Getting nutrition education into medical schools: a computer-based approach[1–4]

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ABSTRACT Despite awareness of the importance of nutrition as part of medical student's education, numerous barriers exist to incorporating nutrition education into the medical school curriculum. Chief among such barriers is that most medical schools do not have faculty trained specifically in nutrition. A curriculum is needed that can deliver comprehensive nutrition information that is consistent across medical schools. One way to deliver this information is to use computer-assisted instruction (CAI). To meet the different needs of medical schools and provide a consistent base of nutrition information, we developed a series of interactive, multimedia educational programs (Nutrition in Medicine) that teach the basic principles of nutritional science and apply those principles in a case-oriented approach. Curriculum content is derived from the American Society for Clinical Nutrition consensus guidelines. These modules offer the advantages of accessibility, self-paced study, interactivity, immediate feedback, and tracking of student performance. Modules are distributed free to all US medical schools. Preliminary data from surveys gathered by our team at the University of North Carolina at Chapel Hill indicate that 73 US medical schools use, or are planning to use, these modules; more schools are currently evaluating the programs. Successful implementation of CAI requires easy program access, faculty training, adequate technical support, and faculty commitment to the programs as a valuable resource. CAI fails when the program is just placed in the library and students are told to use it when they can find the time. *Am J Clin Nutr* 2000;72(suppl):868S–76S.

KEY WORDS Medical education, nutrition education, computer-assisted instruction, curriculum, problem-based learning, medical students, clinical competence

INTRODUCTION

Medical school graduates must master many skills and concepts before their training is complete. They must become proficient in basic science concepts and clinical decision-making and must possess sufficient knowledge to begin assessing patients and providing basic therapy for the treatment of identified problems. Although diet plays a significant role in the onset and progression of 5 of the 10 leading causes of death (1), nutrition knowledge has not always been included in the catalog of required medical skills and competencies. The need to incorporate nutrition into the medical school curriculum has been widely recognized (2–8) and the urgency of this issue has led many organizations to call for change in medical school curricula (1, 3, 6, 9–13). The federal government decreed that nutrition education be an integral component of medical education [the National Nutrition Monitoring and Related Research Act (14) mandates that ≥50% of the physician pool be adequately trained in nutrition]. The Dietary Supplements Health Education Act of 1994 (15) and the Public Health Service's Year 2000 Objectives for the Nation (16) also called for medical student education in nutrition. Efforts have increased to ensure adequate coverage of nutrition in the US medical licensing examination (9, 11), providing a powerful incentive for medical schools to cover nutritional knowledge.

In 1991, despite awareness of the importance of nutrition as part of medical students' education, the Association of American Medical Colleges (AAMC) reported that of 128 US medical schools, only 23% (29 schools) had a required nutrition course, with an average of <6 h of class time; 25% of schools failed to offer any formal nutrition education (17). In the past decade progress has been slow. The AAMC raw data for the 1997–1998 academic year reported that 26% of schools had a required nutrition course whereas 25% of schools still did not require or could not quantify nutrition education in their programs (3). There is reason to believe, however, that this is an underestimate of the extent of nutrition education in US medical schools. Preliminary data from a survey conducted by our team at the University of North Carolina at Chapel Hill (UNC-CH) indicate that, of responding medical schools (95 responding of 119 surveyed), 70 now offer some nutrition education (**Table 1;** K Adams, H Morehouse, C Plaisted, unpublished observations, 1998–1999). The schools that require

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TABLE 1
Nutrition education in US medical schools

	Number of schools
US medical schools owning NIM programs[1]	138
Schools using NIM programs as of 1999–2000	73
Schools not yet using or not yet planning to use NIM programs	30
Did not respond to query	35
Responses to medical nutrition education survey, 1998–1999	95
Schools surveyed	119
Nutrition required	54
Nutrition optional	9
Required or optional not specified	7
Did not complete this part of survey	25
Hours of nutrition education at responding schools	70
0	1
0–2.9	4 (1 optional)
3–5.9	9 (5 optional)
6–15.9	22 (1 optional)
16–29.9	21 (2 optional)
>30	11
Failed to specify number of hours	2

[1] Since submission of this article, all US medical schools have been sent Nutrition in Medicine (NIM) programs (includes osteopathic schools and 4 medical schools with multiple campus sites); 119 schools owned NIM programs at the time of the survey.

nutrition education report that they provide, on average, ≥6 h of this education. Although there has been some improvement during this decade, far more work remains to be done.

Many barriers to incorporating nutrition education into the medical school curriculum exist and are identified elsewhere (3, 4). Chief among such barriers is that most medical schools do not have faculty trained specifically in nutrition. For this reason, a curriculum is needed that can deliver comprehensive nutrition information in a consistent manner across schools and that can be used by medical school faculty who may lack expertise in some areas of nutrition. One way to deliver this information is to use computer-assisted instruction (CAI).

