TEACHING INNOVATIONS

Redesign and process of reforming an existing undergraduate Nutritional Sciences program

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INTRODUCTION

Traditionally, faculty-designed undergraduate Nutritional Sciences (NS) programs as biochemical science with an emphasis on nutrients’ effects on metabolism and pathophysiology (5). Thus most NS programs primarily focus on biomedically based content to prepare undergraduate students for postbaccalaureate training as physiologists, biochemists, and/or healthcare practitioners (5). However, modern pedagogical approaches within higher education emphasize the students’ needs to apply knowledge in diverse contexts, solve complex problems, and learn how to learn across their lifetime (8, 16). This literature suggests that narrow content-focused teaching for a specific job or profession is not as important as giving students the skills to excel in multiple professional contexts that will span their careers.

In 2001, the American Society for Nutritional Science’s Long-Range Planning Committee (ASNSC) published a paper that summarized the current NS program’s challenges, emphasizing how modern NS requires an integrative approach that interfaces with numerous disciplines, including public health and sustainability (26). For example, numerous nutrient-deficient diseases in developed countries have all but been eliminated within Western communities due to fortification and enrichment processes and policy changes (21). Allen et al. (2) suggested guidelines about how to integrate the ASNSC’s findings into graduate-level NS programs; however, a similar discussion related to applying the ASNSC’s findings to undergraduate NS programs has not been published.

Michigan State University (MSU) has had a nutrition-related program for at least 90 yr (17). Recently, MSU tasked its Department of Food Science and Human Nutrition with evaluating current undergraduate curricula. Several considerations drove the task for curricular revision. First, the department had not undertaken a curriculum review in many years. Second and related, the university was approaching an accreditation review, and the College of Agriculture and Natural Resources (CANR) requested that all units advance the use of learning outcomes and assessment. Finally, and perhaps most importantly, the program had recently transitioned from the College of Natural Science (CNS) to the CANR, and, during this move, the student numbers in the NS program decreased significantly.

Currently, multiple food-based majors exist within the Department of Food Science and Human Nutrition: three undergraduate Bachelor of Science degrees (Food Science, Dietetics, and NS), three Master of Science degrees (Human Nutrition, Food Science, and Dietetics), and two Doctor of Philosophy programs (Human Nutrition and Food Science). Among the undergraduate programs, the Institute of Food Technologists (13) and Accreditation Council for Education in Nutrition and Dietetics (1) certify the Food Science and Dietetics programs, respectively. No official accrediting body or standards exist for NS programs. Therefore, the only accrediting guidelines are the same as those for the university, the Higher Learning Commission, which accredits colleges and universities within 19 states of the North Central United States, including Michigan (10). The Higher Learning Commission requires academic programs to have learning outcomes, and it does provide guidance for some program goals, such as an emphasis on diversity, communication, and inquiry skills (11).

The NS program began a redesign of the major in Fall 2012 to address the university’s and college’s mandates, better meet NS undergraduate student needs, and broaden appeal. Official program paperwork was submitted in 2015, and the new curricular courses were first offered in Fall 2016. This article describes the rationale and backward design (25) process
utilized during NS program reform. It emphasizes concepts such as learning outcomes development, assessment, and integration with related fields, and suggests some necessary tactics for modifying a strict, linear backward design process to meet contextual realities.

Nutritional Sciences Curriculum Redesign

Rationale for Nutritional Sciences redesign. As stated, several factors contributed to the decision to redesign the major. First, the college leadership charged the program with reviewing the program’s curriculum to consider student learning outcomes and evidence of student learning. This mandate coincided with major efforts within the college and university to enhance the use of learning outcomes and assessment due to accreditation. Additionally, the university was entering a process for its accreditation, and all units were asked to review their curricula. If there was no entity that granted accreditation for an existing program, then departments were to use the university’s undergraduate learning goals (ULG) (19) and the Higher Learning Commission’s criteria (10).

The review also came at a time in which the program was changing between different administrative leadership, and the NS program also needed to increase NS undergraduate enrollment and develop better relationships with external stakeholders, such as alumni and potential employers of graduates. The major was originally housed in the CNS, where enrollment was as high as 380. Once the major moved to the CANR, enrollment dropped to 97 in 2013. By moving colleges, the NS program lost its direct connection to the preprofessional medical designation and advising services in CNS. A related issue, CANR did not tend to attract as many incoming students interested in prehealth professional majors, and students did not know to look to CANR to find the NS program/major.

