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A Case Study in Effective Education-to-Workforce Pipelining: An Advanced Manufacturing and Innovation Academy

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Abstract

An advanced manufacturing and innovation academy (AMIA) had been implemented to engage talented young people in the community and connect them with regional advanced manufacturing careers and related entrepreneurial activities. College professors and administrators used collaborative educational approaches to integrate advanced manufacturing pedagogy with robotics, digital manufacturing, and 3D printing with the community students. A tour to a local advanced manufacturing facility was conducted to broaden participants' understanding of advanced manufacturing through direct examples of the themes of the academy. This paper covers the first year of AMIA (a work in progress) and details the background and motivation of the academy. Goals, educational components, community partners and process implemented in year one of the AMIA is discussed. Interim assessment results, success, and lessons learned based on feedback of the participants is covered. Conclusions and next steps for AMIA year 2016 are discussed. This is work in progress paper and authors plan to follow up with detailed assessment results in year two of this academy.

Background and Motivation

Funded through a $1.25 million 3 year grant [1, 2,4], the first phase of the AMIA brought together community comprising of middle school students and teachers, technology and engineering students, and university professors and administrators for a two week workshop in the summer of 2015. Approximately 40 middle school teachers worked side by side with 30 middle school students in this academy hosted by East Carolina University's College of Engineering and Technology (CET). Academy participants learned about advanced manufacturing in a team oriented, learning focused, problem solving, and hands-on educational environment.

One of the prime motivations for this academy was to instill the concepts of entrepreneurship, science, technology, engineering, art and design and math (eSTEAM) [1, 2] early enough to get the community students excited about the careers in advanced manufacturing and erase the concept that manufacturing is a "dirty greasy" occupation[1, 2]. The teachers worked alongside the students with majority of the instruction conducted by East Carolina University professors. The motivation for this approach was such that the teachers could carry the instruction techniques with them to their respective schools upon completion of the academy. As per the quote by Dean of the CET, Dr. David White "East Carolina *University's College of Engineering and Technology will help prepare these middle school students by exposing them to the tremendous career opportunities that lie before them and developing the academic and technical skills that are required for employment in this industry*," [1, 2].

Objectives, Partners, and Components,

The primary objectives of the AMIA are to establish a robust education-to-workforce pipeline for students in the community and 1) enhance their awareness of regional advanced manufacturing careers; 2) increase their STEAM skills, knowledge and abilities; 3) develop their competency in innovation processes; 4) develop their leadership/soft skills; and 5) prepare them for successful, employment and entrepreneurship[1,2,3]. To meet these objectives, it is required that students demonstrate effective use of technology in real-world, authentic student-centered applications. The CET partnered with several departments on campus, middle schools from around 13 surrounding counties, and several local industries. Beginning with these objectives, the CET designed and implemented four primary educational modules/components. They were 1) Robotics; 2) 3D modeling; 3) 3D Printing or additive manufacturing; and 4) Computer Aided Machining/Computer Numeric Control (CNC). These modules were delivered over a two week time frame.

Robotics was taught during the first four days and provided an opportunity to combine multiple disciplines in one application. The concepts of mechanics, electronics, programming and design all converged to make the robot. To accomplish that, the robotics portion had to be cost effective, readily learned, well documented and, if possible, open source. That led to the development the programmable Roboxsumo[5] platform. This is a very simple robot that students can quickly assemble and program. The robotics activity was organized into five training and builds sessions with a presentation session on the last day. The participants were also exposed to an industrial graded pick and place robot to understand the applications of robots in a manufacturing environment. Figure 1(a) depicts the teachers and students working on the robot and Figure 1(b) depicts the robot build by the student, Figure 1(c) depicts robot test runs being conducted, and Figure 1(d) depicts the industrial pick and place robot being programmed and used.


Figure 1(a)

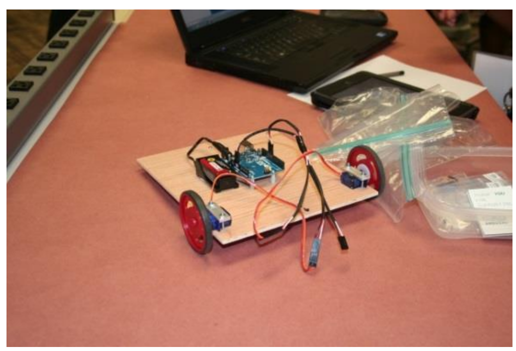
Figure 1(b)


Figure 1(c)