COMPUTERIZED EDUCATION IN MEDICINE

Computerized instruction is fast becoming a large component of education, including medical education. Educational instruction has progressed from using computers as an adjunct to teaching, to delivering core material to students, to offering entire (nonmedical) degrees online (18). Currently, information technology allows students to access electronic syllabuses, medical journals, and libraries of images; learn science concepts in an interactive medium; listen to digitized heart rhythms and breath sounds; and even simulate practice of surgical techniques. Case study presentations are changing too, from a lecturer giving a history of a patient and asking students questions, to virtual cases in which the students make the decisions and witness the (virtual) outcomes.

There are many reasons medical institutions should embrace computer technology. CAI offers advantages of accessibility, consistency, self-paced study, interactivity, immediate feedback, and tracking. Online testing is beginning to be used; this year marks the first year that the medical licensing exams were given as a computer-based test (19).

A policy requiring students to have computers has been adopted at many institutions, a trend that is expected to continue in medical schools (18). However, it is important to note that it is our experience as well as that of others (20–23) that institutional commitment beyond the requirement for hardware and software purchasing is requisite for successful implementation of CAI in any medical school curriculum. Faculty need to be shown how to use and integrate CAI into their existing courses, adequate support in terms of training and technical problem-solving must be available to users, access to CAI must be easy, and the CAI or other online resources should be perceived as valuable. CAI fails when it is just placed in the library and students are told to use it when they can find the time, or when the program is given to students to do on their own without guidance or class involvement. Including content from CAI when testing and incorporating the material in class discussions underscores the relevance and importance of the content to students.

Rationale for Nutrition in Medicine

To meet the widely different needs of medical schools and to provide a consistent base of nutrition information, the Nutrition in Medicine (NIM; copyright UNC-CH) programs were developed. This fully electronic curriculum allows for the implementation of nutrition education into the medical school curriculum without depending entirely on a comprehensive group of nutrition educators, which does not exist at most medical institutions. The NIM modules were designed to teach the basic principles of nutritional science and to apply those principles in a case-oriented approach with the goal of presenting nutrition information in an understandable and enjoyable way that will enhance learning (24). The NIM modules represent an independent nutrition curriculum. Widespread dissemination of nutrition principles throughout other courses is not ideal: unless the relevance and unique aspects of nutrition are made evident, it is easy for students to complete a course and to be unaware that they learned about nutrition (25). Because the series is comprehensive, medical faculty who may not have expertise in a specific area of nutrition can still cover all relevant topics. By helping to fill in gaps, the NIM curriculum can serve as an alternative to a multi-instructor course. The modules are distributed free to all US medical schools, specifically to the faculty member who is responsible for teaching nutrition (for information see www.med.unc.edu/nutr/nim).

Medical educators, expert nutrition panels, and medical students themselves, have published guidelines for topics and scope of nutrition coverage that medical students should master (5, 9, 26). The American Society for Clinical Nutrition consensus guidelines were instrumental in the development of the NIM curriculum (27). In addition, within our own department at UNC-CH we have a full range of curricula in nutrition for undergraduate, graduate, and medical training. Our faculty provides comprehensive nutrition expertise; many of our faculty members have contributed to the development and implementation of the NIM curriculum and serve as valuable resources to the project. Further, an advisory board of nutrition experts from academia, government, and industry has been instrumental in providing ongoing review and guidance throughout the development and implementation process. For example, the advisory board provided valuable feedback for the development of the program interface. The first approach used a hypercard (index card) user interface accessed via a map of the course. The advisory board

