Integration of STEM Community College Curricula and Industry Partnerships through National Certifications

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Abstract

As need for a highly skilled STEM workforce increases, the linkage between secondary and post-secondary STEM curricula and their potential employers becomes increasingly important. The following paper details the implementation of the Advancing Manufacturing Initiative in collaboration with regional manufacturing partners, regional workforce development and Ivy Tech Community College. This initiative includes the increase of awareness of the need for skilled labor in manufacturing disciplines, the training and evaluation of local workforce and the creation of a bridge between regional workforce needs and the use of a standard measurement of skills through the implementation of the Manufacturing Skills Standards Council (MSSC) Certified Production Technician (CPT) exam.

After regional workforce needs were determined, a multiphase approach began integrating standardized testing at three different levels of education including high schools, dislocated workers and college students. Implementation included three variations for delivery, including blended (hybrid) learning of online and hands-on instruction, instructor led online only instruction and self-paced online instruction. These various educational levels and delivery methodologies aim at giving each learner the most applicable and effective instruction leading directly to the workplace or on an educational pathway from high school, to two year, to four year college degrees. The data collected shows a very successful model, which is both economically sustainable and able to meet current and future workforce needs.

Introduction

In 2011, President Barack Obama launched the Advanced Manufacturing Partnership, linking corporations, universities, community colleges and the K12 STEM curriculum to the growing demand of new skills required by today's workforce. This partnership was a key element in his overall economic plan to double manufacturing exports by 2015 (Alterman, 2012). However, meeting workforce demands is not always easy, as the manufacturing industry has negative associations due to past reductions in workforce or the image of being low skilled or low wage positions. The Manufacturing Institute found that much of the image the newest generation has regarding manufacturing jobs comes from their parents and teachers discouraging them from

pursuing manufacturing careers, making it very difficult to meet workforce needs (Manufacturing Institute, 2013).

Training and educational opportunities must be flexible to meet the various populations that can potentially meet this workforce need, including the K12 student, the college student and the dislocated or underemployed worker. Additionally, a clear path from the educational process to the workforce must be created, linking industry and STEM curriculum to ensure graduates are adequately prepared and aware of the opportunities awaiting them in the workforce. This was the problem that served as the catalyst for the creation of the Advanced Manufacturing program, along with the Advancing Manufacturing industry partnership. These two initiatives provide education and training in key skill areas including safety, quality, manufacturing and production processes, required to succeed in the new high tech industries (Advancing Manufacturing, 2013).

As with many elements of higher education, best practices in pedagogy are researched and documented or shared in other ways between faculty members to the betterment of education. These best practices may include individual course elements, curriculum development, student and faculty interaction and effective presentation of the subject matter. Therefore, it is important that each of these elements be considered for every course, regardless of the delivery format used. As online formats are a relatively new way of teaching, these best practices are still under development.

This also applies to hybrid delivery formats, which are a blend of both traditional face to face elements and elements making use of online technologies. This blend can vary on a course by course basis, making the establishment of best practices difficult. However, understanding the potential impact of the hybrid delivery format is essential to those developing curriculum making use of this blend.

In looking to offer the most flexibility to our various leaners and create a consistent level of quality in our curriculum, this process began by identifying the coursework that was independently verified to meet the manufacturing sector needs. This was accomplished through the Manufacturing Skills Standards Council (MSSC) Certified Production Technician (CPT) exam, which addressed issues of safety, quality, manufacturing and production. This nationally recognized certification exam was approved by the MidWest Indiana Economic Development Partnership, the NorthCentral Indiana Economic Development Partnership, Region 4 Workforce Board, WorkOne, and over 25 regional employers, including several global and Fortune 100 companies. This overwhelming support within the region and nationwide for this certification process provided an avenue for connecting high school graduates, college graduates and dislocated workers to enter the workforce with a measure of confidence in the ability to meet industry needs for a high skilled employees.

The hybrid course format, a blend of both face to face elements and distance delivery elements, was created out of a desire to maintain the benefits found in traditional face to face classrooms, while adding the convenience in having a reduced on-campus presence by students and faculty.

