DEMOS WITH POSITIVE IMPACT:

A Project to Connect Mathematics Professors with Effective Teaching Tools

David R. Hill
Mathematics Department
Temple University
Philadelphia, PA
hill@math.temple.edu

Lila F. Roberts
Mathematics and Computer Science Dept.
Georgia Southern University
Statesboro, GA
somatlr@gsvms2.cc.gasou.edu

Introduction

Demos with Positive Impact is a project to connect mathematics professors with effective teaching tools. The project, initiated in 1998 [1], will develop a web-based database of instructional demonstrations for teaching topics across the undergraduate mathematics curriculum. This is a report on the project's progress and an invitation to our colleagues around the world to participate as contributors and end-users of the database.

Background

At most universities, a high percentage of classroom instruction is primarily 'instructor centered' and delivered in a lecture format. There are a number of reasons for this situation. Some faculty members are reluctant to embrace new approaches. Fear of technology, a lack of ideas about where and how to use technology, a lack of desire, and very often, a lack of access to an infrastructure that facilitates new teaching and learning approaches that utilize instructional technologies may fuel this reluctance ([2]-[4]).

Recent reform in undergraduate mathematics education and the development of a variety of technologies has changed the way we teach and has increased the flexibility we have in developing lessons ([5]-[8]). Instructional technologies provide a vehicle for developing meaningful demonstrations that contribute in a positive way to student understanding. This has dramatically enhanced the educational process [5].

In any form of instruction (lecture, software-assisted module, self-study manual, lab investigation, or distance learning) good demonstrations that accompany the ideas and concepts are a requirement. Presenting information that fosters an intuitive understanding of concepts is perhaps the greatest challenge of mathematics instruction [9]. **Demos with Positive Impact**, an on-line database of instructional demos, will meet a critical need for a collection of tried-and-tested public domain resources to be utilized by the instructor for illustrating concepts across the mathematics curriculum.

"Instructor as Facilitator" Approach

Much of the work to date in the area of integrating technology into mathematics instruction has focused on making the classroom more student-centered. As a result,

many projects have produced software-based notebooks, tutorials, or exploratory modules as aids for student learning.

What we have in mind is a vignette incorporated within a lecture, discussion, or presentation that engages the learner on a level beyond that created by the accompanying dialogue of the instructor. In contrast to student activities such as projects or lab activities, these vignettes are to be presented by the instructor.

We emphasize the use of instructional technology for **Demos with Positive Impact** because use of technology encourages 'teacher as facilitator' approaches [10] while providing flexibility for the instructor and for the student through visualization components inherent in technologies.

Project Goals

The main goal of **Demos with Positive Impact** is to develop an extensive database of high quality instructional demonstrations for teaching mathematics and to make this resource readily accessible by undergraduate mathematics instructors. Our plans to achieve this goal include

- making the database web-based,
- collecting tried-and-tested ideas from colleagues and peers,
- evaluating the merit of demos based on informal user feedback and formal peer review,
- disseminating information by way of peer networking as well as print and electronic media advertisement.

The project clearly has four facets: we must GET ideas for demos, PROCESS the demos into a web-friendly format, DISSEMINATE information about the project, and EVALUATE the demos, database design and usefulness.

The database will be beneficial to a large number of mathematics instructors only if we can effectively spread the word about the project. An important mission of this project is to seek out colleagues and peers who are willing to share their successful ideas and demos for adaptation and distribution via the web database. Experienced instructors have private toolboxes of instructional demos, conceptual approaches, or physical gadgets they use to encourage students to tune-in to the mathematics. By tapping this rich, but largely unharvested resource of tried-and-tested ideas, we will utilize the experience of our colleagues to build the demo database.

Quality control of the demos is an important issue. We will put into place a formal peer evaluation process to review and judge the educational merit of each demo. In addition, we will establish an informal evaluation procedure to allow users to critique the demos they use in their classes. Effectiveness of the database design is also an important

consideration. Evaluation of the database will involve an assessment of the appeal of the design of the database and its general educational usefulness.

A Prototype Database

A prototype database has been established at the URL:

http://www2.gasou.edu/facstaff/lroberts/demos.

The database is organized according to various instructional technologies and by content area (Fig. 1). This organization will make the database even more appealing to faculty members who lack experience, time, or confidence to develop technology-enhanced demos. Within this classification scheme, we will include demos from precalculus,

