Research Article

The Design, Implementation, and Evaluation of Online Credit Nutrition Courses: A Systematic Review

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ABSTRACT

Objective: To assess how postsecondary online nutrition education courses (ONEC) are delivered, determine ONEC effectiveness, identify theoretical models used, and identify future research needs.

Design: Systematic search of database literature.

Setting: Postsecondary education.

Participants: Nine research articles evaluating postsecondary ONEC.

Main Outcome Measures: Knowledge/performance outcomes and student satisfaction, motivation, or perceptions.

Analysis: Systematic search of 922 articles and review of 9 articles meeting search criteria.

Results: Little research regarding ONEC marketing/management existed. Studies primarily evaluated introductory courses using email/websites (before 2000), or course management systems (after 2002). None used true experimental designs; just 3 addressed validity or reliability of measures or pilot-tested instruments. Three articles used theoretical models in course design; few used theories to guide evaluations. Four quasi-experimental studies indicated no differences in nutrition knowledge/performance between online and face-to-face learners. Results were inconclusive regarding student satisfaction, motivation, or perceptions.

Conclusions and Implications: Students can gain knowledge in online as well as in face-to-face nutrition courses, but satisfaction was mixed. More up-to-date investigations on effective practices are warranted, using theories to identify factors that enhance student outcomes, addressing emerging technologies, and documenting ONEC marketing, management, and delivery. Adequate training/support for faculty is needed to improve student experiences and faculty time management.

Key Words: online nutrition education, web-based instruction, nutritional sciences/education, college students, computer-assisted instruction (*J Nutr Educ Behav*. 2011;43:76-86.)

INTRODUCTION

The majority of colleges and universities in the United States (US) offer online (OL) education.[1] Enrollments in OL courses are growing at a faster rate than overall higher education offerings.[2] More than 4.6 million students participated in OL courses in 2008, an increase of 17% over 2007. Furthermore, the economic downturn has resulted in institutions seeing even more demand during the fall of 2009 for new and existing OL programs and courses than for traditional, face-to-face (F2F) offerings.[2]

Online, Web-based instruction in higher education uses the Internet and other communication technologies such as e-mail for research, interaction, and participation in classes. This form of course delivery differs from F2F education, which presents materials to students in writing or orally without using OL technology, and *Web-facilitated* courses, which post syllabi and assignments on Web pages or course management systems, although essentially the course is conducted F2F. Some OL courses blend F2F with OL delivery, typically using OL discussions and few F2F classes. These combined courses are usually referred to as *blended/hybrid* courses.

Nutrition is among many postsecondary subjects taught by OL instructional methods. Increased availability and access to OL credit courses in nutrition may be an avenue for meeting general education science requirements and professional education needs in dietetics,[3] medical,[4,5] nursing, and other allied health curricula.[5,6] Current estimates suggest that approximately 26% of all new jobs in the US will be in health care and social assistance; of the 20 most rapidly growing occupations, half are health care related.[7] Distance education in nutrition can lead to students' job advancement and leadership development.[8]

In comparison to F2F, OL nutrition education offers several advantages to postsecondary students. For example, participants can learn from, and interact with, peers and instructors from anywhere and at any time,

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accommodating variations in professional and personal schedules. Furthermore, traditional-age college students generally have poor eating habits and have demonstrated a need for more instruction to improve nutrition knowledge.[9] Nutrition coursework can result in positive changes in nutrition behavior;[10,11] thus, OL nutrition instruction has the potential to be a mode not only for teaching nutrition and science concepts, but also for improving personal health and eating habits.[12]

Given the growth in and demand for OL learning in higher education, more information about the current state and effectiveness of OL nutrition education at the postsecondary level is warranted and will be useful to guide future course design and delivery efforts. A systematic review of the literature was conducted to help determine the current state of research related to the design, implementation, and evaluation of OL nutrition credit courses. The following questions were addressed in this review:

1. How are postsecondary OL nutrition courses marketed, managed, designed, and delivered?
2. How is effectiveness measured in studies of OL nutrition education credit courses?
    a. Is OL nutrition education effective in increasing knowledge and/or performance?
    b. Is OL nutrition education effective with respect to student satisfaction, motivation, or perceptions?
3. What theoretical models are used to ensure that postsecondary students are satisfied and have high performance when learning nutrition OL?

Key findings, research gaps, recommendations for delivering effective nutrition education in an OL format, and implications for future research and practice are also discussed.

METHODS

Articles were identified for inclusion using 2 main approaches: database literature searches and reviewing references of articles selected for review (backward searching). The authors conducted an initial search using electronic databases: CINAHL, Academic Search Premiere, Expanded Academic ASAP, Education Complete, and Medline. Each author searched 1 or 2 databases using these key terms: *online nutrition, online nutrition education, online nutrition course, nutrition and online course, distance education and nutrition, nutrition education and Internet, nutrition and Web-based instruction,* and *Web-based nutrition course.*

Articles were included in the review if the abstract, title, or key words indicated that the studies focused on the delivery of nutrition Web-based credit courses for professionals or students. Articles had to be published in a peer-reviewed journal and available in English, and published before October 2009. Publications were not included if they were descriptions of curricula or were evaluations of OL modules or units that were part of primarily F2F courses. Hybrid courses in which the primary method was OL teaching, but used F2F training sessions or examinations, were included.

