

Using Mobile Applications for Paperless Assignments in Mathematics: A Pilot Study

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Introduction

Maths writing does not lend itself easily to a traditional computer keyboard (Livingstone et al., 1988), which is the reason why maths software was not successful in meeting the needs of tertiary students. Scanners were not portable enough to carry them everywhere and not many students will have their own. With the development of smart phones and tablet computers since 2010, a significant amount of applications that can scan, handwrite and annotate documents are being developing (Reyna 2010). Digital pens have been around for a long time, but only in the past years we have seen a few that work smoothly (Bradford, 2013). They are adding the ability to smoothly draw on high resolution screens to the repertoire of applications, imitating the paper experience. This creates a new opportunity for tertiary institutions to initiate the paperless submission of assignments in maths courses. At present, there is a research gap on how math courses are using mobile technology in assignment submission. This pilot study will address this gap, investigating academics' and students' perspectives/experiences using a mobile paperless workflow for assignment submission.

Aims of the study

- Design a paperless workflow for a second year maths unit
- Capture students/tutors acceptance toward paperless assignments
- Investigate new ways to redesign assignments that are more 'tablet and stylus friendly'

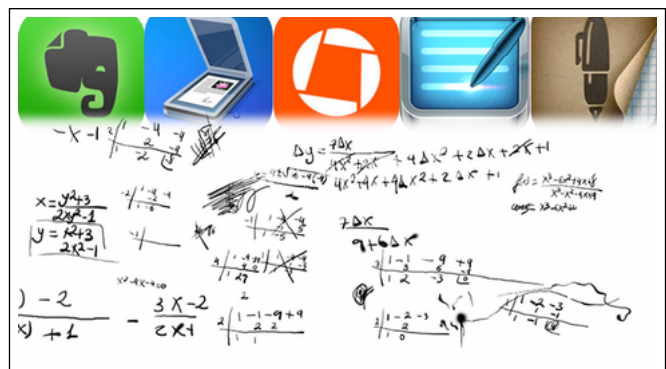
Advantages of paperless assignments

The explosion of student numbers and the changing face of academia have only exacerbated the labor intensive task of assignment management. The general thrust of the literature on these 'new' processes identifies a number of advantages of electronic assignment handling. These were summarised by Price & Petre (1997) and include: (1) more efficient administration and reduction of workload; (2) improved turnaround time; (3) more environmentally friendly (less paper), and; (4) improved accountability, with better assignment tracking and security.

Material and methods

Maths232, Mathematical Techniques is a second year unit at the Faculty of Science at Macquarie University and it has been identified as a potential unit for piloting a mobile paperless workflow. In this unit, the students need to submit 5 assignments (weight=20% of total mark) due on Week 4, 6, 9, 11 and 13 of the semester. Each assignment is 10-15 pages long. The unit size (n=30) and academic familiarity with tablet computers, applications and stylus, made this an ideal unit to test this initiative. We designed a paperless workflow for assignment submission.

Evaluation techniques will be undertaken using students' and tutors' online surveys at the end of the semester. Surveys will use Likert scale type questions and also open ended questions to gauge participants' acceptance, experiences and issues with the paperless workflow.



Results

We had identified 3 sets of applications (<https://drive.google.com/file/d/0B7g5oEgawH61eG9aZDQwTzY1X0E/view>) for students and tutors that would be required to allow paperless workflow in maths: (1) document scanning; (2) handwriting notes; and, (3) marking/annotating applications. Research into suitable applications (free and paid) was undertaken considering 3 platforms: iOS, Android and Windows (Table 1). The findings can be summarised as:

- Document scanner applications need to offer creation of a single PDF from multiple captured images and output small file size.
- Handwriting note applications need to support 'palm rejection' functionality to make the task easier for students and academics.
- Applications that offer dual functionality such as handwriting and marking, handwriting and scanning, etc. have been identified as ideal to recommend to students/academics.
- Tested 4 different stylus (Jot Script Evernote, Maglus, TruGlide Pro and Gecko), all are suitable to write maths (iOS, Android and Win devices) and depends on user preference.
- The Windows platform offers the least amount of suitable applications, but this should not be an issue as uptake from students is low (1-3%).

Table 1: Applications suitable for paperless workflow in maths

Application	Platform			Comments
	iOS	Android	Win	
Document scanner				
TurboScan	\$1.99	\$1.07	No	Multiple page PDF support
Camscanner HD Pro	\$6.49	\$4.99	No	Multiple page PDF support
PDF Document Scanner	No	Free	No	Multiple page PDF support
Scanner Mini	Free	No	No	Multiple page PDF support
Scanny	No	No	\$2.99	Multiple page PDF support
Handwriting notes				
Noteshelf	\$7.49	No	No	Also can mark/annotate PDF's, palm rejection functionality
Penultimate	Free	No	No	Palm rejection fail sometimes
GoodNotes	\$7.49	No	No	Also can mark/annotate PDF's
Lecture Notes	No	\$4.84	No	No palm rejection
Inkredible	Free	Free	No	Works well in both platforms
Note Anytime Lite	No	Free	No	Premium version \$4.71
Handwritten Notes	No	No	Free	No palm rejection
Marking/annotation				
Adobe Reader	Free	Free	Free	Export to DropBox for free
iAnnotate PDF	\$12.99	No	No	Expensive but <u>great</u> functionality
PDF touch	No	No	\$2.99	Supports marking by fingerprint and mouse
GoodNotes	\$7.49	No	No	Supports handwriting as well
Neu Annotate + PDF	\$2.99	No	No	Wide range of editing/annotating features.

Highlights from Academic perspective

- Scanners generated large documents of poor quality (>25MB) that download slowly on iPads.
- Some students scanned pages upside down, which was a real issue to read on the iPad.
- Assignments were lengthy – up to 20 pages in some cases – which is difficult to deal with on a relatively small iPad screen.
- Download and upload from Dropbox to GoodNotes and vice versa took time due to internet connectivity and possibly connectivity between applications.
- The paperless assignment work-flow requires technical know-how to set-up Assignments in Moodle and GoodNotes with Dropbox applications on the iPad.
- Marking assignments on iPads with a stylus took longer than paper-based assignments. Lot of zooming in and out was required, and this caused eye fatigue.

Students' Perspective

- Students did not experience issues using the paperless work-flow and they found the approach to be very flexible.
- They mentioned there was no need to come to University to submit the assignment and they saved time and fuel.

Recommendations

- This paperless assignment workflow could work for smaller cohorts but preferably when they don't have very long hand-written assignments.
- There is a need to put in place a strategy to reduce variability in file size and quality of scanned documents via conventional scanning or mobile applications.
- Develop guidelines for paperless assignments for students to avoid upside down issues, reduce the amount of pages and make the process faster.
- Test large devices such as Samsung Galaxy Pro 12.2 + S Pen for marking assignments.

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