Nutritional Sciences undergraduate committee formation. The overall curriculum redesign process timeline is illustrated in Fig. 1. In Fall 2012, the Department of Food Science and Human Nutrition formed a committee to revise the NS curriculum. This process included benchmarking the current curriculum against peer institutions and best practices; developing clear learning outcomes for the major; reevaluation assessment methods; and mapping the learning outcomes, assessments, and objectives to a redesigned curriculum. While doing this work, the group considered learning outcomes to be measurable statements about student performance (outputs) after an educational intervention, while objectives were the content inputs that faculty used to design a course. This process followed a version of backward design (25), but also acknowledged the importance of content in relationship to the science-based major and faculty expertise.

The department consists of 35 tenured and 16 fixed-term faculty members, including 2 full-time instructors. The committee consisted of 10 of these individuals, representing numerous subdisciplines related to NS, including biomedical nutrition, dietetics, animal science, exercise science, epidemiology, public health, and sustainability. Overall, the NS Curriculum Committee (NSCC) members represented the teaching, research, extension, and advising appointments at the university, and each of the members had experiences teaching courses for the undergraduate NS program or the Human Nutrition graduate program.

In addition to the 10 NSCC members, the process used a professional consultant. This person came from the Provost’s office, and his role is to help campus units with curriculum design using his expertise in backward curriculum design (25), curriculum evaluation, and learning outcomes development. Specifically, the consultant helped the NSCC chair with organizing the meetings and helped facilitate discussions about the curriculum redesign. The consultant also managed the benchmarking process, brought in campus experts to talk with the NSCC about curriculum policies, such as the design of online and experiential learning (EXP) courses, and helped navigate the NSCC through the university curriculum process. The external professional was a neutral party who could ask difficult questions and help the chair navigate through the department’s history and politics associated with the current curriculum. As the NSCC wanted a specific time commitment from the consultant, CANR bought 15% of this professional’s time to ensure that he could help the NSCC and with other CANR programs.

Nutritional Sciences undergraduate program major overview. During the early stages of the redesign process, the NSCC used data from exit surveys to ascertain former students’ job occupations and their overall satisfaction with the previous program. This process helped the NSCC understand the destina-

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**Fig. 1.** Timeline of Nutritional Sciences curriculum redesign. NSCC, Nutritional Sciences Curriculum Committee; HNF, Human Nutrition and Foods; EXP, Experiential Learning.

**2012**
- NSCC formed
- Outside consultant brought in to assist in redesign
- Information gathering: Feedback from students/faculty, benchmarked comparable programs

**2013**
- New concentrations added
- Learning objectives created
- Learning outcomes created
- Core courses created (HNF 150, 250, 350, 450, EXP)
- Concentration-specific courses conceived (HNF 310, 385, 485)

**2014**
- Mapping course outcomes across the program
- Created assignments to be “Introduced”, “Practiced”, and "Summatively Assessed" across program that map to outcomes

**2015**
- Final paperwork for curriculum redesign submitted to University
- HNF 101 taught for the first time
- HNF 102 conceived

**2016**
- New core courses offered for the first time
- HNF 250L and HNF 415 conceived
tion of its students, but it also helped to confirm some of the speculated reasons behind diminishing enrollments. One critical issue that emerged was a lack of clear understanding about what careers NS programs connect to and lack of awareness of NS as a preprofessional degree option.

An initial benchmarking process investigated the size, administrative placement, graduation requirements, content themes, and nomenclature of peer institutions in the Big Ten Academic Alliance (4), as well as public research universities with ranked programs. Specific questions included the following: 1) how many NS programs have expanded beyond a biomedical focus; 2) what is the volume and level of science and math courses required for the programs; and 3) how much basic science is offered within the NS program itself versus taken outside the program. Answers to these questions helped guide discussions about the overall structure, purpose, and goals for the NS program.

