 1100 lb of TDN

Value of energy in hay – Weight of TDN in 1 ton of hay x cost of energy from corn = value of hay

>4. 1100 lb TDN/ton hay x
>5. 3.75¢/lb TDN = $41.25 value/ton of hay

If the hay sells for $42 per ton, is it a cheaper source of energy than corn at $1.68 per bushel? Obviously not! If cost is more than value, NEVER buy.

NOTE: The screen displays information until an answer (>) is needed. Type in the value at the arrow (>). Once they have completed one arrow they are automatically sequenced to the next arrow. In this manner, the student is led through the problems in a step-wise fashion consequent to his ability to obtain specific information contained in the problem and place it at the appropriate arrow.

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SOME GUIDELINES ON THE USE OF MULTI-MEDIA FOR TEACHING

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At conventions or conferences in recent years publishers and producers are often displaying materials for use in elementary or secondary grades and you have probably noticed the profusion of materials that are offered as multi-media. Many of these are earnest attempts to provide a well-rounded system of materials on a subject. Others are frauds and merely present a neatly packaged program that meets the definition of multi-media merely by content of materials such as a filmstrip with a record and accompanying script.

The purpose of this paper is to present some guidelines, from our experience with an advanced farm management course, on the use of multi-media and multi-image in the context of the definition of instructional media.

Terminology: Media

A dictionary definition for media (plural of medium) is, "any means, agency, or instrumentality: as, radio is a medium of communication" and "any material used for expression or delineation: as in art, the painter's favorite medium was oil."

Bretz (1) in his book, A Taxonomy of Communication Media, defines media "A means of effecting or conveying something. Medium is a general term roughly comparable in many ways with tool, instrument, vehicle, means, etc." He then refers the reader forward to communication medium which he defines as "A system for conveying messages through reproducible and self-contained programs." And again he forwards the reader to his definition of instructional medium, "Any component of the learning environment which provides or helps provide stimuli to learning."

Multi-Media

We conceive of multi-media as combinations of instructional media which motivate students and help reach the terminal objectives of the instructor. To be most effective, these combinations of media should be used simultaneously.

Professor John Herbst utilizes 2 x 2 color slides, 16mm black & white motion pictures, overhead transparencies, amplified telephone, and printed handouts to teach management and operations of a confinement swine system with the owner-operator (Figure 1). Maps, schematic diagrams, record sheets, and data are presented on the left screen and slides and movies are presented on the center screen. The farm operator discusses his program with Professor Herbst. Two images may be presented simultaneously, for example, a picture of the maternity house by slide and floor plan of the house by overhead transparency. As details of the facility are discussed additional slides are presented. For example, the overall floor plan on the overhead is left in place for student reference while color slides are used in sequence to explain farrowing crates by overall and close-up detailed photography. Copies of record forms can be shown on the overhead projector and the students can compare them to completed printed materials in their possession. Similarily, students can enter data on printed hand-outs while information is presented progressively by the instructor and in this case by the farmer. In cases of tele-lecture presentation the resource person on the end of the line has a copy of the visual materials that the instructor is using. This usually takes the form of a duplicate set of slides or black and white composites of the slides and photoduplications (Xerox, Thermofax, etc.) of the overhead transparencies. Blank slides in the slide projector allow the center screen to be darkened when not needed and keeps control of the system in the hands of the teacher.

Figure 1

Multi-Image

Instructional media reinforce each other in a true multi-media presentation. In turn, a multi-media presentation may develop into a multi-image presentation. Multi-image is an extension of the multi-media concept utilizing more than one projected image in the learning environment.

In the Office of Agricultural Communications at the College of Agriculture, University of Illinois at Urbana-Champaign we use for multi-media two screens (or one large screen surface) one slide projector; possibly a movie projector, either Super-8 or 16mm; an overhead projector and an audio source. The instructor can be reinforced by recordings or amplified telephone. Multi-image media involves the use of more than one image of the same or similar kind (for example, three 2 x 2 color slides) projected simultaneously on one large or multiple screens and controlled by a pre-recorded program source.

A variety of presentation formats are possible and a few possible combinations are illustrated with figures 2, 3, and 4. The actual combinations are dependent upon the creativity of the developer, physical resources such as space and equipment, and

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