To create a curriculum that serves the needs of the workforce, the external validation of a national certification is critical. However, implementation across multiple ages, ranges of experience, learning platforms and timelines requires high flexibility. Cost considerations are also important as public education budgets are reduced. This study investigates both the effectiveness of the hybrid delivery platform on learners, to ensure academic achievement is not reduced with a reduction in face to face class time. With this change in delivery comes increased flexibility and decreased cost for the educational institutions. Additionally, it is essential to ensure the curriculum meets the needs of the workplace and can be effectively taught across multiple learning groups. Finally, once trained, the student must have connections to both the workforce and continued education to truly serve the needs of our industry.

Literature Review

Hybrid courses were created with the intention of blending the best element of face to face instruction with the convenience of online delivery formats. Additionally, administrators viewed hybrid courses as a middle ground between traditional coursework and full online course delivery formats. Goals of the administration include reduced classroom time or faculty loads (El Mansour & Mupinga, 2007; Lorenzetti, 2004). Additional benefits are the increased to college enrollment experienced, especially in community colleges. Academic leaders agree that online demand is growing and found a 9.7 percent growth rate in online enrollment compared to the 1.5 percent growth rate in college enrollment over all (Bradley, 2008).

Deployment of hybrid courses and online courses requires some sort of course management system allowing students access to materials, email, chat, discussion boards and other areas of functionality from remote locations. Blackboard Learning Systems, a course management system used by nearly 70 percent of academic institutions in the United States, can be specifically applied to hybrid course delivery formats to eliminate difficulties in transitioning between online components and face to face components of a hybrid course (Bradford, Porciello, Balkon, & Bakus, 2007). This tool helps to facilitate the online learning portion of the hybrid course and supports the benefits of the hybrid format described above.

Students enrolled in hybrid courses are not always prepared for the experience that awaits them, as it is neither an online course nor a face to face course, but a unique blend of the two formats. This blend may be different from instructor to instructor or course to course (“Hybrid course”, 2004). In a survey of students enrolled in hybrid courses, Dourin (2000) discovered that many students choose the hybrid environment because they do not necessarily look to engage other

students and form a community of fellow learners. However, Artino (2008) found that student collaboration directly impacts a student's success in a course. Having engagement between students and the faculty is important. Instructors need to intentionally increase the quality and opportunities to develop social structure, as the platform of hybrid course can hinder these structures from forming as they would in a traditional setting (Slagter van Tyron & Bishop, 2009). Slagter van Tyron and Bishop (2009) provide a framework for creating social structure in online hybrid learning environments, looking only at social interaction, instead of social interaction's impact on academics.

Students surveyed by Jackson and Helms (2008) were found to identify student to student interaction as one of the commonly found weaknesses in hybrid courses. In a survey of hybrid students, Yang and Lui (2007-2008) identified four key ways to build community in a hybrid environment, with two of them directly related to student to student interaction. Social environments and collaboration have been previously identified as required elements for successful and satisfying educational experience (Dourin, 2000). This solidifies the need to overcome challenges presented in creating collaborative engagement in hybrid courses to help the students reach their optimal potential.

Methodology

The first portion of this study determined whether hybrid delivery format impacts a student's engagement with the course, measured by academic achievement with the hybrid platform. The information gathered from this study was used for course development and deployment at various other educational settings, including high school dual credit coursework and dislocated worker training.

The ADMF 101 "Key Principles in Advanced Manufacturing" course was developed during the summer of 2008 by the Advanced Manufacturing curriculum committee and was first offered at the Ivy Tech Community College in the summer of 2008 as a pilot program. This course has been offered every semester since the summer of 2008. This course makes use of two national assessments, from the Master Skills Standards Council (MSSC). The first assessment covers concepts in safety and the second assessment covers concepts in quality. These assessments are mandatory course elements and are each worth 25% of the course grade. The assessments are given in a proctored environment, with a proctor who is certified by MSSC. The instructor cannot serve as proctor.

The course includes e-learning content and proctored assessments which have been used to evaluate baseline understanding of industry and government defined standards for both entry level positions and incumbent workers (MSSC Overview, 2009). The e-learning content, proctored assessments and certification are required elements for this course. The additional two

tests, completing the MSSC CPT exam are administered through the ADMF 102 "Technology in Advanced Manufacturing" course. This course is identical in format and was modified to the hybrid format, once success was demonstrated in the ADMF 101 course.