A common theme was that many peer NS programs had different tracts within their program from which a prospective student could select a focus. Three major tracts observed included the traditional prehealth professional tract, a public health tract, and a global health tract. A second theme is that these different concentrations had differing levels of science and math requirements, with the biomedical concentrations often having higher levels of requirements to prepare students for health professional graduate programs. Third, the group found that, in some cases, the comparable NS programs taught biochemistry and physiology content internal to the program, whereas the current NS program was reliant on these courses and content outside the program and college.

Findings confirmed and supported the exit survey data. Students often thought of medical or graduate school as the only option for the science-heavy curriculum and did not associate NS majors with CANR. Nationally, many NS programs are located in science or health colleges, although still maintaining a biomedical, preprofessional track, these schools are increasingly adding new options linked to content, such as public health, food systems, social justice, food security, and international development. Students interested in nutrition, but not in attending medical school, found the significant focus on sciences courses and lack of career options a disincentive.

The conclusions from the NSCC benchmarking exercise supported ASNSC findings that NS needs to be integrated with related fields (26). The findings also aligned with institutional goals related to enhancing funding and focus on food security, public health, and global issues in the curriculum (20). Based on the evidence, the NSCC decided on two major focus areas to include the following: 1) preparing students for competitive studies for preprofessional (e.g., medicine, dentistry, paramedical) and graduate careers; and 2) preparing students for industrial, corporate, government, public health, and sales positions. The NSCC then decided to redesign the single major, creating three distinct subconcentrations: biomedical, public health, and global nutrition. New NS concentrations developed at MSU are described in Table 1.

### Nutritional Sciences Learning Objectives and Outcomes Creation

**Backward design.** Numerous health professional programs have utilized backward design as a process to guide curricular design, including NS graduate majors (2, 7). Thus the NSCC used this process to develop course outcomes and assessments. The backward curriculum design incorporates three stages into course development: identifying desired results, determining acceptable evidence, and planning learning experiences and instruction (25). Furthermore, this design process emphasizes the six facets of understanding when creating learning outcomes, which include explanation, interpretation, application, perspective, empathy, and self-knowledge. Situational factors that surround the reform effort are often overlooked in backward design literature (20). In theory, the process of backward

| Table 1. New Nutritional Sciences concentration areas |
|---------------------------------------------|
| **Concentration** | **Content Emphasis** | **Curricular Requirements** |
| Biomedical and Molecular Nutrition | • Advances understanding of issues in human nutrition related to human health  
• Emphasizes the sciences (chemistry, biochemistry, biology, physiology, physics, microbiology)  
• Meets admissions requirements of most Doctor of Medicine, Doctor of Osteopathic Medicine, dentistry, physician’s assistant, pharmacy, and other graduate health programs | • Requires calculus course, basic biology, and basic chemistry  
• Experiential learning  
• Nutrition in medicine course  
• Introductory statistics  
• Higher-level requirements for physiology, chemistry, and biochemistry  
• Requires physics  
• Optional classes drawn from health and medical course offerings |
| Global Nutrition and Health | • Emphasizes the international aspects of nutrition  
• Expands understanding of community nutrition, food security, sustainability, agricultural economics and policy, social justice, and intercultural communication  
• Provides practice in program planning, intervention, and evaluation | • Requires calculus course, basic biology, and basic chemistry  
• Experiential learning  
• Courses in community and global nutrition  
• Requires coursework in intercultural communication and international development  
• Requires program evaluation or grant writing  
• Optional classes drawn from international development, political science, philosophy, and other social sciences |
| Public Health Nutrition | • Focuses on nutritional epidemiology and public health, and skill building in biostatistics  
• Develops understanding of community nutrition, health promotion and disease prevention, and social policies related to population health  
• Provides practice in program planning, intervention, and evaluation | • Requires calculus course, basic biology, and basic chemistry  
• Experiential learning  
• Courses in public health and public health nutrition  
• Higher-level requirements for statistics  
• Requires program evaluation or grant writing  
• Optional classes drawn from public health, epidemiology, public policy, and social sciences |
design can seem straightforward and linear; however, its application in real-world, practical settings requires iterative reform and on-going dialogue related to context. Curriculum change efforts must accommodate the reality of institutional, college, and department structures, finances, instructional resources, and personnel. For example, reformers must think about issues such as:

- What are the metrics used to hold the academic program accountable in terms of research productivity, external funding, and class sizes?
- How many courses can the department offer with existing faculty based on their existing teaching appointments, and what is an appropriate advising load for its staff?
- What facilities exist in terms of classrooms, laboratories, and technology?
- What existing expertise is available in the department, and are there topics that only certain faculty can teach?

