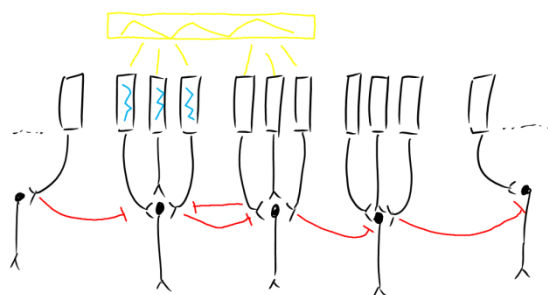


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Case study 2.

Illustrating the problem: digital annotation tools in large classes



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Summary

The use of digital annotation tools (also known as inking tools) by lecturers to build visual explanations in class to promote an increased level of class interactivity and receive real time feedback regarding students' understanding. Specific aspects of this case study include:

- Large scale visualisation: lecturers able to 'think out loud' by building visual explanations on the large lecture screens
- Real-time feedback: changing or adapting the presentation of lecture content as the lecture progresses according to student feedback
- Large group interaction: creating real-time visual stimulus for large classes of students (300+) to comment on, question, interject and interact
- Multiple modes of presentation: providing different means of understanding including drawing, symbols, text and speech

Keywords

Large-class engagement; pen-based technologies; inking; tablet PC; visual learning tools



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What worked?

This case describes two lecturers in the Business and Medicine faculties who have incorporated digital annotation into the delivery of their lectures. The term digital annotation encompasses the use of technological tools such as electronic pens and tablet PC's to visually illustrate aspects of lecture content. The main goal of this use of technology as noted by both lecturers is to be able to visually communicate ideas such as processes and relationships between concepts and equations. The lecturers use a tablet and stylus to sketch, doodle and annotate various aspects of their lecture. These illustrations and diagrams are then projected onto the large lecture theatre screen in 'real time,' with students encouraged to ask questions and offer comments. This enables teachers to interact with students, even in class sizes of over 300 students, and gain real time feedback regarding student's understanding. The annotations are recorded as part of the university's video lecture capture service and are uploaded onto the learning management system, enabling the annotated slides to be accessed by students as and when they require them.

Annotation in the Faculty of Business and Economics

Sarah is a lecturer in the Faculty of Business and Economics. Several years ago, Sarah and her colleagues were given tablets by the head of their department to use for teaching purposes.

Sarah teaches introductory statistics with class sizes that can exceed 400 students. She was searching for a way in which to be able to visually communicate the steps involved in conducting calculations during class that were practical given the large space of the lecture theatre. Sarah has incorporated the tablet into her classes by using it together with a stylus to annotate onto her lecture slides. During class, the tablet is connected to the projector cable and her annotated calculations are then projected onto the lecture theatre screens.

The need to be able to visually clarify the equations has been particularly important in this case given that 80 percent of the students in class are international students with varying levels of English language proficiency.

Language - and everybody here will say that - is a massive issue for us...they'll come to you and say 'I don't understand this' but they can't explain to you what it is that they don't understand. (Sarah)

Sarah is able to surpass the language barrier by providing students with a visual means to engage with and understand the material. Specifically, Sarah annotates the process of developing and solving equations, using formulae and symbols that are non-specific to an English speaking context.

Sarah is able to convey the basic theories and concepts behind the numbers through mathematical notation which therefore reduces the level of English language explanation required.

I think with being a numerical subject they're obviously really quite smart, they got in so they're going to be smart but seeing the numbers it transcends the language, they

understand when you show them the numbers...and show them how the numbers are derived it sort of overcomes that issue. (Sarah)

Sarah has found that annotating on a tablet at certain points in her lectures has proved to be effective at regaining and retaining student engagement in her classes. Sarah reported that there is a drop in student concentration levels between 20 and 30 minutes and the inclusion of annotation offers a change of delivery and consequently 'breaks up' the lecture, this is particularly important as the lectures can be up to 3 hours long. She noted that while students tended to copy the drawings down exactly as she drew them (just like they do with printed diagrams), the students were more 'connected' or engaged with the written diagrams. Sarah has found that by annotating over a slide, or working through an equation, the students seem less self-conscious and are more likely to speak up in class and contribute their thoughts.