Each author compiled a list of articles in each database and identified those that appeared relevant for full review. These articles were compared, and data were collapsed to include a complete list of nonduplicative articles from all 5 databases. The number of articles identified in each database by title only, abstract, brief review, and full review was compiled (Figure).

Once the final list of relevant articles was generated for full review, a data matrix was developed with the following headings: paper (author, title, etc.); course or module (title, objectives, number of credits, resources, engagement, technology, learner support, accessibility, marketing); students (learner characteristics); faculty (instructor characteristics); evaluation (design, sample, measures, results, recommendations); and additional comments. These headings were subsequently collapsed into the 6 columns shown in the Table.

All authors began by reviewing the same 2 articles and entering data into the matrix. Findings were discussed and consensus reached regarding the type of information to include under each heading. This process helped establish consistency and facilitate the review process. Each article was reviewed by 2 or 3 of the authors. Institutional Review Board approval was not required.

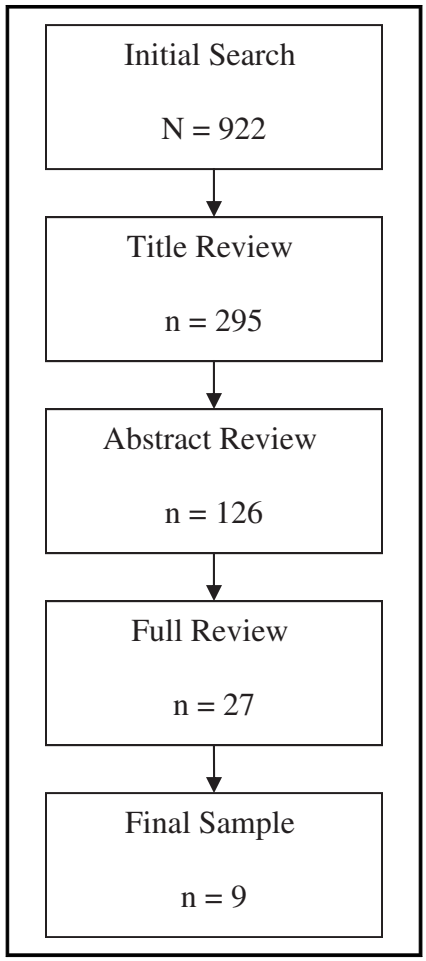

Figure. Literature included in the review process to examine the design, delivery, and evaluation of online credit-based nutrition courses.

RESULTS

General Characteristics of Online Nutrition Courses Reviewed

Results of the literature search, depicted in the Figure, yielded a final sample of 9 articles that described research regarding the design, delivery, and evaluation of OL nutrition credit courses.[13-21] Of the OL nutrition credit classes reviewed (Table), all but 2 were introductory-level courses.[20,21] Four of the studies had 17 or fewer OL subjects per semester,[13,16,17,21] and most courses had only 1 instructor.[13-17] Some studies compared OL to F2F

Table. Characteristics and Evaluation of Credit-based Online Nutrition Courses

Reference	Course[a]	Online Instructional Design	Methods and Measures	Results	Conclusions and Recommendations
Bearden et al[13]	*Nutrition for Dental Hygienists* • Semester • No. of credits: NA • 1998 and 1999 • No. of faculty: 1 • F2F n = 24; OL n = 30 (dental hygiene students)	• *Technology:* all students had notebook computers • *Resources:* PowerPoint and Video "lectures" viewed in the library • *Engagement:* NS	• Posttest only comparison group • Course grades; GPA before course; K (% correct on nutrition-specific questions on the National Board of Dental Hygiene Exam [NBDHE] and overall NBDHE score)	• Course grades, GPA before course, K: NS between F2F and OL • Low-GPA students performed more poorly OL	• No difference in performance between F2F and OL • Consider setting a minimum GPA for OL course enrollment
Beffa-Negrini et al[14]	*Nutrition for Health Online (intro nutrition)* • Semester • No. of credits: 3 • 1999 and 2000 • No. of faculty: 1 • OL n = 54 (general education students; 44% over age 25; most familiar w/ computers and experienced w/the Internet)	• *Technology:* WebBoard • *Resources:* workbook with course activities; textbook; Web sites • *Engagement:* application-based activities; reading reflections, research, or applications shared in small groups using asynchronous threaded discussions; self-assessment quizzes, collaborative small-group project	• Pre-post • Adapted Dunkin and Biddle's variables in teaching and learning • Context variables: age, sex, prior K (28-item multiple choice; Kuder-Richardson reliability = 0.68), A toward nutrition, A toward technology • Process variables: self-reported effort, time spent learning, satisfaction with instructor behaviors, satisfaction with S-S interaction • Product variables: achievement of K from pre to post, course grade, self-reported K gain, course satisfaction, desire to change nutrition B, computer competence	• K increased significantly ($P < .001$) • Satisfaction with instructor predicted achievement in K • Self-reported learning predicted by satisfaction with instructor and with S-S interaction • Satisfaction with course was predicted by S-S interaction, satisfaction with instructor, and prior A toward technology • Older learners had higher course grades than younger learners	• Positive interaction between learners and instructor is important, as it can affect student success and satisfaction • Timely, personal feedback by instructor recommended • Contact with instructor more important than interaction with course technology • Consider maximum S-S interaction when designing OL courses • Identify younger students, those who lack prior K and skills or who are not participating and provide encouragement and support • Instructors should model OL interaction
Beffa-Negrini et al[15]	*Nutrition for Health Online (intro nutrition)* • Semester • No. of credits: 3 • 1999 and 2000 • No. of faculty: 1	• *Technology:* O'Reilly WebBoard (F2F training at start of course)	• Post-course evaluation • Stipek's and Keller's theories to motivate learning	• Overall, course components and assignments were useful (3.5-4.4); instructor	• Motivation theory is a useful framework for OL course design