Departments should also note that using backward redesign to redesign a curriculum is different than creating something new. In the redesign process, individuals may fear the changes and fear the loss of “their” course, expertise, or experience. To manage this process at the university, the external consultant used two tactics. First, the external consultant worked with the NSCC chair to outline meeting norms for dialogue and decision-making. The NSCC started taking minutes and using Robert’s Rules of Order (18) to facilitate discussions. Second, the consultant guided the team to begin the process by outlining the content they felt was essential to a Bachelor of Science degree in NS. A model of curricular prioritization suggested by Fink (8) was then employed to help transition the group away from a focus on content and objectives, toward application and outcomes.

Learning outcomes development. Learning objectives are defined as the inputs into the curriculum: what instructors want to teach or the content to be included (6). To move the discussion forward, the consultant and NSCC chair led a session in which the faculty brainstormed all of the possible content they wanted covered, then put this information into a draft outline for the program. This process helped the group prioritize the content they wanted to cover and become more comfortable with a focus on applied learning techniques instead of content coverage, in alignment with the learning outcomes.

One important lesson from this process was agreement about the use of illustrative examples and a focus on teaching students to learn how to learn. In nutrition, covering all possible micro- and macronutrients in depth in a single course is impossible, so the faculty agreed to highlight different nutrients in different courses and use their time to highlight transferrable ideas. For example, they could use a specific nutrient to highlight how the dietary reference intake is established (14), another to teach intake and absorption, and another to talk about supplements, etc. In this way, the department agreed to eliminate overlap in coverage, think strategically about the examples they used, and focus on teaching students how to think about nutrition instead of just reiterating nutrition facts.

Learning objectives development. After prioritizing the content to be covered across the major and setting that information aside, the NSCC focused on developing learning outcomes for the major as a whole—not for the specific concentrations. The NSCC wrote major learning outcomes that aligned with MSU’s five ULGs: analytic thinking, cultural understanding, effective citizenship, effective communication, and integrated reasoning (19).

To accomplish this task, the NSCC instructors needed to consider their goals, examine established content standards, and review curriculum expectations. Examples of questions asked in backward design (25) include: 1) what should students know, value, or accomplish at the end of the academic program; 2) what content is essential for knowing; and 3) what enduring knowledge and comprehension are desired of our students. The NSCC determined four key themes to use for the development of major outcomes including: 1) research, thinking, and inquiry skills; 2) science of nutrition; 3) dietary patterns, food, and supplements; and 4) social science and sustainability. They created a matrix to compare these themes with the five ULGs (19), and, through an iterative process, the NSCC decided on 11 program outcomes that aligned with the university outcomes (Table 2).

Redesigned courses. Once the committee agreed to outcomes for the program, they reviewed the existing courses and created a core set of NS courses, along with courses for the

Table 2. New Nutritional Sciences major learning outcomes

| University Outcome         | Major Outcome                                                                                                                                 |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| Analytic thinking          | 1. Interpret and analyze the relationships between health and diet status for individuals and populations using nutrition evidence.          |
| 2. Justify how nutrient recommendations change across the lifespan, population, and health status. |
| 3. Analyze food, health, and nutrition problems using appropriate research methods.               |
| Cultural understanding     | 5. Acknowledge the socioeconomic, cultural, environmental, and geographic influences of diet, access to nutrients, beliefs about health, and healthy lifestyles. |
| 6. Actively seek out and acknowledge diverse perspectives related to nutrition and health.       |
| Effective citizenship      | 7. Connect codes of ethics, academic integrity, and responsible and ethical practice in nutrition contexts to one’s personal and professional behaviors. |
| 8. Understand the role of diverse government and nongovernment stakeholders in determining of food, health, and nutrition policies. |
| Effective communication    | 9. Inform stakeholders about food, health, and nutrition using effective communication techniques based on audiences’ need, understanding, and context. |
| Integrative reasoning      | 10. Connect food and nutrition knowledge with the biological and/or social sciences to address contemporary topics in infectious and chronic disease prevention and treatment. |
| 11. Evaluate multiple sides of a complex nutrition or food issue using diverse, appropriate evidence. |
three concentrations (Table 1), in which each had at least one specialized course. They agreed that each concentration would have slightly different math, statistics, and science requirements to support a wider range of students with an interest in nutrition, but no plans on attending a health professional graduate program. As part of the conversation, the committee discussed adding, combining, and eliminating courses. Additionally, the NSCC examined how existing learning objectives were covered across courses. This section will outline how the committee addressed the curriculum structure. Former and newly designed core courses, along with new course descriptions, are listed in Tables 3 and 4, respectively.

