Title: Development of an Interactive Online Pathology Tutoring System: Pictation

Project team:

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Snapshot

Medical professionals have the ability to make meaning of clinical images collaboratively with their colleagues. To develop this ability in our Health Sciences students, we designed a social constructivist learning activity where students jointly annotated clinical images via an in-house developed web application Pictation. A case study was conducted over 12 weeks during which 85 third-year students used Pictation in concert with lectures and tutorials. Course evaluation results revealed mixed success. Drawing on survey results, interviews, field observations, and log files, we identified three challenges in enacting a social constructivist learning environment related to: insufficient prior knowledge; perceived risk in exposing one's incomplete understanding to peers; and discomfort with uncertainty. Recommendations to address these challenges are presented. At the final summative assessment, this class achieved statistically significant better results ($p=0.001$), with narrower standard deviation than the previous three years (same material, assessed with similar assessments, and tutored by the same tutors).

Project Aims and Outcomes:

This project aimed to develop students' thinking processes of making clinicopathological judgments based on visual material. More broadly, we aimed to help students learn how to 'see' as a pathologist (Bleakley, Farrow, Gould, & Marshall, 2003), (although not become a pathologist)

Aim 1) To enhance student learning of pathology (without increased resources for pathology teachers): ***Achieved- please see results***

Aim 2) To test prototypes of tutorials 1-3 and 4-6 to ensure appropriate software design for the students and tutors ***Achieved and further progressed***

Aim 3) Assessments of the completed tutoring system: ***Achieved- please see results***

Aim 4) To collate results and report/present: ***Achieved and further in progress***

Background:

This was a Strategic Project that supported the goal of promoting student-centred learning at the university (Goal 2a in the *University of Otago Teaching and Learning Action Plan*). Specifically, we aimed to develop and examine students' meaning-making processes as they study clinical images, exploiting the plurality of meanings they make (Jonassen, 1991) in the online activity that can serve to guide face-to-face discussions during tutorials. Few medical intelligent tutoring systems are available. Our project was novel because it is an undergraduate pathology based system. Our design was also novel, focusing on a combination of case-based characteristics (SlideTutor®-like) but also incorporating pathology specialist knowledge-focused interfaces. This therefore brought the advantage of

both low and high information quantity, and, hierarchical and non- hierarchical structure to student (and non-specialist tutor) learning.

One of the objectives of medical education is to develop and progress students' understanding of *normal* structure and function of the human body, to an understanding of *abnormal* structure and function. Expertise in the latter is held by the medical pathologist, who is trained to recognise and interpret abnormal structure and function through, for example, laboratory testing of blood samples, microbiological specimens, tissue biopsies and post mortem examination. As financial and workload constraints on trained expert teachers increasingly limit the learning opportunities for students, intelligent medical training systems have emerged (2-4). In these systems students are given guidance and feedback, without the patient being harmed.

To enhance the current case-based method of instruction using visual materials, we proposed to incorporate recently available interactive computer programmes combined with elements of knowledge-focused cognitive tutoring directed by a pathologist. Layers of information will annotated each image- from anatomy, to cellular matrix, to cellularity, to nuclear and cytoplasmic features. Students received immediate feedback when they were failing to recognize the required aspects. They were encouraged and reinforced when they were successful in appropriately recognizing aspects.

An intelligent tutoring system in pathology has been proposed for American residents training in dermatopathology (5) and is being expanded to other disease systems. SlideTutor ® is the commercial product of this system (4).While undergraduate teaching does not require the detail of these systems, they have been shown to significantly contribute to learning in this area and enhance the enjoyment of that learning (5). Non-pathology focused medical intelligent tutoring systems take a pedagogic approach that can be characterised along a spectrum from purely knowledge based to purely case-based. The most well known include the GUIDON, MYCIN, and NEOMYCN systems. This project was novel because it focused on pathology, or understanding disease, and was thus fundamental to medicine.

Methods:

Project Plan (including timeline and evaluation of impact):

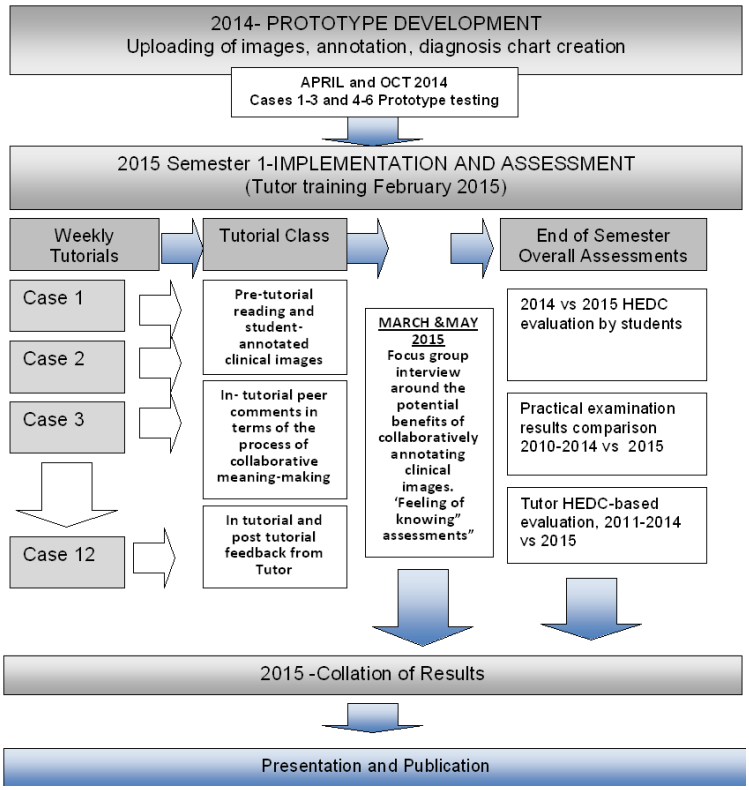
The operational plan in conducting the project (summarised in figure 1) required collaboration between Dr Hung, Mr Loke, and Mr Moskal. Dr Hung annotated the images and constructed knowledge-based material to accompany the images. Mr Loke designed the instructional environment and educational research. Mr Moskal designed and developed the web application (with support from Mr Richard Zeng from HEDC's Educational Technology team). A test of improved knowledge was applied with each of the tutorials.