Figure 1(d)

Figure 1. Robotics Module

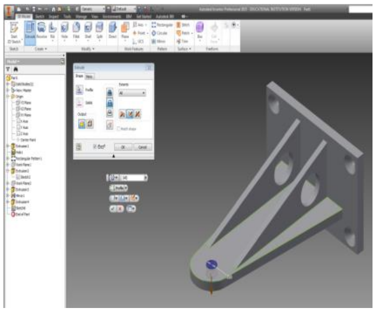

Figure 2(a)

Figure 2(b)

Figure 2(c)

Figure 2(d)

Figure 2(e)

Figure 2(f)

Figure 2. 3D Modeling, 3D Printing and CNC Modules

A tour of a local advanced manufacturing facility, Hyster-Yale Materials Handling that specializes in manufacturing forklifts and trucks was conducted at the end of first week to broaden the perspective of the AMIA participants in advanced manufacturing and for them to experience how AMIA concepts were applied to solve real world problems. The participants were then exposed to the concepts of 3D modeling, 3D printing, and CNC during the first four days of second week. 3D Printing is increasingly becoming an integral part of the visualization, design, and prototyping process and in the area of advanced manufacturing. AMIA Participants designed a 3D model of a bracket in Autodesk Inventor[6] which is a 3D modeling tool as depicted in figure 2(a). The 3D bracket model was printed using 3D System's Z printer 650[7] (figure 2(b)) and Makerbot Replicator's 3D printer[8] (figure (2c)). The 3D printed parts of the brackets are depicted in figure 2(d). The participants were also exposed to computer aided machining such as CNC. Figure 2(e) depicts the participants working on a Denford 3-Axis milling machine[9]and CET student worker providing lab help. Figure 2(f) shows participants displaying the machined parts.

Success, Interim Assessment and Lessons Learned

A post AMIA workshop survey was conducted and the results are depicted in figure 3. As per the survey results, a large majority of the teachers and the students were very satisfied or satisfied with the STEM modules delivered by the CET. The participants expressed the need to breakdown the 3D modeling modules into smaller sub modules and start with simple models. Since this is a work in progress paper, and the authors are limited to four pages, the readers are encouraged to contact the authors for detailed survey instruments, assessment results, and participant comments.

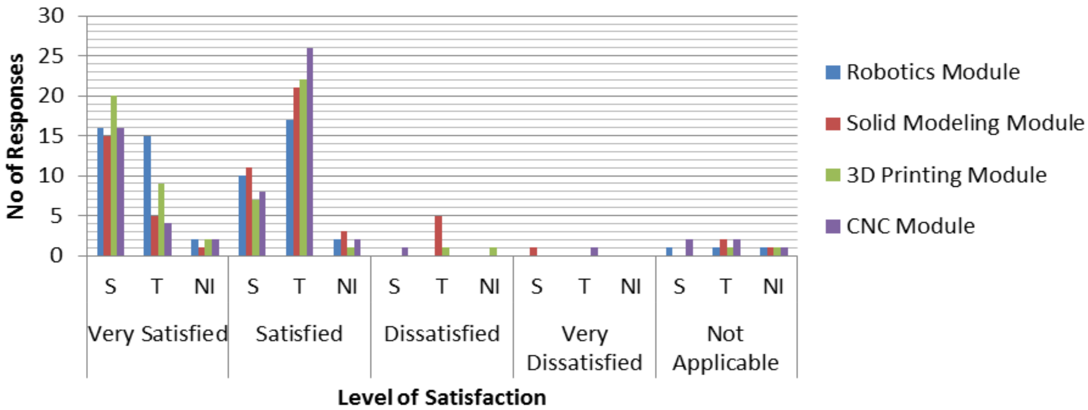

Figure 3. Overall satisfaction with different modules for Students (S), Teachers (T), and those who did not identify themselves (NI).

Conclusions and Next Steps

AMIA participants were exposed to a large number of concepts in mechanics, electronics, controls, programming, 3D modeling, 3D printing, and computer aided machining. The structure of the AMIA as implemented in year 2015 worked well and hence the same structure is planned for year 2016. Based on the feedback received from the participants, the 3D modeling module will be broken down into smaller and simple modules. Also for the 3D modeling module, the students and the teachers will be grouped separately due to their disparate learning pace.

The goal of this academy was to create an effective education-to-workforce pipeline in the area of advanced manufacturing for the community students. This approach and the educational model were successfully implemented.

Acknowledgement

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