Results From the NSF-ATE Distributed-Hybrid Instructional Delivery Project

James Jay Houdeshell
Quality Engineering Technology Department at Sinclair Community College

Abstract

The National Center for Manufacturing Education (NCME) in partnership with the Quality Engineering Technology (QET) Department received a NSF-ATE project grant in August 2003 to develop and test a hybrid instructional delivery methodology. The design uses small group activity-based instructional materials developed under previous grants in conjunction with supportive web-based content and learning objects for the individual online component. This allows face-to-face interaction to occur despite the groups' working at different locations and times. Web-based supplemental instructional materials and learning objects created and under test include the following content modules encompassing approximately twenty quarter hours of materials: *Basic Statistical Variation, Probability, Sampling and Hypothesis Testing, Statistical Experiments, Teamwork, Quality Foundations, Process Control, Financial Management, Performance Measures, Supply Chain Management*, and *Introduction to Just-in Time.* A second deliverable is the creation and testing of a community of practice that supports all the students enrolled in the courses. Current on-line instructional components are accessible at the NCME resource center web site: http://www.ncmeresource.org/onsite/. Access to an extensive faculty facilitation-training guide for synchronous and asynchronous communications is also available at this site.

This paper defines the current status related to meeting the project objectives, in particular research into student perceptions and the use of a hybrid delivery mode. Instructional examples will be presented at the poster session along with additional pilot results.

Background

The primary outcome of the NSF-ATE grant, *A Distributed Hybrid Approach to Creating a Community of Practice Using NSF Funded Manufacturing Engineering Technology Curriculum Modules* — DUE 0302574, is to evaluate the effectiveness of the delivery method as a means to increase the number of students in manufacturing-related programs by providing institutions, companies, and students a way to work together both onsite and online in a cost-effective, practical way. The distributed-hybrid instructional delivery method uses face-to-face modular activity-based instructional materials, developed under previous NSF-ATE grants including most recently the *Completing the Curriculum: Modular Manufacturing Education Model for Advanced Manufacturing Education* —DUE 0071079. The *Completing the Curriculum* grant focused on the development and testing of the curriculum for an AAS degree in Manufacturing Engineering Technology in nine subject matter clusters[1]. What is the urgent need for this new approach to delivery?

The Society of Manufacturing Engineers has documented the need for qualified technicians and manufacturing practitioners, at a time when the number of TAC/ABET accredited Associate degree programs in Manufacturing Engineering Technology has dropped from eighteen to fourteen. Given the current economic conditions it is safe to predict that the number of manufacturing and manufacturing related programs will continue to decline, reducing student access to these programs unless some new intervention is proposed. One proposed solution to increase the viability of manufacturing related technology programs is to service a larger geographical area through the use of distance education. While pure distance education addresses the accessibility issue, it has inherent problems of higher attrition for lower division undergraduates, greater difficulties in applying teamwork skills, and lack of student access to equipment for appropriate laboratory experiences. While computer simulations can provide realistic instruction for many laboratory experiences, many of the current solutions require either moving the laboratories to the students or moving the students for extended time to the laboratories. These choices are costly logistic nightmares or prohibitive in cost and time for the typical two-year college student. The DH delivery methodology provides a cost-effective alternative.

The distributed hybrid project addresses the viability option by developing curricular materials and an online-onsite distance delivery system that economically expands the geographic area serviced by an individual college. The hybrid delivery system consists of small group face-to-face activities, web based asynchronous communications tools and supporting web based instructional materials and learning objects[2]. Wiley (2002) defines a learning object as "any digital resource that can be reused to support learning"[3]. Other published research reinforces the use of hybrid delivery.

The first published hybrid research study conducted by the University of Tennessee concluded that 26 MBA students participating in a hybrid delivery system performed at a significantly higher level than students participating in just a resident program, $p < 0.01$ [4]. Another highly successful documented MBA hybrid program is at Ohio University[5]. A successful example of the use of a hybrid delivery of courses occurring at the doctoral level is Purdue's School of Education[6]. Given the overall documented need, the project was funded to meet a defined goal and supportive objectives. These are detailed in Table 1.

