AC 2011-1210: USING RETROSPECTIVE ASSESSMENT TO MEASURE LEVELS OF STUDENT AND FACULTY ENGAGEMENT IN THE DEVELOPMENT OF SUSTAINABILITY SUPPLY CHAIN AND FACILITY LOGISTICS CURRICULUM

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Using Retrospective Assessment to Measure Levels of Student and Faculty Engagement in the Development of Sustainability Supply Chain and Facility Logistics Curriculum

Abstract

This paper details the use of retrospective assessment by a multi-institutional partnership to measure the level of student and faculty engagement in the course development process. This partnership includes two universities in the U.S., one in Puerto Rico, and one in Spain and is in the final year of an NSF funded project to integrate sustainability into supply chain management and facility logistics curriculum across institutional boundaries and international time zones. Lessons learned from the assessment are used to identify progress toward learning and pedagogical development goals as well as suggest measures for overcoming engagement barriers.

Introduction

Global strategies and skill sets are essential to meet the challenges of the modern business environment. Engineering managers and other technology-based business professionals must be prepared to excel in a variety of social, political, and cultural settings. Awareness of these business strategies must begin in the classroom and should be an essential component of supply chain-logistics management programs. Many efforts are underway to introduce these valuable concepts into engineering management and industrial engineering curriculum, but how deeply are these concepts being internalized by the students and faculty involved? Accreditation bodies stress the importance of building programs that not only contain a global emphasis, but also include adequate assessment measures to assure student learning and success with established objectives. We detail the use of retrospective assessment by a multi-institutional partnership to measure the level of student and faculty engagement in the course development process.

Effective definitions of sustainability must address the long-term strategic importance of the idea or process and its inclusion in standard practice. Change can be difficult for students and faculty alike and must be considered in the development or implementation of new pedagogy. The implementation of new processes or technology can impact the traditional culture of the classroom and lead to both active and passive change resistance. University classrooms are akin to an organization with respect to change management best practices. Long-standing classroom traditions and work processes have the benefit of familiarity. Even if they are no longer effective, the work processes are familiar and there is a level of resistance due to the move outside of classroom norms and comfort zones. Resistance may also result from fear of disruption caused by the introduction of the new technology and its impact on established patterns and evaluation processes[1]. Common factors that impact resistance to change[2] include lack of trust, belief that change is unnecessary, belief that change is not feasible, fear of personal failure, loss of status and power, threat to values and ideals, and resentment of interference. Improved communications strategies and participative decision making involving faculty and student stakeholders are essential mechanisms for overcoming change resistance[1, 2, 3].

This paper discusses the development and use of retrospective assessment tools as a mechanism for combating change resistance in the curriculum design process. These tools provide opportunities for faculty and student engagement in the change process and allow greater validity in measuring self-reported change and reducing response-shift bias[4].

Collaborative Partnering Framework: Development of Integrated Coursework

An ongoing multi-institutional partnership between four engineering departments, two in the U.S., one in Puerto Rico, and one in Spain, is in the second year of a collaborative project developing an integrated supply chain management curriculum. This curriculum is designed to produce life-long engineering learners capable of understanding the complex logistics of sustainable manufacturing processes and communicating effectively with global colleagues. During the first year of the partnership, opportunities for global learning[5, 6] by future engineering managers were infused through the integration of common themes of global sustainability and scalability in existing courses[7]. A new course on sustainability management was introduced to explore supply chains as a sustainable sociotechnical system and evaluate effective management strategies.

A table of equivalent courses for partner schools is presented in Table 1. This table identifies relevant topics needed for the integrated curriculum and coordinates the topic with existing courses offered at all partner universities. In some cases topics are covered in multiple courses or combined.

