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First-year Redesign: LabVIEW, myRIO, EML, and More

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An Exploration of Students Needs for an App Based Interactive Nanotechnology Education

Abstract

Nanotechnology education is being offered by more and more universities around the world as the field of nanoscience is growing exponentially. It is considered having an effective educational object for new generation of individuals in nanotechnology. This paper explores students' needs on an app based learning for undergraduate nanotechnology education. The objective of the approach is to transform the traditional instructor-driven, lecture-intensive teaching to more engaging student-driven interactive learning based on smart phones. A content analysis and a prototype exploration were conducted with 80 students to identify students 'needs on an app based learning.

Background

The field of nanoscience is growing exponentially and nanotechnology is impacting our daily lives in many ways (Crawford, 2016). The National Science Foundation estimates that the job projection for nanotechnology is around two million workers worldwide (Roco, 2011). With this demand, nanotechnology education is being offered by more and more universities around the world. This implies the importance of the education and training of a new generation of skilled individuals in nanotechnology. In other words, it is necessary to have an effective nanoscience teaching and learning methodology. However, nanotechnology in science and engineering is taught in a traditional manner that is typically based on lecture note slides along with a few multimedia supports such as movie clips and 2D/3D images, and this traditional way of nanoscience education lacks high level of students' engagement. One way to address this challenge is to utilize collaborative learning which can facilitate students' participation and leverage their learning. We explore the needs of an app based interactive nanotechnology learning for undergraduate education. The primary objective is to transform the traditional instructor-driven, lecture-intensive teaching to more engaging student-driven interactive learning. The rationale behind the approach is that, in a nanotechnology class, discussions based on virtual experiments using nano devices help students better understand the principles of nanotechnology.

Methods

A content analysis (Preece et al., 1994) on nanotechnology teaching materials and a usability testing (Nielsen & Mack, 1994) on a low fidelity prototype were conducted. Both studies were to identify the students' need on mobile based nanoscience learning with a goal to facilitate their learning both inside and outside the classroom.

The content analysis was to review what forms of materials are utilized in teaching nanotechnology. Four different teaching materials were collected from existing courses that were taught by faculty in material engineering and nanoscience. The prototype was a graphical mock-up shown in figure 1. The graphical mock-up was to evaluate the feasibility of the app based nanotechnology education. A survey was used after experiencing the graphical mock-up. Any college students majoring in disciplines related to nanotechnology participated in the study.

Figure 1. A Graphical Mock-Up for Nanotechnology Education

Results and Discussions

Content Analysis

Four subjects - The Concept of Nanotechnology, Scaling Law, Devices, and Applications were collected and reviewed in terms of material type. All the four subjects were Power Point presentations. All the slides had images and diagrams. The images were mix of color and black/white images and a few of them were 3D shape visualizations. The diagrams were conceptual drawings, scientific charts and engineering style visualization. Certain subjects in the PPT slides had videos on YouTube.

Prototype Exploration

A total of 80 college students participated in evaluating the prototype. Juniors participated in more than the other college students as shown in Figure 2. About 90% of the participants (72 students out of 80) heard the name, nanotechnology or knew the concept of nanotechnology. They heard about the nanotechnology were TV, Internet and classroom. Mass media was the primary source for them to hear about the terminology. Obviously, classroom was the source where they both heard and learned about nanotechnology.

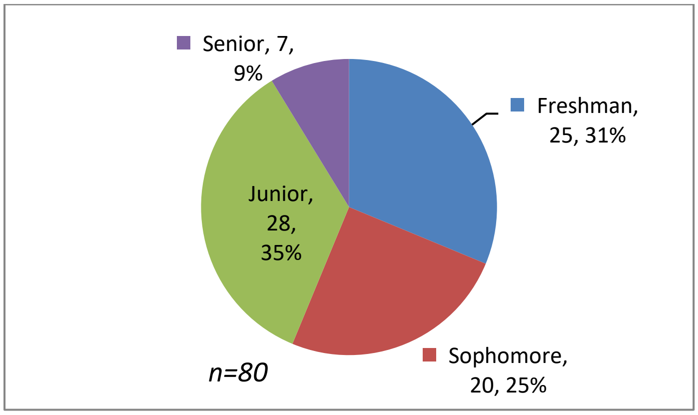

Figure 2. Participants Distribution

We asked the participants a total of four questions in the four areas. It seemed the participants do not have good understanding for the four areas based on the results of Wilcoxon Signed Rank test ($p = 0.128$, $m=3.5$). We wanted to know what factors would hinder their learning about nanotechnology. We asked the participants to list three items that most limit their nanotechnology learning. We invited two independent coders and asked them to do a card sorting as shown in figure 3.