Table 1.
Distributed Hybrid Project Goal and Supportive Objectives

Goal	Objectives
The goal of the funded project is to develop, test, and evaluate the effectiveness of new web-based primary instructional materials, leading to a certificate in *Continuous Process Improvement*, which utilizes a unique distributed-hybrid delivery model.	The project objectives are to: 1. Supplement eight existing NCME face-to-face instructional modules (delivered within five college classes) with web-based declarative and structural supporting materials, within a reusable learning object format, suitable for a distributed-hybrid method of delivery. 2. Pilot test the materials and delivery method at a total of two or more industry and college sites with an average of four or more students per site per term; 3. Develop a web-based virtual "community of practice" over the length of the program that includes subject matter experts, participating students, and module instructors for the purpose of creating self-sustaining, student-led environments for sharing and growth; 4. Test the effectiveness by comparing student performance

	and retention in at least four modules; student, faculty, college, and industry satisfaction; and institutional and industry return on investment when compared to face-to-face or pure web based instruction; 5. Research and create a dissemination plan that addresses adoption barriers identified in the project.

The next section addresses the current progress towards the objectives and outlines the unexpected challenges.

Grant Progress and Challenges

To date the grant activities have focused on project objectives one, three, and five. The resource concentration has been in the development and pilot testing of the web-based course enhancement instructional materials, and web-based facilitator training. The facilitator training focuses on the implementation of the distributed hybrid concept and on the effective use of synchronous and asynchronous communications in support of the on-line community. Student surveys have been conducted to determine student preferences. The web-based instructional materials can be accessed at the NCME resource center web address provided in the abstract section. These three objectives are discussed below in fuller detail.

The progress to date, as of January 2005, includes the development and pilot testing, within face-to-face courses, of 75% of the web-based supplements for the previously developed activity-based constructivist modules. Feedback from the students and faculty has been positive for the initial pilot testing of the materials within a pure face-to-face environment. This is attributed to the Principal Investigators' decision to develop and to apply web-based templates and assessment instruments based on Merrill's Five-Star Instruction Principles [7, 8]. The five key elements of the Principles include: (1) the problem to be solved should engage the learner, (2) the instructional unit must activate the participant's prior learning, (3) the instructional unit must demonstrate to the participant examples of what is to be learned, (4) the instructional unit should require the learner to apply the new skills and, (5) the instructional unit should aid the learner in integrating his/her new knowledge by providing the learner with opportunities to transfer the knowledge to a new context. For example, when an instructional designer/subject matter expert did not provide a complete accounting example of a problem to be solved within the *Performance Measures* module, the pilot students exhibited frustration and a high problem solution error rate. Table 2 displays the assessment instrument that was developed based on Merrill's criteria.

Table 2.
Instructional Unit (IU) Assessment Criteria

Principle	Assessment Criteria
Problem	• Does the IU present a problem in the context of the real world? • Does the content show the learners the task or problem that they will be able to solve as a result of completing the IU? • Is the learner engaged at the problem or task level not just the operation or action level? • Does the content, if appropriate, support a progression of problems rather than a single problem
Activation	• Does the IU attempt to activate relevant prior knowledge or experience?

	• Does the IU direct the student to recite, relate, describe, or apply knowledge from relevant past experience that can be used as a foundation for the new knowledge? • Does IU provide relevant experience that can be used as a fountain for the new knowledge? • Does the IU provide a diagnostic pretest at the start of each unit? • Does the IU activate a mental model?
Demonstration	• Does the IU demonstrate (show examples) of what is to be learned rather than merely tell information about what is learned? • Are learner guidance techniques used? • Is the media relevant to the content and is used to enhance learning?
Application	• Does the learner have an opportunity to practice and apply their newly acquired knowledge or skill? • Are the application and the posttest consistent with the stated or implied objectives? • Does the IU require the learner to use new knowledge or skill to solve a varied sequence of problems and do learners receive corrective feedback on their performance? • Are learners able to access context help or guidance when having difficulty with the materials?
Integration	• Does the IU provide techniques that encourage the learner to integrate (transfer) the new knowledge or skill? • Does the IU provide an opportunity for the learner to publicly demonstrate their new knowledge or skill? • Does the IU provide an opportunity for the learner to reflect-on, discuss, and defend his or her new knowledge or skill? • Does the IU provide an opportunity for the learner to create, invent, or explore new and personal ways to use his or her new knowledge or skill?