Table 1: Courses by Topic for All Partners

Course Topic	**Missouri S&T**	**CSUP**	**UPRM**	**UPNA**
Supply chain management	EMGT 366	EN 477	ININ 4075	88322
Industrial Systems Simulations	EMGT 356	EN 420	ININ 4022 / ININ 4018	35419
Production Planning and Scheduling	EMGT 372	EN 477	ININ 4039	35422
Materials Handling and Plant Layout	EMGT 257	EN 475	ININ 4040	Various
Facilities Planning	EMGT 357	EN 475	ININ 4040	35422

The new course, Energy and Sustainable Management Systems, was developed at Missouri S&T as the equivalent of a capstone sustainability course. This course focuses on student learning outcomes that define sustainability from the user, environmental, and economic perspectives and explore the management of global supply chains when modeled as energy-intensive sociotechnical systems.

Year One Results: Indications of Change Resistance

Rather than begin with integrated projects for all campuses, the partnership opted to integrate three courses at Missouri S&T and use courses at Colorado State University-Pueblo and University of Puerto Rico-Mayaguez as control groups. This was done to better understand the mechanics of virtual student teaming and allow effective comparison. The partner from Spain provided input and assisted with the development of sustainability-based short courses as well as an exchange framework.

In order to document outcomes of the project, participating students completed pre and post online surveys adapted from prior successful programs. Survey questions pertained to the direct benefits of the program (e.g., attitudes toward sustainability, acquisition of a range of skills, interest in a career in science or engineering, self-confidence, and student perceptions of experiences with virtual teaming). Faculty mentors also completed online surveys and participated in monthly conference calls to track progress and make adjustments to the curriculum development approach.

Pre and post test data from the integrated student project teams show change resistance based on several of the key indicators. Students reported high levels of anxiety and fear along with limited understanding of the need for the change. Support was high for the course content, but students were unclear of the benefits of the new integrated course approach.

Follow-up interviews with student participants reinforced that students felt tremendous pressure in adjusting to the required change environment and uncertain of how to handle grading scenarios involving multiple classes and multiple faculty evaluators. The change environment required by the integrated project included high levels of ambiguity in an attempt to simulate a global supply chain. Further evidence of student discomfort and change resistance is seen when assessing self-confidence levels. Select results are presented in Table 2.

Table 2: Sample Results Regarding Student Self-Confidence and Subject Matter Mastery

Q: I am confident that I can work with global partnerships		Strongly Disagree (1)	Disagree (2)	Unsure (3)	Agree (4)	Strongly Agree (5)	Mean	Std Dev
Missouri S&T	Pre	0.0%	2.0%	9.8%	41.2%	47.1%	4.33	0.74
	Post	0.0%	0.0%	20.8%	45.3%	34.0%	4.13	0.73
Colorado State University-Pueblo	Pre	0.0%	0.0%	0.0%	50.0%	50.0%	4.50	0.58
	Post	0.0%	0.0%	0.0%	0.0%	0.0%	0.00	0.00
University of Puerto Rico-Mayaguez	Pre	0.0%	0.0%	21.4%	35.7%	42.9%	4.21	0.80
	Post	0.0%	0.0%	0.0%	70.0%	30.0%	4.30	0.48
TOTAL GROUP	Pre	0.0%	1.4%	11.6%	40.6%	46.4%	4.32	0.74
	Post	0.0%	0.0%	17.5%	49.2%	33.3%	4.16	0.70

University Response Demographics:		
Items	**Pre**	**Post**
Missouri S&T	73.9% (N =51)	81.4% (N =53)
Colorado State University-Pueblo	5.8% (N = 4)	0.0% (N =0)
University of Puerto Rico-Mayaguez	20.3% (N =14)	15.9% (N =10)

Student post survey results indicated high levels of agreement regarding their perceptions of the value and need for sustainability-focused supply chain education; thus, students were questioned about their reduced levels of confidence. Lack of familiarity with virtual teaming and the extended requirements for dealing with other cultures in real-world global scenarios were the root cause of anxiety.

Participating faculty agreed that industrial engineering and engineering management students need better preparation for the complexities of the global supply chain environment, but they differed on how best to structure the integrated curriculum. Some faculty felt that tighter controls and more detailed schedules were needed. Others felt that high levels of ambiguity provided opportunities for creative learning. Common areas of agreement focused on the importance of mapping coursework to learning outcomes designed to increase communication and critical thinking skills.

