The Online Professional Master of Science in Food Safety Degree Program at Michigan State University: An Innovative Graduate Education in Food Safety

Edward C. Mather ■ Pattie A. McNiel

ABSTRACT

A market-research study conducted in 2000 indicated a need for a degree program in food safety that would cover all aspects of the food system, from production to consumption. Despite this, such a program was not enthusiastically supported by employers, who feared losing their valued employees while they were enrolled in traditional on-campus graduate programs. A terminal professional degree was successfully created, offered, and modified over the succeeding five years. The innovative, non-traditional online program was developed to include a core curriculum and leadership training, with elective courses providing flexibility in specific areas of student interest or need.

The resulting Professional Master of Science in Food Safety degree program provides a transdisciplinary approach for the protection of an increasingly complex food system and the improvement of public health. Enrollment in the program steadily increased in the first three years of delivery, with particular interest from industry and government employees.

The curriculum provides a platform of subject material from which certificate programs, short-courses, seminars, workshops, and executive training programs may be delivered, not only to veterinarians but also to related food and health specialists. The program has fulfilled a need for adult learners to continue as working professionals in the workforce. The benefit to the employer and to society is an individual with enhanced knowledge and networking and leadership skills.

INTRODUCTION

In July 2002, a Professional Master of Science (ProMS) in Food Safety degree program, devoted to the education of professionals seeking advanced education in food safety, was initiated at Michigan State University (MSU). The fourth class of students was admitted in June 2005. In this article we describe the rationale for creating the program and for developing it as an online program and provide a description of the targeted student. We then describe the challenges of creating the program and the results and experience after two years of planning and three years of delivery. Finally, we share expectations and further development plans.

BACKGROUND

The National Food Safety and Toxicology Center (NFSTC) at MSU evolved over many years following the accidental incorporation of polybrominated biphenyls (PBB) into Michigan's livestock feeds in the mid-1970s.[1] Initial concern and emphasis were placed on improved animal diagnostic capacity, especially in the area of toxicology. Not until a federally funded research facility was constructed and opened in October 1998 was significantly targeted emphasis placed on the multiple and interdisciplinary aspects of food-safety research. Soon after the initial opening and development of a comprehensive interdisciplinary research center, requests were received from industry, government, and consumers for delivery of a variety of educational programs.

A marketing research study was conducted in the fall of 2000 to determine the need and most desirable venues for education programs in food safety.[2] The study revealed a significant need for education but little consensus on the particular scientific level of education or venue for delivery. The study determined that the most pressing needs were for employees in industry and in government who were called upon to assume food-safety responsibilities and program development; often these employees lacked the scientific knowledge needed to carry out their new assignments in the most efficient or effective manner. Additional surveys were conducted targeting employers and employees through personal interviews. A common finding was that many employers preferred short-term executive training and workshop venues, whereas employees preferred more extensive, degree-related programs.

In the late 1980s and early 1990s, several national studies, conducted primarily under the auspices of the Council of Graduate Schools and supported by the Pew Charitable Trusts, reported overall concern with the value and delivery of master's degree programs throughout higher education. The highly critical report stimulated the review and assessment of the protean master's-level programs at many major universities in the mid-1990s. The authors recognized the initial and very successful master of business administration (MBA) programs that had evolved over the past 40 years. The same report acknowledged valuable and successful master's programs in various disciplines but noted that nationwide numbers were small. An excellent

and comprehensive summary of the above findings was published in 1993 by Conrad et al.[3] As a result of this attention, in 1997 the Alfred P. Sloan Foundation funded several universities in what has been called a "Professional Science Master's (PSM) Degree Program."[4] These multi-year projects were intended to develop stand-alone degree programs independent of traditional PhD research degrees; they were to explore the feasibility of the master's degree as a professional terminal degree designed for those not wishing to pursue traditional research career goals. However, all these programs were proposed and designed for resident student bodies.

By 2000, universities, companies, and associations were seriously exploring the use of online education in an effort to reach adult learners unable or unwilling to leave their place of employment. Various public and private universities viewed online education as a method to deliver education to large numbers of students more efficiently and at a significantly reduced cost. Many early attempts to use traditional lecture-hall approaches to deliver online courses were found to be significantly deficient. Underestimation of technical cost and faculty workload has led to disenchantment by many faculty members.[5] Nevertheless, various universities and privately funded for-profit businesses did successfully launch online programs.