Co-Principal Investigator Giguere has led the development of faculty training using web-based slides and voice recordings. Additional support is provided from a question-and answer-format Webinar using *Interwise* and a supportive discussion board. The discussion board supports a faculty "community of practice" related to implementation issues. The implementation and pilot testing of the faculty development training will be completed by April 2005. The defined pilot testing steps include: (1) solicit faculty volunteers, (2) registration and pre-test, (3) orientation Webinar focusing on the use of the web-based materials, (4) web-based discussion forum, and (5) a post-test and a follow-up question and answer Webinar. What has not been as easy to implement is the testing of the distributed-hybrid course structure.

The logistics to test the distributed-hybrid delivery has been challenging with no students volunteering to join a "hybrid" site i.e. not coming to class but meeting with an instructor/facilitator in a small group to carry out the activities. The author informally interviewed classes as to their reluctance to be excused from coming to face-to-face classes at the college. Several students stated they preferred to drive fifty miles to class citing "I learn a lot from other student's questions". The team response was to ask our external evaluator, Social Science Research and Evaluation Corporation (SSRE), to develop a questionnaire to determine student's perceptions concerning distance education versus face-to-face instruction. The questionnaire was submitted to fifteen 200 level Quality Engineering Technology students in three different face-to-face classes and to fifty-six pure distance-learning 200 level courses. The questionnaire allowed the use of a paired data t-test to determine preferences related to distance learning and pure face-to-face instruction. The questionnaire was administered to 200 level distance-learning students enrolled in the same course as one of the face-to-face course sections and to two additional courses. No significant differences among the responses among the three distance education courses were observed. Paired data t-test results displayed in Table 3 provides insight into the student's perceptions as to the benefits of face-to-face instruction over distance learning. The students strongly perceived that they would receive more feedback and that the course would be easier to learn within a face-to-face environment when compared to a distance-learning environment. They also perceived that it would be easier to work with other students within a face-to-face environment.

Table 3

Survey Results —200 Level Student Perceptions, Face-to-Face and Distance Education

Comparative Questions (1 to 4 scale)	Average Paired Data Difference Response (F-to-F – DE formats)	
	F-to-F students	& DE students
How much feedback on your coursework would you expect to get in the face-to-face format? Distance- learning?	1.1***	0.6***
How helpful would you expect the feedback on your coursework to be in the face-to-face format? Distance- learning?	0.5	0.6***
How easy would it be to learn the materials in the face-to-face format? Distance-learning?	1.6***	0.7***
How easy would it be to get your questions answered in the face-to-face format? Distance-learning?	0.7	0.8***
How convenient would it be to take the course in the face-to-face format? Distance-learning?	0.4	-0.8***
How easy would it be to work with other students in learning the material in the face-to-face format? Distance- learning?	1.2*	1.0***

*<0.05, **<0.01, ***<0.001

The group of distance-learning students answering the same questionnaire concurred with the face-to-face student results with the exception of two questions. The distance-learning students perceived, at a very significance level, that it would be easier to get questions answered within a face-to-face environment and also concluded participating in distance learning classes was more convenient than face-to-face classes. The students also completed questions related to their learning styles and social interaction, No differences were apparent for these questions except for the statement; Being required to attend class is helpful in motivating me to learn the material. The distance education students scored this as less important as a motivator when compared to the face-to-face students. Overall the only major perceived benefit for distance - learning is convenience. A proposed solution to the lack of volunteers is to enhance perceived convenience and to reduce the concerns related to distance education classes is discussed in the next section.

In order to meet this challenge the Principal Investigators in conjunction with the QET department proposes to split courses that have designated lecture-laboratory components into two separate courses, for example the current three credit hour course, QET 201 Statistical Process Control (SPC) is a two lecture and a two laboratory hour/week course. This would become two courses QET 201 SPC, three credit hours, a two-lecture hour course, and co-requisite QET 181 SPC Laboratory, zero credit, two laboratory hours per week course. With this course combination a variety of options are possible: Offering totally face-to-face, offering the face-to-face laboratory course (at the college and offsite) with a distance-learning lecture class (hybrid) or offering a pure distance-learning experience. Table 4 outlines the proposed course combinations under a hybrid mode.

Table 4.
Hybrid Course Offering Combinations

Course	Face-to-Face	Web	Day	Eve	Sat	Off site
QET 201		X				
QET 181	X		X	X	X	X

The pilot testing of these combinations will occur beginning in the Fall Term 2005. In total 15 courses will be changed to this new format. This new format should allow students to feel like they are in a structured class and will have access to a subject matter expert. The issue of student reluctance to volunteer raises the last issue to be discussed within this paper: What are the barriers to the successful dissemination of this innovation?