	• OL n = 54 (general education students)	• *Resources:* e-mail, online nutrition resource library, Internet resources, workbook • *Engagement:* asynchronous small-group discussions, self-quizzes, virtual study sessions, OL research, personal health assessments, reflections, case studies, team project	• Usefulness of course components and satisfaction with instructor and S-S interaction (5-point Likert scales, with 5 being more positive)	interaction (3.9) and participant interaction (3.2) were satisfactory	• Courses should include easy access to technical support; challenging and varied assignments, active projects; clear, timely, friendly, and flexible instructor communication; attention to community building • Allow for mastery and improvement, rather than focusing on evaluation
Buckley[16]	*Nutrition and Health* • Duration: NA, 15 modules • No. of credits: NA • 2000 and 2001 • No. of faculty: 1 • F2F n = 24, hybrid n = 23, OL n = 11 (nursing students)	• *Technology:* WebCT • *Resources:* textbook, hyperlinks to supplementary materials; online syllabus, calendar, e-mail • *Engagement:* quizzes, asynchronous discussion questions with hypertext links; 5 live synchronous chats	• One-time, convenience sample; comparison of 3 groups • K = midterm, final exam, course grades • Perceptions of course content and instructor (Summa standardized validated scale) • Open-ended questions on course strengths, weaknesses, what to change, general remarks	• K = NS among the 3 groups on midterm ($P = .06$), final exam ($P = .62$) or course grades ($P = .30$) • Perceptions = Summa evaluation scores were significantly lower in OL and highest in hybrid course • Open-ended questions from OL students: 5 of 11 liked format: convenient, enjoyed discussions and chat	• Not all OL courses may be appealing to younger, traditional F2F students on campus • OL should address student needs for structure, instructor interaction, and feeling of belonging • Use information regarding students' preferred learning styles and motivation in course design
Knous[17]	*Nutrition for Healthy Living* • Semester, 16 wk • No. of credits: 2 • Year: NA (before 2000) • No. of faculty: 1; additional funds for instructor time • F2F n = 111; e-mail n = 17 (early childhood, food systems and technology students for general education)	• *Technology:* e-mail • *Resources:* textbook, videos, handouts, study guide, exams completed on campus; e-mailed quizzes; videos checked out of library and viewed independently • *Engagement:* nutrition project (distant students returned by mail); e-mailing instructor and other students encouraged but not required	• Quasi-experimental • Exam, project, course grades • Perceptions: open-ended questions at final exam	• Prior GPA, age, and class level showed NS between F2F and e-mail. Prior comfort with K higher in e-mail group • Exam, project, course grades: NS between F2F and e-mail • Perceptions: Perceived learning = NS. Perceptions varied, with e-mail group significantly more satisfied with their decision to take the course, more improvement in independent study skills, more at ease using e-mail, and preference for more courses via e-mail	• Academic performance similar in traditional F2F vs e-mail course • Subjective results indicate benefits of e-mail to be convenience and flexibility

(*Continued*)

Table. (*Continued*)

