2014

Dissemination of Microprocessor Courses Through Classroom and Interactive Cyber-Enabled Technologies

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Original Publication Citation

Hsiung, S. C., Ritz, J. M., Yaprak, E., Stout, T. B., & Jones, R. L. (2014). *Dissemination of microprocessor courses through classroom and interactive cyber-enabled technologies.* Paper presented at the ASEE Annual Conference and Exposition, Indianapolis, Indiana.

Dissemination of Microprocessor Courses through Classroom and Interactive Cyber-Enabled Technologies

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Richard Jones is a senior lecturer in the Old Dominion University Electrical Engineering Technology Department. In addition to his experience with PIC and Microprocessor/controller hardware, he has experience in development of synchronous On-Line Electronics Labs, Digital and Linear System design, and submarine strategic ballistic missile and tactical weapons and sonar systems.

Dissemination of Microprocessor Courses through Classroom and Interactive Cyber-Enabled Technologies

Introduction

This report covers a research effort that is aimed to train 120 teachers to instruct courses using microcontroller technologies and related hands-on laboratory experimentation using distance learning methods. This is the second phase of an NSF funded grant. It is a joint venture with Old Dominion University, Wayne State University, Blue Ridge Community College (VA), and Tidewater Community College (VA).

During the first year of the 3-year project, researchers refined the design of a laboratory training system and further refined and developed course curriculum modules and laboratory modules to teach microcontroller concepts. During the second year 60 faculty throughout the U.S. were taught microcontroller/embedded system concepts and exercised hands-on laboratory experiment activities using distance learning technologies. Feedback has been favorable. During year three an additional group of faculty will be taught these concepts and an academic community with common interest of embedded system design will be built, bringing the total faculty trained to 120.

Goals of the Project

To accomplish this statement of work, there are four guiding goals that include:

1. Create a teaching platform with supporting instructional and hands-on laboratory modules to teach microcontroller concepts and activities.
2. Design an instructional system to deliver professional development training using active distance learning technologies.
3. Enhance the knowledge and skills of 120 faculty throughout the U.S. for teaching microcontroller/embedded system design technologies.
4. Establish an academic community seeking to improve instruction of embedded system designs.

Year 1 - The Preparations

The Training System

The training system was originally designed and developed in the first phase of the NSF funded project in proofing the concept of the distance delivery of hands-on teaching and learning. This training is further refined with many add-on features based on the lessons and suggestions learned from the previous project. Photo 1 demonstrates the PIC training system designed and used in this project. The following are a list of the training system functions that are used as a common training platform in the distance training.

1. All the parts are off-the-shelf and are available through general venders.
2. Useable with Microchip devices: PICKit2, PICKit3, NXP/Philips: 32 bit LPC1114FN28 ARM0, and Arduino programming, simulation, and debugging.
3. Available Open VPP, DATA, & CLK Programming Interface for Universal Programming on any PIC Microcontroller.
4. Available +-5V, +-12V, +3.3V source voltages, digital and analog I/O's, LCD and LED displays, RS232 and USB communications, 2.4GHz wireless module, and High and Low power isolation for digital/analog controls and motor drives.
5. Available Op-Amp, EEPROM, and DAC operations.

6. Available SPI bus communication and interface.
7. Available GS encoder (EVEGA2).
8. Available isolated power FET/IRF530*8 for stepper and DC motor controls.
9. Available 2.2”*6.5” breadboard for additional interface.
10. Available header socket and molded jumper wire for easy interfacing.