Retrospective Assessment Tools

Retrospective assessment (RA) was introduced as part of the new course development process and will be used for the year two assessment. This was done to decrease evidence of change resistance in year one by inviting students and faculty to share their goals throughout the curriculum design and implementation phase. RA can be used as part of a series of assessment activities and provides quick, usable feedback that can be used for course improvement at any point in the duration of the course or project. Two RA activities were used for the Energy and Sustainability Management Systems course. Students were invited to share their reasons for taking the class and progress toward learning goals at mid-semester. At the end of the course, students completed an RA activity designed to measure their self-reported progress in personal learning. RA activities reduce bias through the use of reflective response regarding increases in personal knowledge and are considered valid measures of programmatic change[4] similar to the curriculum innovation developed by our collaborative partnership. Sample RA tools are below.

Purpose of the Assessment

Today's engineer faces a complex assortment of challenges in the modern global business environment. Awareness of these issues should be an essential component of any engineering management program. Through a NSF-funded, ongoing curriculum development effort, engineering departments at four universities are developing and piloting curriculum that addresses global sustainability. During this course, your instructor has used some of these materials and/or projects.

We would ask you to complete this interim assessment tool which is designed to provide you an ***opportunity to reflect*** *and to give us information that will* **help us improve our curriculum and**

teaching practices. *This assessment is anonymous and voluntary and should take less than 10 minutes to complete. Responses to this interim assessment tool will be summarized by an external evaluator and overall results will be returned to project staff.*

We encourage students to reflect on their personal learning experiences. Such meta-cognitive thinking can help in determining the next steps in professional growth. Please use the exercise below to reflect on your learning related to this curriculum and/or project.

Directions: *Read each of the statements in the left-hand column and place an **X** to rank your understanding before this curriculum or project in the Pre-Project columns. Then rank your understanding of the statements at the completion of today's session by placing an **X** in the Post-Project columns.*

Personal Learning	Pre-Project Assessment						Post-Project Assessment				
	None	Little	Moderate	Almost Complete	Complete		None	Little	Moderate	Almost Complete	Complete
Understanding of an accurate definition of sustainability											
Understanding of role of innovation in sustainability management											
Understanding of the feasibility and use of various energy-intensive systems											
Understanding of the feasibility and use of alternative/renewable energy sources											

Retrospective Assessment Results

Mid-point RA activities provided valuable feedback for the instructor regarding the clarity of course and group project goals. The instructor was able to add additional lectures on topics to bridge knowledge gaps and address issues of anxiety reported in year one results.

RA course-end activities showed clear gains in personal learning in 90% of respondents (N=17). Gains ranged from incremental improvements (progress by one category) to transformational improvements (progress by three categories). Students showed high levels of learning with respect to their understanding of sustainability and the connection of energy-intensive supply chain environments to global sociotechnical systems. Improvements were made in their mastery of sustainability management processes and techniques as well as systems design.

Students continue to struggle with the role of management in fostering innovation. Although progress was made, gains were typically at the incremental level.

Conclusions and Directions for Future Research

Change management is a valuable tool for organizational improvement and has direct applicability for curriculum design and improvement. Change is not easy and clear, well-formulated strategies will positively impact the change environment.

Progress has been made in integrating sustainability and the importance of global teaming into the supply chain and facility logistics curriculum as a result of the multi-university partnership, but the linkages are not sufficiently developed to cement lasting change. Integrated teaming has value, but must be introduced through the use of greater student participative decision making.

Retrospective assessment is an effective mechanism for inviting students and faculty to reflect on their learning goals and desired course outcomes from the perspective of both stakeholder groups. Tools developed by the multi-university partnership have led to initial reductions of anxiety and improved stakeholder communication as well as higher levels of participative decision making.

Future work will explore long-term changes in teaching strategies by the five participating faculty as well as increased mastery of subject area knowledge resulting from the integrated curriculum. The ultimate goal of this pedagogy is to create an integrated curriculum of engineering sustainability built on global processes and factors. The addition to the realm of engineering conceptual knowledge will create a highly skilled, competitive workforce capable of understanding global forces driving complex environmental systems.

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