

Work in Progress: Providing Continuing Education for Teachers in the Dominican Republic Using Online Modules Developed through a First Year Capstone Project

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Introduction

Two professors (from engineering and education) and students from a variety of engineering disciplines (engineering education, mechanical, electrical, and civil) from Ohio Northern University have traveled to the Dominican Republic for the past two years to run workshops involving inexpensive, hands-on engineering projects for teachers in both public and private (sponsored) schools. This effort is a different take on the IEEE Teacher In Service Program (TISP), which is normally designed to train engineers to hold in-service workshops for teachers using lesson plans available from tryengineering.org¹. Due to the limited availability of practicing engineers in the Dominican, the team worked directly with the teachers².

The first trip included running workshops in three different private institutions: Center for Christian Education & Development (CCED) / Lucille Rupp Schools, Elias Piña, and El Cercado³. The following year, a three day workshop was held at one large public high school, Liceo Pedro Henriquez Urena. These workshops included design challenges often found in a first year engineering course, discussions on learning styles, and methods of integrating an engineering mindset into the Dominican curriculum. However, while the workshops did generate significant teacher interest in engineering, the students who devoted one week each summer to develop, run and assist with the workshops were largely required to pay their own way. After the initial enthusiasm of performing such an outreach wore off, it was determined that this model is financially unsustainable. Given the great desire on the part of the Dominican teachers to have access to continuing education, it was determined that methods of bringing content to the teachers through online modules would be investigated, as it has a great potential to make a large impact without incurring considerable expenditures.

Distance Education--Assessing the Scale and Goals

Arger recites the promise of distance education to be "offering mass, quality, cost-efficient education which could affect social change"⁴. While *mass* certainly has different values depending on the implementation, the intent of this project is to appropriately scale the effort. This project is not intended to reach a huge audience such as that of a MOOC (massive open online course). Progressive change needs to be enacted one school at a time, especially in the Dominican, where the country's education system is in a state of flux. In fact, UNESCO and the World Forum, ranked primary education in the Dominican Republic as the worst in the Central American and Caribbean region in 2010^{5,6}. In response, a program entitled the "Effective Schools Program" was implemented to improve the overall quality of the country's education system. An audit in 2013 revealed negligence in supporting this upheaval of the Dominican Republic's schools, including poor monitoring, outdated or missing program documents, and tight lipped schools not reporting success⁶. Furthermore, ten suggestions for improvement were made to ensure the program increased in effectiveness in the coming years.

Quality is another benefit in the "promise" of distance education⁴. Because of the varying quality with distance education, the developers would need to take care when creating the tools.

When considering cost effectiveness, it is difficult to argue against the economics of online modules versus on site modules. If modules (online learning tools) are not developed by an outside company and the schools already have the necessary equipment, the majority of the costs have been dealt with at the practical level.

Arger concludes with the common tag of "affecting social change"⁴. While an admirable goal, it is outside the scope of this project at the current level to usher in new age of Dominican education. Online learning tools have the potential improve the Dominican schools, under the umbrella of the "Effective Schools Program".

Although distance education has both advantages and disadvantages, the instruction through the distance modules is typically intended as exclusive to students. This effort will place the teachers in the learner's role, where they will be introduced to STEM through modules developed by engineering students.

Distance education can be successful on a small scale if the six core elements of the teacher support system are considered (Figure 1). This model is intended for the development of a student support system--adapted for teachers. In this case, paying particular attention to flexibility and differentiating the management of services will be imperative if the modules were implemented elsewhere⁷.

