Lessons Learned: Outreach Efforts in Building Science Education

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ABSTRACT

This paper analyzes the effectiveness of a community outreach program that aimed to improve young people's skills and job prospects in energy and environmental conservation in Western Massachusetts. The program included young people between 16 and 20 years old enrolled in GED preparation at YouthBuild-Holyoke and vocational students from Putnam Technical High School, many of whom were predominantly low-income, minority, at-risk youth. Graduate students taught the energy efficiency workshops that were designed to give young people valuable job skills for the green building industry. The focus of each workshop was on teaching principles of energy efficiency, durability, and health effects in the residential sector, as well as providing field training in energy auditing and weatherization. A main challenge of the workshops was the lack of integration into an existing building science curriculum, though there were measurable positive outcomes that resulted from the outreach effort. This paper analyzes how well the program addressed student goals and objectives, and suggests lessons on how to successfully prepare young people entering the green building workforce by exposing them to a variety of professions, teaching beneficial professional and technical skills, and providing job placement opportunities.

Introduction

In the past decade the green technologies and energy efficiency industry has grown considerably and will continue to do so with new energy efficiency and conservation legislation being introduced each year. Since the American Recovery and Reinvestment Act (ARRA) of 2009, more than 213,000 jobs have been created employing people in a variety of professions, including jobs in the energy efficiency sector (US 2012). In response to the promise of funding from ARRA, economic analysis from Robert Pollin's Apollo Alliance, and inspiration from Van Jones' The Green Collar Economy (2008), UMass faculty and graduate students proposed and developed training and education materials to provide critical 'green job skills' to young people entering the workforce. The purpose was to create a replicable model for Massachusetts similar to California's Long Term Energy Efficiency Strategic Plan (UC, Berkeley 2011), which has created 1.5 million jobs, increased payrolls by $45 billion, and yielded $56 billion in energy savings since the 1970s (Roland-Holst 2008). By training the upcoming workforce for jobs as energy auditors and weatherization specialists, the goal was to capitalize on the need to rehabilitate and renovate Massachusetts' aging building stock by offering the job skills and knowledge to youth entering the building energy retrofit industry. This paper analyzes the process by which the program was delivered to the students and its overall effectiveness in preparing students towards this goal.

Background and Motivation

The stakes for young people in obtaining and keeping secure employment, particularly those with limited education, are high (Friedman 2000). For those without high school degrees or the equivalent, work experience is extremely important in building a base for future advancement in the work force (Levin 1983). Existing youth job training programs can have a significant impact over the long term (Jekielek, Cochran et al. 2002), but programs need to focus on involving the local community and promoting local economic development (Shuttleworth 1984). However, the ability of many communities across the nation to match training programs with job opportunities remains underdeveloped. This deficiency contributes to the continuing mismatch between the actual training that people need and the jobs available. Furthermore, in order for the skills of American workers to rise in ways that meet labor market demands, an effective workforce development system that is well-coordinated with secondary and postsecondary education programs is needed.

Program Overview

UMass faculty and students designed workshops that were organized as four separate but related modules focusing on various aspects of building science. The modules were intended to be flexible enough to be integrated into both existing classroom conceptual learning as well as hands-on field exercises to prepare students for jobs in the green workforce. The four modules consisted of (1) Introduction to Home Energy Auditing, (2) Field Training, (3) Energy Modeling and Audit Reporting, and (4) Weatherization. Each module was sequenced to build in-depth knowledge of how a building works as a system.

The concept of "the building as a system" was used to underpin and structure the learning objectives, and to introduce students to the many interrelated functions and impacts of a building. The course focused on single-family homes in heating dominated climates. The first module, Introduction to Building Energy, focused on basic building science concepts, energy efficient features, diagnostic equipment, and safety when working in the field. The second module, Field Training, applied the concepts learned in the classroom to a specific real-world scenario, by introducing students to the process of conducting an energy audit. With the information collected from the field-training project, the third module, Energy Modeling and Audit Reporting, introduced students to building simulation tools, synthesizing data, and creating an audit report. Lastly, the fourth and final module, Weatherization, involved more hands-on fieldwork, providing students with the skills to weatherize a home for improved energy performance.

