Getting nutrition education into medical schools: a computer-based approach\textsuperscript{1–4}

Karen Cooksey, Martin Kohlmeier, Claudia Plaisted, Kelly Adams, and Steven H Zeisel

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
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 1

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

¹Since 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.
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.

Table 2

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

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
Nutrition across the life cycle

Synopsis of topics covered by the Nutrition in Medicine curriculum

- 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, pantothen, 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
- Maternal 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
- 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.
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

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consistency of information across institutions and instructors</td>
<td>Fixed content</td>
</tr>
<tr>
<td>Optimizes faculty time</td>
<td>Impersonal</td>
</tr>
<tr>
<td>Portable to many sites</td>
<td>Unable to ask questions</td>
</tr>
<tr>
<td>Adaptable to existing school curricula</td>
<td>Potential cost issues</td>
</tr>
<tr>
<td>Flexibility of course implementation</td>
<td>Potential technical problems</td>
</tr>
<tr>
<td>Encourages active learning: immediate feedback via interactive features; self-paced learning; extensive references&lt;sup&gt;1&lt;/sup&gt;; capability to add instructor notes&lt;sup&gt;2&lt;/sup&gt;; features familiar educational tools: learning objectives, key concepts, case studies, and exams&lt;sup&gt;3&lt;/sup&gt;; electronic grading eases instructor burden&lt;sup&gt;3&lt;/sup&gt;; and immediate instructor access to user data&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Varying time to completion</td>
</tr>
</tbody>
</table>

<sup>1</sup>Specific to Nutrition in Medicine modules; may be features of other computer-assisted instruction.

<sup>2</sup>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
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.

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

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

REFERENCES