The hybrid format, by definition, is a reduction of in class time, which inherently leads to a reduction in time with both their peers and the instructor. As previously defined, the hybrid format being used is a 50% reduction in class time, meaning the hybrid course will only meet two hours in face to face sessions and the traditional course will meet for four hours in face to face sessions. This portion of the study investigates the impact of the reduction in time with the instructor on academic achievement. Academic achievement in the hybrid course is compared to previously taught traditional face to face sections, by comparing the assessment scores of previous sections with the assessment of current sections.

The second portion of this study reviews the certification scores for the various demographics and ages (high school, incumbent workers, dislocated workers, and traditional college students) are compared to examine differences in success rates and the implications for best practices in teaching.

Course Content

For the original pilot program using high school students, a traditional face to face structure was used, which included the e-learning content, lab activities, quizzes, discussion questions and lab time. The e-learning content was developed by Amatrol Learning Solutions and adopted by the Manufacturing Skills Standards Council to deliver computer based learning. This content includes embedded practice quizzes, video, interactive computer based activities and simulated exercises in safety, electrical principles, machining and other manufacturing processes. For high school students in the pilot or enrolled in dual credit opportunities in the high school, only the traditional format has been used.

The hybrid format requires students to complete their e-learning activities outside of class time, leaving the course time focused on discussion and hands-on lab activities. Hands-on lab activities include quality inspections, electrical wiring, safety inspections, manual machining and other activities conducted in the manufacturing environment. Group discussion questions are reviewed in small groups or by the entire class. Quizzes are embedded in the e-learning and are therefore reviewed outside of class time. The hybrid format was piloted by a single section of students during the time the research took place. However, given their comparable test scores in the national assessment as seen in Table 2, additional hybrid sections have been offered for students attending courses on the college campus. The online only format is made available to incumbent workers with over five years of manufacturing experience. In this format, the students have

access to the same e-learning content and are given discussion group questions through the online learning management software. No face to face interaction takes place in this format.

Materials for the ADMF 101 hybrid course were identical to the course materials previously available to students who had taken the course as a face to face course. With regard to the ADMF 101 course, the only difference with the hybrid delivery format was the lecture portion of the course. As no lecture took place in the hybrid course, the power point files were placed online, via Blackboard to make the content available to students. Students were instructed to review the content, as they would be held responsible for this content on the certification exam. Additionally, there was only one time each week available for questions as a group. Students were encouraged to email the instructor with additional questions, in between weekly meetings. The workbook was also made available online, in addition to the hard copy, required of all students. All assessments were conducted on campus in a proctored environment, as required by the certifying body (MSSC) associated with the ADMF 101 course certification.

Table 1: *Difference in Course Materials*

Course Element	Previously Taught Face to Face sections	Hybrid Section
Workbook/ Text Book	Yes – available only in hard copy	Yes – available both online and in hard copy
Homework Activities	Yes	Yes
Lab Activities	Yes	Yes
E-Learning Content	Yes	Yes
Online quizzes	Yes	Yes
Interactive lecture using Power Point	Yes	No - Power Point file available via Blackboard
Question and Answer Period	Yes –incorporated into lecture and lab sessions	Yes – during lab session only

National Certification Exam

The national certification exam, provided by the Manufacturing Skills Standards Council (MSSC) is a required element of the course for all students and is nationally recognized as an assessment of basic manufacturing knowledge. Benefits to using the MSSC certification process are reported as:

- Increases industry client base and student enrollment through MSSC network and nationally recognized certification-based training.
- Increases student enrollment through on-demand e-learning solutions

- Provides fully developed courses for immediate implementation
- Offers high-quality courses with proven results
- Provides teacher certification to increase skills and opportunities for instruction
- Enables schools to offer certifications as well as degrees

The certification includes individual assessments for each of the four areas: safety, quality practices and continuous improvement, manufacturing processes and production, and maintenance. In the ADMF 101 course, the safety and quality practices and continuous improvement assessments are administered as part of the curriculum.

To measure academic achievement the exam provided by the Manufacturing Skills Standards Council (MSSC) was used in the ADMF 101 course. The national certification exam is used as part of the graded components for the class and all grades of the students who have taken the exam, since the inception of the course, have been recorded. The researcher compared the previous test takers to the current section of ADMF 101 to compare the impact of the hybrid format on the certification process.

Certification Scores

The scores on the MSSC CPT certification scores are saved and tabulated for every participant within our regional jurisdiction. Currently, there have been several thousand exams given through dual credit courses, non-credit training to dislocated or incumbent workers and credit training via the Advanced Manufacturing department. Over the course of the past five years, certification exams have increased as the opportunity for dual credit has increased, as well as the impact of the Advancing Manufacturing initiative.