Overall, the workshop focused on basic concepts learned in the classroom and their application to real-world examples in the field. Consequently, the pedagogical structure followed a project-based model, where lessons were designed to incorporate what students learned in the classroom in actual real-world building science problems. This means that the students were asked to do something with their newly acquired knowledge. Both the first and third modules, which relied more heavily on didactic exercises, were also designed to focus on 'facilitating' student learning by posing questions and/or introducing scenarios rather than classroom style lecturing. In modules two and four, field exercises or projects were designed to guide the learning process, where students were forced to respond physically and intellectually to real building situations designed to get them thinking and acting on the material they were learning.

Building science is both an analytical and hands-on endeavor, with a variety of skillsets ranging from in-field labor personnel to building modelers. The four modules totaled over 100 hours of training preparing youth for a wide variety of jobs in the energy services industry.

Target Audience

The workshops were delivered at two different sites, to two different audiences. The initial workshop was presented to a non-profit education program called YouthBuild-Holyoke, where low-income young people work full-time towards their GEDs while learning building construction-related job skills. YouthBuild-Holyoke was founded to address education, employment, crime prevention, and leadership development among low-income youth in Holyoke, MA. Holyoke is a former industrial mill-town with a substantial minority population—48% of its residents are Latino and the city has the largest percentage-wise population of Puerto Rican population of any city in the US (excluding Puerto Rico proper). The city has a median household income of $30,400, which is 40% lower than the national median income in the USA and 26% of its residents are below the poverty line. Seven male and five female students ranging in age from 16 to 20 years old participated in the workshop. YouthBuild-Holyoke members, in general, have to overcome a number of personal challenges that compromise their ability to succeed in both educational and employment arenas. Specifically, many struggle with substance abuse, come from unstable family lives, are young parents, live in insecure housing situations, and/or have extremely low literacy. Many have grown up in poverty and have parents who received public assistance. Finally, a significant number of participants did not have reliable transportation or childcare, and these logistical barriers prevented many of them from attending program meetings consistently.

The second installment of the workshop was presented at Putnam Vocational Technical High School, in Springfield MA. Five males and three females, who were primarily sophomores and juniors in the Building Systems (heating, ventilation, and air conditioning) or Carpentry programs, enrolled in the workshop. Putnam is a vocational school directed at teaching students technical skills for the labor workforce. Students were selected by their teachers to participate in the workshop based on perceived interest in the subject matter and good behavior. Students at both locations were primarily minority, low-income, at-risk youth and young adults.

Teaching Successes

The most successful method of teaching students in all modules of the workshop was to include a high level of hands-on learning experiences in each lesson. To generate student interest in the workshop and enroll participants, students were invited to a demonstration of a basic home energy audit by a field technician from a local energy services company. The technician explained what he was doing at every stage of the audit, and gave students the opportunity to handle the equipment (blower door, thermographic camera, combustion analyzer, etc) and participate in the set-up and simple diagnostic activities. The audit demonstration took place in an actual house and students observed how to prepare a home for an audit, inspect the building envelope, and use diagnostic equipment such as the blower door and infrared camera to detect areas of air leakage in the home. The demonstration was also intended to gauge student interest in participating in the workshop, and it served to help Putnam instructors and YouthBuild coordinators determine which students should enroll in the program.