Reference	Course[a]	Online Instructional Design	Methods and Measures	Results	Conclusions and Recommendations
Mazurak et al[18]	*Nutrition 100 – Introductory Nutrition* • Semester • No. of credits: NA • 2002 and 2003 • No. of faculty: NA • n = 21 for post survey; n = 8 for focus groups (nutrition, nursing, and physical education majors; mature students)	• *Technology:* WebCT • *Resources:* course calendar, course materials, online tests, e-mail, links to Web site activities • *Engagement:* case studies with human interest or personal application; asynchronous discussions; self-study quizzes with instant feedback; problem-solving activities	• Post only (convenience sample) • Theory: student-centered, active learning; instructional message design = CAP • CAP skills: online survey and focus groups	• Overall, favorable evaluation results, but mixed ratings of preferred use of WebCT and technology, usefulness of case studies, and discussion • Mixed opinions regarding preference for online vs F2F education	• OL format can overcome significant barriers to access • OL format can provide quality education to allied health professionals
Miller et al[19]	*NUTR 130: Nutrition for a Healthy Lifestyle* • Semester • No. of credits: NA • 1999 • No. of faculty: 1 for F2F, 1 for OL • F2F n = 434, OL n = 35 (general education students)	• *Technology:* WebBoard and online homework and interactive quizzes; F2F training at start of course • *Resources:* textbook; online library links; 3 F2F exams • *Engagement:* assignments, self-quizzes, asynchronous threaded discussions, small group collaboration, 1 small group project	• Quasi-experimental comparison group pre-post design • K: 28 multiple choice nutrition questions • Achievement: difference between pre and post K scores • Course grades • Engagement: No. of posts (highly involved = > 30 posts during semester) • Age: >24 y vs 18-24 y	• Pretest K: OL > F2F • Achievement: NS between OL and F2F • Course grades: OL > F2F • Engagement: Older students posted more often - No relation between engagement and achievement • Age: Older students had higher pretest K - Older OL students had higher grades than younger OL and all F2F students at end of course	• NS in achievement between OL and F2F • Older students performed better in OL course than younger students. More research needed to identify and better understand factors contributing to achievement among older OL learners • More research needed to explore factors such as age, attitudes, confidence in K, or motivation that may lead to more frequent postings and course engagement
Rochester and Pradel[20]	*Principles of Human Nutrition* • Duration: NA • No. of credits: 1 • Year: NA • No. of faculty: 3 plus course master, IT specialist, and TA • n = 148 pretest, n = 124 posttest (third-year pharmacy students)	• *Technology:* Blackboard; SofTV.ShowandTell; faculty did not receive OL design training beyond technical assistance; F2F student training at the start of course • *Resources:* 1-hour videotaped lectures; OL final exam • *Engagement:* self-study tutorials; research encouraged; group discussions and problem	• Pre-post (1 group) • Pretest: comfort with technology and prior distance learning experience • Posttest: perceptions and satisfaction with OL format • Surveys pilot-tested by 5 pharmacists	• Pretest: 48% had no prior experience with OL courses, but most were comfortable using technology • Posttest: - 43%-86% felt they mastered course goals - 83% agreed that course provided flexibility	• Most students felt OL course provided flexibility, but most felt it was more difficult to understand than F2F • Students recommend a hybrid (OL+ classroom) course be developed vs OL alone • The OL course was time intensive for the instructors.

		solving; responding to peers encouraged; weekly assignments; 6 case-based assignments; 2 F2F workshops		- 66% agreed they mastered course outcomes - 55% felt it was more difficult to understand OL than F2F lectures - 48% agreed that OL should be used over F2F for select courses - Students did not feel that OL learning should completely supersede F2F	
Sigulem et al[21]	*Nutrition in Public Health* • 4 months • No. of credits: NS • 1997, 1998, 2000 • No. of faculty: 5 • n = 11 nutritionists and physicians working in public health in Brazil; n = 7 (completed course and evaluation)	• *Technology:* Web site and e-mail • *Resources:* course calendar; each problem included links to references and resources, Web sites, and OL supplementary texts • *Engagement:* problem-based and task-based learning	• Posttest only • K = final exam • Course satisfaction	• K: 7 students completed course and passed final exam • Course satisfaction: - Course required serious time commitment from participants (2 to 4 h/d); all reported change in practice and improved professional skills - Mixed feedback on length of course - All students would take another OL course - Students reported issues with computer technology and Internet service interruptions	• Some teaching faculty distant from central university, so this project showed that collaboration in online education is possible • High interest in online learning based on large numbers of applicants • The Web is very useful for distance education of professionals • Course was time consuming for teaching staff

A indicates attitudes; B, behavior; CAP, cognitive, affective, psychomotor; F2F, face-to-face; GPA, grade point average; IT, information technology; K, knowledge; OL, online; NA, not available; No., number; NS, no significant difference; S-S, student-to-student; TA, teaching assistant.
[a]Course name, duration, no. of credits, year(s) taught, no. of faculty, sample size (no. of students).

instruction;[13,17,19] 1 compared OL, hybrid/blended, and F2F;[16] most evaluated OL only.[14,15,18,20,21] Six of the studies were wholly or partly conducted in the late 1990s,[13-15,17,19,21] and the latest research was conducted no later than 2003 in 1 study.[18]

Evaluation of Research Findings

Marketing and management. There is little evidence of OL nutrition course marketing or management in the literature. Although marketing was not addressed per se, Sigulem et al noted great interest among health professionals for OL public health nutrition training in Brazil.[21]