First, examining the first-year curriculum, the NS program was used to teach two different courses: Human Nutrition and Foods (HNF 150): Introduction to Human Nutrition for nonmajors and HNF 260: Principles of Human Nutrition for NS majors and other prehealth professional students (e.g., nursing students). The dual offering was onerous on the department’s teaching resources, and upon review, the content for both courses was largely overlapping. Collectively, the student reviews from the courses were mixed, as nutrition and health students wanted a more rigorous science-based course, and nonmajors wanted more of an applied or personal development focus. This dichotomy highlights the challenge of trying to satisfy multiple needs of a service course, elective, and introduction to the major at the same time.

To resolve these concerns, the NSCC decided to eliminate HNF 260 and transform HNF 150 into a science-based introduction to nutrition course that would satisfy the interest of NS and health-related majors. To manage students’ desire for a less technical nutrition course, as well as the desire to generate credit revenue from nonmajors, the committee decided to create two summer online service courses to accommodate students looking for a general, personal-development nutrition

Table 3. Former and new Nutritional Sciences core courses requirements

| Year | Original Curriculum | New Curriculum |
|------|---------------------|----------------|
| 1    | • HNF 260: Principles of Human Nutrition (3 credits) | • HNF 150: Introduction to Human Nutrition (3 credits) |
|      | • HNF 250L: Professional Development and Career Planning in Nutrition (1 credit) | • FSC 211: Principles of Food Science (3 credits) |
| 2    | • HNF 250: Contemporary Issues in Human Nutrition (3 credits) | |  |
|      | • HNF 250L: Professional Development and Career Planning in Nutrition (1 credit) | • HNF 350: Advanced Human Nutrition and Metabolism (4 credits) |
| 3    | • HNF 461: Advanced Human Nutrition: Macronutrients (3 credits) | |  |
|      | • HNF 462: Advanced Human Nutrition: Micronutrients (3 credits) | • HNF 450: Nutrition in the Prevention and Treatment of Disease (3 credits) |
| 4    | • HNF 464: Nutrition in the Prevention and Treatment of Disease (4 credits) | • FSC 455: Food and Nutrition Laboratory (3 credits) |
|      | • HNF 464: Nutrition in the Prevention and Treatment of Disease (4 credits) | • Experiential Learning Requirement (3 credits) |

Table 4. Course descriptions of new Nutritional Sciences core courses

| Core Course | Course Description |
|-------------|--------------------|
| HNF 150: Introduction to Human Nutrition | This course is a general survey of nutrition topics, including the biochemical interaction of foods, nutrients, genetics and health; human eating behaviors; government and corporate regulation and influences on human eating behavior; ethical issues, including hunger and food security; the relationship between our food system and the environment; and factors affecting the availability of a safe, nutritious food supply. |
| HNF 250: Contemporary Issues in Human Nutrition | This course is the second in a series of core courses in the Nutritional Sciences curriculum. The course will cover current topics and controversies in nutrition and health and disease. The concepts of health, credible sources of nutrition information, historic studies, stake holders, and ethical issues surrounding nutrition will be introduced. The assignments will practice critical thinking and communication skills using nutrition content. |
| HNF 250L: Professional Development and Career Planning in Nutrition | This course is designed to teach necessary skills students will need for their EXP requirement, as well as career planning and development. Students will learn strategies for experiential and career exploration, resume and cover letter development, visual and verbal communication skills, workplace etiquette, and strategies for networking. |
| HNF 350: Advanced Human Nutrition and Metabolism | This course will use basic science concepts to explain nutrient function, metabolism, and interaction in humans. This course will cover the metabolic and physiological functions of nutrients at the molecular, cellular, tissue, organ, and system level, integrating the effects of nutritional status in health and disease. An emphasis will be made on current research as it is applied to content covered in the class. Recent published papers pertaining to a topic related to lectures will be analyzed. |
| HNF 450: Nutrition in the Prevention and Treatment of Disease | At the completion of this course, the successful student should understand how basic nutritional research is utilized to understand the role of nutrition in immunity as it relates to both normal and disease states. |
| FSC 455: Food and Nutrition Laboratory | Principles and application of analytical techniques. Analysis for fats, proteins, carbohydrates, minerals, vitamins, and additives. Techniques include spectroscopy, fluorimetry, chromatography, electrophoresis, and proximate composition. |
| EXP Requirement | An EXP requirement is required for all Nutritional Sciences students and is intended to give each student practical experience in the field of nutrition and health. To meet the EXP requirements, students must enroll in a minimum of 3 credits of either HNF 490 (research experience), HNF 494 (internship), or ANR 475, or an equivalent course. Students would be able to substitute credits with the approval of their adviser and the EXP coordinator. |
experience. First, it created HNF 101: Personal Nutrition and Health, and second it created HNF 102: Dietary Supplements: Evidence versus Hype. These courses will be discussed in detail later in this paper.