TABLE 2
Content overview of the Nutrition in Medicine modules

Title	Content	Video case
Nutritional anemias	Metabolism of iron, vitamin B-12 and folate; dietary requirements and best sources; prevention and treatment; and nutrition assessment	44-y-old white male with Crohn disease and nutritional anemia; student diagnoses type
Nutrition and stress	Metabolism of amino acids and fatty acids, assessment of critically-ill patients, importance of nutrition, and impact of metabolic response to trauma or sepsis	8-y-old white boy with gunshot wound to the abdomen and subsequent removal of a portion of the small bowel
Nutrition and cancer	Food-borne carcinogens, nutritional modulation of carcinogenesis, and nutritional epidemiology	30-y-old African American male seeking risk-reduction strategies because of family history
Diet, obesity, and cardiovascular disease	Lipid metabolism and transport, thrombosis and arterial calcification, obesity and hypertension, and role of free radicals, homocysteine, and fiber	47-y-old male of Italian descent with several risk factors, ie, obesity, elevated cholesterol, hypertension, and family history
Diabetes and weight management	Fuel metabolism (focus: carbohydrates), appetite and weight regulation, and metabolic changes in diabetes and obesity	42-y-old Hispanic woman with type 2 diabetes; 17-y-old with type 1 diabetes
Maternal and infant nutrition	Nutrients in fetal development, assessment during pregnancy and lactation, lactation, and infant nutritional needs	36-y-old lactoovovegetarian, white woman seen at preconception, prenatally, and during lactation
Nutrition and growth	Physiology of the digestive tract, fat-soluble vitamins, nutrients affecting organ development, obesity, disordered eating, and failure to thrive	Inadequate nutrient intake by a 2-y-old, cystic fibrosis in an 8-y-old child, disordered eating in a 15-y-old girl
Nutrition for the second half of life	Age-related changes in nutrient needs, nutrients affecting bone health, food fads, and self-supplementation	70-y-old woman with hypertension and osteoporosis
Nutrition supplements and fortified foods	Biochemistry of nutrients and nonnutrients, estimation of biological requirements, and delivery with foods compared with supplements	An expectant couple and their parents; both couples interested in optimal nutrition for different stages of life (pregnancy and aging)
Sports nutrition	Nutrition and physical performance, supplements used by athletes, protein and carbohydrate metabolism, and fluid balance	23-y-old college female athlete with amenorrhea; 35-y-old male weightlifter taking protein supplements

cited problems such as linearity of learning, lack of flexibility in navigation, and poor integration with multimedia. The design was then modified in response to the initial reviews and first user reports. We developed an innovative and flexible educational format that took advantage of the interactive capabilities of technology as reflected in the current structure of the NIM modules.

The goals of the NIM curriculum are as follows:

1) Motivate students to consider nutritional factors in medical decision-making.
2) Teach the role of nutrition in prevention and treatment of disease.
3) Familiarize students with criteria to use to distinguish between sound nutrition and food faddism.

There are 3 topic series in the NIM programs; asterisked titles in the list below indicate that the module has been released to medical schools, the rest are in production for release in 2000–2002. Titles include The Disease Series (Nutritional Anemias*; Nutrition and Stress*; Nutrition and Cancer*; Diet, Obesity and Cardiovascular Disease*; and Diabetes and Weight Management: Aberrations in Glucose Metabolism*) (28–32); the Lifecycle Series (Maternal and Infant Nutrition* (33), Nutrition and Growth*, and Nutrition for the Second Half of Life), and the Special Topics In Nutrition Series (Nutrition Supplements and Fortified Foods, and Sports Nutrition).

An overview of the content and video case study of each topic is listed in **Table 2** and the scope of nutrition information across the entire series is provided in **Table 3**. When the entire series is complete, all the basic nutrition concepts, from function and sources of a particular nutrient to counseling patients on dietary changes, will be covered in the curriculum.

Description of the modular elements of the NIM series

Each module of the NIM series has a similar format. At the beginning of the program, students are given an overview of module objectives and navigation directions and a suggested sequence for completing the module. This is followed by a video segment in which the student is introduced to a virtual mentor and meets one or more patients. The mentor directs the student to go to the lessons to learn about aspects of nutrition that are pertinent to the patient case or cases.

The student then studies the first lesson topic; each section opens up with the learning objectives for that section. Lessons present the basic science of nutrition within the context of a disease, life cycle stage, or other relevant setting. Students are presented with visual and audio information, medical illustrations, and animations. The material is interspersed with interactive exercises that test knowledge or allow further exploration of the topic. Sample screens from the programs are shown in **Figure 1**. At the end of a series of lessons, the key concepts from the lessons are displayed to emphasize the take-home messages. Before returning to the virtual patient case, a short text-based case study is presented. Students are asked to respond to 3 questions and then receive immediate feedback to their response.

The video case has several purposes, which include showing how health care providers can incorporate nutritional evaluation into their decision-making, demonstrating how to spur patient interest in nutrition issues, and delivering up-to-date

TABLE 3
Synopsis of topics covered by the Nutrition in Medicine curriculum[1]