I find that as soon as I start writing on a slide then... people will say "yeah but why this?"— It's almost like it gives them a window into commenting... They really just suddenly become engaged. (Sarah)

According to data collected from the lecturer, the outcomes of the technology for this case study included:

- Decreased need for English language to describe equations
- Increased level of in-class student feedback to the lecturer, with students more confident to question and comment on the annotations
- Students more confident and comfortable interacting with peers during the lecture
- Use of annotated slides in class has significantly reduced the number of students requiring one-on-one help

In the future Sarah is considering recording supplementary videos prior to class. She is also interested in incorporating a program like *Blackboard Collaborate* in which students can interact with their peers via virtual classrooms.

Annotation in the Faculty of Medicine, Nursing and Health Science

Chris is a lecturer in the Faculty of Medicine, Nursing and Health Science. He became interested in using annotation as a tool in his classes following his involvement with a university trial initiative that focused on increasing the level of interaction between students and the lecturer during class. Chris has long been interested in incorporating more visual explanation to his lectures in addition to his use of *PowerPoint*; he was particularly interested in having the freedom and capability to build visual explanations spontaneously during his classes.

The main goal of Chris' use of this technology is to provide an opportunity for him to visually communicate and reiterate key areas of understanding to his students without being limited solely to the pre-prepared nature of a *PowerPoint* presentation. The impromptu nature of digital annotation allows Chris to respond to students 'in the moment', as he is able to spontaneously add a blank *PowerPoint* slide to his presentation and annotate aspects of his explanation if necessary.

That's the thing, you can't teach in the moment, you can't have an easy response to certain questions that just doesn't rely on you being able to talk your way through it. I do see that as a way of getting around that problem because very few places, even if they've got a whiteboard, they don't have a pen, you can't find it or it's tiny and you've got 500 people that need to see it. (Chris)

Similar to overhead transparencies, digital annotations can be projected onto the large screens at the front of the lecture theatre making the technology ideal for large classes in which the large size of the lecture theatre can make it impossible for students to see handwriting on regular white or blackboards.

Chris uses a tablet computer with a digitiser input which gives him the capacity to write or draw onto the tablet screen using an active digitiser 'pen'. Using *PowerPoint* software he is then able to annotate directly onto the lecture slides. Chris noted that he felt students appreciate the annotation being drawn 'from scratch' in that they are able to see it being created.

I think that's useful because as you're drawing it you're talking about what you're drawing rather than having the static slide that already had the stuff on it that you're then just explaining... [It] also means you can respond to students' questions or need for more information on the fly. (Chris)

The annotated slides are recorded as part of the university lecture recording system, which is convenient for students and enables them to hear the audio recording of the lecture while watching the diagram being drawn.

According to data collected from the lecturer, the outcomes of the technology use for this case study included:

- Increased student understanding of core concepts – with the annotation exercises reinforcing the importance of particular elements of the lecture content
- Increased motivation and engagement of students with the curriculum content
- Lecturer feeling more motivated by the challenge of 'live' improvisation
- Lecturer able to add additional content and thoughts as they occur

Why it worked

Enablers

There are a variety of enabling factors that have led to or established the conditions within which digital annotation has been successfully used. This section highlights specific enabling factors that were evident in these particular case studies. These include:

Good fit with previous teaching practices and culture: Historically, chalkboards were used to teach visual aspects of learning. However, as the number of students in classes has increased and the classroom sizes with them, lecturers have needed to discover a way in which they are able to teach their subject with tools appropriate to their circumstances. The projection of annotations through the use of tablet technologies, onto the large lecture screens enables all students to have equal opportunity to the lecture content regardless of where they are seated in the lecture theatre.

Process of annotation signals an invitation for students to participate, question and co-construct: Both lecturers noted that the on screen annotations give students a 'neutral point' to talk at - with the screen acting as a mediator between the student and the lecturer. In addition, the fluid and unscripted nature of inking (whether it is annotating over a document or building up a diagram) means lecturers are able to be responsive to students and invite them to participate. The act of annotation sets the tone of the lecture as being one created especially for the students in that class. As a result students felt more comfortable providing comments, suggestions and asking questions.

Challenges

There are several challenges that can be noted in these cases of digital annotation. These include:

Writing/drawing on-screen is different: Both lecturers reported an initial learning curve in understanding how the tablets and styluses work and how annotation could be best incorporated into their lectures. This included coming to understand the right amount of screen space required (for example, how much space was needed to write or draw, and therefore how much content should be on the screen).

