MoLE-SI: A New and Effective Paradigm in Computer Platforms in Engineering Education

A Challenge Situation Promoting Innovation: A brief Roadmap to MoLE-SI.

In 2009, TTU was forced to reduce the amount of student access to computer facilities, mainly triggered by class size increases, challenges to upgrade or renew computer lab infrastructures across campus, availability of qualified IT personnel, etc. This situation directly affected every college, but most dramatically the college of engineering (CoE), where research and undergraduate student activities were, and still are heavily dependent on computer resources. The situation provided an excellent challenge and a great opportunity to find an effective solution, something that engineers are well accustomed to do: An innovation-driven paradigm of change was behind the creation of MoLE-SI!

Largely motivated by the factors mentioned above, a team of faculty and staff centered at the Department of Chemical Engineering at Tennessee Technological University (TTU) developed MoLE-SI. MoLE-SI (Mobile Learning Environment System Infrastructure) was conceived, not just as a technological infrastructure, but as its name implies, it is a *mobile learning environment* supported by the pillars of technology (systems infrastructure) and all its components as illustrated below (see Figure 1).

Three main interconnected components, i.e. "parts" form MoLE-SI. One of the components, i.e. "Part A" is provided via the mobile devices that the student opts to use, whether it is a laptop, a smartphone, or a tablet with Wi-Fi capabilities; allowing the seamless integration of new students' habits with technology with the instructional elements of a classroom and/or laboratory. A second component, as illustrated by "Part B" provides the backend computational resources (CPU, memory, storage, etc.) needs for a large student population. Lastly, an additional component is provided via the classroom model, accommodating mobility, interactivity and group activities, efficiently promoting the collaborative nature of learning, as illustrated by "Part C" with the focalized and unstructured instruction models. All three components are interconnected via Wi-Fi, although it can be noted that any Internet enabling technology like 3G/4G or wired internet can be used as well, bringing, in fact, the "computer" 24/7 to all the students wherever they are and whenever they need.

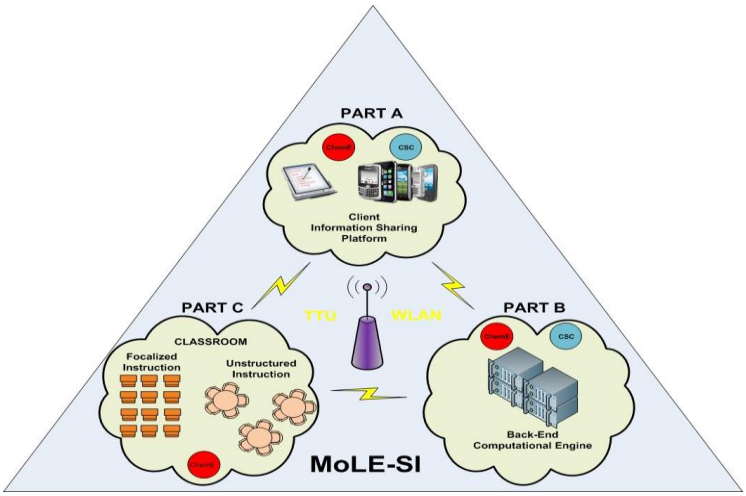

Figure 1. Basic Model of the MoLE-SI Infrastructure

MoLE-SI provides a mobile, dynamic, and collaborative environment for student learning, where engineering software can be accessed on-demand, remotely or from campus provided there is an internet connection. Since its early conception stages, MoLE-SI meant to break out from the conventional separated classroom and computer lab environment, and has shown over the years to impact students' active learning abilities, and provide a hands-on-ready and collaborative environment in line with the National Academy of Engineering (NAE) Vision: The Engineers of 2020.

In MoLE-SI, the computer is always with the student, there are no requirements for student's computer during their entire career, it is for the most part platform independent which gives the student their own ability to choose what O.S. platform suits them best, the performance of the computer is not limited by the local CPU/memory resources of the client device which can vary significantly from user to user, and instead the backend servers provide an equal baseline field of performance for all connecting users. Additionally, MoLE-SI provides a secure and very scalable platform that is transparent to the end user (students/faculty) and minimizes the requirements of physical space while enabling the focus on the instruction and learning process.

MoLE-SI goes beyond BYOD (Bring Your Own Device), although it could be said that both models share several characteristics. MoLE-SI is not pure technology; it incorporates innovative pedagogical approaches inside and outside of the classroom to take full advantage of interaction and collaboration. MoLE-SI also allows seamless interaction between the remote software engines and local instructional or engineering devices such as microcontroller development boards, data acquisition cards, sensors, actuators, and/or running experiments allowing the students to "practically" take the experiments or labs with them.

Why is MoLE-SI Needed?

Technology, and easy access to information has become an intrinsic part of our daily lives, however as ubiquitous as it might be in our social activities, it seems like there is a considerable gap in the use of the latest advances in technologies in engineering schools across the country where many barriers or traditions still hinder an efficient learning process. In fact, while liberal art programs have largely incorporated mobile technology into their curricula, engineering schools remain behind.

Promoted by the availability of new wireless technologies and a variety of mobile computer-based communications devices such as laptops, tablets, netbooks, iPods, and smartphones, among others, the habits and familiarity with technology of Generation-Y students are remarkably different from those of previous generations. Therefore, it makes it possible and appealing for engineering schools to shift from a traditional computer-based instruction, mainly centered on the "fixed computer laboratory," to mobile-based platforms. In addition, fixed computer laboratory rooms are, in general, not ergonomically fit for efficient collaborative learning environments which should be driving the learning experience in engineering education. Therefore, it appears that an educational environment that is centered on the student-based mobile device is economically feasible, pedagogically efficient and effective, and ergonomically attractive. It is a surprise, therefore, that engineering schools have, at large, not been involved in the development of this type of new educational platform.

The classical multimedia classroom still very prevalent today in schools of engineering is equipped with a standard computer, a projector, a screen, and one or two whiteboards, and although they are still useful, these are standards from nearly twenty years ago. Additionally, computer labs, where the student is supposed to apply some of the skills acquired in the classroom, are not ergonomically fitted for the most part to foster collaboration and group activities. Students also tend to forget or miss part of the content needed to successfully get their classwork effectively finished in the lab since there is a physical disconnection between classroom and laboratory. To make matters worse the vast majority of classrooms today in engineering schools are lecture-type classrooms.

The Present and the Future:

MoLE-SI is currently in use in three colleges at TTU, and has been chosen as the platform of choice for CoE and is tightly integrated in the college's strategic plan. Additionally, several rooms and traditional computer laboratories are currently being transformed into MoLE-SI type rooms where video collaboration equipment has been added as a key component.

Preliminary surveys and assessments have shown that MoLE-SI can be a powerful recruitment tool, has shown increased learning potential on the students, more specifically focusing on their critical thinking skills; it has significantly broadened access to computing resources and engineering experiments, fostered innovation, and opened the doors to the adoption of a paperless instructional environment. It also provides an environment where the dynamics of technology and instruction are tightly integrated. Major companies such as VMware and Dell, have started to highlight and showcase the relevance and wide range of applications that MoLE-SI brings to the users in a variety of industry sectors.

Due to its variety of applications, its success, and results, it is expected that MoLE-SI will become the platform of choice of TTU, and it may very well influence other institutions across the nation looking to adapt not only to the changes in technology, but also the changes we need to embrace in education to keep our global competitiveness.