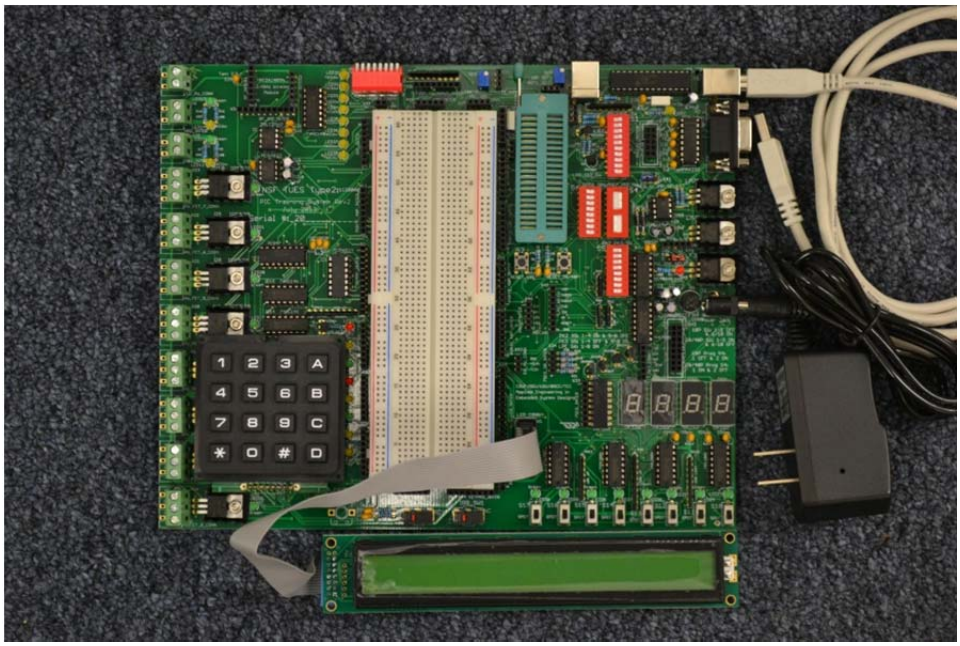

Photo1. PIC Training System

Plan of Project Implementations

The plan for this project has been designed to achieve these goals through multiple project components that will contribute to the development of exemplary undergraduate STEM education. These include:

1. Use workshop attendee, student, advisory committee, and external evaluator input to enhance the current PIC training system through improved hardware and software designs that are capable of fulfilling ECE and EET curriculum requirements.
2. Use open-source software to design and develop a web-based server to assist with video conferencing and course management for cyber-enabled learning via the PIC training system.
3. Develop audio and video demonstrations, step-by-step guides on hardware and software designs, deliverable forms of instruction for iPod/iPad/flash drives, Google, Skype, Facebook, and YouTube internet technologies.
4. Add six additional advanced course modules to meet engineering and engineering technology course objectives.
5. Develop instructional materials to assist in the effective delivery of the microcontroller/ microprocessor training to faculty.
6. Provide distance learning training to 120 faculty (university, community college, and 5 reserved seats/workshop for high schools; 30% of the seats will be given to underrepresented groups) in the content and equipment to teach microcontroller/microprocessor technologies and project applications.

7. Perform assessments on the effectiveness of the dissemination and transformation of the training system, instructional materials, distance learning tools, and student learning achievement.

Expected Outcomes

To prepare college faculty and high school teachers to become better prepared to teach courses in embedded microcontroller technologies and STEM related fields. Transform the active real-time distance teaching and learning material, experience, and tools to other interested teachers across the states.

Contributions within Discipline

This project design and development provides an alternative teaching and learning platform for both face-to-face and distance education in engineering and engineering technology fields that can be a cost effective way to implement embedded system related courses. Through the workshop implementation and server support, it paves an easier path toward collaboration in teaching, learning, and project development among academic communities to share experience and expertise that will benefit tremendously to students learning in STEM related fields. This platform design and development will not be limited to electrical engineering fields. The other disciplines will be able to use the same model and PIC training platform to attract a new generation to join the professional STEM fields of learning.

Contributions to Resources for Research and Education

There are advanced projects implemented on this PIC Training System that are also presented in the 2012 ODU training and 2013 distance training workshops. These advance implementations and designs take advantage of the platform's available resources and are able to enable advanced designs that usually take a long time to build. The projects also demonstrated that the advance designs can be built on the base of previous design works, thus eliminating redundant processes and enabling the capability of meeting more advanced objectives.

IRB Approval

To collect data to address the goals established for this project from workshop participants, a second IRB application was developed. Because this project is federally funded, university requirements were to seek research approval from the Old Dominion University Human Subjects Review Board. An application was developed and full approval was gained to collect pre-test, post-test, and opinions of workshop participants.

Conference Workshops

During this project year 2 workshops were advertised and offered at the professional association meeting of ATMAE (The Association of Technology management and Applied Engineering) on November 15, 2012 and ITEEA (International Technology and Engineering Educators Association) on March 9, 2013. These were three-hour training sessions and each participant was given a complete training system. A total of 28 technology and engineering professionals attended these workshops. Overall the opinions of the participants were positive toward the training system and many sought further education in microcontroller technologies and wished to learn more to explore using distance learning techniques to deliver the content.

Year 2 - Instructional Support System and Initial Training

Instrument Design and Assessment Tools

Three instruments were designed for data collection to measure the effectiveness of the training system and workshops provided by the faculty for the second and third years of this project. These included (1) pre-test on the knowledge designed into the microcontroller technology training system and post-test to measure learning gains of workshop participants, (2) a survey to assess participants' attitudes toward learning using the microcontroller training system and cyber-enabled training system, and (3) interviews of a selected group of workshop attendees implemented by independent consultants as a follow-up study to determine if teachers have implemented the teaching of embedded technologies in their classes and assess the effectiveness of this learning system in teaching key concepts.