Changes to pace and pedagogy within a lecture: The lecturers reported considerable trial and error to discover the best time during the lecture to use annotation, and how to manage the student interactions and flow of the lecture.

Confidence to be spontaneous: Both lecturers noted that it was important to feel confident in their ability to maintain control of the class and regain control if necessary. The spontaneous nature of annotation involves the lecturer 'going off script' and has a number of associated risks. There is an element of vulnerability with the lecturer exposing competencies with spelling, drawing and so on. Both lecturers

emphasised the need to be comfortable with presenting a less polished performance during use of annotation.

What the research literature says

Tablet PCs (often simply referred to as *tablets*) are becoming commonly used by lecturers in larger-scale lectures for creating digital annotations on prepared lecture content in various disciplines in higher education (Choate, Kotsanas, & Dawson, 2014). The most notable features of a tablet are its digitising screen and its ability to allow users to input natural writing and drawing using a pen-like stylus. Tablet use in lectures is typically based on a one-tablet model of instruction, where the lecturer uses a tablet to project content on the display and uses pen-like gestures to annotate, demonstrate, problem-solve, guide brainstorming, comment or mark-up (providing feedback) (Benlloch-Dualde et al., 2013). The digital inking feature of tablets also enables the lecturer to handwrite notes, draw and annotate on static lecture material. Lecturers can easily erase, edit comment, annotate, and can save their digital annotations as notes for students to access later.

The functionalities of tablets can enable lecturers to create annotations which assist in facilitating better lecturer-student interactions (van Oostveen & Muirhead, 2007). Tablet lecturing enables lecturers to deliver lecture content while writing comments, drawing diagrams and graphs on prepared content in real-time (Choate, et al., 2014; Weitz, Wachsmuth, & Mirliss, 2006). Lecturers are able to explain complex examples and explanations better through digitally annotating on prepared content, particularly in engineering and chemistry courses which are mathematically and graphically-oriented (Benlloch-Dualde, et al., 2013). Digital annotations thus alter the dynamics of lecture-student interactions, enabling lecturers to better respond to students' questions and needs that arise during lectures (Choate, et al., 2014). Students are no longer the passive recipients of knowledge but rather are becoming more active participants in the bi-directional sharing of information and interaction with the material, the lecturer and their peers. Annotations (such as circling items or drawing arrows) can also act as signals of particularly relevant content to students, prompting them to mentally process relevant information as they take notes, becoming more engaged in lectures.

Increased student engagement has been found to be one of the key outcomes of digital annotations using tablets (Choate, et al., 2014; Derting & Cox, 2008; Lee & Lim, 2013; Maclaren, 2014; van Oostveen & Muirhead, 2007). Improved attention and greater lecturer-student interaction lead to better student engagement, as Lee and Lim (2013) propose: a) tablets' digital inking function enables lecturers to create vivid handwriting that captures students' attention on the key features of the handwritten visuals; b) tablets enable the instructor to mark-up flexibly while retaining eye contact with students, therefore improving the quality of interaction between teacher and students; and c) digital annotations can be saved as notes and references for students to view later. When lecturers use tablets to write and work through problems with students in real-time in tablet-based lectures, students are able to view the progressive developments of the content by following lecturer's cognitive process as the lecturer digitally handwrites and/or annotates onto the electronic projection or prepared lecture content (Lee & Lim, 2013). Students have also reported an improved

understanding of classroom content as a result of participating in lectures which involved digital annotations (Galligan, Loch, McDonald, & Taylor, 2010). In some studies it has also been argued that students who participate in tablet-based lectures perform better than those who participate in traditional lectures (Benlloch-Dualde, et al., 2013; Derting & Cox, 2008).

In addition to improved student engagement, digital annotations in tablet lectures have also been found to have enhanced students' learning in several ways. The lecturer was able to assess student understanding frequently during the process of instruction and problem-solving when students are given the opportunity to share ideas with peers. This then enables the lecturer to conduct formative assessment to quickly identify common difficulties encountered by students, allowing them to provide immediate feedback, and redirect classroom activities based on student feedback received (Benlloch-Dualde, et al., 2013). Students benefit from digital annotations by being able to keep pace with lectures and gain a better understanding of the lecture content (Choate, et al., 2014). Additionally, annotation gives students the ability to see the progressive development of the content, and find learning a more enjoyable experience through opportunities to construct mental representations from words, pictures, graphs and calculations shown to them as they learn (Mayer, 2002; Venema & Lodge, 2013). Collaboration is also promoted when both the lecturer and students integrate their own handwritten input for problem-solving in whole-class discussions and/or in group work (Maclaren, 2014).