CHALLENGES TO BE OVERCOME

Unlike traditional students who pursue a baccalaureate or professional degree and immediately embark upon a graduate degree, the students who were most interested in, and targeted by, the ProMS degree in food safety were adult learners. They had valuable experience in the workplace and wanted additional education for a number of reasons. Their characteristics, desires, and expectations were found to be similar to those described by Levine as follows:[6]

1. The adult learner is primarily independent/self-directed in what he/she learns.
2. The adult learner has considerable experience to draw upon.
3. The adult learner is most apt to be interested in topics that relate to the developmental stage of his/her life.
4. The adult learner is most interested in information and ideas that solve the problems that they are presently faced with.
5. The adult learner is most interested in information that can be immediately applied.
6. The adult learner is motivated from within him/herself.

Most faculty members faced with the request to develop new graduate courses needed assistance in preparing for such an audience, which differs significantly from the campus-bound student. An excellent article by Glicken defines the many challenges faced by faculty members assuming the development of a totally new curriculum for adult learners.[7] Glicken's article reinforces the recognition that a major component of what drives the adult learner is his or her need and motivation. Given the students' diverse experiences and heterogeneous educational backgrounds, the faculty benefited from knowing a great deal about the individuals in their classes. The challenge was for the planners to collect personal and professional information about the students and make student profiles available to the faculty. If these challenges were not addressed, attrition rates would likely be high.

A challenge with respect to securing faculty specialists was met predominantly through the existence of a large and diverse faculty within the NFSTC. Where specific additional needs were encountered, outside guest lecturers were solicited. Team teaching and division of workload were used to minimize individual faculty contributions. Faculty input was limited, as much as possible, to course content contributions; program coordinators and design specialists were responsible for design and technical delivery.

Another challenge in developing the ProMS program involved faculty teaching styles. Few faculty associated with the NFSTC had experience teaching online; their experience was with lecture rooms, laboratories, clinical settings, and extension presentations, as well as a great deal of one-on-one graduate research advising. Since all faculty participation was on a voluntary basis, educational delivery assistance was considered essential and presented yet another challenge. Periodic sessions on instructional design and final course reviews were used to assist faculty.

The Higher Learning Commission of the North Central Association of Colleges and Schools accredits Michigan State University. As is common at Association of American Universities/Land Grant institutions, the creation of a totally new, sustainable, and academically accredited master's degree program at MSU required extensive review by the following six academic governance units: the administrative delivery unit (NFSTC), the college curriculum committee (CVM), the university graduate committee (MSU), the university research committee (MSU), the university academic council (MSU), and the Michigan Committee on Higher Education (state of Michigan).

As the NFSTC includes faculty from six colleges and 16 departments, participating units voiced considerable interest where overlap and duplication might occur. Successful arguments for support of the program were based on the unique content and emphasis of the program. Approval of totally new courses for the program was simultaneously requested and defended. Because of the proposed online delivery, arguments were presented that potential plagiarism, cheating, and other unethical student practices could be controlled, and methods of doing so were explained. The above process has proved extremely important to stakeholders who support their employees and those individuals choosing to pursue the ProMS program in Food Safety. Meeting the required rigor of the system was indeed a challenge, but it was also of great value as development proceeded. Since the program was created and administered through MSU's College of Veterinary Medicine (CVM), faculty input had to be secured from veterinary faculty conversant with course delivery to variably trained individuals, including, but not limited to, veterinarians.

Finally, technology itself is a challenge because of the need both for content to stay fresh and for the program to be sustainable. Emerging and continual rapid advances in technology used for online education were a hurdle for

many faculty members, students, and program developers. Extensive communication between faculty primarily interested in current subject and content material and computer science faculty and staff primarily interested in continually upgrading technology had to be facilitated.

PROGRAM DEVELOPMENT, CURRICULUM, AND RESOURCES

Admissions criteria were developed by an appointed admissions committee selected from NFSTC and CVM faculty. Entrance requirements are as follows: an online application sent to the MSU Office of Admissions and Scholarships, a letter of intent, two letters of recommendation (three for international students), and original college transcripts. International students are required by MSU to submit a qualifying TOEFL score or appropriate alternative documentation of competency in English. Experience in the workplace with a food safety component is weighted heavily in the admissions process.