Two studies used teams of instructors, some of whom were physically distant from one another.[20,21] Others noted use of assistance in instructional technology.[15,19,20] Two articles indicated that OL teaching was time intensive for instructors,[20,21] and 1 indicated that additional pay for additional time was used.[17]

Course design and delivery. Technology has rapidly changed over the past decade, as indicated by the articles in this review. In the 1990s, OL courses used mostly e-mail, Web sites, and videos.[13,17,21] In 2000, courses began using discussion boards of threaded asynchronous (students do not have to be present OL at the same time) discussions, F2F trainings to teach the technology, and F2F exams.[14,15,19] In 2002, courses began documenting the use of course management systems (CMS) with OL tests and self-quizzes, collaborative learning, group projects, and problem-based learning and cases.[16,18,20] Only 1 article in this review was published after 2005,[20] thus more recent OL innovations, such as use of wikis and podcast lectures, were not addressed.

Measurement of effectiveness. Four of the 9 studies reviewed used quasi-experimental designs comparing OL to F2F or hybrid courses;[13,16,17,19] most of these studies were posttest-only comparisons. Another 3 studies used pretest-posttest designs of only the OL group,[14,19,20] and 2 studies used a 1-group, posttest-only design.[18,21] No studies used a true experimental design, and only 3 assessed validity or reliability of the measures used, or pilot-tested an instrument.[14,16,20] In addition, OL sample sizes appeared to be, on average, 30 or fewer per cohort in 5 studies.[13,16-18,21] Few studies used theories to guide evaluation models; those that did cited learning theories in course or evaluation design.[14,15,18]

Knowledge and/or performance outcomes. Six of 9 articles in this review examined knowledge, course grades, test, or assignment grades.[13,14,16,17,19,21] Results from the 4 studies using a quasi-experimental design indicated that there is no difference in knowledge or achievement between OL and F2F learners in nutrition courses.[13,16,17,19] One study by Miller et al did show that grades were higher in OL than F2F, but this could have been a result of the different weightings for the assignments in the 2 course formats.[19]

Student satisfaction, motivation, or perceptions. Six studies evaluated course satisfaction as an outcome. Overall, results were inconclusive, with 2 studies indicating positive post-course ratings.[14,21] One study showed lower evaluation scores in OL versus F2F,[16] 1 showed higher satisfaction in OL versus F2F,[17] and 2 indicated mixed preferences for OL methods.[18,20] One article investigated factors about the instructor that may lead to improved course outcomes. Beffa-Negrini et al identified that satisfaction with the instructor is related to knowledge gain, self-reported learning, and course satisfaction.[14]

Five studies in this review examined student factors as they relate to course outcomes.[13,14,18-20] Most of the studies used self-selected groups for the OL courses, and several documented differences in prior knowledge, attitudes, or comfort, as well as age of students who chose the OL course as compared to F2F learners. In the study by Beffa-Negrini et al,[14] older students had higher course grades than younger ones. Miller et al found older students posted more often than traditional-aged students, had higher pretest knowledge, and had higher course grades than F2F students.[19] However, age was not a factor in achievement in the study by Knous.[17] Prior attitude toward technology was also related to course satisfaction, whereas student-student interaction was related to self-reported learning and course satisfaction.[14]

DISCUSSION

Because of the limited number of available studies and the paucity of data after 2005, more up-to-date research on effective practices for OL nutrition education is warranted. Only 9 articles were found to address the state of science relative to marketing and management, design and delivery, efforts to measure OL course effectiveness, and models that can guide OL course implementation and evaluation.

Marketing and Management

Based on results from this systematic review, research regarding best practices for marketing OL nutrition education courses is not available. Although low OL course sample sizes seen in this review may indicate low interest in OL learning or limits on class sizes, it may also indicate the need for better marketing to attract additional students. In addition, as OL learning becomes more common, students may seek additional OL nutrition coursework. Successful marketing techniques—such as posting to relevant listservs, links to university and college nutrition department home pages, and presenting or setting up informational booths at professional conferences—are needed to attract off-campus learners to OL nutrition course developers.

Regarding course management, several studies in this review indicated that OL teaching is time consuming. Similarly, a 2008-2009 survey of more than 10,700 higher education instructors across the US determined that faculty feel OL learning takes more effort to develop and more time to teach than F2F offerings.[22] Furthermore, faculty express concern regarding sufficient support for OL course design and teaching.[22] Nationally,[23-28] and possibly institutionally, there are numerous supports for OL education, but the extent to which nutrition educators have access to or