Looking beyond the first year, the NSCC decided to create new 200- and 300-course requirements to better scaffold material across the undergraduate experience (9, 12). In the previous curriculum, students often had to complete several prerequisite courses outside the major during their freshman and sophomore years, which left little room to complete any core courses. Furthermore, since students did not enroll into most of the core courses until their senior year, they lacked the cohort atmosphere and connectiveness that students should establish with others in their major. Closing this gap provided several advantages for the department: 1) it ensured students' consistent exposure to and reinforcement of NS content; 2) it helped faculty members to monitor student progress through the program; and 3) it created more of a community within the department by enhancing connections between students and between students and faculty members.

At the 200 level, the department created HNF 250: Contem- porary Issues in Human Nutrition and HNF 250L: Professional Development and Career Planning in Nutrition to address research skills, information literacy, and professionalism. The main goal for the creation of HNF 250 was to introduce and practice identifying credible evidence and using health information literacy to evaluate nutrition and health claims (22). The NSCC intended for students to take this course after HNF 150 and restricted it to students in the major, and they used a lecture/recitation model to provide more classroom time to develop critical thinking, practice skills application, and bring a cohort/caring feel to the major.

Another identified problem with the previous major was the lack of a professional skills course that developed abilities, such as resume building, public speaking, interviewing, and networking. Both the Dietetics and Food Science programs required at least one professional development course in their curricula; therefore, the NSCC developed a tandem course (HNF 250L) to fill this void. The NSCC linked HNF 250L as a laboratory class associated with HNF250 content and learning outcomes and intended it to be taken concurrently. HNF 250L was added as a new major requirement later in the revision process than the other course after the faculty found that they did not have enough time in HNF 250 to accomplish all of their professional development outcomes (Spring 2016).

At the 300 level, the NSCC consolidated two existing 400-level courses into a new course, HNF 350: Advanced Human Nutrition and Metabolism. The NSCC decided that offering core courses that can be taken every year was instrumental to student success and to encourage the cohort feel of the community of NS students. One major reason to merge the courses was that both original courses heavily emphasized material across the undergraduate experience (9, 12). The NSCC categorized major outcomes by level of student mastery and university’s outcomes and mapping across the courses. The NSCC decided what the courses should be doing. The main goal of this step was to ensure that each program outcome was covered in at least three required courses.

Table 5 presents the program outcomes that align to the university’s outcomes and mapping across the courses. The NSCC categorized major outcomes by level of student mastery (introduction, practice, and summative assessment). At the introductory level, faculty introduce students to major topics. Along with additional knowledge, at the practicing level, students begin developing and practicing skills related to foundational knowledge. At the summative assessment level, stu-