Our timeline allowed one month for each tutorial, and therefore twelve months in total for development (2014). The implementation of the material was carried out in semester 1 of 2015 in parallel to the currently used material and therefore the students had access to both. Assessments occured during the implementation and at the conclusion of the semester.

A running evaluation of the impact was carried out by:

1. Analysing student-annotated clinical images in terms of students' thinking processes;
2. Analysing peer comments in terms of the process of collaborative meaning-making; and
3. Conducting focus group interviews around the potential benefits of collaboratively annotating clinical images.
4. Summative assessment and comparison to the previous three years

Figure 1: Outline and Timeline Achieved



Results:

Descriptive data sources and analysis

The course evaluation (prior to the final examination) revealed mixed success: e.g., only 50% found annotating images using Pictation helped them to understand the principles of pathology. In the description of data sources and analysis we identified three challenges:

1. Insufficient prior knowledge: Many students expressed that they did not have the necessary prior knowledge to fully participate in the Pictation activity (e.g., "Didn't understand material enough to use [Pictation]"). Insufficient prior knowledge is a known challenge for enacting social constructivist learning (Kirschner et al., 2006). We recommend future cases to be of specified levels of difficulty (e.g., easy-intermediate-hard) so that every student can participant to some degree, and to group students with differing abilities so that the more capable peers can help the less capable ones.
2. Perceived risk in exposing one's incomplete understanding to peers: We designed the Pictation activity to be collaborative (groups of 5 students annotated on single image). However, only 21% found that working in a group on Pictation helped them understand the principles of pathology. Student views included: "Was often worried about labelling diagrams in case I was wrong and everyone could see"; "You basically publicly embarrass yourself". We recommend that tutors further emphasise Pictation as a space for students to articulate their developing and incomplete understandings, and to reassure students that it is a safe learning environment where students are allowed to make mistakes.
3. Discomfort with uncertainty (of being correct or incorrect): We designed the Pictation activity to emphasise the *process* of knowledge-building, which inherently involves a period of grappling with uncertainty. Many students expressed their

discomfort with this period of uncertainty: "There was uncertainty of being correct"; "Please give us some examples of fully-labelled, correct answers. Otherwise, it is the blind leading the blind". This is supported by students desire for the correct answer: e.g., students clearly expressed that Pictation would be a very useful revision tool with correctly-annotated images put up, and that they preferred to use Pictation during tutorials when their tutors are showing the correct answers. Students' discomfort with uncertainty reflected some academics' view that the typical university classroom is a "fail-safe environment" (Wood & Reiners, 2015, p. 316). We recommend that tutors emphasise that Pictation is a space for students to articulate their incomplete understandings. To reassure students, we also recommend that tutors share correctly-annotated images after students have participated in the Pictation activity.

Summative Results

Compared to the previous three years, the group with the online tutoring system (2015) showed much more variation in results in the first few weeks, as measured by the mean and standard deviation (table 1). We attribute this to the unsettling nature of a very new teaching tool, as outlined in the comments above. However, by the final examination, the students were well ahead of other years (by at least 5% mean), and the standard deviation had narrowed significantly. By the final mark the pictation class equalled the 2013 class (which was outstanding in the prac exam for that year), and significantly surpassed the other two years.

Table 1: Summative results for four years

Year	Tutorial Assessments		Practical Exam		MCQ final		Overal FINAL	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
2012	7.82	1.74	79.62	17.69	93.66	8.00	0.78	10.00
2013	8.39	1.71	87.88	14.70	95.78	8.22	82.96	7.91
2014	8.44	2.00	73.54	21.74	95.09	12.23	77.04	10.40
2015*	7.61	3.33	78.81	16.83	99.31	6.32	80.61	6.88
Comparison between years								
2012 vs 2015	P= 0.1325		P= 0.4968		#p= 0.0000		#p= 0.0000	
2013 vs 2015	#p= 0.0000		#p= 0.0000		#P= 0.0182		P= 0.0588	
2014 vs 2015	#p= 0.0000		#p= 0.0000		#P= 0.0039		#P= 0.0172	
*Pictation # Significant P<0.05								

Outputs to date

Publications:

- Hung, N., Moskal, A.C.M., & Loke, S. K. (2014). Do you see what I see? Learning to see like a pathologist via collaborative annotating of clinical images. [Sharing practice session]. Rhetoric and Reality: Critical perspectives on educational technology. 31st annual ascilite conference

Workshops:

- A HEDC workshop "Building knowledge by annotating images on Pictation" was conducted for Otago teaching staff in April 2015. Another workshop to train teachers in the pathology dept to use pictation is planned for November 2015.

Discussion and Implications

This project has completed the stated aims, and has further work in progress. Although the students felt that there were issues with insufficient prior knowledge, perceived risk in exposing one's incomplete understanding to peers, and the discomfort with uncertainty (of being correct or incorrect), their final results speak to the best performance in four years, and a narrower standard deviation of these results in the same time period.

Improvements in satisfaction from the students using Pictation in the following year will be strived for by allowing student choice of work mates, tutor counselling concerning risk-taking, and the provision of model answers.

A further publication is planned and in draft mode.

References

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