A Case Study on Digital Era Engineering Education in an Increasingly Integrated Global Environment

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Introduction and Objectives

The overall objective of the proposed educational project is to explore the practical aspects of teaching an online engineering course on "Materials Engineering and Nanotechnology Development for Energy Applications" to:
a. include students from diverse backgrounds beyond one single campus in a single country.
b. offer assigned labs to provide hands-on experiences
c. develop a short project from conception, through design and fabrication to testing.

This will be an attempt to develop an 8-week short online course with rigorous engineering syllabus, lab components emphasizing students' hands-on experiences, and most importantly, team projects involve students from different disciplines and different geographical locations.

We plan to first offer this course online to students at both Rice (Houston, TX) and Tsinghua (Beijing, China) campuses as an experimental test bed for possible future offering to a broader online audience.

Developmental History of Innovation

As an engineering educator, one has to give some serious thoughts on what Massive Open Online Courses (MOOC) mean to teach engineering subjects which are generally thought to be more practical where hands-on experiences and personal interactions are highly valued. Equally important, Because of the rapidly growing interdependence of regional priorities and the overall globalization trend in engineering education, our teaching practice should prepare our students to face challenges not only at the national level but also from a global perspective.

During the past decade, the increasing influences of internet and globalization on our students are very noticeable. The new generation of students is also more aware of what other students in other parts of the world with similar background are doing and is more willing and eager to have some experiences working with their international counterparts. This is very evident when the PI initiated a collaborative research project based undergraduate course with professors and students in the School of Materials Science and Engineering at Tsinghua University in Beijing two years ago, we received enthusiastic responses from the students in both schools. Based on these experiences, it seems to be a timely exploration to develop such a short online course emphasizing the critical engineering aspects of hands-on and team-work.

Learning Activities and Materials

Part of the teaching materials have already been developed in an advanced nanomaterials course that the PI taught for 4 times at Rice and also from the research project based Rice-Tsinghua summer course. The strong Rice-Tsinghua interactions over the past 4 years (See below) will significantly help the development of the proposed course.

We will accomplish the purposes outlined by implementing an online platform with lecture videos and slides accessible to students across the Pacific Ocean not only at the set lecture time but at any time as needed. Online "office hours" and "discussion time" will be scheduled by using "chat room" type of software to improve the interactions between the instructor and the students, and also among the students.

The course project will emphasize teamwork and the use of basic engineering skills and principles to produce an integrated engineering system (energy conversion plus energy storage) of any kind for a specific application.

Execution

Based on the course plan, the instructor/PI will pay special attention to the "interactive" part of the course. We will explore a number of available online platform and software to enhance students' experiences. Keep in mind that such course would be eventually open to more general and larger number of students online in the future, how to effectively maintain a "personal" contact with students will be an important area to be investigated in this educational project.

It is planned to have the first two weeks dedicated to lecturing basic knowledge and background for the subject. Starting from the third week, lecture hours will be notably reduced to allow time for instruction sessions on practical aspects of the teaching labs and the project. It is envisioned that both real-time and recorded instructions on labs will be provided, with the real time labs emphasizing more on questions and answers.

Major Issues to Resolve

(What you hope to learn at FOEE)

The difficult task for any online course is how to provide real hands-on experiences through carefully designed labs that is beneficial to student learning. This aspect will be explored in this project by developing some standard lab tool kits with all components readily available at local vendors. It basically means that a trade-off between availability of lab supplies and maintaining the engineering rigor has to be carefully made. One example of such tool kit is a dye-sensitized solar cell (DSC) kit that has been in development in the PI's and the Tsinghua partner's labs for some time.

Another big challenge is the language barrier when offering the course to students in non-English speaking countries. An in-depth grasp of any curriculum can be greatly enhanced by delivering the subject matter in a language which the pupil understands. In this try-out effort, two strategies will be tried for Tsinghua students : a) the lecture notes in English while the actual lectures in Chinese; or b) the lecture notes in Chinese while the actual lectures in English. The feedback from the students will be collected and analyzed to determine the best strategy with the consideration for future expansion of the course to different languages.

Discussion

For the course project, it is obviously not practical for one engineer alone to design anything of such complexity. Hence, engineers usually work in teams. It is hoped that this course would attract engineering students with diverse background and encourage them to work together in a way resembling engineers facing a real challenging problem.

We believe it is important that engineering education to include the team-work aspect: individuals working together in cross-disciplinary teams. We feel this part of development for the course will give our undergraduate students more hands-on and teamwork experience which will serve them well for their future career, no matter which path they decide to take. In addition, it also gives students a rare but valuable opportunity to apply knowledge they learned from various courses in an integrated way.

Although we have experiences on part of the proposed activities, never before have we had the opportunity to integrate them into a bold online course with potential aim for a MOOC course as proposed. It remains to be seen if such attempt will be successful or at least proven to be useful as many of us are trying to understand better the future of engineering education in a digital era facing an increasingly internet proficient generation.

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