Mapping outcomes across the curriculum. Once the NSCC had defined its program outcomes for the NS curriculum, it needed to map the outcomes across the courses in terms of learning outcomes and objectives. For this step, each instructor decided how the program’s outcomes should flow through the curriculum. This was an iterative process in which existing courses stated what they currently did, and the NSCC decided what the courses should be doing. The main goal of this step was to ensure that each program outcome was covered in at least three required courses.
students are evaluated on a mastery of skills as defined by the program outcome. For example, one program outcome related to analytical thinking and the objective of the recommended dietary allowance (RDA) (14) is “justify how nutrient recommendations change across the lifespan, population, and health status.” The curriculum expects that, at the summative, graduation level (in 400-level class), students will be able to produce work that fulfills this outcome. The instructor might use an essay exam question, case-study response, or research paper that requires students to make a well-supported argument for how an RDA for vitamin D was established in the United States. Earlier courses have already introduced students to the content knowledge needed to perform this task and allow students to practice making arguments and include examples of how the curriculum scaffolds (9, 12). As such, a student might learn about the concept of RDA in HNF 150; practice public speaking and reading research about how the RDA is created in HNF 250; and in HNF 350 they would be confronted with the controversy and policy related to the RDA. The background and exposure are all designed to prepare students toward the time of graduation, so all of the capstone experience outcomes are the same as the program outcomes, which, in case of the aforementioned example, is “justify how nutrient recommendations change across the lifespan, population, and health status.”

Table 5. Nutritional Sciences outcome mapping across the curriculum

| University Outcome | Major Outcomes | Core Courses |
|--------------------|---------------|-------------|
| Analytic thinking  | Interpret and analyze the relationships between health and diet status for individuals and populations using nutrition evidence. | 150 250 250L 350 EXP 450 455 |
|                    | Justify how nutrient recommendations change across the lifespan, population, and health status. | I  P  S |
|                    | Analyze food, health, and nutrition problems using appropriate research methods. | I  P  S |
|                    | Evaluate lay and technical nutritional claims using scientific evidence. | I  P  S |
| Cultural understanding | Acknowledge the socioeconomic, cultural, environmental, and geographic influences of diet, access to nutrients, beliefs about health, and healthy lifestyles. | I  P  S |
|                    | Actively seek out and acknowledge diverse perspectives related to nutrition and health. | I  I  P  S  S |
| Effective citizenship | Connect codes of ethics, academic integrity, and responsible and ethical practice in nutrition contexts to one’s personal and professional behaviors. | I  I/P  S  S |
|                    | Understand the role of diverse government and nongovernment stakeholders in determining food, health, and nutrition policies. | I  P  S |
| Effective communication | Inform stakeholders about food, health, and nutrition using effective communication techniques based on audiences’ need, understanding, and context. | I  P  P  S  S  S |
| Integrative reasoning | Connect food and nutrition knowledge with the biological and/or social sciences to address contemporary topics in infectious and chronic disease prevention and treatment. | I  P  P  S |
|                    | Evaluate multiple sides of a complex nutrition or food issue using diverse, appropriate evidence. | I  P  S  S  S  S |

EXP, experiential learning experience; I, introduced; P, practiced; S, summative assessment.
The knowledge and skills needed to complete this program outcome, according to the map (see Table 5), is introduced in HNF 150 (as knowledge-based questions on an exam) with course outcomes that state the following: 1) to recognize important nutrition issues related to human development from pregnancy through aging; and 2) to identify key government agencies and regulations related to food and nutrition. Then the outcome is practiced in HNF 350 (assessed using a nutrient imbalance assignment) with course outcomes that require students to 1) analyze diverse and conflicting perspectives on nutrition problems and use valid evidence to support decisions; and 2) seek out information from diverse sources to understand nutrition and health issues. Finally, the outcome is summative assessed in HNF 450 using a position paper and debate related to nutritional intervention and immune function.

New Nutritional Sciences concentrations courses. As previously mentioned, the NSCC settled on three concentrations in the major (Table 1). The NSCC reviewed numerous concentration components, including concentration requirements, number of courses, and course concepts. To satisfy the NSCC’s requirements for each concentration, some concentration-specific courses were developed (Table 6). The biomedical and molecular nutrition concentration was designed to meet the admission requirements for postbaccalaureate training in the field of medicine and other healthcare professions. In addition to the major’s core courses, students in this concentration enroll in a new course, HNF 310: Nutrition in Medicine for Pre-Health Professionals. The global nutrition and health concentration was designed to prepare students who will pursue careers in international health and nutrition settings. Students in this concentration enroll in additional courses related to nutritional intervention and immune function.

