

# Use of General Surgery and Urology Online Modules in Medical Education

Dwayne Chang,<sup>1,\*</sup> Steve McCombie,<sup>2</sup> Callum Logan,<sup>3</sup> Astrid Davine,<sup>4</sup> Fiona Leece,<sup>4</sup> Diana Jonas-Dwyer,<sup>4</sup> and Dickon Hayne<sup>2,4</sup>

<sup>1</sup>Royal Perth Hospital, Perth, Western Australia

<sup>2</sup>Fiona Stanley Hospital Urology, Murdoch, Western Australia

<sup>3</sup>Repatriation General Hospital, Daw Park, South Australia

<sup>4</sup>University of Western Australia, Crawley, Western Australia

\*Corresponding author: Dwayne Chang, Royal Perth Hospital, Perth, Western Australia. Tel: +618-92242244, Fax: +618-92243577, E-mail: Dwayne.Chang@health.wa.gov.au

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## Abstract

**Background:** Web-based learning is increasingly used as an adjunct to, and a replacement for, traditional learning methods. We investigated the impact of web-based learning modules in improving the delivery of undergraduate medical education in general surgery and urology.

**Objectives:** To determine if online learning modules improve student performance in general surgery and urology. To determine if previous use of online learning modules promote future utilization of such modules among students.

**Materials and Methods:** Four general surgical and urologic web-based learning modules were delivered as an adjunct to traditional teaching via an online learning management system to fourth year medical students in 2009 and 2010. Each module contained 40 identical pre-module and post-module questions which allow analysis of change in student performance after delivery of these modules. The student t-test and Fisher's exact test were used for statistical analysis.

**Results:** In urology, the mean pre-module score was 22.4 (SD 4.3) and the mean post-module score was 33.0 (SD 2.1) ( $P < 0.001$ ). Students who completed all the pre-module and post-module questions had a mean increase of 12.8 score points (SD 3.9). In general surgery, significantly more students completed all of the pre-module (42.7% vs. 27.5%) and post-module (23.2% vs. 7.3%) questions for the general surgical modules in 2010 compared to the urology modules in 2009 ( $P \leq 0.001$ ).

**Conclusions:** The introduction of web-based general surgery and urologic learning modules as an adjunct to traditional teaching improved student knowledge, and their usage improved over time.

**Keywords:** Education, General Surgery, Online Systems, Urology

## 1. Background

The internet is transforming the way in which medical education is delivered; it is being increasingly used as both an adjunct to, and a replacement for, traditional learning methods (1, 2). Web-based learning involves the use of learning resources that are accessible remotely via the internet. A wide-range of resources and methods of deliveries exist, such as online modules, discussion forums and podcasts, videocasts (2). Web-based learning provides a convenient, flexible, and cost-efficient medium for student learning which can be processed at one's own pace (3). Outcomes from web-based learning were shown to be comparable to traditional teaching methods; a systematic review found no significant difference in learner outcomes between online learning and traditional teaching methods (4). Web-based learning seems particularly well-suited to medical education because medical students can be placed in several different hospitals over a wide geographical area, and travelling to one place

for a lecture can prove inconvenient (3). Additionally, medicine is a field that lends itself to visual, independent learning. Anatomy, pathology, and physiology are good examples of subjects that are difficult to learn from just a lecture. Web-based learning tools for these core subjects may allow more teaching time dedicated to other skills in medicine, such as communication and interpersonal skills.

## 2. Objectives

To determine if online learning modules improve student performance in general surgery and urology. To determine if previous use of online learning modules promote future utilisation of such modules among students.

## 3. Materials and Methods

The modules were developed in consultation with medical education e-learning staff, consultant sur-

geons, consultant urologists, medical students, and experienced nurses. The modules were developed using a rapid e-learning tool, articulate Engage™. Each module was exported as a sharable content object reusable module (SCORM) and then imported into the learning management system 'WebCT', which is accessible via the university website 24 hours a day. Each module is interactive and contains important information relating to a specific medical condition; pictures and videos are included that demonstrate key points (Figure 1).

