Feature Article

Body Weight as a Health Index: A Minicourse in Nutrition

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An effective high school minicourse in nutrition allows students to discover experientially the principles of energy metabolism.

Summary

A high school minicourse entitled "Body Weight as a Health Index," developed at M.I.T., demonstrates how the science of nutrition can be taught in an interesting, interdisciplinary manner by teaching the principles of energy metabolism as they relate to the daily experiences of each student. The minicourse materials comprise a Student's Guide and a Teacher's Guide. The Student's Guide includes: a pre-post test, simple laboratory experiments, "take home" projects and a reading assignment. The Teacher's Guide contains: course objectives, outlines for lectures and discussions, and selected reading matter. The feasibility of teaching the minicourse in the regular high school classroom was demonstrated by: successive teaching trials of the minicourse at five high schools in the Boston area; formative evaluation of the learning outcomes; evaluation of students' and teachers' attitudes; and classroom observations.

The following is a summary account of the rationale, objectives, concepts and content of one of a series of minicourses on nutrition designed for use in an average U.S. high school. The 20-hour minicourse was developed at the Education Research Center in collaboration with the Department of Nutrition and Food Science, Massachusetts Institute of Technology. Energy metabolism and its health consequences is the subject of the minicourse. An account of another minicourse was previously published in this Journal (1).

Since 1960, new topics have been sought and new teaching strategies devised to illustrate the personal, moral and social implications of scientific and technological developments and to encourage students early in their education to engage in individual experimentation, research and discovery. Nutrition is such a topic because it involves a multitude of personal considerations of food beliefs and practices.

Selection of Topic

An outline of a comprehensive course on nutrition was prepared (2), consisting of seven minicourses progressing in complexity:

A. Body Weight as a Health Index[1](2)
B. The Nature of Food as a Source of Nutrients (1)
C. Food Habits and Diets
D. The Specific Role of Food Nutrients in the Body
E. Nutritional Requirements for Health
F. Nutrition and Disease
G. World Food Problems

Of these, "Body Weight as a Health Index" was selected for development into the first minicourse of the series. The reasons for selecting this topic were: the marked prevalence of obesity and its health hazards (3, 4); the limited success of weight control programs (3, 5, 6); the general interest in the topic (7); and the low level of knowledge among students of the concept and implications of energy balance (8-10).

Objectives

The minicourse is aimed mainly at the non-obese child as a preventive and educational measure. Administration of the minicourse, suitable for inclusion in 11th or 12th grade biology or chemistry classes, requires about 20 (50 minute) class periods. It is designed to introduce high school students by means of laboratory experiments, simple projects, lectures, readings and discussions to a selection of fundamental scientific concepts—outlined below—deemed to be basic to the understanding of human nutrition. Secondly, the course shows that these concepts and principles, conforming as they do to universally applicable rules considered to be laws of nature, are directly related to man's life experiences and concerns. Further, the minicourse is designed to lead students to recognize that their body weight is indeed one of the indices of their state of health. During the minicourse, students acquire knowledge and laboratory skills needed to determine the gross composition and energy content of foods, become conversant with the use of food composition tables and draw up their own energy balance sheet. They are also made aware of certain social, statistical and health aspects of body weight.

Concepts

The minicourse attempts to introduce several basic ideas to the students, including the food, oxygen and energy needs of the human organism; definitions of work and energy; the relationships between work, energy and food; the similarities and differences between food and body composition; basal metabolic rate; energy utilization and body weight; and some biochemical aspects of energy conversion.

Course Format and Content

The minicourse is so structured that it can be taught equally well as part of a wider course in nutrition or by itself; also it can serve as an introduction to a discussion on bioenergetics. The course contains laboratory experiments performed with simple, inexpensive laboratory equipment, take-home projects and a reading assignment for the students. The teacher is provided with a list of course objectives, outlines for lectures, suggestions for topics and questions for discussions, and selected reading matter. There is also a pre- and post test complete with answer key to evaluate gain in knowledge of the students, as well as a questionnaire for student evaluation of the minicourse.