Feedback from companies, agencies, and faculty members helped guide the development of the curriculum. The feedback led to the creation of an on-campus introductory course in which food safety challenges could be addressed, faculty introduced, and leadership skills developed. All remaining courses would be taught online.

CURRICULUM

At least 30 semester credits must be taken by students pursuing a master's degree at MSU, although an academic unit may require additional credits. Table 1 lists the required and elective courses in the ProMS curriculum. Thirty semester credits are required for graduation from the ProMS program, and these must include the 21 credits of required courses listed above. With the approval of the student's advisor, other elective courses may be utilized if this appears beneficial to the individual student's program.

All online courses use a modular approach that allows for multiple instructors to participate in courses in their specific area of specialty. The courses vary in the number of instructors participating, from one to eight. In year 3 (2004), 35 faculty members contributed to 10 courses, or 3.5 per course. Faculty provide the course content, with a Web developer providing design and assisting with the format of the course. To provide for quality control and course improvement, the courses are then beta-tested with three to five students in the first offering, after which they are offered as established courses.

All online ProMS courses are electronically delivered through MSU's Virtual University, using A New Global Learning Environment (ANGEL),[a] course management system. Students receive 24/7 toll-free assistance for both Virtual University technology and ANGEL. Among other aids, ANGEL provides a monitoring mechanism to determine how much time each student spends online. Students have automatic access to the MSU Library's online resources, including book distribution services.

Students can enroll in courses at their own pace. Faculty members advising on course load consider workplace demand on students' time, academic background, and personal commitments. Five years are allowed for the completion of the asynchronous program.

Table 1: Required and elective courses in the ProMS curriculum

Course Number	Title	Number of Credits	Required or Elective[†]
VM 810	Introduction to Food Safety and Professional Development*	3	Required
VM 811	Evolution and Ecology of Foodborne Pathogens	3	Required
VM 812	Food Safety Toxicology	3	Required
LCS/EPI 830	Public Health Impact of Foodborne Pathogens	3	Required
ANR 810	International Food Law	3	Required**
ANR 811	Domestic Food Law	3	Required**
VM 815	Applied Research Project	6	Required
VM 816	Food Irradiation	3	Elective
VM 817	Pre-harvest Food Safety	3	Elective
VM 813	Special Problems in Food Safety	1–3	Elective
VM/PKG 814	Packaging for Food Safety	3	Elective
VM/CJ 821	Food Protection and Defense	3	Elective
ANR 490 Sec. 1	Food Regulations in the European Union	3	Elective
ANR 490 Sec. 2	Food Regulations in Canada	3	Elective
ANR 490 Sec. 3	Food Regulations in Latin America	3	Elective

*A 10-day, on-campus intensive study of food safety and professional development.
**Students may choose either ANR 810 or ANR 811.
[†]9 credit units required from either this list or, with special approval, other courses.

Both student entrance profiles (through a student motivational factors assessment and the Myers-Briggs assessment) and student exit surveys are solicited to provide the basis for change in course content and delivery. Biographical sketches, including student snapshots, are provided to classmates and faculty by means of PowerPoint documents.

FINDINGS AND RESULTS

Information from the first three years of the program provides a profile of the ProMS in Food Safety graduate student. The average age at admission was 34 years, and approximately two-thirds of the student population was female. Approximately two-thirds had experience in industry or private consulting and one-third in government agencies.

The first three classes of ProMS in Food Safety graduate students came from a diverse background. Table 2 lists some of the companies and agencies represented in the student body. The initial 47 students were admitted from 21 states and three foreign countries. Thirteen students were admitted to the first year's class, 15 to the second year's class, and 18 to the third year's class. The maximum number of 20 students is anticipated for the fourth year's enrollment. Of the initial class admitted in 2002, three graduated in two years and three in three years; one has been dropped from the program; one withdrew from the program; and one lost her life in an accident. The remaining four students continue their work. It is too early to evaluate the results from the next two classes, but it appears that the established pattern will continue.

A significant factor to students and their employers was program cost. Table 3 compares the ProMS student out-of-pocket cost and the cost of traditional on-campus master's degree programs. Additional considerations include relocation costs for the student and, more importantly, the income lost while enrolled as a full-time student. In addition, employers are reluctant to encourage employees to seek graduate programs when this means losing valued individuals; however, in our online program, we have observed that many of our students are now financially supported by their employers.

