Capacity Building for Organizational Resilience: Standards-Based Curriculum on Risk, Disruption and Continuity

Lisa Greenwood, Rochester Institute of Technology, llgcem@rit.edu

Introduction

Disruption is an inevitable factor in business and society, and this became painfully clear during the COVID-19 pandemic. There is a critical need in business and society to be able to recognize vulnerabilities, anticipate disruption, and mitigate and manage risk. The inability to do so can cause significant, potentially irreparable harm to the economy and our ways of life. Although businesses had increasingly incorporated continuity planning following acts of terrorism, security breaches that compromised consumer and business information, and increasing frequency of extreme weather events and natural disasters, many found themselves unprepared to meet the challenges for continued operations during a pandemic (Greenwood et al., 2023).

Our project focused on integrating risk, disaster and continuity standards content into graduate and undergraduate courses and programs as a means to develop student capacity to contribute toward crisis preparedness and organizational resilience as they enter professional practice. With funding from the National Institute of Standards and Technology (NIST) Standards Services Curricula Development Cooperative Agreement Program, we applied a modular approach based on a proven educational structure, developed curricular materials, and supported instructional faculty to implement the standards-based content in a range of academic programs and course at a large private university and a regional community college in the Northeastern United States. The project was highly successful and we continue to utilize and expand upon the content developed beyond the scope and duration of initial work.

Importance of the Project

The global crisis associated with the COVID-19 pandemic heightened private and public interest in systems and standards based strategies for risk management, disaster preparedness, and business continuity to enhance organizational and societal resilience. Such standards and strategies shape how society deals with vulnerability and disruption, and those entering the workforce must understand the role of standards as well as the influence of particular standards and their application upon professional practice. In order to enhance competitiveness, resilience, and sustainable development, we as a society need to cultivate capable professionals who understand the challenges and risks facing organizations and society, and who grasp standards and systems for strategic planning, preparedness, response, and recovery.

National and international documentary standards have an increasing presence and influence in risk management, crisis preparedness, response, recovery and organizational continuity, and these areas of expertise are interwoven in health, safety, environmental, policy, business, and information technology disciplines (Greenwood et al., 2023). Framework and operational standards in these domains provide an opportunity for the implementation of innovative systems and strategies that reduce organizational vulnerability, provide for efficient crisis response and

recovery, and promote continuity and resilience in the face of disruption. As the pandemic has demonstrated, understanding and being able to apply such systems and strategies is a useful, practical, and sought-after professional skill-set. Standards and conformity have a significant role in the global economy, and curricula that incorporate and apply key standards used in the U.S. offer students a rich and practical foundation, expanding their capacity to contribute tangible value and effective performance in their careers.

Project Goals and Approach

Our project involved integrating risk, disaster and continuity standards content into graduate and undergraduate courses and programs at the Rochester Institute of Technology (RIT) and Finger Lakes Community College (FLCC), as well as development of curriculum that can be offered as stand-alone course(s) on risk, disaster science, integrated business continuity, and critical systems resilience. In order to promote effectiveness and continual improvement, our curricular content was validated within FLCC and RIT, as well as by faculty in two other universities in New York State, including a large state university campus and the School of Management at a large private university. This allowed for feedback across the range of early college constituencies and later college and graduate education.

The core project team was based in RIT's College of Engineering Technology (CET), in the Department of Civil Engineering Technology, Environmental Management and Safety, and team partners at FLCC were associated with enterprise risk management, and the Instrumentation & Control Technologies Associate in Applied Science degree and certificate programs. The applied science perspective of each of these programs is designed to prepare professionals, making it important for graduates, as emerging professionals, to be able to apply risk-based management systems as well as applicable technical standards related to risk, disruption, and continuity.

To prepare students to meet the increasing challenges organizations and society face, our approach was designed to introduce students to specific national and international standards applied in the U.S., and to enable them to identify and apply a range of relevant and applicable standards based on the locality-driven, community-based nature of disaster, response, and recovery. Ultimately, our aim was to prepare students to integrate systems and develop strategies across several relevant standards for risk, disruption, and continuity in their future roles. Our project included curricular, faculty, educational effectiveness, and dissemination goals, as follows.