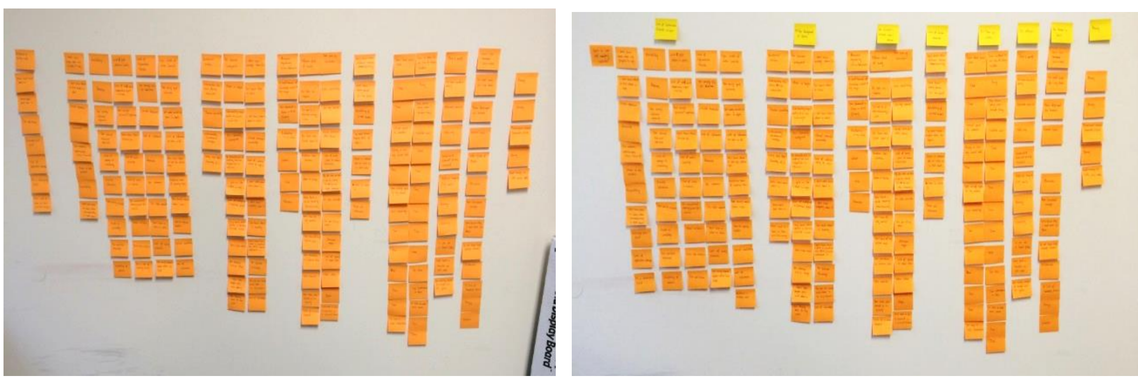
Figure 3. Card Sorting on Participants' Feedback

The card sorting identified eight factors that hinder their learning of nanotechnology - Lack of Informational Resources to Learn, Little Background in Science, No Involvement in the Subject Area, Little Human Network to Obtain the Info, Lack of Time to Learn, Lack of Interest, Subject Difficulty, and Cost.

We wanted to know what study aids they used or they are using. The results were very interesting that 34% (27 out of 80) used certain aid when studying nanotechnology. 15% (12 out of 80) answered they used the Internet when studying. If we exclude Internet search from the answers, only 21% (17 out of 80) utilized study aids for their nanotechnology learning.

We hypothesized that students would like to study nanotechnology as a group rather than an individual. The results showed that there is no significant preference between the two study types ($p=0.128$, $m=3.5$). However, there were interesting feedbacks. The reason for studying together was to help each other on the further understanding of nanotechnology by interacting together. The other reasons were to enjoy the learning by studying together and reinforce each other in learning nanoscience which can be interpreted as to make themselves engage in nanotechnology learning.

The participants seem to like both a web interface based nanotechnology learning (p=0.036, m=6.5) and an app based learning (p=0.02, m=6.5). For a question, which format of learning they prefer between a web interface and an app based learning, there is no significant preference between them (p=0.563). We asked the participants about the concept of an app based nanotechnology learning using the mock-up. It seemed they think the prototype app is helpful for their nanotechnology learning (p=0.010, m=7.5).

For a question, what features they would like to include in an app based nanotechnology learning, they commented the following potential features: Social, Collaborative UI, Virtual Experiment, Multimedia, Assessment, Accessibility in UI, and Visualization. We asked what they would like to include in the app if they were a part of design team. They would like to include - Nanotechnology examples in the real world, Actual Nano Lab that they can do as hand-on experience, Effective visualizations as diagrams/interactive figures, Tablet as stereo scope, Effective assessment module testing their learning progress periodically, Persuasive module (e.g., Comparison to fiend grades), and Gamification concept rewarding their learning (e.g., scholarship).

Conclusions and Future Works

This paper explored students' needs on an app based learning for undergraduate nanotechnology education. A content analysis and a prototype exploration were conducted with potential users. The study revealed factors that hinder their learning as well as features that they would like to see from an educational app for nanotechnology learning. It is our belief that an app based learning would engage undergraduate students more in nanotechnology learning because it provides accessibility and it will increase their familiarity with nanotechnology learning.

Acknowledgement

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