take advantage of these supports is unclear. A synthesis of effective practices to support OL teaching by the Sloan Consortium (Sloan-C) reveals the need for training OL faculty, including how to use technology to help organize OL teaching, with the goal of reducing faculty time burden.[29] Ko and Rosen provide tips for record keeping, file management, creating a consistent method for sharing announcements, setting rules for e-mail, using teaching assistants when class size is above 30 students, finding balance between student-centered and instructor-centered activities, and team teaching.[24] To help OL faculty optimize their time, Simon recommends that faculty have a thorough knowledge of their subject; adequate keyboarding skills; the ability to identify and use effective software applications; effective database-management skills; efficient reading skills; comfortable work environments; and knowledge about how to anticipate/prevent technical problems.[30] A systematic review of the distance education literature related to time management in OL courses gives a number of suggestions for optimal instructional time management, such as providing peer faculty mentors, teaching assistants for courses with more than 20 students, and administrative support from instructional technologists.[31] More research is needed to determine the most effective methods for managing OL nutrition courses and supporting OL nutrition instructors.

One benefit of OL teaching and learning is the ability to access distant instructors, including teams of instructors at a distance.[29] However, there are no data documenting the benefits of using instructional teams in OL nutrition education as they relate to outcomes, or on instructor time. More research and documentation on course management, including sharing of instructional techniques for time management, are needed. As most courses in this review had 17 or fewer students per semester, it would be useful to identify practices that "scale up," leading to positive outcomes in larger student groups. Sloan-C recommends sharing resources, knowledge, and costs between institutions; and course redesign to prevent student withdrawals or failure, thus maintaining increased enrollments.[29]

Design and Delivery: Frameworks

In the majority of studies reviewed, the focus was to evaluate effectiveness of an OL nutrition course rather than to describe education theories and how these theories relate to course design and delivery. Some suggestions for designing OL nutrition courses were made. For example, maximum student-student interaction is encouraged, and opportunities for personal feedback by the instructor should be implemented.[14] Beffa-Negrini et al found motivational theory to be useful in OL course design and suggested ways to help motivate OL learners, including easy access to technical support; challenging and varied assignments; active projects; clear, timely, friendly, and flexible instructor communication; and attention to community building.[15] Buckley suggested using information regarding students' preferred learning styles and motivation in OL course design.[16] In the nursing field, DeBourgh reviewed distance-education literature and found the following aspects of course management to be important to student satisfaction: clarity of assignments and expectations; access to campus-based resources; prompt exchange of course assignments and materials between instructors and students; availability of technical support; and opportunities for orientation to course technology.[32]

One tool that might be helpful for those designing OL nutrition courses is the Quality Matters rubric.[25] This rubric presents 40 guidelines for evaluating OL course design in the following standards: course overview and introduction, learning objectives, assessment and measurement, resources and materials, learner engagement, course technology, learner support, and accessibility. Billings proposes variables to be used in Web-based nursing courses to assess outcomes (educational practices, faculty support, learner support, and use of technology),[33] which could be updated and applied in the nutrition discipline. However, use of these or other educational frameworks in postsecondary nutrition education is limited at present.

Design and Delivery: Technology

Historically, distance education has been delivered through correspondence courses in which students received educational materials and submitted learning assignments through surface mail. With the emergence of telephone, radio, TV, fax, videoconferencing, and electronic mail, distance education reached the technological age. In the latter part of the 20th century, the Internet allowed hyperlinked resources to be shared OL through CMS such as WebCT, Blackboard, or Moodle. In addition to linking students to instructional content, these CMS allow students to interact with peers and instructors through live synchronous text chats, asynchronous threaded discussions where students post and reply to messages at their convenience, or through virtual live classrooms with audio, video, and application sharing. The authors saw a similar evolution in this review, with studies reporting the use of e-mail and Web sites before 2000 and studies using CMS after the year 2000.

More recently, Web 2.0 technologies such as social bookmarking, social networking, podcasts, wikis, blogs, and document sharing services have entered the mainstream, allowing for new methods of delivery, increased interaction among users, and increased learner engagement.[34] Unlike closed CMS, Web 2.0 technologies are open and allow for the social construction of knowledge. New technologies for communication between students and instructors, such as mobile phones and netbooks and virtual learning environments such as Second Life,[35] continue to emerge. In a survey of medical school (n = 36) and nursing school (n = 19) educators, 45% of medical schools and 53% of nursing schools use Web 2.0 tools (most commonly, blogs, wikis, videocasts, and podcasts) in their curricula.[36] In a survey conducted during a human anatomy course for medical students (n = 91), 92% of respondents found podcasts to be very helpful for self-paced learning, 89% found podcasts an excellent resource for

studying anatomy, and 79% supported the use of podcasts for exam preparation.[37] Examples of the usefulness of wikis and blogs in nursing education have been reported.[38] An investigation of health-related activities in the VLE Second Life found most (n = 68) were aimed toward patient education or increased awareness of health issues.[36] Research using Web 2.0 technologies such as blogs, wikis, podcasts, instant messaging, voice discussion tools, social bookmarking, content creation tools (Slideshare, Flicker, YouTube), social networking (Facebook, MySpace, Twitter), RSS feed aggregation, virtual worlds (Second Life), and so on is needed in OL postsecondary nutrition education. Online nutrition educators will need to keep up with technology changes and evaluate their effectiveness for delivery of course content, learning activities, faculty-student communication, and peer interaction. Technologies in the next 5 years may include mobile computing, open content (free applications on the Internet), electronic books, and gesture-based communication (devices controlled by natural movements of fingers, hands, etc.).[39]