Nutrient metabolism in health and disease
Digestion, absorption, transport, and storage: carbohydrate, fat, and protein
Regulation of metabolism: carbohydrate, fat, protein, and hormonal effects
Protein metabolism: regulation of catabolism, metabolism of nonessential amino acids, tryptophan, phenylalanine and tyrosine, methionine and cysteine, glycine, and branched-chain amino acids
Malnutrition: protein, energy, and protein-energy
Metabolic consequences of obesity: hyperlipidemia, insulin resistance, and hypertension
Best sources of vitamins: A, D, E, K, B-1, B-2, B-6, B-12, folate, and niacin
Best sources of minerals: calcium, iron, sodium, potassium, iodine, magnesium, zinc, selenium, and phosphorus
Best sources of antioxidants and phytochemicals: carotenoids, vitamins C and E, and polyphenols
Digestion: gastrointestinal tract function, nutrient absorption, and gut nutrition; malabsorption
Fatty acids: transport with lipoproteins, structure and function, storage and release, atherogenic potential, effect of dietary modulation, and essential fatty acids
Physiology of hunger and satiety: energy intake regulation
Effects of trauma and infection on nutrient metabolism
Effects of starvation and weight loss on fuel metabolism
Water and electrolytes: fluid balance and sodium restriction
Vitamins: metabolism, function and consequences of deficiency and excess (eg, ascorbate, thiamine, riboflavin, niacin, pyridoxine, folate, cobalamin, biotin, pantothene, choline, vitamin A, provitamin A carotenoids, and vitamins D, E, and K)
Minerals: metabolism and function and consequences of deficiency and excess: calcium, phosphorus, iron, zinc, magnesium, selenium, and iodine
Dietary nonnutrients: anticarcinogens, phytoestrogens, antioxidants, and activation and excretion of carcinogens
Types and functions of dietary fiber
Nutrition and immunity
Inborn errors of metabolism
Food processing and cooking practices: influence on nutrient and nonnutrient compounds
Nutrition across the life cycle
Infant feeding: premature, newborns, and transition to solids
Nutrition guidelines across life cycle: infants, toddlers, children, adolescents, pregnancy during adolescence, adult pregnancy, adulthood, and aging
Nutritional concerns and risks across the life cycle: infants, toddlers, children, adolescents, pregnancy and lactation, adulthood, and aging
Maternofetal transfer of nutrients
Physiology and mechanics of breast-feeding
Human milk composition and benefits
Composition of human milk substitutes (ie, formulas)
Nutrition and disease
Criteria for an adequate diet and dietary guidelines
Nutritional prevention of disease and dietary disease management: cancer, cardiovascular disease, osteoporosis, obesity, diabetes, nutritional anemias, birth defects, and malabsorptive disorders
Aberrant nutrition-related behaviors: anorexia nervosa, bulimia nervosa, binge-eating disorder, disordered eating, and pica
Nutritional epidemiology: methods
Critical evaluation of health claims
Food-borne illness
Nutrition assessment
Anthropometrics: BMI, body composition, and waist-hip ratio
Diet history and nutritional interview techniques
Comprehensive dietary assessment
Biochemical evaluation: nitrogen, lipids, iron, folate, and vitamins B-12 and D
Assessment of energy balance: pregnancy, infancy, childhood, adolescence, adulthood, obesity, weight loss, and indirect calorimetry and respiratory quotient
Estimation of energy needs and influencing factors
Growth assessment: growth charts

nutrition advice. Under the guidance of a virtual mentor, students have the opportunity to "practice" what they just learned in the previous lesson. Immediate feedback is provided at the end of each interaction. In some of the modules, diagnosis is part of the challenge; in others, students can choose to try again to see what would have happened if they had selected a different course of action. Students are expected to decide on what questions to ask the patient, which tests to order, how to intervene (eg, prescribe a vitamin or mineral supplement or change medications), and what specific recommendations should be made to the patient.

Students can use the 3 board-type exams provided with each CD-ROM as a pre- or posttest or as a study guide. An electronic glossary, index, and reference section provide additional user resources. For example, the reference section offers the following components: anthropometric procedures, nutrient allowances, diagnostic tests, nutritional assessment, food labeling, further readings, and bibliography.

An optional tracking feature records test scores, measures time spent, and monitors which parts of the program were viewed and then stores these data on a floppy disk. The latest modules (versions 2.5 and later) in the series allow this function to be set by instructors who wish to monitor student use and performance. Another feature bookmarks the sections that have been viewed already; this is particularly useful when viewing the programs in multiple sessions.

New way of teaching

Whereas CAI is becoming more widely used and is shown to be efficacious (34–36), it represents quite a departure from the more traditional teaching method of lectures, seminars, and problem-based learning. Limitations of more traditional methods of teaching include requirement of significant faculty time, limited portability, and a high degree of variation between instructors and between institutions. Advantages and disadvantages of CAI are listed in **Table 4.** Students and faculty often prefer the direct contact provided by the traditional lecture and seminar formats because it helps instructors to tailor their presentation to a particular audience and to respond with great flexibility to the individual needs of students. CAI provides consistency of information across presenters and institutions, allows instructors to focus on advanced topics, and permits faculty to spend more time working with students on synthesis and application of the learned concepts.