Data Analysis

To begin the statistical analysis of academic achievement, the researcher looked to use a one way ANOVA test to examine if there was any difference between the assessment scores from the previously taught traditional sections of ADMF 101 and the assessment scores from the current hybrid section. Using MiniTab to construct an ANOVA, it was discovered that the data was not normal. To verify these results, the data was tested for normality, using the Anderson Darling test through the statistical analysis tool of MiniTab. The data failed the Anderson Darling test for normality, making it impossible to use an ANOVA to test the hypothesis. Therefore the Kruskal-Wallis test was used to determine if there was a difference between the hybrid assessment scores and the scores of the previously taught sections using the traditional delivery format.

Findings

Using the Kruskal-Wallis test, a non-parametric test comparing medians of samples, the following results were calculated, as seen in table 2. The sample size for the pilot, which used the hybrid format, was 11 students. As this was the first section ever to make use of the hybrid format, the college administration limited the experiment to one section of students. Since the initial experiment was performed, almost all sections offered of the ADMF 101 and 102 courses statewide now use the hybrid format.

Table 2: *Kruskal-Wallis Test Results*

Course Section	N	Median	Ave Rank	Z
Traditional – 01D-093	9	90.00	21.9	-0.90
Traditional – 50D-092	12	92.00	29.4	0.91
Traditional - 50D-093	12	91.00	25.4	-0.17
Traditional – 20D-101	7	30.2	30.2	0.81
Hybrid – 7HD – 102	11	91.00	23.6	-0.61
Overall	51		26.0	
H = 2.18	DF = 4	P = 0.703		
H = 2.20	DF = 4	P = 0.699	(Adjusted for ties)	

As seen from the data above, there is no statistically significant difference in medians of the academic assessment scores between the hybrid section and those sections taught using the traditional face to face format. This information is critical, as the assessment is not only a graded element of the course, but also a national certification that can be included in the student's resume. Successfully completing the national certification assessment is considered to be an essential element to completing the Advanced Manufacturing program.

Summary and Suggestions for Best Practices

Academic achievement, measured by comparing the assessment of previously taught face to face sections of ADMF 101 and the hybrid section of ADMF 101 showed no impact of the hybrid format on the certification scores. This information was critical to the expansion of the Advancing Manufacturing Initiative and the proliferation of dual credit options to high school learners, as this delivery model helps to decrease cost of deployment and increase the delivery rate for incumbent and dislocated workers.

As a pilot program, sponsored by grant funding, a summer program for high school juniors and seniors was created using this curriculum, with the goal of discovering the effectiveness of the curriculum with high school students. The summer program included the identical materials, e-learning curriculum and lab activities of the college course. It was taught by the researcher, on

location at the community college. It was found that the students had a 87% pass rate of the certification exams. It was also noted that the two students who did not pass were non-native English speaking students. The Manufacturing Skills Standards Council was contacted to see if the exams were available in Spanish, however, MSSC stated that English proficiency was a requirement of the exams, based on employer requirements and therefore must be given in English. The summer program was repeated the following year using grant funds, with an identical curriculum. A pass rate of 92% was achieved by the class. It was also noted that between the two courses, over 30% of the high school students who participated in the program enrolled in the college, as a college student within 12 months. From these results, this course was adopted by the Department of Education for dual credit course offerings, statewide. Dual credit courses require identical course format and assessment, ensuring consistency of content and quality of instruction. With support of industry, four year institutions, two year institutions and high schools, these courses were integrated to the Manufacturing pathway, a priority Career and Technical Education pathway (Indiana DOE, 2013). Dual credit course offerings are given at no cost to high school students, including the cost of the certifications themselves.

This program was also highlighted in the Manufacturing Institute's Roadmap for Manufacturing Education, where the articulation of courses embedding the MSSC CPT certification, from high school, to two year degree, to four year articulations was identified as one of the top four needs for the nation to regain a stable manufacturing economy (Manufacturing Institute, 2012).