The minicourse begins with a discussion of the human body as part of the total ecosystem. During this discussion, the students are led to formulate on the basis of their present knowledge an overall view of the interaction between the body and

[1]Copies of the course materials will be available commercially in 1977. The Ph.D thesis (2) can be obtained from ERIC, Information Analysis Center, The Ohio State University, Columbus, OH 43210.

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its environment, in particular the interaction between food and the body. The discussion focuses on how food is transformed and incorporated into the body. This topic is explored several times and on different levels.

The minicourse then examines in discussions, laboratory experiments and take-home projects, a series of basic questions, such as: how food serves as an energy source; how this energy can be measured; what determines the energy needs of the body under different conditions of health, disease, environment, and physical activity; what is understood by basal metabolic rate; what is the significance of the concept of energy balance and conservation; and how this energy balance is related to body weight and how the latter, in turn, affects the health of a person.

Laboratory Experiments and Projects

In order to illustrate the processes of scientific inquiry (11), the laboratory experiments are inquiry oriented. Each experiment is centered around a specific quantitative problem about which the students hypothesize and suggest a research procedure before they start their investigations. The students, working in groups, determine, for instance, in a simple tin-can calorimeter, the caloric content of a cracker and a peanut. They also estimate the water, ash, organic and inorganic matter content of a piece of beef muscle, fat and bone as analogs of these tissues in the human body.

The experiment on metabolism illustrates the fact that respiration rate can serve as a measure of energy consumption. Each student measures how long it takes for the red color of phenolphthalein in sodium hydroxide solution to disappear when (s)he is breathing in at different rates after different states of activities in comparison with the effect of gases liberated from a burned peanut.

The interaction of environmental, biological and sociocultural factors as determinants of food intake, body weight and health is illustrated by viewing the film "Hungry Angels."[2] The film shows the recovery of two Guatemalan children from malnutrition. Practical conclusions are drawn regarding body weight, diet, physical activities and health status.

In accordance with Bruner's approach (12), the take-home projects are designed to be centered upon research problems that are directly relevant to the students' own daily experiences. The projects include: food and activity records for a determination of the student's own daily energy balance; determination and comparison of caloric input (foods eaten) and of caloric output (activities); analysis of the environmental, social, genetic and other factors that, in the opinion of the students, have contributed to give them their present appearance; a specific gravity determination by water displacement with calculation of the fat content of their bodies.

Evaluation

Sample. The minicourse was taught at five high schools in the Boston area to 77 students. It was taught by a regular high school teacher of biology or chemistry within 15 to 20 classroom hours. The students were from different socioeconomic levels and enrolled in different types of high school programs (college-bound or non-college bound). Class sizes, years of experience and sex of the teacher all varied.

Design. The original version of the course material, tests, and other evaluative instruments were named Version I. Version I of the minicourse was taught at school 1. On the basis of analysis of students' learning outcomes, teacher comments and class observer reports, the minicourse was revised into Version II. Version II was taught simultaneously at schools 2, 3 and 4 by the classroom teacher. On the basis of preliminary analysis of data collected as detailed above, the minicourse was revised into Version III. Version III was then taught at school 5, and the data collected were used for the last revision of course material into the final version.

Implementation. The instructional material package and suggestion for its use were given to each high school teacher prior to instruction. During each teaching trial, a constant exchange of views, suggestions and criticisms was maintained between author and teachers.

Methods of Evaluation. The effectiveness of the learning was evaluated by means of formative evaluation (13, 14). Methods of evaluation included the design, development and use of the following components:

1. A pre- and post test questionnaire measured students' cognitive learning of six topics: Energy Balance, Basal Metabolic Rate & Energy Needs, Caloric Content, Body Composition, Food Composition, and Need for Oxygen. A representative sample of the various types of test questions is given in Table 1. The questionnaire included 59 items judged to be appropriate for testing students' knowledge, understanding, transfer capability and analysis ability. The same test was given at the beginning and end of instruction.

2. Two measures based on students' score results on the questionnaire were selected for assessment of learning effectiveness.

$$(1) \quad D_i = Q_i - P_i$$

Equation (1) states that the "Absolute Gain" in score, D_i, is the percentage of questions which student *i*, after exposure to the minicourse, learned to answer correctly. D_i is a function of two factors: a) P_i which is the total score percentage of student *i* for all pre-test questions and b) Q_i which is the total score percentage of student *i* for all post test questions.

