Enriching Teaching with Technology
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Abstract
Here are some general thoughts about the use of technology in the classroom. This is a working draft.

Variety for learning
Learning works best when many different channels are used.

Available Technology

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<th>Lectures in Classes</th>
<th>sometimes with demonstrations</th>
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<td>Reading textbook, handouts</td>
<td>usually done in private</td>
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The use of technology provides many opportunities to enhance a lecture. How it is done depends of course personal preferences and taste.

Pitfalls in using technology
The question, how a teacher should enrich class room experience is difficult. It is easier to list some pitfalls.

I) Technological challenges
Technology should not be used for the sake of using technology. Pitfalls:
- teacher is not comfortable with technology
- cable forgotten, projector compatibility not tested.
- application crashes, machine needs to reboot.
- projector needs adjustments, i.e. picture not sharp.
- overhead projector using slides which are unreadable.

II) Illustrating the obvious.
Enrichment which focus on simplistic concepts only offend the intelligent mind. Examples:
- Applets illustrating the “rate of change” using the tangent.
- Interactive matrix multiplication.
- Animating the Riemann sum.
- Animating a function like traveling wave.

III) Overuse
Too much technology can be like adding too much salt to a well prepared dish.
- A teacher is proud about a specific software program and spends time explaining the inner details of it.
- Online problems which are routine and boring and of the same multiple choice type.
- Students sit behind computers in classrooms. No class-time left to cover essential material.

IV) Too much Complexity
A in class or online demonstration should be memorable, fun and still easy to use.
- Assignments in CAS, which need serious programming from the student.
- Assignments which challenge the CPU of the computer too much and don’t run on older machines.
- Assignments with unnatural problems.
- Assignments requiring too much background knowledge.

V) Big brother
Technology can be used to gauge and monitor the learning progress of students.
- Monitored online homework is as stressful as an exam.
- Computer security is known to be lax at educational institutions.
- Students fear that scores are used for grades and letter of recommendations.

VI) Laziness
Technology can enhance but not replace the direct student-teacher interaction. Pitfalls:
- Using technology to save human resources.
- Automated grading does not reveal key obstacles.
- Series of lectures in power-point format.
- Too much information on overhead.
- Reusing problems for exams.

VII) Lack of time to prepare
Preparing a class using technology needs lots of time.
- Testing equipment and program before class.
- Having alternative in case of failure.
- Embed the module with didactic merit.
- Try out many many things and throw what does not work.

VIII) Outdated/emerging technology
Languages for the web like SVG, VRML, AIML, MathML, Flash are evolving and changing.
- Emerging not yet fully standardized technology does not yet work.
- Older technology is often no more supported.
- Even simple programs need attendance.

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Interactive examples

Interactive Flash Example

The shown example from the center of technology and teacher education is quite useful. It allows the student to experiment a bit get the idea for Rolles theorem. Flash works pretty well on all browsers. Disadvantages are that one needs proprietary software on limited operating systems to develop the code.

Interactive Javascript Example

Simple javascript programming can be quite effective to do simple things. The example allows students to play with Gauss-Jordan elimination.

Interactive Java Example

Java is widely used in educational pages. Unfortunately, certain combinations of browsers and Java versions do not work properly. This example allows students to measure the area of simple regions using the planimeter.

Interactive Virtual Reality Example

Virtual reality allows to explore surfaces and objects by moving around in a virtual world. It is effective for demonstrations in class. There are plug-ins for VRL for most browsers.

Multimedia examples

Presentation software

Presentation software like Power-point or Keynote are suitable for introduction meetings or reviews. Using presentation software for lectures is dangerous because the teacher does no more see the need to develop the thoughts and is in general too fast. One sees this often in conferences.

Quicktime Video

Here is the example of a movie published 1995 by the geometry center. It is originally published in the quicktime. In order that one can see the movie on every platform, one has to place the movie in different formats.

Other Video Formats

The same movie embedded into a flash movie or converted to the avi format. The flash version is a fifth of the size and viewable on any browser. The avi size is of less quality and a 10’th of the original movie.

Slideshow

The web browser is a decent presentation software too. It can be used for example to present an exhibit of graphics.
Interactive Problems

Online Quizzes

Multiple Choice quizzes, which are graded instantaneously are easy to build and maintain, work. Students like them.

Online Homework

Webwork is an internet based method for delivering homework problems over the internet. Students get instant feedback and progress can be monitored. Webwork was developed at the University of Rochester.

Diagnostic Tests

Internet based diagnostic tests are of similar form the above two examples. In this case, students have to do the test supervised.

Online resources

Just a few examples

Connected Curriculum Project

One of the best collection of interactive learning materials is the CCP project. http://www.math.duke.edu/education/ccp/

Mathworld

One of the best collection of online knowledge with sometimes interactive demonstrations is Mathworld.

Mactutor

One of the best collection of articles on Math history and Biography is the Mac Tutor History of Mathematics archive http://turnbull.mcs.st-and.ac.uk/history/.
**Computer algebra systems**

Just three examples. The highest obstacle for a student in all CAS systems is to learn the graphics user interface (GUI), which are often confusingly built, unstable and too complex.

**Mathematica**

Mathematica is one of the best CAS for beginners.

**Matlab**

Matlab has the possibility to build nice interfaces and is strong in linear algebra.

**Maple**

Maple is similar to the above mentioned CAS. It is also widely used at many places.

**Interfaces**

A Chatterbot which knows math and can access CAS systems is in development by a project supported by the Provost at Harvard.