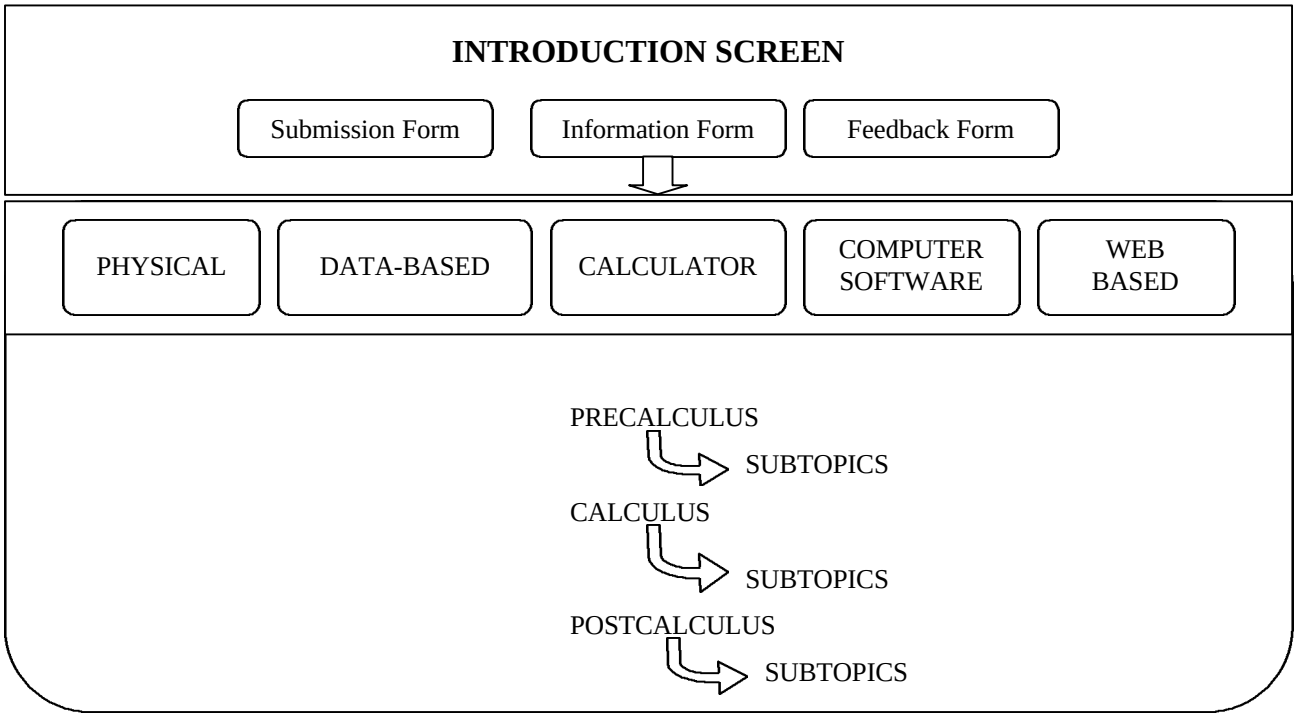

Figure 1. Schematic of Database Map

calculus, and post-calculus areas of the undergraduate mathematics curriculum.

Currently, there are several demos in the database. These include:

- **Colorful Linear Combinations:** This software-based demo is appropriate for linear algebra. It involves generating colors using linear combinations of red ([1,0,0]), green ([0,1,0]), and blue ([0,0,1]). The weights in the linear combinations, restricted to be between 0 and 1, represent the intensities of red, green, and blue, respectively.

- **My Favorite Mug.** This physical demo is appropriate for Calculus in the study of solids of revolution. It involves guessing the volume of 'my favorite mug', estimating the volume using physical measurements, and utilizing Simpson's Rule to obtain a numerical estimate of the volume.
- **Using Sound to 'Illustrate' Mechanical Vibrations.** This is a software-based demo is suitable for a first course in ordinary differential equations during the study of solutions to second order linear differential equations that model mechanical vibrations. The demo utilizes sound capabilities of two different software systems to generate sounds that correspond to solutions of the differential equations that model free, damped, and forced physical systems.
- **Leaky Faucet**. This data-based demo illustrates that a leaky faucet can be modeled using a linear function and that the model can be used to predict how much water is wasted as a result of a leak. This demo is appropriate for courses that involve mathematical modeling of physical phenomena.
- **Circular Functions.** This demo, appropriate for precalculus and trigonometry courses, illustrates how sine and cosine can be defined by wrapping around a circle.
- **What you see…**Many modern textbooks for college algebra employ a graphical approach using graphing calculators. Students are often asked to determine domain and range of functions using a graph. However, in many cases the graphs generated by graphing calculators or software systems do not tell the whole truth. In this demo, students see examples that underscore the need for an analytic analysis of domain, rather than relying strictly on a graphical interpretation.

In the demos, we utilize animated graphics whenever possible to illustrate how a particular demo works. Links are included that enable users to obtain relevant computer codes.

Recently, the National Science Foundation has agreed that an instructional resource of this kind would be an important and exciting contribution in mathematics instruction. NSF has awarded a Course, Curriculum, and Laboratory Improvement grant to the authors to support the establishment of a permanent **Demos with Positive Impact** instructional database on the World Wide Web.

An Invitation

The database will be useful only if it contains a significant number of demos that represent the major concepts in undergraduate mathematics. In order to build a substantial database we must be able to encourage active participation from a large number of our colleagues.

To that end, we invite our colleagues to submit ideas for demos. We do not expect 'web-ready' submissions. Instead, we need to gather ideas that have been tried and that work

in the classroom to teach concepts in mathematics. In addition, we ask for feedback on the site as it develops as well as feedback on the demos that may be downloaded and used in class. We need to know what works and things that need to be changed. Suggestions for greater accessibility and usability are also encouraged.

Summary

Demos with Positive Impact is an exciting project that will provide a valuable instructional resource for mathematics professors at all levels of the undergraduate curriculum. We encourage our colleagues to visit the database, provide feedback, and contribute ideas that can be incorporated into the database.

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