Abstract
Virtual laboratory experiments were developed for use in a variety of formal and informal science education. It is designed for easy dissemination to a large variety of institutions around the US and abroad. The lab is 3D and fully interactive. We used two HP grants we were awarded, to develop, small-scale, virtual 3D experiments. Based on the laboratory success and to supply the large demand, we have applied and been awarded a grant from NSF to scale-up the lab.

Background
Despite the growing need for engineers in the workforce, there has not been a significant increase in engineering degrees awarded. In fact, foreign-born engineers account for a significant portion of engineering and technology companies established in the US during the last decades. So attracting K-12 students in the US to pursue an engineering career is critical for the nation’s prosperity and security.

Engineering is viewed by many as a very demanding curriculum. Among WMU sophomore engineering students, only about 50% are passing with the required C or better.

In response, we have been developing 3D virtual for elevating the educational experience of students at a variety of educational levels. Our goal is to drastically improve undergraduate student success rate and attract middle- and high-school students to engineering.

Activities
We have been developing a virtual 3D laboratory that aims at moving the student's learning experience from the instructional to the exploratory. The virtual laboratory (VL) is designed to simulate a real hands-on approach. Using computer graphics simulation and natural interaction with virtual 3D objects enable the student to experience the quality presentation of real environment.

We continue to develop modules and use the completed ones for instruction at the university and for recruitment (presentations to K-12).

Audience
Our goal is to reach students at all levels, to facilitate student learning and attract the K-12 students to STEM fields.

The VL enables us to use peer instruction.

Project Development Steps
- Design real lab experiments
- Perform the experiments in the lab (collect data)
- Produce video-tapes of the experiments
- Develop VL lab modules (simulations) using videotapes and data
- Produce a manual for the Virtual Lab
- Train VL instructors
- Assess the Enhancement of Student Learning (and further improve the lab)
- Disseminate to other sites in the US and around the globe

Guiding Principles in Lab Development
1. The student has to be able to conduct the experiment without a need for an instructor.
2. The simulated equipment was designed to give a feeling of the ‘real thing’ while also look attractive.
3. Experimental values were recorded while operating a real machine and incorporated into the simulation.

Impact
- We have been using an intervention group and control group to test the hypothesis: A survey of attitudes toward the VL sessions and perceived learning impacts indicated those students in the VL had a positive experience that reinforced concepts from the course and provided application opportunities.

- The VL modules were introduced to students in middle grade level (~age 12-13), and a survey of attitudes toward the use of VL and career goals indicated positive impacts of the experience.

  - Gained knowledge about engineering from the VL lessons
  - Were able to understand and perform the VL lessons
  - Expressed interest in doing more VL lessons
  - Expressed interest in studying engineering in the future

Groups Reached So Far
- Within our university
- At community colleges (e.g. Muskegon, MI)
- At middle and high schools (currently at a 50 mile radius)
- Wide dissemination of modules to many other institutions nationally and internationally. Examples include: Texas State Technical Center Waco, Texas; Bristol CC, MA; Universidad Nacional de Colombia; Tafresh University, Iran; Riso, Denmark

What’s Next?
- Introducing “safety hazards”, scoring, and game effects.
- Scaffolding” approach. Students move from the pre-designed to self designed experiments.

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