In this time of exciting innovation in technology and rapid growth in the ability to deliver multimedia interactive programs, it is important to keep in mind the important role of the instructor. In our experience and in that of others (21–23), students are not ready to rely solely on computer programs for learning and instead benefit from teacher-student interaction in learning problem-solving and other skills. No matter how good the CAI is, discussion of the material with the instructor remains important because this can clarify questions, reinforce concepts, and emphasize the material's relevance. The best learning outcomes are reached when CAI is used in conjunction with both instruction and support by faculty. Our model at UNC-CH uses this approach to provide the human interaction component that is essential to the learning process. It is our belief that the experience and strategies shared here will be useful to anyone planning on implementing CAI into their courses.

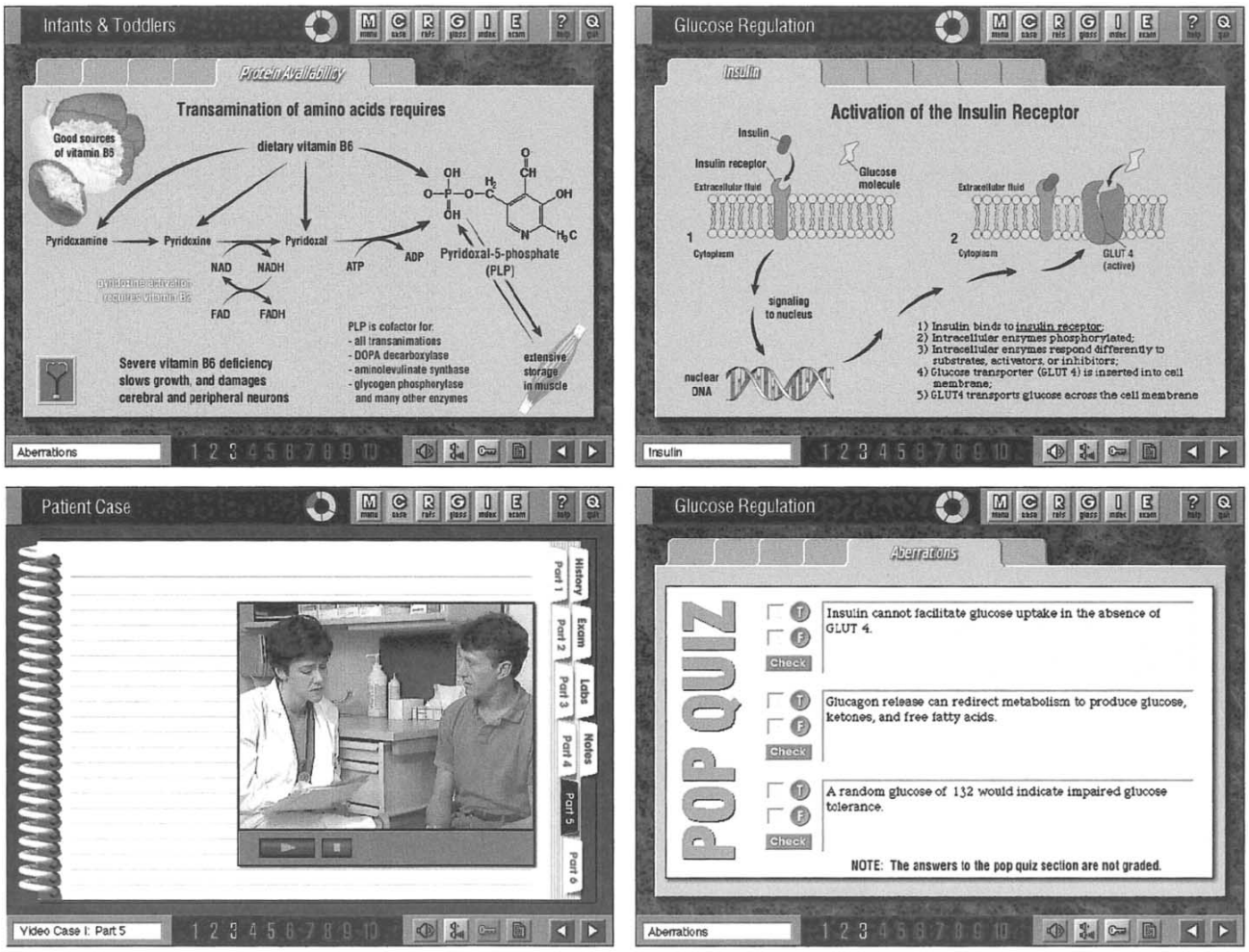

FIGURE 1. Selected screens from Nutrition in Medicine. Four examples of instructional approaches used in various modules: top left, illustrations link the nutrients in foods to their specific metabolic role; top right, illustrations of nutritionally important metabolic relations; bottom left, the video case models the role of nutrition in clinical decision-making; bottom right, key concepts are reinforced with interspersed quizzes.