Modules focus on teaching knowledge and skills required for history-taking, examination, investigation, and management of patients with common surgical and urologic conditions. There were 40 questions in each module and it takes approximately 15 to 20 minutes to complete each module. Identical multiple choice questions are included at the beginning (pre-module) and end (post-module) of the modules, and results from these are given to the students upon completion. The questions were designed to assess core knowledge, as well as understanding of key concepts. Anonymous qualitative feedback is requested electronically upon completion of the modules in the form of free-text 'like' or 'dislike' comments about the modules.

Common presentations and conditions were chosen as the topics of the learning modules for urology and general surgical modules. Additionally, modules were designed to focus on pathologies in different organs, to avoid repetition of material on topics such as anatomy and physiology of each organ. General surgical topics were; (i) diverticular disease, (ii) gallstones and biliary disease, (iii) gastro-oesophageal reflux disease and oesophageal cancer, and (iv) peri-anal sepsis. Urology topics were; (i) haematuria and bladder cancer, (ii) lower urinary tract symptoms and benign prostatic hyperplasia, (iii) renal stones, and (iv) prostate cancer.

All fourth year medical students studying at the university of Western Australia in 2009 (218 students) and 2010 (220 students) were invited to participate in the study and access to the learning modules was enabled; the urology modules were analysed for the 2009 cohort and the general surgical modules were analysed for the 2010 cohort. Students were able to complete the modules at any point during the academic year, but were encouraged to complete them during their surgical attachments. The focus of the analysis of the urology modules was to assess the efficacy of the modules in improving knowledge; the main outcomes for this cohort were mean pre-module and post-module question scores. The focus of the analysis of the general surgical modules was to assess change in the usage and adoption of the learning modules over time; the main outcomes for this were the percentage of students completing the pre-module and post-module questions for urology and general surgery. The amount and content of qualitative feedback on the

modules was a secondary outcome for both cohorts. The independent two samples student t-test and Fisher's exact test were used for data analysis, which was conducted using SPSS (IBM SPSS statistics for windows, version 22.0). Ethical approval was obtained from the university human research ethics committee (HREC numbers: RA/4/1/2352, RA/4/1/4437).

## 4. Results

### 4.1. Urology Modules

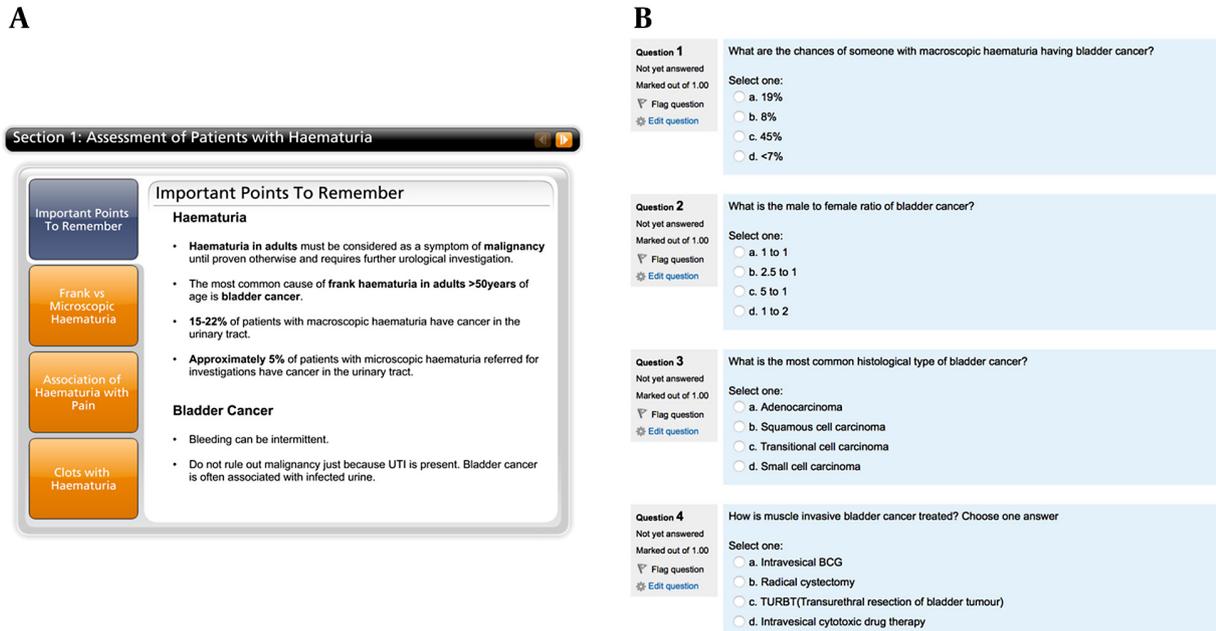
Of 218 fourth year medical students in 2009, 60 (27.5%) completed all of the pre-module questions and 16 (7.3%) completed all of the post-module questions. There were 40 identical pre-module and post-module questions; each correct answer received one point and there was no negative marking. The distribution of results from the pre- and post-module questions were normal with a confidence of 9.35% and 8.86%, respectively, based on the Anderson-Darling normality test. The mean pre-module score was 22.4 (SD 4.3) and the mean post-module score was 33.0 (SD 2.1) ( $P < 0.001$ ). Of 12 students (5.5%) who completed all the pre-module and post-module questions, there was a mean increase in score after the module was completed of 12.8 points (SD 3.9). As can be seen from Table 1, and Figure 2. Post-module scores were significantly higher than pre-module scores for all four learning module topics ( $P < 0.001$ ).