Table 2: Some companies and agencies represented in the student body

Companies	Agencies
Barber Foods	Center for Food Safety and Applied Nutrition (CFSAN)
Dow Chemical	Cornell Cooperative Extension
Foster Farms	Michigan Department of Agriculture
Frito Lay, Inc.	Laboratorio do Alta Tecnologia de Zalapa, SA
Gerber Products Co.	Animal and Plant Health Inspection Services
Gorton's Seafood Co.	US Air Force
JohnsonDiversey Co.	Food and Drug Administration
Koch Foods, Inc.	Food Safety Inspection Service
Perrigo Co.	Virginia Department of Agriculture
Quaker Oat Co.	Various local health departments
Ralston Foods	
Senisent Technologies	
Private consultancies	

DISCUSSION

Attrition rates have been shown to be 10% to 20% higher for online students than for students in traditional classrooms.[8] Based on discussions with faculty teaching in both hybrid programs (those with both face-to-face and online course hours) and programs without a face-to-face experience, we decided to develop a hybrid course that would allow for an initial on-campus experience for the students admitted to the ProMS program. MSU does not require a residency period for online degree programs, and several MSU programs have been conducted totally online.

Introduction to Food Safety and Professional Development (VM810) was created in part to give students an introduction to future course faculty from a variety of disciplines (Table 4). It also gives students from a variety of employment and educational backgrounds an opportunity to learn from and share experiences with one another. It has also been observed that the students ''bond'' to a great extent during this time and become group-oriented in the subsequent online courses. The resulting close interaction

Table 3: ProMS 2004/2005 program cost versus on-campus graduate program cost

Degree Program	Explanation of Costs
ProMS	Approximate tuition for the two-year ProMS program is $17,425 based on a summer 2004 start date. VM 810 (3 credits) is an on-campus course with tuition of $5,865, which includes all expenses while on campus but does not include transportation to and from the MSU campus. The remaining 27 graduate credits are based upon a rate of $430 per credit hour. This is a great value for the student; in addition, students benefit from the ability to remain on the job and collect a salary.
On-campus MS	An on-campus graduate student at MSU would pay approximately $32,000 for a master of science degree (including tuition, room and board, matriculation fees, and other miscellaneous fees). Most employers do not want to lose their best and brightest employees by sending them back to the university knowing they will only get one out of 20 back.

Table 4: Topics covered in VM 810 (Introduction to Food Safety and Professional Development)

Category	Topics Introduced in VM 810
Food safety	Risk Assessment and Risk Management; Discovering and Identifying Hazards; Listeria Transfer Risk Assessment; Food Safety Issues Associated with Genetically Modified Organisms; Nature of Food Hazards: Microbial, Chemical, Physical, Biotechnological, etc.; Hazard Analysis Critical Control Point (HACCP) and meat lab visit; Pre-harvest Food Safety and farm visit; Legal Issues and Introduction to Food Law; Bioterrorism; Industry Perspective on Food Safety (production); Industry Perspective on Food Safety (restaurant); Risk Communication and Public Perception; Risk Analysis and Department of Homeland Security Center for Excellence; National Food Safety and Toxicology Center (NFSTC) laboratory tours; Sanitation Monitoring using ATP and Protein; Office of Radiological, Chemical, Biological Safety; Regulatory Perspective on Food Safety (FDA); Bioethics in Food Safety
Professional development and other topics	Welcome and Introduction to graduate school at Michigan State University; What to expect from the ProMS Program; Technology workshop (ANGEL course management system and Breeze technology); Myers-Briggs Assessment workshop; Gregorc Learning Inventory; Magic of Leadership dinner; Bridge Building teamwork workshop; What Scientists Need to Know about Financial Management; Professional Business Etiquette dinner; Leadership workshop; FISH Philosophy; Ethics and Research; Faculty and Course Moderator panel discussion; Presentations Skills Put to the Test; Questions and Evaluations

produces professionals who network throughout the program and after graduation.

Increased emphasis on professional development in VM 810 since the initial offering has instilled increase leadership confidence in students as they progress in their careers. The faculty believes that the above approach has contributed to lower attrition rates as well as better preparing students to assume leadership roles in their careers.