HNF 415: Global Nutrition This course describes the burden and consequences of undernutrition, including protein-energy malnutrition and micronutrient deficiencies, their causes, epidemiology, and approaches to prevention at various levels of society. Several “emerging” or special topics will also be addressed, including the “nutrition transition” toward obesity, nutritional interactions in HIV/AIDS-affected populations, nutrition and reproductive health, and the epidemiology of famine.

HNF 485: Advanced Public Health Nutrition Addresses methodological aspects of nutritional epidemiological research using key epidemiological analysis approaches for studying the relationship between nutrition and health outcomes. Students will be introduced to use of statistical software, such as SPSS/SAS. Students will gain hands-on experience in data analysis, as well as in presenting and interpreting research results using a self-assembled data set.

Table 6. New Nutritional Sciences concentration-specific courses

| Concentration                        | Course Descriptions                                                                 |
|--------------------------------------|-------------------------------------------------------------------------------------|
| Biomedical and Molecular Nutrition   | Relationship of nutrition and dietary practices to human health, aging, and treatment of clinical conditions. Healthcare team approach to nutrition issues. This course describes the burden and consequences of undernutrition, including protein-energy malnutrition and micronutrient deficiencies, their causes, epidemiology, and approaches to prevention at various levels of society. Several “emerging” or special topics will also be addressed, including the “nutrition transition” toward obesity, nutritional interactions in HIV/AIDS-affected populations, nutrition and reproductive health, and the epidemiology of famine. |
| Global Nutrition and Health          | This course will examine the intersection of the science of nutrition, epidemiology, and public health to understand how diet modulates disease. Basic epidemiological and diet assessment techniques will be covered and used. Students will study relationships of diet with health or disease in human populations; integrate basic knowledge and results of animal and clinical studies to understand dietary risk or protective factors in various diseases. Includes basic epidemiology, diet assessment, and topics in public health as they relate to nutrition. |
| Public Health Nutrition              | Addresses methodological aspects of nutritional epidemiological research using key epidemiological analysis approaches for studying the relationship between nutrition and health outcomes. Students will be introduced to use of statistical software, such as SPSS/SAS. Students will gain hands-on experience in data analysis, as well as in presenting and interpreting research results using a self-assembled data set. |

AIDS, acquired immune deficiency syndrome; HIV, human immunodeficiency virus infection; HNF, Human Nutrition and Foods.
program has been implemented for 4 yr, with enrollment having grown to 221 as of 2020. Focus groups from students who have graduated from the new program reveal that students like the range of skills they acquired, such as data analysis, inquiry, and communication. Furthermore, students believe the new program combines strengths of a STEM (Science, Technology, Engineering, and Mathematics) program with professional skills developed from a liberal arts program.

During the redesign process, numerous lessons were learned. First, curricula need to shift from a traditional focus of content based, to knowledge application and problem solving to meet the needs of the current economy. Contextual and historical factors influence curriculum design, as these can trigger a faculty member’s sense of personal and professional identity. One method to address this issue with this committee was to emphasize that the faculty have a vested interest in the program as collectively they own it. Individual faculty members do not singly own a course. To maintain order and facilitate during the redesign process, it is important to design specific agendas, use Robert’s Rules of Order (18), collectively agree to a decision-making process, and make minutes available following each meeting. In addition, it is very important to have an individual (the chairperson of the NSCC) with strong leadership skills and a clear focus for success to oversee this process.

Another lesson learned was the importance of seeking outside help during a curriculum redesign. None of the NSCC members had a formal background in curriculum design, aside from various workshops offered on campus. Bringing in an outside consultant with expertise in this area was paramount for the success of this process. Lastly, it is important to note that the backward design (25) process does not end with the implementation of a new curriculum. The curriculum needs a process to continually improve, which includes ongoing discussion and monitoring of assessment data, while making necessary adjustments. This is currently being practiced annually in the NSCC.

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DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS

T.B.B., J.L., and J.I.F. conceived and designed research; T.B.B. prepared figures; T.B.B. drafted manuscript; T.B.B., J.L., W.L., and J.I.F. edited and revised manuscript; T.B.B., J.L., W.L., and J.I.F. approved final version of manuscript.

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