### 4.2. General Surgery Modules

Of 220 fourth year medical students in 2010, 94 (42.7%) completed all of the pre-module questions and 51 (23.2%) completed all of the post-module questions. Significantly more students completed all of the pre-module (42.7% vs. 27.5%) and post-module (23.2% vs. 7.3%) questions for the general surgery modules in 2010 as compared with the urology modules in 2009 ( $P \leq 0.001$ ). Additionally, if students completed the pre-module questions then they were significantly more likely to go on to complete the post-module questions for the general surgery modules in 2010 as compared with the urology modules in 2009 (54.3% vs. 26.7%,  $P < 0.001$ ).

The number of qualitative feedback sections completed was significantly higher for the general surgical modules in 2010 as compared with the urology modules in 2009 (36 vs. 6,  $P < 0.001$ ). Of the thirty-six qualitative feedback sections completed for the general surgical modules, 20 'likes' and 16 'dislikes' were reported. Reasons for liking the modules were related to their: length and structure (65%), content (25%), or visual nature (10%). Reasons for disliking the modules were related to their content (50%), the tests (18.75%), technical problems (18.75%), and their length and structure (12.5%).

Figure 1. Modules Focus on Teaching Knowledge and Skills



A, Example slides; B, questions from the web-based learning modules.

Table 1. Pre-Module and Post-Module Scores for Urology Modules<sup>a,b,c</sup>

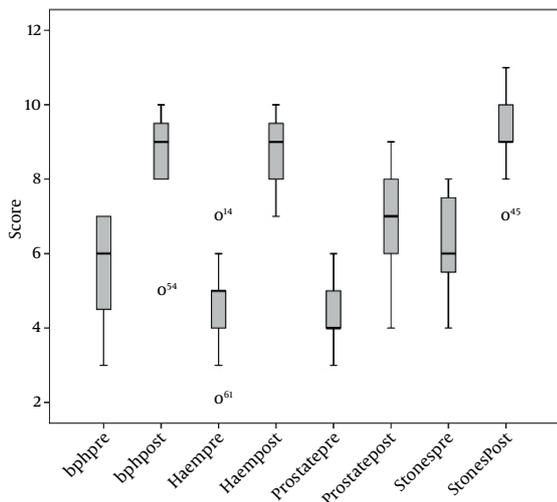
Topic	Pre-Module (n)	Pre-Module Mean (95% CI)	Post-Module (n)	Post-Module Mean (95% CI)
Hematuria	62	4.69 (4.30 – 5.09)	29	8.00 (7.25 – 8.75)
Prostate cancer	60	4.87 (4.52 – 5.21)	16	7.00 (6.27 – 7.73)
Stones	60	6.48 (6.12 – 6.84)	21	9.19 (8.64 – 9.74)
BPH and LUTS	60	6.27 (5.84 – 6.69)	19	8.26 (7.36 – 9.17)

<sup>a</sup>Independent two samples student t-test used, P < 0.001.