Early course development met with some reluctance on the part of faculty members who had little experience in developing new courses for online delivery. To alleviate this reluctance, experienced facilitators and staff assisted faculty in course design and development. Delivery enhancement and content changes led to improvements over the three-year period. Faculty confidence improved, and enthusiastic participation became common. This confidence and enthusiasm were particularly evident in the willingness to develop new courses in packaging, food protection and defense, food irradiation, and pre-harvest food safety in year 3 of the program.

Based on exit surveys and course evaluations, a need for course alterations was most evident in the VM 810 introductory course. A clear need for more leadership training was expressed by students as a result of their workplace responsibilities. By the end of year 3, nearly one-half of the course involved leadership training and team-building exercises. Many of the instructors expanded team-building concepts in later courses through assigned group exercises that mimicked workplace scenarios.

Our experience with courses listed jointly between multiple departments and between faculty from different departments and universities has been very positive. This study confirmed previous reports that interdisciplinary program development and delivery can be a positive stimulus for both students and faculty.[9] Constant course improvement based on program review by students and faculty provided a more connected, documented, and meaningful learning experience for students and strengthened teaching vitality for faculty.

It is the intent of this program to enhance students' employment opportunities and improve their performance within their present employment. The program helps to create valuable credentials and a lasting network of food-safety experts. Applied research projects (VM 815) with employer, faculty, and student collaboration have resulted in valuable information for the participating companies and agencies as well as publishable material for students and faculty. The applied research projects taught through VM 815 require student ingenuity and creativity. Those students who have been most successful in previous team-building exercises perform the best. Because of our finding that more time is required to develop, initiate, and complete a project, students are encouraged to begin thinking about their choice of a project and its development early in the program. This approach also encourages students to better utilize their course work to enhance the quality of their projects. Completed projects through 2004 are listed in Table 5.

New information-retrieval systems are emerging, and students are learning to better evaluate good and bad literature and to use resources not previously available.

New technology is emerging almost daily. In year 4 of this program we will provide each new student with a Logitech camera system[b] for his or her computer and a license to use Breeze software for the visual integration of chat rooms, Web talk, and video technology.[c]

From the present platform of courses and participating faculty we will be able to more easily deliver short courses, executive training programs, and certificate programs. For example, a certificate program in food law and regulations has become very popular, as has a certificate program in homeland security. An executive education and certificate program in packaging for safe food is in development. A short course in international food safety is offered annually at Michigan State University and has also been

Table 5: Titles of completed applied research projects (VM 815) through 2004

Hazards associated with water infiltration
Tweaking HACCP: Combining HACCP with ISO in poultry operations
Growth of *Bacillus cereus in* commercial batter during storage and parfry process on battered and breaded fish products
Prevalence of *Salmonella* spp., *Staphylococcus aureus* and *Listeria monocytogenes* in fresh cheese from Xalapa, Veracruz, Mexico
Interpretation of present labeling practices in the food industry
African Americans' dietary habits and consequential health effects
An evaluation of the ''GRAS'' submissions to the Federal Agencies by the food industry
A case study: Sudan Red—Industry perspective on public standards and protection of public health
Determination of propiconazole and lambda cyhalothrin in materials used to detect residues in seed corn production
Survey of changing results of water quality test from various sites as related to environment and the food chain

Table 6: Some comments on the ProMS in Food Safety program from graduate students, industry leaders, and stakeholders

Comments from Graduate Students	''I am participating in this course as it is cutting-edge in food safety and in regulatory. Two inter-related areas that will continue to become more important to the food industry world-wide.''
	''The timing of the program and the needs of the food industry allowed resources and approvals to make this opportunity happen for me. I have a full travel schedule through most of the year; this is the only type of program that I can accomplish.''
	''The present trend on this issue of food safety that directly affects human life as well as the economy of the country. As veterinarians we have to have sound knowledge on this issue, being a lecturer in a veterinary school I'm responsible to disseminate knowledge on food safety to budding veterinarians and to the community.''
	''My first year with the ProMS course has already provided me rich information and knowledge applicable to my day-to-day regulatory job; I highly recommend this program to everyone involved in keeping our food supply safe, especially to my fellow colleagues in the USDA.''
	''The ProMS program is an enlightening program for professionals who desire to further their education in food safety. The topics are routinely updated to include timely issues impacting the food industry.''
Comments from Industry Leaders and Stakeholders	''Food safety is now a central issue in the international trade of food. Successful trade requires knowledge of national and international food laws and regulations. Lecturers located around the world bring national and regional relevance to the regulation of food safety to this program.''
	''ProMS is a unique program that provides students with scientific and practical aspects of food safety practices. They have the opportunity to meet with leading-edge faculty and observe how food safety diagnostic products are produced.''
	''The online Professional Master of Science Program is one example of MSU's shining achievement in food safety education with infinite possibility.''