Simultaneously to the implementation of hybrid "for-credit" courses, offered at the collegiate level and at the high school through dual credit offerings, a collaborative initiative blending regional manufacturers, regional WorkOne centers and other stakeholders, a non-credit course, using identical curriculum and delivery was launched, called "Advancing Manufacturing". This organization served to educate the community about the available careers in manufacturing and link employers to skilled labor through this training process. The students in these courses received outside funding, making the course available at no cost. The students were drug tested and were required to maintain a high level of attendance. Students were trained and completed the four certification areas, receiving the MSSC CPT credential. The students then participated in a job fair, connecting them to employers who had immediate openings for trained individuals. Over 7,000 job referrals have been made through this effort. Additionally, students have maintained a 95% pass rate. To help connect these dislocated workers to additional educational opportunities, students are given a certificate from the community college, awarding them six course credits in the Advanced Manufacturing program. Employers who hire these individuals give back to the scholarship fund a donation of $1000, to help maintain the economic sustainability of the program.

With a pass rate of over 90% for all test takers within the region and priority hiring practices for those holding the MSSC CPT certification at more than 40 regional employers, the integration of this industry credential into the high school dual credit and two year collegiate degree or workforce training program, has proven highly successful. While currently the dual credit courses remain the traditional format, based on the ongoing success of the hybrid format in the college environment, high schools are open to the idea of trying to pilot hybrid versions for dual credit. One obstacle involves the Department of Education contact hour requirements in the high school environment, which are different from those in the higher education system. Proven success in delivery makes this course a great model for how to link education with STEM careers.

References

Advancing Manufacturing. 2013. *We have jobs here. We have training here.* Lafayette, IN: Advancing Manufacturing. Retrieved from http://advancingmanufacturing.com/#!home

Alterman, E. (2012, May 29). Advanced manufacturing could spark next industrial revolution. *CNBC*. Retrieved from http://cnbc.com/id/46222415/Advanced_Manufacturing_Could_Spark_Next_Industrial_Revolution

Artino Jr., A.R. (2008, May/June). Promoting academic motivation and self-regulation: Practical guidelines for online instructors. *TechTrends, 52* (3), 37-45.

Bradford, P., Porciello, M., Balkon, N., & Balus, D. (2007). The Blackboard Learning Systems: The be all and end all in educational instruction. *J. Educational Technology Systems, 35* (3), 301 – 314.

Bradley, P. (2008, May 5). Leading the way: Online enrollments tilting toward community colleges [Special Report]. *Community College Week,* 9.

Brunner, D.L. (2006). The potential of the hybrid course vis-à-vis online and traditional courses. *Teaching Theology and Religion, 9*(4), 229 – 235.

Dourin, M. (2000). The relationship between students' perceived sense of community and satisfaction , achievement, and retention in an online course. *The Quarterly Review of Distance Education, 9*(3), 267-284.

El Mansour, B. and Mupinga, D.M. (2007, March). Student's positive and negative experiences in hybrid and online classes. *College Student Journal, 4*(1), 242-248.

Indiana Department of Education. (2013, February). Manufacturing Cluster Pathway. Retrieved from http://www.doe.in.gov/achievement/career-education/cluster-manufacturing-logistics

Jackson, M.J. and Helms, M.M. (2008, September/October). Student perceptions of hybrid courses: Measuring and interpreting quality. *Journal of Education for Business,* 7-12.

Manufacturing Institute. (2012, December). Roadmap for Manufacturing Education. Washington DC. Retrieved from http://www.conexusindiana.com/documents/roadmap-for-manufacturing-education.pdf

Manufacturing Institute. (2013). *Image of Manufacturing.* Washington DC Retrieved from http://www.themanufacturingistitute.org/image/image.aspx

Manufacturing Skills Standards Council. (2009). *MSSC Overview.* Retrieved from http://www.msscusa.org/overview.shtml

McGraw Hill Glencoe. (2005). High Performance Manufacturing e-flier. McGraw Hill Glencoe.

MSSC USA. (2009). *MSSC System Benefits*. Retrieved from Manufacturing Skills Standards Council: http://www.msscusa.org/system_benefits.shtml

Hybrid Courses – hidden dangers. (2004, April 1). *Distance Education Report,* pp. 3, 6-7.

Slaster van Tyron, P. and Bishop, M. (2009). Theoretical foundations for enhancing social connectedness in online learning environments. *Distance Education, 30*(3), 291-315.

Yang, H.Y. and Liu, Y. (2007-2008). Building a sense of community for text-based computer mediated communication courses. *J.Education Technology Systems, 36*(4), 393-413.

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