The pre- and post-tests were based upon the goals established for each module of the training system. These tests are to determine the amount of new knowledge gained with trained teachers and students. In addition an attitudinal assessment instrument was designed to measure participant's attitudes toward learning from the microcontroller training system and their attitudes to learning in a distance learning environment. This survey is to measure if the participating workshop teachers learned the new technologies and if distance delivery was successful. Interviews were conducted by an independent consultant team of 3 members on a group of selected workshop attendees to further assess the effectiveness of the workshop implementations.

Distance Workshop Advertisement

The summer faculty training workshops are the major components of years 2 and 3 of this project. An invitation letter was developed and was posted on ASEE, EDT, ATMAE, ITEEA, and TeachingTechnicial.org list-serves, plus it was emailed to each state department of education technology and engineering education supervisor for distribution within their states. The list-serves included EDT, ATMAE, ITEEA, and International Technology and Engineering Educators Association Idea Garden. From this advertising, 180 participant applications were received to the training workshop spaces.

Three, three-day (eight hours/day), workshops using the same outline and content were held during summer 2013. These included a Western Region Workshop scheduled on June 6-8 and hosted by California State University-Fresno, Eastern Region Workshop scheduled on June 17-19 and hosted by Old Dominion University, and a Mid-Western Region Workshop scheduled on July 10-12 and hosted by Wayne State University. A summary of applicants by region included:

Western Region – 43 applicants
Eastern Region – 71 applicants
Mid-Western Region – 67 applicants

Distance Workshop Participant Selection

After the 180 applications were received, they were coded by the Co-PI in charge of data collection and analyses. The applications were coded by region, male/female, ethnicity, level of teaching (high school, community college, and university), experience in working with microcontrollers and programming languages, and economic disparity of the region where the applicant teaches. Ensuring representation to meet the grant proposal requirements, 22 participants were selected for each region. Tables 1 - 3 show the Western region, Table 4 - 6

cover the Eastern region, and Tables 7 - 9 demonstrate the Mid-Western region of the demographics of participants who attended the cyber delivered workshops.

Applicants (N=43)	High School	Community College	University	Totals
Totals	9	10	24	43
Male	6	10	23	33
Female	3	-	1	3
White	4	7	9	17
Black	-	-	-	0
Hispanic	-	-	-	0
Asian/Pacific Is.	1	2	10	12
American Ind.	5	1	4	8
No Report	1	-	3	4

Table 1. Western Region Workshop Applicants at California State University-Fresno

	Totals	Female	White	Black	Hispanic	Asian /PI	Am. Ind.	No Wish	Unemployed Region
High School	5	2	4	-	-	-	1	-	3
Community College	5	-	2	-	-	2	1	-	2
University	12	-	5	-	-	4	2	1	6
Totals	22	2	11	0	0	6	4	1	11

* No Wish means the individual does not want to reveal his/her ethnicity background.

Table 2. Western Region Workshop Selections at California State University-Fresno

	Totals	Female	White	Black	Hispanic	Asian /PI	Am. Ind.	No Wish	Unemployed Region
High School	2	1	1	0	0	0	1	0	2
Community College	4	0	3	0	0	1	0	0	2
University	12	2	5	0	0	5	2	1	6
Totals	18	3	9	0	0	6	3	1	10

* No Wish means the individual does not want to reveal his/her ethnicity background.

Table 3. Western Region Workshop Attendees at California State University-Fresno on 6/6-8/13

Applicants (N=69)	High School	Community College	University	Totals
Totals	26	18	27	71
Male	20	15	23	58
Female	5	2	4	11
White	17	14	11	42
Black	3	-	3	6
Hispanic	1	1	2	4
Asian/Pacific Is.	2	2	7	11
American Ind.	2	-	4	6
No Report	-	-	-	0

Table 4. Eastern Region Workshop Applicants at Old Dominion University

	Totals	Female	White	Black	Hispanic	Asian/ PI	Am. Ind.	No Wish	Unemployed Region
High School	5	2	2	2	0	0	1	0	3
Community College	9	2	6	1	1	1	0	0	4
University	8	1	4	0	0	3	0	0	4
Totals	22	5	12	3	1	4	1	0	11

* No Wish means the individual does not want to reveal his/her ethnicity background.

Table 5. Eastern Region Workshop Selections at Old Dominion University

	Totals	Female	White	Black	Hispanic	Asian /PI	Am. Ind.	No Wish	Unemployed Region
High School	4	2	2	2	0	0	0	0	3
Community College	10	2	6	1	1	0	0	0	4
University	7	1	4	0	0	4	0	0	4
Totals	21	5	12	3	1	4	0	0	11

* No Wish means the individual does not want to reveal his/her ethnicity background.