IMPLEMENTATION OF NIM AT UNC-CH

Computer-based nutrition instruction of medical students has been used at UNC-CH since 1994. The first module, Nutritional Anemias, was used by freshman medical students who volunteered to participate in a formative evaluation study. Since 1995 computer-based instruction of the class with >160 first-year students has been an integral and required part of the nutrition course. Starting this academic year, 1999–2000, the course is given to second-year students and includes modules from the entire NIM disease series. The other modules will be used during the third and fourth years.

Over the years, several issues have emerged that have significantly affected the delivery of instruction: computer platform, faculty support, time requirements, student acceptance, and note-taking ability. The following observations relate to the use of NIM at UNC-CH in 1997, unless noted otherwise.

Computer platform

Initially, NIM programs were accessible at all times on 10 dedicated computers located both at a central computer lab and at the students' labs. Network delivery of the programs was available, but at peak times was too slow to deliver to more than a few students simultaneously. It proved more practical to provide the complete set of CDs for each computer. In 1997 the UNC-CH medical school introduced a uniform computer requirement. All students were required to have the same laptop computer model preloaded with identical system software and other programs, including the NIM modules. Medical school staff provided introductory training for using the various hardware and software components. The provision of full technical support reduced barriers to rapid attainment of competent and effective utilization of the offered electronic resources.

Faculty support

The course directors provided an introduction of the nutrition modules to small groups of students and explained the role of the programs in the course. A weekly discussion group headed by a faculty member was instituted to provide support to instructional content and technical issues. E-mail was an efficient and vital support element for the implementation of the nutrition computer modules. Messages were sent frequently to remind students of deadlines, provide updates on technical issues, respond to frequently asked questions, and send supporting instructional

TABLE 4
Comparison of the advantages and disadvantages of computer-assisted instruction compared with traditional methods

Advantages	Disadvantages
Consistency of information across institutions and instructors	Fixed content
Optimizes faculty time	Impersonal
Portable to many sites	Unable to ask questions
Adaptable to existing school curricula	Potential cost issues
Flexibility of course implementation	Potential technical problems
Encourages active learning; immediate feedback via interactive features; self-paced learning; extensive references[1]; capability to add instructor notes[1]; features familiar educational tools: learning objectives, key concepts, case studies, and exams[1]; electronic grading eases instructor burden[2]; and immediate instructor access to user data[2]	Varying time to completion

[1] Specific to Nutrition in Medicine modules; may be features of other computer-assisted instruction.
[2] Included in the instructor module.

material (such as key concepts and sample questions). Students also used e-mail as the preferred method of contacting faculty. About one-third of the students e-mailed questions about the instructional content of the nutrition modules that were generally answered on the same day.

Time requirements

Representative program use was tracked for the Nutrition and Cancer module and recorded on local floppy disks. Of the 163 students taking the course, 116 turned in their disks with readable tracking data and 91 of these had completed all sections. Use time (which included all idle times) varied widely, ranging from 1.2 to 15.5 h with a median of 4.8 h. The 8 students who did not take any of the practice exams spent a median of 2.7 h with this module and the 16 students who completed only 1 of the 3 practice exams (20 questions each) spent a median of 3.5 h with the module. Anecdotal comments from students who took longer to complete the cancer program indicated that they viewed sections more than once and made use of the optional resources (eg, general information on recommended intakes, assessment techniques, and biomarkers).

Student acceptance

Our course was offered in August and, as incoming freshmen, many students felt overwhelmed by their other course work and considered the need to use their computers for studying an extra burden. They were almost equally divided in their opinion of the usefulness of the computer modules. The most common complaint was the time requirement. On the other hand, many students liked that they could view the presentation at a time of their own choosing, usually in several sessions, learn at their own pace, and have control over the sequence in which to use the sections within a program. Several students commented that studying the material changed their own dietary habits and that they subsequently teased each other about any unfavorable food selections.

Note-taking ability

Students still have little experience with computer-based instruction and their learning habits are often based on the traditional model of note-taking during lectures and then reviewing these notes at a later time. When surveyed at the end of the course, more than half of the students responded that taking notes was indispensable. We now provide a half-page sized space for notes on printed handouts (available for printing on the CD-ROMs). These handouts summarize overall module objectives and key concepts for each major topic section and help those students who later want to be able to quickly review the core content on paper.