offered in Costa Rica and China. Seminars for various departments on campus, as well as at national and international meetings, utilize the wealth of scientific information generated through the ProMS program. Expanded and improved courses could be developed between universities in a much more efficient and productive manner, at lower cost, and without compromising intellectual-property rights.

Routine student evaluations are required by MSU for each course and instructor. These results are reviewed and used to alter delivery and content where needed. Considerable effort has been expended to conduct an annual stakeholder review of the ProMS program. In addition, exit interviews are conducted with all graduates. Table 6 provides a sample of typical comments received from the graduates and stakeholders.

CONCLUSION

The online master's degree program has had several positive effects. Students are taking what they learn daily from the program and research projects and applying the knowledge toward their daily food-safety decisions and situations, thereby positively improving the food-safety system. Graduates are receiving career advancement, along with increased work responsibilities and confidence

in food-safety decision making, as a result of their advanced degree work. The program is cost effective compared with a traditional master's degree program: Online students do not have to pay room and board, do not have to lose wages/salary, and do not have to travel to attend classes (apart from the VM 810 course). Employers are sponsoring their employees as students because they are continuing to work while taking the courses. Overall, the online Professional Master of Science in Food Safety Program at MSU is helping food industry and government professionals take the most up-to-date knowledge back to their employers to solve real-world food-safety and food-protection problems.

NOTES

a ANGEL Learning, Inc., Indianapolis, IN <http://www.angellearning.com/>.

b Logitech QuickCam Communicate, Fremont, CA <www.logitech.com>.

c Macromedia, Inc., San Francisco, CA <www.macromedia.com>.

REFERENCES

1 Fries GF. The PBB episode in Michigan: an overall appraisal. *Crit Rev Toxicol* 16:105–156, 1991.

2 Lillie J. Personal communication, 2000.

3 Conrad CF, Gaworth JG, Millar SB. *A Silent Success*. Baltimore: Johns Hopkins University Press, 1993.

4 Simons C. New Career Paths for Science-Trained Professionals <http://www.sciencemasters.com/conference_board_full_report.pdf>. Accessed 3/29/2006. The Conference Board, 2003.

5 Carnevale D. Professors seek compensation for online courses. *Chron Higher Educ* August 13:A27, 2004.

6 Levine SJ. The Challenge of Helping Adults Learn: Characteristics of Adult Learners and Implications for Teaching Technical Information <www.learnerassociates.net/workshop/adltlrn1.pdf>. Accessed 03/29/06. Learner Associates, 2001.

7 Glicken AD. Becoming an effective instructor: applied principles of adult learning. *J Vet Med Educ* 31:268–272, 2004.

8 Frankola K. Why online learners drop out: high dropout rates are e-learning's embarrassing secret <http://www.workforce.com/archive/feature/22/26/22/index.php?ht=learning%20embarrassing%20secret%20learning%20embarrassing%20secret>. Accessed 03/29/06. *Workforce* June 3, 2001.

9 Johnson F, Marchese A, Mosto P. Crossing interdisciplinary boundaries: impediments to and enablers of faculty collaboration and integration. *The Department Chair* 11(3):20–22, 2001.

AUTHOR INFORMATION

Edward C. Mather, DVM, PhD, is the Director of Education and Deputy Director of the National Food Safety and Toxicology Center. He is Professor of Large Animal Clinical Sciences in the College of Veterinary Medicine, Michigan State University, East Lansing, MI 48824-1302 USA.
E-mail: mather@cvm.msu.edu.

Pattie A. McNiel, BS, MS, is an Academic Specialist and the Coordinator of the ProMS Program in Food Safety, National Food Safety and Toxicology Center, Michigan State University, East Lansing, MI 48824-1302 USA.