Online Course Effectiveness

Online learning has advantages such as overcoming time and distance barriers, capacity to share resources among colleges and universities to wide audiences, and the ability to use innovative multimedia and virtual instructional methods. However, if OL courses are designed in such a way that traditional F2F methods (textbook readings, lectures, examinations) are published on the Internet without considering social isolation, de-individualized instruction, and using technology for the sake of technology, effective learning may not occur.[40] When designing and delivering OL nutrition courses, faculty and instructional designers should avoid these potentially negative aspects by incorporating opportunities for regular student-student and student-instructor interactions,[14,16] through discussion forums and engaging activities such as OL debates, problem-based case studies,[41] and collaborative projects.

Overall, as with OL learning in general,[42] postsecondary OL nutrition courses are as effective as F2F for improving cognitive-based outcomes. Although students may learn equivalently in OL formats and F2F classes, not all students prefer OL methods or are highly satisfied with OL learning. In this review, students with low grade point averages performed more poorly OL,[13] OL courses were not as appealing to younger students,[16,19] and for some, OL lectures were more difficult than F2F lectures to understand.[20] This review showed that it is important to identify students who lack prior nutrition knowledge or skills or who are not participating.[14] As with traditional instruction, student satisfaction could be a function of course design, instructor factors, or student factors. In a study of 43 graduate-level nursing students,[32] DeBourgh concluded that students adapt to the mode of delivery (F2F or OL), and student satisfaction is determined mostly by quality and effectiveness of the instructor rather than the technology. Furthermore, DeBourgh posits that student satisfaction is related to clear communication and clarity of course expectations, optimal selection and use of visuals, timely feedback on coursework, and effective instructional strategies that assist learners to grasp course content.[32]

In the 9 studies in this systematic review, effectiveness of OL courses, as judged by post-course grades and comparisons to F2F courses, was found to be related to students' ages, satisfaction with student-instructor or student-student interaction, and prior nutrition knowledge or attitudes toward technology. However, no structured framework for measuring effectiveness or quality of OL nutrition education was presented. Furthermore, the Quality Matters rubric mentioned in the previous section is useful only for evaluating the design of courses and does not address faculty teaching, facilitation, or delivery skills nor the quality of students' learning experiences.

Beffa-Negrini et al used the Seven Principles for Good Practice in Undergraduate Education when designing their course, which encourages student-faculty interaction, collaboration among students, active learning, prompt feedback, time on task, high expectations, and respect for diversity.[15,43] These principles address what instructors should consider during course design and delivery, but they do not address other aspects of OL instruction, such as curriculum design for learning outcomes; instructional design and the optimal use of course technology; Web design and ease of use; learners' prior knowledge, learning styles/preferences, and OL learning experiences; and OL course presentation aspects such as readability, grammar, consistency, and organization.[44] In the nursing literature, Cobb provides guidelines for peer review of OL nursing courses.[45] Similarly, Little presents a review of a variety of standards and methods for evaluating OL nursing courses, which the reader may find useful for guiding the evaluation of OL nutrition courses, as well.[23] Clearly, a gap exists in the nutrition literature, as it does for OL learning in general,[42] in using and evaluating current models for OL post-secondary education.

IMPLICATIONS FOR RESEARCH AND PRACTICE

This review of predominantly undergraduate introductory nutrition classes demonstrates that students can gain knowledge as well in OL as in F2F formats. As the practice of nutrition OL instruction expands, additional research is needed to document process and outcomes for higher-level undergraduate nutrition courses, laboratory courses, and graduate-level classes. Much more research is needed on how OL nutrition courses are marketed, managed, designed, delivered, and evaluated. Studies using experimental designs with validated tools and relevant frameworks are also needed to determine the effectiveness of OL nutrition education, particularly using emergent technologies and models specific for OL teaching and learning.

Further work is needed to identify the qualities of an instructor that lead to improved student satisfaction and to examine the cognitive outcomes related to improved satisfaction with the course or instructor. In addition, identification of student

factors such as age or prior knowledge and attitudes that may affect course selection, participation, and outcomes will also be useful. Since several studies note the time demands for teaching an OL course, it would be beneficial to determine time-efficient techniques for teaching nutrition that can maintain or increase positive outcomes. Finally, as OL learning modalities make their way into the traditional F2F classroom, more research on blended/hybrid OL nutrition courses is warranted.