EFFICACY TESTING

Thus far, the efficacy of use of the computer programs to teach nutrition concepts has been evaluated most extensively at UNC-CH with the Nutrition and Cancer module. In 1996 the 160 incoming medical students were invited to participate in a voluntary study. The 65 students who volunteered were randomly assigned either to a group who would use the computer module for studying or to a control group who were presented with the same material in a traditional 85-min lecture by one of the authors of the program. Learning efficacy was tested by comparing performance on nonidentical, written, 20-item exams before and 1 wk after the lecture. The computer group's average score increased slightly more than the score of the lecture group (38% compared with 14%; $P < 0.01$). Note that in 1996 the grade on this exam was not used in calculating the course grade.

In 1997 the gain in test performance of the entire class was tested (36), this time without a control group and with a repetition of the test items. Correct responses increased from an average of 22% before using the program to 86% immediately after completion of the module, and then fell to 62% on the retention test 3 mo later. Note that in 1997 the grade on this exam was used in calculating the course grade. The students' subjective learning experience was evaluated on a 5-point Likert scale (2 = disagree that I am knowledgeable, 4 = agree that I am knowledgeable). Confidence in their knowledge about nutritional issues involving cancer increased from an average 1.9 to 3.5. Students also felt more confident in their ability to give advice to patients about nutritional cancer prevention (scores increased from 1.8 to 3.6). These data show that the tested module is an effective tool for teaching basic principles of nutrition to our medical students.

USE OF NIM WITH STUDENTS OTHER THAN MEDICAL STUDENTS

Additional experience relevant to the implementation of NIM into a course was obtained using a modified version of the modules with 2 undergraduate college nutrition classes. Three modules were used and integrated into the course syllabus. An attitudinal survey was administered before and after viewing the modules. Eighty-eight percent of students looked forward to using the modules before use and 76% reported that they felt the modules were an effective way to learn upon completion of module use (K Cooksey and K Adams, unpublished observations, 1999). In addition, 32% of students reported feeling knowledgeable about a specific topic in nutrition before viewing the corresponding module. After module use, this number increased to 76%. The time spent (self-reported) using the module varied considerably, with the mode at 3–4 h (56% of class). At the end of the semester, a focus group session provided additional feedback. The students positively reviewed the nutrition applications and "experiences" in the virtual patient case. They

TABLE 5
Implementation suggestions for computer-assisted instruction (CAI)

Step	Specifics
Institutional commitment	Proper equipment, faculty assignment, and time allocation in schedule
Instructor familiarity	Thoroughly review the module and support materials
Determine how users will access CAI	Local server, computer stations, discs on loan, etc
Secure adequate technical support	Work with computer support staff early; provide start-up instructions and contact information
Integrate CAI into the syllabus	CAI must be considered a core part of the learning material; faculty need to indicate that they consider it essential
Orient students to CAI	Minimize students' start-up time and reduce ambiguity
Establish a relation between CAI and course material	Demonstrate modules in class; in-class discussions of content; link module concepts into lecture material
Provide the students with clear expectations of CAI	Assignments should be specific with a set timeline; students need to know what they are responsible for
Follow-up of CAI in class	Offers students the opportunity to ask questions, clarify assignments, etc
Direct students to support materials	Handouts, start-up instructions, Web site, and technical support
Assess learning and performance	Medical students study what they will be tested on

felt the presentation of the material helped them to learn to apply and remember the information, and they particularly noted the immediate feedback features. In addition, they cited the freedom of navigation, organization, and ease of use as other positive aspects. They felt that a preliminary orientation, direction from the course instructor, and direct correlation to the course material were key in the use of the module being a success. Helpful information gathered from the focus group included the need for a study guide or workbook and the need to know what students were responsible for in terms of module material, as well as a recommendation for in-class discussions. Unsolicited positive comments also appeared on the class evaluation at the end of the semester; with the most common negative comment related to the length of the module, an issue we plan to address with future modules.

IMPLEMENTATION SUGGESTIONS

From our experiences with both medical and general students using these modules, we have learned valuable information about implementing CAI. When NIM is implemented as an option available in the library with no other institutional or faculty support, busy medical students do not use it. When it is implemented with appropriate support, it is an excellent and valued part of the medical curriculum. As shown in **Table 5**, several elements are critical for successfully establishing the use of CAI in any course, as supported by the experience of others (21, 22).

These modules are freestanding but can be matched with a text chapter, seminar, or lecture, or the whole program can be assigned to illustrate and synthesize concepts that are often spread throughout a course or courses. Several ways in which to use these modules are discussed below.