<sup>b</sup>Prostate cancer scored out of 9.

<sup>c</sup>Stones scored out of 11.

Figure 2. Box Plots of Pre-Module and Post-Module Scores for Urology Modules



Independent two samples student t-test used.

## 5. Discussion

Eight learning modules were successfully introduced, and all fourth year medical students were able to access these. Use of the pilot urology modules was poor with less than 30% of students completing the pre-module questions, and less than 10% completing the post-module questions. Encouragingly, use of the modules a year later was greatly improved with significantly more students completing the pre-module and post-module questions. The significant increases in the both the proportion of students completing the post-module questions (after having completed the pre-module questions) and the amount of feedback received from 2009 to 2010 is also reassuring. This appears to indicate that students are not only more likely to access the modules, but that they are also more likely to then go on and complete the modules as well. Qualitative feedback on the modules indicated that the length, structure, and visual aspects of the modules were generally considered to be good. The overall content, design of the multiple choice questions, and technical problems related to the software were areas identified from the feedback that could be improved.

Completion of the urology learning modules resulted in a significant improvement in question scores, indicating that the content of the modules was helpful in improving urologic and general surgical knowledge. Our findings are in agreement with results from a randomized controlled trial which showed significantly improved mean scores in students who completed an e-learning module compared to those who had had standard didactic learning resources (80 vs. 66,  $P < 0.001$ ) in the subject of leukemia (5). Similarly, in another recent multi-center randomized trial, medical students and interns who received online learning modules were significantly better at making appropriate imaging referrals compared to those who received static didactic teaching (6).

The interactive design of the modules used in this study may have contributed to the improvement in student performance in the post-module questions. A systematic review and meta-analysis of various instructional designs of online learning showed that interactivity significantly improved learning outcomes for health professionals. The fifteen studies included in this study by Cook et al. showed a pooled effect size of 0.27 (95% confidence interval 0.08 - 0.46,  $P = 0.006$ ) for high interactivity versus low interactivity (7).

Limitations of the study includes low numbers of students completing the pre-module and post-module questions. This may limit the generalizability of the results, particularly for the urology modules in 2009. For example, it may be that students who completed the modules are more likely to be high-performing students, better visual learners, or more computer-literate. As a result, the improvement in question scores after completing the modules may not be as pronounced for other students who do not have these characteristics. Another limitation is the use of identical pre-module and post-module questions which may confound the use of pre-module and post-module scores as an indicator of module efficacy at improving knowledge. However, this is a double-edged sword; using identical questions allow direct comparison of performance pre- and post-module but it can attract the confounding factor of students memorizing answers to questions. Using different questions instead may raise the issue of uneven degrees of difficulty, as it is not easy to construct questions with identical difficulty.

Further to the successful introduction of these learning modules, the modules have been introduced at the medical school of a neighboring institution. Local general practitioners and specialist nurses have also been given access to the modules. There are plans in place to develop further mod-

ules in general surgery (e.g. bowel obstruction, colorectal cancer, gastric disorders, bariatric surgery), and the introduction of modules for other surgical specialties is also being considered. We are in the process of developing more user-centered learning modules for future studies.

The introduction of web-based general surgery and urologic learning modules as an adjunct to traditional teaching was successful in improving student knowledge, and their use appeared to improve over time.

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## Footnote

**Authors' Contribution:** Study concept and design, Diana Jonas-Dwyer and Dickon Hayne; analysis and interpretation of data, Dwayne Chang, Steve McCombie, Callum Logan, Astrid Davine and Fiona Leece; drafting of the manuscript, Dwayne Chang, Steve McCombie, Callum Logan, Astrid Davine and Fiona Leece; critical revision of the manuscript for important intellectual content, Dwayne Chang, Steve McCombie, Callum Logan, Astrid Davine, Fiona Leece, Diana Jonas-Dwyer and Dickon Hayne;

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