It is recommended that nutrition education practitioners stay current with emerging OL education technology tools and resources to take advantage of supports for efficient time management, identify practices that "scale up" to larger groups of students, design engaging course activities, and avoid common challenges of social isolation. To attract off-campus learners, OL nutrition educators will need to market their programs. It is also recommended that practitioners present and publish their experiences with OL nutrition education to build the knowledge base in this growing field.

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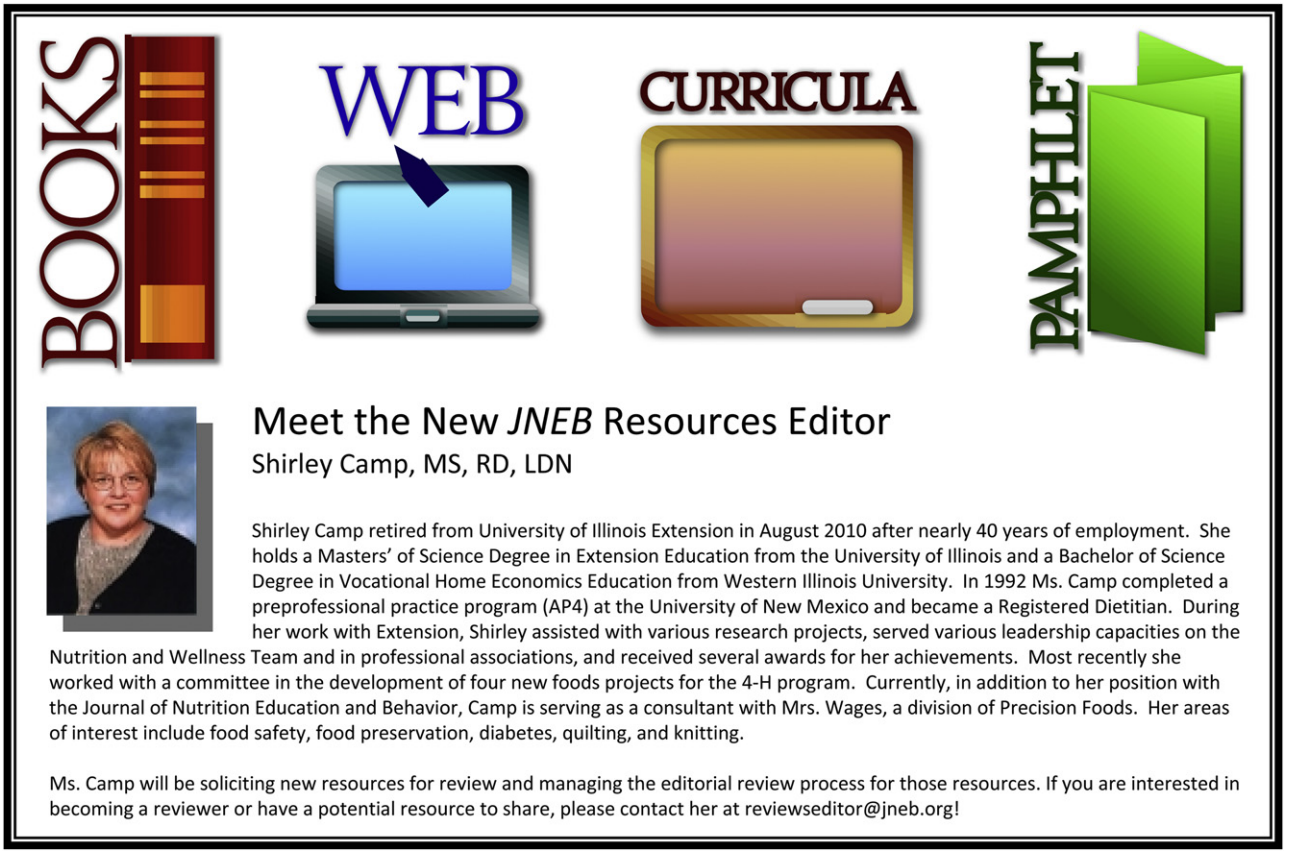

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Shirley Camp retired from University of Illinois Extension in August 2010 after nearly 40 years of employment. She holds a Masters' of Science Degree in Extension Education from the University of Illinois and a Bachelor of Science Degree in Vocational Home Economics Education from Western Illinois University. In 1992 Ms. Camp completed a preprofessional practice program (AP4) at the University of New Mexico and became a Registered Dietitian. During her work with Extension, Shirley assisted with various research projects, served various leadership capacities on the Nutrition and Wellness Team and in professional associations, and received several awards for her achievements. Most recently she worked with a committee in the development of four new foods projects for the 4-H program. Currently, in addition to her position with the Journal of Nutrition Education and Behavior, Camp is serving as a consultant with Mrs. Wages, a division of Precision Foods. Her areas of interest include food safety, food preservation, diabetes, quilting, and knitting.

Ms. Camp will be soliciting new resources for review and managing the editorial review process for those resources. If you are interested in becoming a reviewer or have a potential resource to share, please contact her at reviewseditor@jneb.org!