Project Goals:

1. Develop and embed a set of reusable and customizable course modules on risk, disruption and continuity that integrate relevant documentary standards, organized in thematic elements that can be arranged and synthesized for curricular applicability, at levels appropriate for undergraduate and graduate students *(Curricular Goal).*

2. Support cross-disciplinary faculty expertise development in risk, disruption, and continuity and related standards, by sharing our processes for development and our content across two academic institutions, as well as externally *(Faculty Goal).*

3. Ensure the effectiveness of the course modules via a cohesive and proven educational structure *(Educational Effectiveness Goal).*
4. Disseminate our results via published papers, conference presentations and a website *(Dissemination Goal).*

Project Outcomes

<u>Curricular Goal</u>

Compatible modules were developed that integrated multiple standards in graduate and undergraduate curricula to introduce students to standardization and standards development while incorporating and integrating specific content used in U.S. industry and society in three domains:

1. Risk: risk and vulnerability assessment, mitigation, response.
2. Disruption: disaster and emergency mitigation, preparedness, prevention, and response.
3. Continuity: proactive strategies for recovery, continuity, and organizational resilience.

Each module was organized in thematic sub-sections, or elements, to facilitate uptake and integration by faculty in applicable combinations according to the various course levels and learning outcomes. The module elements are shown in Table 1.

Table 1: Module Elements

Module	Element
Risk	a. What is Risk? b. Risk Assessment c. Risk Treatment and Mitigation d. Risk Communication e. Risk Monitoring and Reporting f. Supply Chain Risk Management
Disruption	a. Introduction to Disruption and Resilience b. Measuring Resilience c. US Emergency Management Cycle, Systems and Processes d. International Emergency Management Perspectives
Continuity	a. Defining Business Continuity b. Determining Critical Operations c. Business Impact Analysis d. Business Risk Assessment and Risk Analysis e. Crisis Communication f. Training and Testing g. Tabletop

Key national and international documentary standards and guides used in the U.S. that offer specifications and guidelines for organizations in one or more of these domains were introduced

and incorporated. These standards promote assessment, planning, preventive action and response to advance organizational and societal preparedness and resilience. Students were introduced to a core set of national and international standards, with an ultimate goal to enable them to identify and apply the standards that are relevant and applicable given an organization's particular locality and context. Examples included the following:

– ISO 31000 Risk Management;

– ISO 14063 Environmental Communication;

– ISO 22301 Security and Resilience –Business Continuity Management Systems;

– ISO 22318 Business Continuity Management Systems –Supply Chain Continuity;

– ISO 37101 Sustainable Development in Communities

– ISO 14091 Adaptation to Climate Change – Guidelines on Risk Assessment;

– IEC 61511 Functional Safety;

– NIST 800-37, 800--39 Information Security Risk;

– NIST Risk Management Framework

– FEMA National Response Framework and National Incident Management System;

– FEMA Pandemic Preparedness/Response Guidance;

– NFPA 1600 Continuity, Emergency and Crisis Management;

– EPA SALT Framework – Risk Communication.

Modules were implemented in nine courses at RIT and FLCC, including three graduate courses, two mid-level undergraduate courses, and four introductory-level undergraduate courses, as shown in Table 2.

Table 2: Courses Using Project Educational Content

Course Number	Course Level	Course Title
RIT ESHS 720	Graduate	EHS Management
RIT ESHS 740	Graduate	EHS System Design
RIT ESHS 150	Undergraduate	Principles of Environmental Sustainability, Health & Safety
RIT TCOM 327	Undergraduate	EHS Professional Communication
RIT ESHS 460	Undergraduate	Accident Causation and Prevention
RIT CONM 650	Graduate	Principles of Construction Leadership & Management
FLCC TECH 116	Undergraduate	Introduction to Careers in High-Tech Ecosystems
FLCC TECH 231	Undergraduate	Smart Systems Technologies
FLCC TECH 234	Undergraduate	Cyber-physical Automation II

In addition, we developed and pilot tested a standards development simulation exercise that can be incorporated in on-campus or online formats.

<u>Faculty Goal</u>

As mentioned with regard to the curricular goal, modules were organized in thematic elements to facilitate integration by faculty in combinations appropriate to their course levels and learning outcomes. Instructional designers incorporated online learning strategies in the development of module materials to ensure that the content could be developed with resources or approaches needed for online delivery and customized accordingly for classroom delivery. Our final modules reflect faculty review and feedback, both internal and external to RIT and FLCC. We have shared both our processes for development of the modules (curriculum development) as well as the overall goal of increasing new professional understanding and future application of these standards through several points of dissemination.