Table 1
Samples of the Various Types of Test Questions

Topic Tested	Sample Test Question
Energy Balance	How many calories do you consume in a day? List all the steps you would undertake to find out.
	Mr. X is an adult who engages in activities that regularly use up a total of 2,500 Calories per day. (a) If he eats every day food that supplies 3,000 Calories/day, what happens to the extra calories? (b) If Mr. X regularly consumes 2,000 Calories/day how will it affect his body?
Basal Metabolic Rate & Energy Needs	What is basal metabolism? (circle the best answer) (a) The amount of energy used up by a person who is lying quietly at rest. (b) The amount of energy used up by a person who is walking slowly. (c) The amount of calories needed to feed a resting man.
Caloric Content	Which group of foods gives nutrients in increasing order of calories per gram of material? (a) Water, white bread, margarine, (b) White bread, margarine, water. (c) Water, margarine, white bread. (d) Margarine, white bread, water.
	Circle the word that correctly completes the sentence: A piece of cake containing 150 Calories will give your body (more, same, less) energy than a bowl of soup containing 150 Calories.

[2]The film "Hungry Angels" is available from Association Sterling Films, Inc., distributor of UNICEF films; rental $6.00, purchase $85.00.

$$(2) \quad C_i = \frac{Q_i - P_i}{100 - P_i}$$

In equation (2) the "Maximum Possible Gain," C_i, is defined as the ratio of the percentage of questions which student i learned to answer correctly, to the percentage of questions (s)he could have learned to answer correctly. Because C_i has an internal standard of reference, it was judged to be the most suitable index for assessment of instructional effectiveness. The rationale for this argument is beyond the scope of this article.

3. A course assessment questionnaire evaluated students' attitudes towards the various components of the minicourse.

4. A trained classroom observer was present in classes 1, 2, 3, and 4. An observation checklist was supplied to each observer to help in compiling the specific information which was sought. Reports of the observers included descriptions of lesson content and of methodological and technical problems that students and teachers encountered.

5. An analysis of student performance on home projects and in the laboratory was prepared by the teacher and the author.

The above data served as a basis for successive revisions of the curriculum between and after the teaching trials.

Summary of Results

A thorough analysis of data gathered from small-scale trials of the minicourse in classrooms of five different school systems was completed. A statistical analysis[3] of the pre- and post test results of 77 students indicated that:

1. The students learned on the average 37% ±8% of what they could have learned, as measured by the index (see Equation 2).

2. The students' mean absolute gain in score was 23% (see Equation 1). The mean pretest score was 37% ±5%, and the mean post test score was 61% ±5%. An absolute gain of 20-30% indicates that the learning outcomes can be regarded as satisfactory (15).

3. Successive revisions of the course material seemed to affect score gains advantageously. However, the amount of experimental data did not allow analytical separation of teacher effect from material quality effect on learning outcomes.

A course assessment questionnaire was given to each student upon completion of instruction; it was designated to reflect the students' attitudes towards the various parts of the instructional material. The minicourse was found to be of interest to 77% of the students. The course level was appropriate or slightly difficult for 80% of the students, who indicated that they needed "more" or about the "same" time as was given. Sixty percent of them rated the minicourse quality as "good," "excellent" or "outstanding" in comparison with other work done in their biology or chemistry course.

Observers' reports on course implementation helped to focus on methodological and technical problems that students and teachers encountered. Most severe problems were: shortage of class time; insufficient teacher preparedness; technical difficulties in laboratory execution; and some student computational difficulties. Between successive teaching trials, attemps to solve the problems by revisions of the instructional material were made, such as changes in the Teacher's Guide and students' lab sheets and the simplification of lab procedures.

Evaluation of students' performance on home projects revealed that:

- 30% of the students carried the project through to completion and seemed to understand the concepts involved as indicated by their post test results
- 70% of the students found the projects to be interesting.

Overall, students' performance in the laboratory was satisfactory—as measured by the percentage of errors made (see Table 28 in Ref (2)). The frequency of procedural and computational errors made by students in the laboratory reports decreased with successive revisions of the instructional material from 28% to 14% of total possible errors.