Rogers (1995) provides example and research insight into the problem of diffusing innovations to other organizations and to potentially adopting individuals. The process is complex and begins with the adoption of the innovation within an organization by individuals characterized as ‘innovators’ and ‘early adopters’[9]. These individuals analyze the characteristics of the ‘innovation’, the availability and completeness of the ’information’, and the level of ‘uncertainty’ surrounding the innovation. In particular the potential adopter initially looks at five characteristics before deciding whether or not to adopt. These characteristics of innovations are relative advantage, compatibility with existing practices and structures, complexity of the innovation, ease of trialability, and how quickly can the adopter observe the impact of the change. An example of the efforts to test the acceptability of the proposed course structure change was the use of additional questionnaires and interviews with students about providing students with greater flexibility on the times for course offerings within the hybrid laboratory structure. Out of this process came a proposal to create a “Saturday School”, which will allows students to take two or three of the “hybrid” laboratory courses, in two-hour blocks on Saturday morning and early Saturday afternoon. This was enthusiastically endorsed by many of the ‘adult‘ students who currently work 10-12 hour days during the week. The team is currently developing questionnaires for interviewing other colleges and industry sites as to the ‘acceptability’ of the method.

Summary

The impact of the documented project is potentially national in scope and could change the way college level educational content is delivered by adding another point on the continuum between pure face-to-face and pure web-based. This approach ends the isolation of the distance education student by providing a combination of group face-to-face and individual asynchronous learning opportunities. The effectiveness of the delivery system is accomplished by providing the students with high quality instructional materials and activities. The application of Rogers' diffusion principles will assist in the adoption of the concept at other institutions.

This research is supported in part by the National Science Foundation under DUE-0302574. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

References

1. NCE/AME, *A Novel Curriculum for the Associate Degree in Manufacturing Engineering Technology*. 2000, Dayton, OH: Advanced Integrated Manufacturing Center.
2. Houdeshell, J. and G. Pomeranz. *Preliminary Results from a NSF-ATE Funded Distributed Hybrid Instructional Delivery Project*. in *ASEE Annual Conference and Exposition*. 2004. Salt Lake, Utah: American Society for Engineering Education.
3. Wiley, D.A., *Connecting Learning Objects to Instructional Design Theory: A Definition, a Metaphor, and a Taxonomy*, in *The Instructional Use of Learning Objects*, D.A. Wiley, Editor. 2002, AIT/AECT: Bloomington, IN. p. 298.
4. Dean, P.J., et al., *Effectiveness of Combined Delivery Modalities for Distance Learning and Resident Learning.* Quarterly Review of Distance Education, 2001. **2**(1): p. 247-253.
5. Stinson, J., *A Continuing Learning Community for Graduates of an MBA Program: The Experiment at Ohio University*, in *Learning-Centered Theory and Practice in Distance Education*, T.M. Duffy and J.R. Kirkley, Editors. 2004, Lawrence Erlbaum Associate: Mahhwah, NJ. p. 167-182.
6. Lesh, R., S.K. Byrne, and P.a. White, *Distance Learning: Beyond the Transmisson of Information Toward the Coconstruction of Complex Conceptual Artifacts and Tools*, in *Learner-Centered Theory and Practice in Distance Education*, T.M. Duffy and J.R. Kirkley, Editors. 2004, Lawrence Erlbaum Associates: Manwah, NJ. p. 261-281.
7. Merrill, M.D., *First Principles of Instruction*. 2001, Utah State University: Logan, UT.
8. Merrill, M.D., *First Principles of Instruction.* Educational Technology Research and Development, 2002. **50**(3): p. 43-59.
9. Rogers, E.M., *Diffusion of Innovations*. Fourth ed. 1995, New York, NY: Free Press. 519.

James Jay Houdeshell
Jim is currently a Professor of Quality Engineering Technology and a Principal Investigator at the NCME, a NSF-ATE funded center. He is a registered Professional Engineer in Ohio, a Certified Reliability Engineer, and Quality Auditor. Completed degrees include a Ed.D, MS degrees in Engr. Mgmt. and Systems Engr., and a BS in Chem. Engr. Prior engineering working experience include consulting and ten years at Inland Division of GMC.