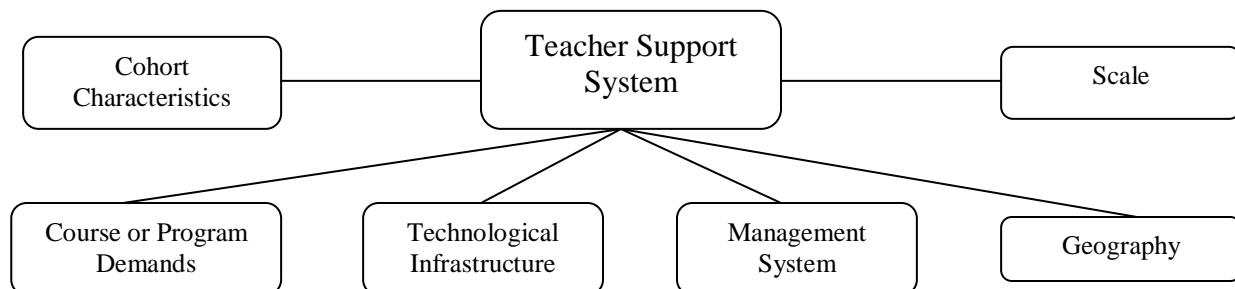


Figure 1: Framework for Teacher Support System Development⁷

While literature to support the effectiveness of student developed educational tools is scarce, the possibility of students as educators should not be ignored. Numerous schools have tutoring programs that are offered by specific departments or social organizations, and these have been shown to be beneficial⁸. In the most general case of students being teachers, educators are encouraged to listen to and learn from their students through a reciprocal relationship of supportive communication. Through this, the teachers are able to adapt to student needs and become more competent educators just by being a more active and accepting listener⁹. This kind of learning does not necessarily include content, but it gives a basis for the accepting nature of teachers learning from students. On the other hand, the fact that online learning tools are designed by students is a mere gimmick if the tool fails to deliver the appropriate content and

intended learning outcomes. The determining factor in the use of distance education in this project is the effectiveness of an online educational tool (a short online course or module) compared to a face to face workshop.

In his work, Zhao cites the differences in learning outcomes in face to face and distance learning¹⁰. This publication reports the findings of a meta-analytical study of research on distance education. When comparing the two methods of instruction, face to face and online, no significant difference appeared under a Random-Effect Model. The only exception was Computer Science, which showed a significant difference ($d = 0.50$, $p < .01$)¹⁰. Other studies have shown similar results other little to no difference in quality when using the same learning objectives^{11,12,13}. In an article by Allen where distance education programs were compared with on campus courses with $N=71,731$, a meta-analysis comparison revealed no significant difference in achievement¹⁴. In fact, distance learners slightly outperformed the traditional students. With this in mind, the quality of the modules are likely to provide the same effectiveness as the face to face workshops.

Teaching the Teachers through Online Modules -- Rationale

After two trips to the Dominican, we have learned that the total cost amounted to approximately \$1300 per student participant, plus an additional \$1200 in materials. While the trips included more service than the workshops, an alternative method of delivery needed to be devised.

Online educational modules (which include a lesson, a web-based educational game application, and assessment) appear to have many benefits when structured in the correct manner. Technological resources at one school in particular, Liceo Pedro Henriquez Urena, could be harnessed to carry out this project. This public school has one computer lab for teachers with internet access and other labs in the building for students. CCED and Liceo Pedro Henriquez Urena have the most developed computer labs (the lab for CCED is shown in Figure 2); other labs, including one for Elias Piña, are being planned by the Northern Engineers Without Boundaries (NEWB) and others. At this time, the planned lab will be similar to CCED, albeit on a smaller scale.



Figure 2: Computer Lab at CCED

For this effort, the following characteristics make this proposal possible and unique:

- *Many Dominican teachers have the necessary resources.* Computer labs already exist in some schools. The reach of the online modules can be expanded in the future as more

schools develop computer labs. There is no need to spend money on developing a place where these modules can be accessed, eliminating the most prevalent cost barrier.

- *Existing course goals at Ohio Northern University match the effort.* Classes at the university already existed with goals similar to the scope of this project. With enough cooperation, two seemingly different classes could work on the modules together. In the case of this project, the two classes are a section of Engineering Projects in Community Service (EPICS) and a Programming 2 class. The instructor of Programming 2 agreed to substitute a project at the end of the semester that had the same focus as the modules: the design of an educational game. The substitute assignment brings a new element of competition and authenticity to the class.
- *Continuing education in the Dominican is desired.* Teachers in the Dominican Republic do not have continuing education requirements like K-12 teachers in the United States. While a workshop with American teachers usually concludes with scattered applause upon completing a task, the Dominican teachers from the workshops had a constant high energy level and were eager to learn. Even the most trivial of activities that may be considered boring to the average American student or teacher was celebrated with cheers. These modules can be a source of content and inspiration well past the duration of the on-site workshops. The intention is to keep the teachers excited and engaged long enough such that they continue to weave more creativity into their lessons long after the first workshop is finished.