Conclusions and Implications

It was demonstrated that:

- the students acquired a significant amount of knowledge
- successive revisions improved students' learning outcomes
- students' and teachers' attitudes toward the minicourse were positive
- the minicourse can be taught effectively within 20 classroom hours by a regular teacher not an expert in nutrition to average high school students from different social and cultural backgrounds
- about 23% gain in score can be expected to result from teaching this minicourse, regardless of differences in teaching style, if the initial level of knowledge of the students is between 30% and 60% on the pretest material.

This range of pretest results indicates that the test is suitable for showing gains from instruction but is not too difficult for the class (16).

Therefore the above implies that:

1. Nutrition can be taught in an interesting, serious and scientific mode at the high school level.

2. Administratively and technically, the time and facilities required permit the minicourse to be fitted into the framework of presently existing biology or chemistry courses.

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Program Ideas

Nutrition Education in the Supermarket

David E. Abbey and Harold F. Googe

The supermarket, where people are thinking about food and deciding which foods to buy, seems a logical place to feature nutrition education. To explore this avenue of nutrition education, the Loma Linda Market Health Education Center was developed. The center has been in operation since 1972. It has been operated by graduate students from Loma Linda University School of Health fulfilling their field requirements for the Master of Public Health in community health education.

The center consists of a display booth 15 feet long located immediately inside the entrance to the store. In the wall behind the booth is an alcove for placing a projector and other audiovisual equipment and materials. There are four stools for customers to use while viewing the presentations. The center owns display material, a LaBelle unit (self-contained filmstrip/sound projector) with programs and a slide-tape projection unit for multimedia programs (see Figure 1). Each program is advertised in the local papers, and signs are placed in the booth showing the current program, next program and times someone will be present at the booth.

From the very beginning the store has given the booth enthusiastic support. The philosophy of the market is that it not only needs to be a quality retailer but feels responsible to educate its clientele regarding the products sold.

Prior to drawing up plans for the Health Education Center, data were collected as to the weekly, monthly and yearly sales-volume cycles. A random sample of customer density was taken, and interviews were conducted with the manager, assistant managers and heads of various departments.

The clientele are primarily from the health professions, as the city is the home of the Loma Linda University Medical Center, an institution run by the Seventh Day Adventists. Many students, as well as a large geriatric population, are also steady customers.

Programs

In the initial planning of the center, weekly programs were envisioned, and the first programs ran for one week each. It was soon realized that weekly programs were not feasible without full-time professional assistance, and a bi-weekly schedule was developed.

Program topics that were developed for the Center were "natural" breads and how they are produced in the bakery; food groups, vegetarian style; adequacy of vegetarian diet; dental health; label information; lacto-ovo vegetarian recipe tips; the story behind textured vegetable protein; the use of "natural" foods; the whole person; food safety; fats; weight control; exercise and physical fitness; environmenal health; health "faddism."

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It was felt that presentations should have an integrated approach to specific topics related to health. The topic of the week should be coordinated with the store's weekly specials, if possible, utilizing posters or other display material, audiovisual programs and accurate handout material for the audience to take with them to reinforce what was presented.

For the present and in the near future, the Health Education Center will continue with regularly changing displays and projected programs. Programs are continually being developed. The cookbook sales area continues to be expanded and developed. A distinctive logo is to be designed which will be used on printed material given to customers. To aid customers in identifying particular products, this logo will also be placed on shelves or bins near foods being featured in the handouts.

For the future, it is planned that a mini-amphitheater be constructed so that patrons may come from the busy activity of the store's environment to where the present Health Education booth is located, sit down, and observe a 10- or 15-minute health education presentation. All the equipment that has been purchased to date can be used either in the present location or in a mini-amphitheater. It is planned that in addition to the teaching equipment now available, a modern kitchen facility will be installed so that live demonstrations may be carried out.

Assessment of Booth's Effectiveness

To assess the relative effectiveness of different methods of attracting people to the booth, four different methods were used:

1. Display only. This consisted of a stationary display with posters, samples of food, etc., displayed on the counter of the booth.

Fig. 1—Supermarket shopper receives nutrition information.