Tablet technology in first year calculus and linear algebra teaching

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Overview

- Handwriting in mathematics teaching
- How did I get involved in tablets?
- (Very) brief history
- Experiences
- Student perception
- Conclusions
One reason we all use blackboards to write down mathematics is the symbols with which mathematics is communicated. Writing the symbols down gives the student a chance to read what has been spoken and thus access the content via several senses.
Loomes et al. (2002)

Students need to learn mathematical explanation
Handwriting in teaching mathematics

- Students part of development process, can contribute, comment, be shown alternate paths, spontaneously change
- More dynamic, flexible
- Can draw additional graphs, pose further problems
- Increases my motivation and engagement
- Passive lecture modes are tiring, tendency to cover material too fast
- Repeat lecture
Situation

- First year Calculus and Linear Algebra
- 320 students
- Three lectures each week, one tutorial, one prac class (Matlab)
- On campus students only
Lecture material

- Lecture material as workbook (PDF or for sale in print)
- Relevant material and blank boxes
- Fill in theorem, proof, part of proof, definition, graph, example during lecture
Lecture material (cont.)

- Intention:
  - Cover material quickly
  - Guide (new) lecturer, provide transparent curriculum, minimize preparation time, standardized way of presentation
  - More time to explain difficult concepts
  - More time to solve interesting examples in detail by writing out steps

- Instructor version: solutions typed
The lecture theatre

- Standard set up:
  - Data projector and OHP until end of S1, 2004
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- **Standard set up:**
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- **S2, 2004:**
  - Either data projector or OHP
  - OHP extremely bright
  - Lost eye contact with students
  - Headache/sore eyes
  - Tried for a couple of lectures

- **Determined to use computer!**

- **Solution:** write on computer!!!
(Very) brief history

- Tablet input device, Wacom (1988)
- Tablet PC (early 1990s)
  - Full version of Windows XP Professional
  - Additional features such as handwriting recognition, Journal software, Sticky Notes
- Used in manufacturing, graphics arts and design
- How about teaching undergraduate mathematics???
Graphics tablet

- Adobe Acrobat Standard
  - Natural conversion from LaTeX to PDF
  - Commenting function allows electronic ink
  - Matlab graphs can be included
  - Saved separate from document, can be edited
  - “printed” to standard format PDF file to allow viewing with Acrobat Reader
- demonstration
Advantages

- Keep electronic record
- Refer back to previous slides
- Can save and post on website
- Can edit later, add notes, fix typos, tidy up
- Combination of prepared material and “live” working, interactive learning atmosphere, flexible
- Can cover material more quickly
Advantages (cont.)

- One medium only, no need to swap
- Easy to use
- Reply to student questions by image or PDF file (email or web forum)
- No need to type in LaTeX, saves time
Disadvantages

- Write blindly on tablet while looking at screen
- Hand-eye coordination required to go back to a particular location on screen
- Student attendance reduced if notes posted on web?
Tablet PC

- More expensive
- More versatile
- Easier to use
- No extra space needed for tablet
Student feedback

- Halfway through semester
- Answers: yes, no, don’t care
- Space for comments
- 65 students participated
Student feedback (cont.)

- Writing in lectures helps my understanding
  - 89% YES

- I prefer if the lecturer writes on the computer
  - 80% YES

- I prefer if lectures are presented with an OHP
  - 85% NO

- I can read what the lecturer is writing
  - 79% YES, 9% DON’T CARE

- I think computer-generated lecture notes on the web site are great
  - 92% YES
Perfect lecture set up. Perfect course for that matter, I’ve really enjoyed this subject, each maths subject should have this setup.
Student comments

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- Keeps me awake in lectures
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- Love the graphics pad! Very useful and modern, 1000x better than OHT
Conclusion

- Students acknowledge importance of hand writing in class
- Students like the graphics tablet
- Students prefer electronic ink to writing on OHPs
- Computer projection easier to see
Conclusion (cont.)

- Tablet is affordable and time-saving teaching tool
- Ease of use
- Lecturer can roam, when explaining concepts
- Notes can be made available on web
- Additional information can be posted
- Explored for on campus teaching – even more important for distance education!
Outlook

- Data for two more semesters
- Leads to conclusion that successful implementation correlates with
  - Lecturer’s level of comfort with unknown technology
  - Technical difficulties encountered
  - Direct comparison with OHP use
  - Further use of the written material
- Other software? Better, cheaper?
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