Independent study

The modules can be used to supplement in-class lecture material. Students can complete a module as part of their outside work or as a lecture replacement. Although many of today's students are computer literate, the following measures help to ensure a smooth start: instructions on how to access the programs (eg, computer lab, library environment, or personal computer), in-class demonstration of how to get started and navigate through the program, suggestions regarding the amount of time to spend on the modules, and a description of precisely what the students are responsible for. If the entire module is assigned, we recommend students view it in several sessions. The advantage with independent study is that the students can go through the material at their own pace, continuously test their knowledge, and review sections of the program as needed. It is essential to link module content tightly into lecture material and plan follow-up sessions upon completion.

Class discussion

Portions of the module can be shown in class and a discussion can be built around the topic. If presentation software is used (eg, POWERPOINT; Microsoft Corporation, Redmond, WA), the instructor can jump directly to the modules using a run-program button. There are numerous ways to incorporate the modules into a class discussion. For example, specific topics can be emphasized (eg, dietary factors that increase risk of a disease entity) and students can then discuss and prioritize contributing factors. Or, one of the animated sequences can demonstrate a physiologic or metabolic process followed by questions on how dietary changes may affect the process. At the University of Nevada, Reno, student leaders are assigned modules, which they go through with their classmates during a multihour class (37).

Group assignment

Another method of implementation that has been useful is to assign small groups (2–4 students) of students to view the module together. Small group interaction allows for different perspectives, interpretations, and fosters discussion. After completing the module, the class meets as a whole to review and discuss the main concepts presented.

Case study presentation

The patient case, or an integrated practice case, may be presented as a case study. The patient case is typically 30 min. At the end of most major topic sections, a text-based practice case challenges the user's newly learned competency. The integrated practice presents a case scenario, followed by 3 multiple choice questions. Presentation of additional case problems in class greatly facilitates student learning and acceptance (37).

INSTRUCTOR SUPPORT

As described earlier, the instructor can track and statistically analyze information about program use and student performance, including exam scores, question responses, and time spent to complete the program via the data analyzer. The data analyzer utility, located on version 1.0 modules and now on the NIM Web site, automates the grading and data collection process. In addition, the instructor module allows instructors to add custom notes for students to each subtopic shown on the menu. It functions as a basic word processor and lets the instructor add, edit, or delete

notes. The notes must then be provided to each user or station via a floppy disk. When the student navigates to a portion of the program where a note has been added, they can see the note before entering that lesson. The instructor can use this feature to highlight specific points within the lesson, add new information or reference material, emphasize or deemphasize sections, identify portions that are optional, or add other useful information. As a result, the instructor module permits some degree of tailoring to better meet each instructor's objectives.

To facilitate instructor implementation of the NIM technology-based instructional materials, registered NIM users can obtain an instructor's pack. This package is designed to help instructors become acquainted with the programs and to understand some of the many ways in which they can be implemented into the teaching setting. The pack presents detailed outlines of each program complete with learning objectives, video virtual case descriptions, and handouts. Key graphics will be posted to the instructor support Web site for registered NIM users to download and use in their teaching.

Included on each CD-ROM is a file entitled "Handouts" that lists the module objectives, key concepts, and key concept summaries for each module, along with space for taking notes. In addition, information on all the necessary steps to get started (eg, Quickstart sheets) are provided on the CD-ROM.

In addition to the instructor's pack, the NIM Web site (www.med.unc.edu/nutr/nim) offers a detailed instructor support section, as mentioned above. Instructors can download utilities, documentation, and instructions to help them use the modules more effectively. An e-mail link for technical support is available for issues not already answered on the Web site.

Finally, Nutraquiz is an on-line examination creator and searchable databank of test questions that can be accessed by NIM-registered nutrition educators. Instructors can use the program to create their own tests of original questions, incorporate questions from the database, or create tests with a combination of the 2 options. They may choose to donate their questions for use by other instructors or not, and can limit access time for students. Nutraquiz serves as a computer-based test site for instructors who wish to use it in this way. Instructors can request their own unique password and access by logging on to http://152.2.58.2/nutraquiz/index.htm or by following the link on the NIM Web site. Preliminary survey information was obtained in the summer of 1999 from medical school instructors who are using NIM modules. Our survey results indicate that medical school instructors would be interested in using this databank; 38% of respondents reported writing ≥50 test questions per semester and all said they would be willing to donate questions to the databank (P Morris, K Adams, K Cooksey, unpublished observations, 1999).

CONCLUSION

Successful implementation of CAI, specifically of the NIM series of programs, requires effort on the part of the teaching institution and faculty, as detailed in this article. Not only has faculty and user feedback been a vital component of our development process, it has been key to developing guidelines for incorporation of these modules into medical schools. The finest software achieves little if it is not appropriately implemented and modified to satisfy user needs. We believe the strategies and implementation suggestions shared here will allow successful incorporation of this series of nutrition education modules into the medical school curriculum, resulting in a consistent base of nutrition knowledge for medical students.

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