Outcomes of the Initial Workshops and Finding the Focus of the Modules

A typical application of online modules is within the context of a flipped classroom, where lectures and interactive lessons are delivered to students outside of the classroom while class time is reserved for collaborative learning and problem solving¹⁵. Instead, the target audience of these modules will be the Dominican teachers. To avoid the common stigma of Americans coming in to demonstrate the "correct" way of teaching, the intent of the modules is to encourage more creative teaching facilitated by STEM activities. Teaching "engineering" directly is difficult in this effort considering not all of the teachers present in the last workshop were math or science teachers (see Table 1). It is advantageous to leave the lessons open ended so that ideas can be taken and applied to the teachers' respective subject area. Further, at the conclusion of the May 2013 workshop, teachers from a wide variety of disciplines discussed how these "engineering" lessons were applicable to their subjects, including art, tourism, and nursing.

Table 1: Teacher Demographics from May 2013 Workshops

Date	5/21/2013	5/22/2013	5/23/2013
Total Teachers	38	43	41
Math Teachers	4	3	1
Science Teachers	2	2	3

Teachers shared their thoughts on how the STEM activities can improve their pedagogy at the end of each day. For example, the website tryengineering.org has one lesson plan titled "Rotational Equilibrium," where students build a 3-tier mobile out of string, washers, and wooden dowel rods¹. The lesson plan calls for students to solve equations using three different

methods: substitution, graphing the equations and finding the intersection, and determinants. For the workshop, the mathematics behind static equilibrium was significantly cut back to make sure that the non-math and non-science teachers could find the lessons relevant to their subjects. Despite significantly “watering down” the content in many instances, some teachers still struggled. Even for a rather Physics-heavy activity like "Rotational Equilibrium," the participants found a unique application to their class, even though the math may not have been understood completely. Table 2 contains the insights teachers had following the activity from post-activity discussion and a post-workshop survey.

Table 2: Teacher Insights from "Rotational Equilibrium" Activity

Subject	Q: "How can this activity apply to your class?"
General	Balancing lessons, covering appropriate amounts of information
Counselor	Stress release, Form of escape
Fashion	Keeping a balance in style, color scheme
Language	Grammar Lessons, keep a sentence balanced (e.g. make sure you have a subject and verb)
Economics	Analyze economical concepts, trade, pay scale
Nursing	Effects of medicine based on height, weight, etc. (finding the right combination of meds)
Bartending	Mixing drinks to keep the right balance of flavor.

While not necessarily a STEM application in each subject, the teachers were able to take something away from the activity. Ideas of STEM can be woven in depending on the confidence of the teacher and relevance to the subject, an idea that deserves further exploration in both the U.S. and the Dominican.

Current and Future Work: Development of Online Modules

In an effort to provide continuing education to the teachers of the Dominican Republic at Liceo Pedro Henriquez Urena, the adoption of online education modules was conceived as a first-year programming project in partnership with EPICS. To clarify what is meant by "module," the term is referring to the complete package: a lesson, a web-based Java educational game, and assessment. The modules will be developed in a three step process between two courses offered at Ohio Northern University: EPICS and Programming 2. The EPICS course previously focused on developing lesson plans for international use; however, its mission is flexible due to the structure of the course. Since 2011, the Programming 2 course has included a culminating project that involved creating a web-based educational game application written in the Java programming language utilizing state educational standards for a selected grade level. The deliverables for this project included the following: problem identification statements, software applications, final written and oral reports, website, and a video that both demonstrated and advertised the application. While this project has been well-received by students and successful in developing grade-appropriate applications, it is hypothesized that the learning experience could be greatly improved if students had a client. Accordingly, with the permission of the Programming 2 instructor, this final project has been modified such that the target audience are now teachers in the Dominican Republic, utilizing educational standards developed by the client-students in the EPICS course.

First Phase--EPICS

The engineering education students enrolled in the Fall 2013 offering of the EPICS course were responsible for developing the framework for the modules. This culminated in a series of lesson plans with topics, learning objectives, content, and resources. An example of such a lesson plan is shown below in Figure 3.

Dominican Modules Lesson Plan	
Topic:	Water Filters and Water Purification
Subject:	Engineering / Enviro. Science
Duration:	30 minutes
Learning Objectives:	
<ol style="list-style-type: none">1) Teachers are informed of the risks of unpurified water (bacteria).2) Teachers understand the workings of a water filter.3) Participants comprehend the difference of materials and order of filtration's effect on water purity. (Amount of Bacteria before versus amount of bacteria after)<ol style="list-style-type: none">a. Able to apply the ENGR Design Process to build a model water filter.	
Main Idea:	
This module will introduce the teacher to the basics of water filtration. The lesson will provide an example of engineering applied in an environmental science / biology setting through the modeling of a water filter.	
Content:	
<ul style="list-style-type: none">• What do we define to be clean water?	