Throughout the workshop regardless of module and level of student participation, it was found that when students had the opportunity to watch a live demonstration of using equipment or watch a video explaining a building science concept, the level of retention was greater than a content lecture. For the students at YouthBuild-Holyoke this was their first introduction to building science concepts. While the YouthBuild construction program focuses on important carpentry and safety skills necessary to construct a home, it lacks in building diagnostics and system-based interactions, which arguably would be enhanced by the workshop. Researchers had an opportunity to observe the YouthBuild program before developing the workshop, and this provided valuable insights into how the workshop ought to be structured. The YouthBuild construction program is a hands-on learning experience, where students learn to build by building – starting from furniture design to larger renovation projects in actual homes. Given this precedent, it was clear that visual and tactile aids to ground building science concepts would be the most effective teaching tools for the students. As such, the workshop teachers incorporated as much hands-on and experiential learning as possible. Similarly, students at Putnam were also enrolled in hands-on technical learning in the HVAC or Carpentry programs, and the workshop was similarly structured to make the participants active rather than passive learners.

Other successful teaching efforts included professional role-playing and building science trivia games. Many of the students were at the stage of entering the workforce within the next six months to a year of completing this course. Learning how to conduct him/herself in a professional manner is a beneficial skill for each student. Role-playing in the classroom was not as effective as when the students conducted an audit in the field. In the classroom, students tended to not take the exercises as seriously, possibly because they were unable to stay 'in character' with their friends and classmates. However, when the students were instructed to conduct themselves in a professional manner conducting a field audit in a client's home, the students exhibited exceptional professional rapport.

Another method used to gauge how much the students were retaining was to frequently structure lessons around trivia games. This was an extremely effective tool in getting the students out of their chairs, working in teams, and keeping their attention in a classroom setting. The first module was designed to spend 20 hours in the classroom building base knowledge of building science to use when in the field. With this demographic of students more creative approaches to teaching and retaining that knowledge were taken and proved most effective.

Outcomes

According to the Massachusetts Department of Elementary and Secondary Education, each vocational school must have a general advisory committee that helps to inform the school's staff on skills most marketable in the current workforce (DOE 2010). In addition, it also requires vocational schools to partner with public institutions of higher education to promote technical teachings and mentorship programs. These partnerships are designed to encourage students to pursue further education or form lasting relationships with professionals in their technical specialty upon graduation (Fraser 2008). A high school diploma is in many instances the minimum prerequisite for employment or post-secondary education. On average, vocational schools in Massachusetts must have a 70% job placement rate for their students upon graduation within their local community (DOE 2010). This is achieved by integrating such programs as the Building Diagnostics modules designed by University of Massachusetts faculty and students along with matching students with mentors in their field of technical study. In 2009 Putnam

Vocational High School had a 70.5% graduation rate (Putnam 2011), 10.9% points lower than the state average of 81.4% (DOE 2011). Thus, it was important that a program successfully prepare students for the real world, with skills appropriate for today's green job trends. Students who successfully completed module one of the building diagnostics course are considered to have a higher level of understanding of the building as a system. This gives them a competitive advantage over other students within their area of technical study that did not participate in the program. As a result, these students pose more marketable jobs skills during an economic time when the unemployment rate is at remarkable historic highs.

YouthBuild-Holyoke had similar positive outcomes for students who completed the workshop. Of the twelve students who joined the program, however, only three were able to complete all four modules. For the three who 'graduated' from the workshop, job opportunities were more readily available. Furthermore, because of the low instructor to student ratio (1:3), the students and the instructor were able to build a stronger rapport among each other. They were also willing to donate additional time and effort to learn the material and requested even more hands-on training. Through UMass faculty connections with Western Massachusetts' energy service providers, the three graduating students were placed in entry-level insulation and weatherization technician jobs in their local communities. The students who did not finish the workshop 'dropped out' for a variety of reasons. The predominant reason given was lack of time. The workshop presented an additional burden by requiring the students to voluntarily commit 100 hours of their personal time to learn about building science. This was not something that every student was willing or able to do, due to family circumstances, other job responsibilities, transportation and childcare challenges, and disinterest in spending additional time in pursuit of a career they did not see in their future. Given this rationale, it seems likely that if the workshop were integrated into the GED courses and carpentry workshops that are integral to the YouthBuild experience, the drop-out rate would have been lower. Given the very low number of graduating students, it is also possible that successful outcomes (such as satisfaction with workshop and job placement) were a result of the individualized attention received, which helped to foster greater commitment and engagement in the subject matter.