<u>Educational Effectiveness Goal</u>

Our final modules were developed using best pedagogical practices in order to achieve students' understanding of the standards, following a model developed by Liu et al. (2013, 2014). Module development was shared amongst the faculty ensuring that each course module included components agreed upon and designed in advance. Each module was structured following a proven educational model and included a module overview and description, module learning outcomes, educational content with sample questions, exercises, and supporting resources, and module assessment tools. The educational content was designed to reflect different learning levels and include key subject concepts, real life examples, checklists and active learning activities. Table 3 provides an overview of the curriculum template.

Table 3. Overview of Curriculum Template

Component	Description
Module Overview & Description	- Executive summary with introduction and overview of the module - Module learning outcomes, description, and rationale - Summary of key standards included in the module
Educational Content	- Slides and notes for lectures with guided activities and exercises - Supplementary resources, e.g., readings, links to materials and tools - Example discussion questions and exercises
Module Assessment	- Example assignments - Assessment tools and methods to measure module effectiveness

Assessment occurred at multiple levels: a review of the module materials themselves during development, evaluation of student learning where modules were piloted within courses and review of the module materials by external partners. Our assessment indicates that this work resulted in improved student learning, state of the art materials, and translation to practice since many of our current graduate students are working professionals. The results in the classroom demonstrated that students gained a strong understanding of concepts related to the standards,

and were able to apply this knowledge. During the active project period, we engaged 144 students in nine courses with standards-based curricular content across the three modules. Overall, 93 percent of students achieved a B or better on module-related assignments across the nine courses, based on the sum of the number of students achieving at least an 80 percent on each graded assignment, divided by the sum of the number of students completing each graded assignment. Effectiveness was also evaluated qualitatively through internal and external faculty feedback, and was used to continually improve the module content. Table 4 indicates the modules implemented in each course and summative module assessment results.

Table 4: Module Effectiveness Assessment

Course	Module	No. of Students	Assessment Method	% B or Better
Principles of ESHS	Risk Disruption	44	Based on student application of module concepts and content in relation to an off campus field trip, including assessment, treatment, and review.	Assignment A: 100% Assignment B: 94%
EHS Management	Risk	21	Based on application of module concepts and content within two unit assignments and a comprehensive case-based term project. Students were responsible for defining and assessing EHS and business risk.	Unit A: 95% Unit B: 86% Term project: 100%
EHS System Design	Continuity	12	Based on discussion and extra credit assignments to (1) relate critical resources to developing controls for major EHS issues and activities; and (2) enhance students' understanding of emergency management, in connection to business continuity.	Qualitative assessment (not graded)
Accident Causation & Prevention	Risk	12	Baed on examination/test questions	Exam questions: 92%
Professional Communication	Risk	21	Based on class observation and student feedback on an in-class group exercise. Students represented stakeholders in disaster preparedness and response communication case study.	80% successfully completed the exercise
Principles of Construction Leadership & Management	Risk	4	Based on the final group project where students analyzed risk in a construction management context focusing on subcontractor prequalification.	Final project: 100%
Intro to Careers in HTE	Risk Disruption Continuity	10	Based on class discussions. Students visited over a dozen high-tech businesses.	Qualitative assessment (not graded)
Smart Systems Technologies	Risk Disruption Continuity	10	Based on class discussions and an essay assignment. Assignments in the SST course related to the Intro course above, in which students visited high-tech businesses.	Essay assignment: 80%

Cyberphysical Automation II	Risk Disruption Resilience	10	Based on an assigned paper where students addressed risk and resilience in the context of an individual automation project.	Paper: 80%

Feedback from instructors has been positive overall, as well as constructive. Course instructors determined that the students were able to grasp concepts well and apply the key concepts and requirements to exercises, assignments, and examination question(s). In some cases, instructors were able to connect the success of the graded assignment with one or more opportunities that were given to the students earlier in course to better understand the material, such as a group discussion or collaborative exercise.