In contrast to the benefits of digital annotations on tablets for student learning, lecturers who wish to use digital annotation should be cautious of the potential challenges associated. It is important that lecturers have appropriate training on the use of tablets and relevant software tools to create effective digital annotations. Lecturers also need to plan ahead for digital inking. In order for digital annotation to be used effectively, attention needs to be paid to inking colours and the annotations should be comprehensible, easy-to-read, with adequate blank spaces for writing and/or drawing (Choate, et al., 2014). Technical problems with the software and hardware of tablets, for example system disruption or issues with screen orientation (Lim, 2011), are likely to hinder lecturers in creating meaningful, contextualised annotations for students. In order for digital annotations to be of value to students, lecturers will require time in becoming accustomed to using a pen-like stylus with the inking feature to produce legible, clear annotations. Also, previous annotations may not be immediately visible in any one view, however the screen can be viewed or treated as a series of discrete pages or slides (Maclaren, 2014), which can later be saved as notes for students to view/access at a later stage. The technology, inking space, and not least, the purpose of the inking in relation to student learning need to be carefully considered in order to avoid digital annotations becoming a distraction rather than enhancing students' learning experiences.

Moving forwards

Participant advice

The respondents articulated several key 'methods for success,' that they noted as being simple and effective practices that were related to the success of digital annotation in enhancing learning among their students.

Prior preparation - ensure the iPad is connected to the lecture screens and the lecture capture software.

Consider reducing slide content - slowly reduce the amount of content on your slides to encourage yourself to annotate digitally.

Consider timing - use digital annotation at appropriate times to break up the lecture.

Use appropriate tools - consider the hardware tools including tablet size and tip of the stylus nib, also consider the software.

Don't overthink it - draw what comes to mind, it's the instantaneous aspect of the annotation that students connect with.

Institutions moving forward

- Institutions seeking to increase the level of interactivity between lecturer and students, especially in large lecture theatres, should consider pen-based technologies to facilitate flexibility for lecturers to expand, explain, and build concepts. Even though *PowerPoint* and similar presentation tools may have inking functions, the facility of pen-based systems and/or touch sensitive screens make the process simpler and more 'natural' for lecturers to express themselves.
- Investment in high resolution inking technology (for example, some stylus and touch screen environments can produce fine and natural looking inking, while others can be coarse or jagged). This needs to be in conjunction with the flexibility to project high quality annotations. And finally this should be supported by the ability to project from lecturer (and potentially student) owned tablet technologies wirelessly.

Resources for exploring

The following table outlines a range of technology useful for implementing digital annotation in class. The list is not comprehensive; each system has been included because it has featured in the project data collection or in related literature or cases. In addition, the list does not mean to suggest endorsement. Each of the technologies needs to be individually evaluated according to the particular needs of the lecturers.

SimplePens

A *PowerPoint* plugin developed by Monash University to assist with

digital annotation. The plugin enables the user to access different coloured 'pens' which can be used to highlight or write in *PowerPoint*, the plugin also provides the option to add blank pages to a slideshow where necessary.

URL: <http://metl.adm.monash.edu.au/SimplePens>

Blackboard Collaborate

An online collaboration platform that enables students to interact in virtual classrooms. The platform provides various tools for interaction including instant messaging and group annotation.

URL:

<http://www.blackboard.com/Platforms/Collaborate/Overview.aspx>

Stylus

A pen-like device that enables users to draw on tablet screens in the same way as a pen drawing on paper.

URL: <http://www.wacom.com/en-au>

Tablet computer

A mobile computer with touchscreen capabilities. Can be used in conjunction with a stylus to produce digital annotation. The lecturers in this case study use an *Apple iPad* and a *Samsung Galaxy* for digital annotation in their classes.

URL: <http://www.samsung.com>

URL: <https://www.apple.com/au/ipad>

Guides, Cases and Readings

- A good article for further reading by Choate, J., Kotsanas, G. & Dawson, P. (2014), titled 'Exploring tablet PC lectures: Lecturer experiences and student perceptions in biomedicine.' The full reference can be found in the reference list below.

URL: <http://ascilite.org.au/ajet/submission/index.php/AJET/article/view/334/934>

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