Lessons Learned

Several lessons were learned over the course of the workshop. These include (1) the importance of integration into an existing building curriculum; (2) tailoring course content and teaching methods to student abilities and interests; and (3) the need to coordinate goals and teaching objectives between workshop instructors and YouthBuild and Putnam supervisors. While both the YouthBuild and Putnam programs provide students with technical skills in the construction industry, they typically specialize in one subject matter such as HVAC, electrical, or carpentry and do not focus on the other interrelated parts of a building. This proved to be a challenge to the workshop framework of 'the building as a system', because the students who had a great understanding of individual structural, mechanical, electrical, or plumbing systems of the building were not always able to connect the importance of all the systems working together. In many instances the students struggled with some of the concepts because of the singular subject matter focus of the standard curriculum. It is likely that if the modules of the workshop were more fully integrated into standard year or semester long curricula, the outcomes would have been more favorable for continued success. The modules were originally designed to be separate, but related and build off of the previous to give the students an entire package of skills

in building diagnostics. If more planning had occurred before the start of the academic year to incorporate the modules into the learning objectives set by the course instructors, the students may have developed a better understanding of the interactions that characterize building performance and their significance. Staff at both YouthBuild and Putnam saw great benefit in the workshop, but no one had anticipated the importance of including it into the entire year curriculum.

The second lesson learned from the workshop was about understanding our audience and their capabilities. Much of the original course content for the workshop had to be revised because it proved to be too advanced for the students. This presented a challenge when attempting to move from one subject matter to the next. When the workshop was designed, it was assumed that the students would have basic math skills and some idea of how a building functions. But for many of the students, the mathematical concepts, particularly geometry and ratios, were too difficult to grasp in a one or two hour class period. At Putnam the students were given a short math skills assessment during the second day of class. This was beneficial because the course content was modified to accommodate teaching the students the math skills they needed in order to fully understand the material. This was not a strategy used at YouthBuild, and presented a learning barrier at the start of the workshop that was not a good precedent for maintaining enthusiasm among the students.

Another challenge was the student's lack of commitment to doing any work outside of the classroom. Several readings and short homework assignments were integrated in the design of the program. In both programs the students rarely did any of the readings or completed the homework outside of class hours. In any add-on teaching situation, i.e. among students who are taking a course that goes beyond their required curriculum, it is best to keep all lessons and activities to the time the students spend with the instructor.

Finally, in addition to course content, integrating more hands-on and visual activities would likely have generated a deeper and more thorough understanding, including building mock-ups of roof and wall assemblies, insulation types, air sealing methods, and building leakage simulations. Incorporating these types of visual aids would have allowed the students to truly see (and take apart) some basic building features, which would have helped them to retain the concepts being taught.

Summary

On the whole, the workshop taught at Putnam Vocational High School and YouthBuild-Holyoke benefited the students and faculty by teaching skills and knowledge needed in the green jobs industry. There were many lessons learned throughout the process of designing and implementing the course that will influence the next version of the workshop or perhaps similar workshops undertaken by other institutions and organizations. Indeed, much of what was learned through this process was shared with local partners in the green building industry. Our primary collaborators, who helped with the design and delivery of the weatherization component of the workshop, the Center for Eco-Technology, received a copy of the preliminary analysis, in order to improve their own outreach and education efforts.

The three primary lessons learned were: (1) integration into an existing building curriculum is essential; (2) course content and teaching methods need to be tailored to student abilities and interests; and (3) the need to coordinate goals and teaching objectives between workshop instructors and school staff. The most positive outcomes of the experience involved

teaching skills the students will benefit from when entering the work force, exposing them to a variety of professions they may not have been qualified for before taking this course, and job placement opportunities for those who completed the workshop. While the workshop was seen as a success, there are improvements to be made to make it a stronger course for students and institutions such as Putnam and YouthBuild-Holyoke to utilize in the future.

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