At the graduate level, one instructor observed that students appeared to "grasp concepts well and were able to successfully apply them to the project and answer the related assignment questions," and noted that the use of a group project allowed participant-participant collaboration to reinforce the concepts and advance students' learning. At the undergraduate level, two instructors noted that students really engaged with the content and case study/scenario-based assignment, and that this helped to "make content more relatable." An instructor for a mid-level undergraduate course commented that the module content was "structured and delivered in a way that enhanced the student's understanding and application of risk management principles."

Conversely, a new instructor in environmental sustainability, health and safety (ESHS) who was just introduced to the content noted that a few students "were confused by exposure to frameworks from disciplines outside of the ESHS realm" and that it was a challenge to present some of the content that fell outside of the instructor's disciplinary expertise. Going forward, the instructor intends to dig deeper into the module resources, and adapt and integrate our content further to target the specific focus of the course, which is consistent with the aim of our module structure and approach. Another instructor initially chose not to integrate the standards-based content in the semester for which it was planned due to lack of confidence with the material, lack of understanding of how and where to integrate the content in their course, and lack of time to review the resources provided with the instructional technology or to work with the instructional designers to address gaps. We worked further with this instructor to determine applicable elements and improve familiarity with our approach and organization of content, and the content was integrated and delivered successfully in the fall semester of 2022.

Dissemination Goal

Our dissemination efforts have been very successful. We presented on both the modular curriculum process and the positive impacts of implementation of risk, disruption, and continuity standards, generating feedback, interest and follow-up from academics and working professionals. In many ways, we were able to magnify our opportunity to showcase the power of standards as a teaching tool and as a professional tool, as well as an opportunity to improve organizational performance. Our dissemination venues and audiences were diverse, including workshops, meetings, conferences, and journal publications reaching business professionals, standards professionals, and academe. We presented on our project at two NIST workshops,

one faculty workshop on Integrating Curriculum with Entrepreneurial Mindset, and three conferences including the American Society for Quality's (ASQ) Quality 4.0 conference, the International Conference on Social and Education Sciences (IConSES), and the U.S. Technical Advisory Group to ISO Technical Committee 207 (TAG 207) Fall 2022 session. Our conference paper for IConSES was published in the proceedings, and a later version of the paper was accepted for publication in the International Journal on Social and Education Sciences (IJonSES), and is in press. Our presentations and papers on our curricular integration and approach are shown in Table 5.

**Table 5: Dissemination on Capacity Building for Organizational Resilience:
Integrating Standards on Risk, Disruption, and Continuity in the Curriculum**

Date	Venues	Audience	Details
November 2020 Virtual	NIST Workshop on Standards Education	Academic faculty NIST personnel	**Presentation** Workshop for awardees
May 2022 Rochester, NY	KEEN ICE Workshop (RIT)	Academic faculty and administration	**Presentation** Workshop for RIT faculty
August 2022 Washington, DC	TAG 207 Fall Conference	Business professionals Government Academe	**Presentation**
October 2022 San Antonio, TX	ASQ Quality 4.0 Summit: An Evolving Approach to Quality	Business/Quality professionals Academe	**Presentation** National Conference
October 2022 Austin, TX	International Conference of Social and Education Sciences (IConSES)	Academic faculty Graduate students	**Presentation & Conference Paper** Proceedings of International Conference on Social and Education Sciences[1]
November 2022	International Journal on Social and Education Sciences (IJonSES)	Academe	**Publication – Journal** Anticipated publication in April 2023[2]
December 2022 Virtual	NIST Workshop on Standards Education for awardees	Academic Faculty NIST personnel	**Presentation** Workshop for awardees – Findings and Lessons Learned

[1] Greenwood, L., Schneider, J., Hess, D., & Abraham, Y. (2022). Capacity Building for Organizational Resilience: Integrating Standards on Risk, Disruption and Business Continuity in the Curriculum. In *Proceedings of International Conference on Social and Education Sciences* (pp. 157-163).

[2] Greenwood, L., Hess, D., Abraham, Y. & Schneider, J. (2023). Capacity Building for Organizational Resilience: Integrating Standards on Risk, Disruption and Business Continuity in the Curriculum. *International Journal on Social and Education Sciences.* In press.

In addition, we collaborated with students on an additional conference presentation and paper that leveraged the curriculum we developed at the Air and Waste Management Association's

Annual Conference & Exhibition. The paper, entitled, *The Role of EHS Leadership in the Era of COVID-19: Exploring the Challenges and Implications for Organizational Resilience,* was awarded Best Paper in the environmental management category and was later published in Environmental Manager magazine in an issue highlight the work of young professionals. Information on the presentation and papers written with students is provided in Table 6.