Table 6. Eastern Region Workshop Attendees at Old Dominion University on 6/17-19/13

Applicants (N=67)	High School	Community College	University	Totals
Totals	20	12	35	67
Male	18	10	30	58
Female	2	2	5	9
White	12	8	17	37
Black	3	1	2	6
Hispanic	-	-	2	2
Asian/Pacific Is.	1	-	9	10
American Ind.	4	3	2	9
No Report	1	-	3	4

Table 7. Mid-Western Region Workshop Applicants at Wayne State University

	Totals	Female	White	Black	Hispanic	Asian /PI	Am. Ind.	No Wish	Unemployed Region
High School	3	1	1	1	0	0	0	1	1
Community College	5	0	4	0	0	0	2	0	4
University	14	3	6	1	2	3	1	0	6
Totals	22	4	10	2	2	3	3	1	11

* No Wish means the individual does not want to reveal his/her ethnicity background.

Table 8. Mid-Western Region Workshop Selections at Wayne State University

	Totals	Female	White	Black	Hispanic	Asian /PI	Am. Ind.	No Wish	Unemployed Region
High School	2	0	1	1	0	0	0	1	1
Community College	5	0	3	0	0	0	2	0	4
University	14	3	6	1	2	3	1	0	6
Totals	21	3	10	2	2	3	3	1	11

* No Wish means the individual does not want to reveal his/her ethnicity background.

Table 9. Mid-Western Region Workshop Attendees at Wayne State University on 7/10-12/13

Year 3 - Training and Community Development

Academic Community

Based on the feedbacks and initial assessments of the first summer distance workshop deliveries in three different regions, there is strong desire in need of exchange ideas of the new embedded system technologies. An academic community building is in progress with this project to bring academic faculty and teachers into a common ground to improve teaching and learning, where the resource sharing, project collaboration and new technologies for faculty development can be learned via distance assistance. A broader picture and full analysis of these academic community development efforts will be available after the second summer workshop assessment data is obtained.

Unexpected Challenges

The planned real-time distance training of the interested teachers is a major part of the project. The acceptance and changing learning habits will be an unexpected factor that affects the trainees' learning outcomes. With the assistance of the common hardware and software platform/trainer, designed course curriculum, step by step guides, audio and video training media, and various distance training tools, it is hoped that this will bridge the gap and reduce the teacher's learning anxieties.

Summary

The project is in the middle stages of the implementation. There seems to be a positive attitude of learning and using of the training system and curriculum package by all project staffs. Microchip, Inc. and microEngineering Labs, Inc. have donated supplies to support the hardware and software development for this project. The next objectives are team training, recruitment of interested trainees/teachers to participate in training for summers 2014, and assess the effectiveness of the implementations with teachers and students. Photo 2 is the project logo that describes all the concepts of this project.

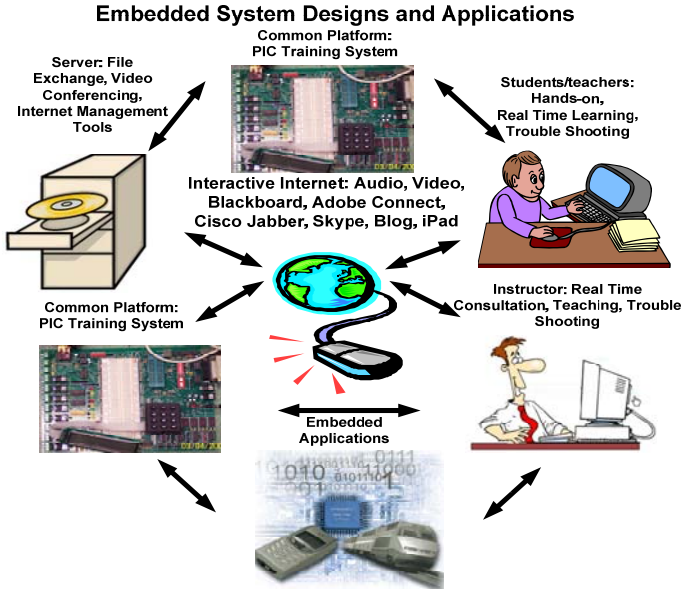

Photo2. Project Concept Logo

Acknowledgement

This Engineering/STEM educational research project is funded by NSF, TUES, Type 2 with the award # of 1120000. This is a group project in the implementation phase 1 that involves researchers from Old Dominion University, Norfolk, Virginia, Blue Ridge Community College, Weyers Cave, Virginia, Tidewater Community College, Chesapeake, Virginia, Wayne State University, Detroit, Michigan, and California State University, Fresno, California.