Figure 3: Example Lesson Plan

The draft lesson plan follows a format to cover basic information to be covered in the lesson. In the United States, these would necessarily be tied directly to educational standards (i.e., “Common Core”), but this will not apply due to the lack of concrete educational standards in the Dominican Republic. Therefore, the plan allows for more flexibility in terms of introducing more creative teaching into the classroom without the pressures of conforming to predetermined outcomes. The EPICS course provides the following information in the lesson plan template:

Topic and Subject: A specific topic in STEM and the applicable subject area(s).

Learning Objectives: What will teachers take away from this lesson? While some learning objectives can be bottom line and traditional, the intention is that the most beneficial portion of the lesson is the teacher's inference on its application to the teachers' subject area.

Main Idea: This is the message to the team of freshmen who pick this topic in order to communicate what the EPICS course is envisioning for this module. These are restatements of the learning objectives with subtle suggestions for the interactivity; however, this decision is ultimately made by the students in Programming 2.

Duration: How long will the module take to complete?

Application Content: Each topic is supplemented with appropriate background to introduce the teacher to the subject and allows for an effective transition into the interactive portion of the module.

Assessment Method: In order to give the teacher feedback on their performance, the modules need to incorporate some form of assessment. Not every lesson needs to end with a cumulative exam. This section contains guiding questions directed toward the teacher to encourage him or her to make connections to his or her subject area.

Resources: Anything that the teacher needs to take the lesson into a classroom will be listed here. If there is an activity, those materials need to be given in the lesson plan. Related links to other interesting sites are given in this section.

Interactivity: Each module must include some degree of interactivity, which will be developed by the Programming 2 students. For example, the students could incorporate a simulation of how a water filter operates by allowing teachers to swap parts and see how water purity is affected in the case of "Water Filters and Water Purification." Typically, the activities best suited for simulation are those that are difficult, costly, or dangerous to perform in a classroom (such as an activity involving AC electric circuits).

Second Phase--Programming 2

The term project for the Spring 2014 offering of Programming 2 will be used for the development of web-based Java applications in support of the lesson plans developed by the EPICS students. Each team of two or three students will submit proposals in response to two randomly assigned lesson plans; these proposals will be vetted by the instructor and one proposal per team will be chosen for implementation. The tentative titles of lessons available to the Programming 2 students for the Spring 2014 semester include:

- Water Filters and Water Purification
- Basics of Circuits
- Assembly Lines
- Finding Optimal Bridge Designs
- Physics of a Boat
- Rockets
- Structures—Towers
- Brainstorming

Each team will be given the respective lesson plan for their assigned topic, and it will be their choice as to how to convey at least some portion of the subject matter. Due to the nature of the lesson plans' structure, the teams will have significant creative freedom during the development stage of the application. The Programming 2 students will receive appropriate mentoring from students who were part of the EPICS course and will also be able to meet with the project leader for assistance.

Third Phase--EPICS

Each of the Programming 2 teams will give a presentation to the EPICS students in an attempt to "sell" their web-based Java application and describe its benefits. Once all of the applications are finished and submitted for grading, the EPICS class will meet and critique the Java applications

in the context of its associated module. Not all applications and modules are guaranteed to be used; only modules that satisfy all of the requirements will be considered (as outlined in the assignment).

The method by which the materials are to be disseminated has yet to be determined. A website is likely to contain these materials, which is to be developed by the students in the EPICS course. The university's modern languages department is a likely source for translating the lesson plans; however, this decision has not yet been finalized.

Conclusion

While the online modules geared toward teachers are, at the time of this writing, still under development, it is the intention of the investigators of this project to continue the development and refinement of educational modules for the eager teachers at the schools visited in previous years, all of whom have requested repeat visits and more workshops. Results of the first collection of modules and teacher reactions will be reported in a future publication. It is our hope that, through the joint effort of a one credit elective class that creates international STEM lesson plans and a second semester programming class, online modules can be developed to be cost-effective, interactive, and educational for both the developers and audience.

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