Table 6: Dissemination of Related Student Research

EHS Leadership in the COVID-19 Era: Challenges & Implications for Organizational Resilience

Date	Venue	Audience	Details
June 2021 Pittsburgh, PA	AWMA Annual Conference & Exposition	Environmental/risk management professionals	**Presentation & Conference Paper** Proceedings of the A&WMA 114th Annual Conference & Exhibition[1] Awarded Best Paper – Environmental Management
May 2022	EM Magazine Publication – Magazine Article	Environmental/risk management professionals	**Publication – Magazine** May 2022 Issue – Young Professionals Edition[2]

[1] Greenwood, L., Stanitz, P. and Lamere, M. (2021). *The Role of EHS Leadership in the Era of COVID-19: Exploring the Challenges and Implications for Organizational Resilience*. Proceedings of the A&WMA 114th Annual Conference & Exhibition. Pittsburgh, PA: Air & Waste Management Association

[2] Stanitz, P. and Greenwood, L. (2022).*The Role of EHS Leadership in the Era of COVID-19: Exploring the Challenges and Implications for Organizational Resilience*. EM Magazine, May 2022.

Lessons Learned

Overall the project was successful, however we did have some challenges along the way with engaging instructors who were not part of the core project team. Since these instructors were not directly part of the curriculum development and did not necessarily have experience or expertise with the standards incorporated in the modules, there were varying levels of comfort with utilizing the content, even with the teaching resources provided. Going forward, we recommend providing the option of interactive review sessions or teaching circles with faculty as needed to enhance their capacity to integrate standards-based content and teach students about standards as part of their pedagogy.

In addition, while we initially shared content and communicated via email and in virtual meetings, we ultimately moved our content and resources onto the online course development platform that RIT uses for online course delivery. We found this much more effective for sharing resources, background materials and module content, and it enabled us to enhance consistency across the modules and to share ideas and best practices while developing them.

Lastly, we appreciated the benefit of having multiple faculty engaged in the project from a continuity perspective. When a co-investigator from our partnering university took a position elsewhere, we were able to continue to work with the second co-investigator to meet our goals.

Suitability of the Project for Adoption in Other Educational Programs

Risk is an ever-present factor in all facets of business and society, and disruption is inevitable. Efforts to enhance continuity and resilience can be applied in virtually any professional discipline. Thus, our content can likely be adapted to suit a wide range of professional disciplines in various educational settings, including academic programs as well as professional development programs in organizations. Within RIT, our content is already being adapted for a proposed stand-alone general education course entitled, *Design for Resilience in a Changing World*. In addition, RIT's new RIT Certified program has contracted with project faculty to develop three courses that incorporate our educational content. This program is aimed at workforce development and continuing education in industry, and the courses are anticipated to be completed and available for delivery after spring semester of 2023.

Our approach for curricular development and standards integration as described in this paper can also be applied to a range of courses and programs, included other university programs as well as workforce development and K-12 applications. The approach has been disseminated to a wide range of audiences, made available via presentation slides, conference proceedings, and journal papers.

Acknowledgements

References

Greenwood, L., Schneider, J., Hess, D., & Abraham, Y. (2022). Capacity Building for Organizational Resilience: Integrating Standards on Risk, Disruption and Business Continuity in the Curriculum. In *Proceedings of International Conference on Social and Education Sciences* (pp. 157-163).

Greenwood, L., Hess, D., Abraham, Y. & Schneider, J. (2023). Capacity Building for Organizational Resilience: Integrating Standards on Risk, Disruption and Business Continuity in the Curriculum. *International Journal on Social and Education Sciences.* In press.

Liu, X., Raj, R., Reichlmayr, T., Liu, C., & Pantaleev, A. (2013). Incorporating Service-Oriented Programming techniques into undergraduate CS and SE curricula. In *2013 IEEE Frontiers in Education Conference (FIE)* (pp. 1369-1371). IEEE.

Liu, X., Raj, R. K., Reichlmayr, T. J., Liu, C., & Pantaleev, A. (2013). Teaching Service-Oriented Programming to CS and SE undergraduate students. In *2013 IEEE Frontiers in Education Conference (FIE)* (pp. 15-16). IEEE.