



Short communication

## Benefits of e-learning in chemotherapy pharmacology education

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### Abstract

**Background:** Chemotherapeutic pharmacology is traditionally a challenging subject to both teach and learn. This study aimed to assess a suite of e-learning tools regarding the mechanisms of action of chemotherapy drugs, and the subsequent effects on learning in two cohorts (control and intervention) of undergraduate pharmacy students in Australia.

**Methods:** The intervention group had access to the e-learning tools in addition to the traditional didactic teaching delivered to the control group. To determine the educational benefit of the e-learning tools, we evaluated student level of understanding demonstrated in the short-answer questions related to chemotherapy mechanisms. Structure of the Observed Learning Outcome (SOLO) taxonomy was used to classify students' exam responses.

**Results:** There was overall improvement in student total exam scores for the intervention group. However, the most significant improvement was evident in the chemotherapy scores for the intervention group who demonstrated a superior level of understanding of mechanisms of action of the three chemotherapy drugs, cytarabine, mitomycin C and trastuzumab. Students in the intervention group performed significantly better than the control cohort with respect to short answer questions on cytarabine and trastuzumab ( $p < 0.05$ ), but most notably on the mechanism of action of cytarabine ( $p = 0.02$ ).

**Discussion:** E-learning tools were shown to improve student level of understanding, as scored by the SOLO taxonomy, in the learning and teaching of chemotherapeutic pharmacology.

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### Introduction

Educating pharmacology students about cancer and pharmaceutical care can be challenging. This is due to

the complexities of the subject in addition to a rapidly expanding chemotherapeutic pharmaceutical formulary.<sup>1–3</sup>

A significant increase in the amount of information covered in pharmacology has occurred in the past decade, rendering an already demanding subject even more challenging.<sup>4,5</sup>

However, teaching strategies have evolved from a teacher-centred process to a learner-centred process, in an effort to enhance students' retention and application of knowledge.<sup>6</sup> Recent modifications of education strategy encourage active

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learning to address student demands for an interactive and technology-inclusive classroom. Active learning engages the student in higher-order thinking, promoting the maintenance and practical application of knowledge, which is highly suited to the demands of chemotherapy education.<sup>7</sup> Recent studies demonstrate that active learning increases retention of knowledge, student responsiveness, and improves exam scores.<sup>8,9</sup>

Active learning has been shown to be supported by the employment of e-learning tools.<sup>10,11</sup> E-learning tools are electronic applications that implement technology-based solutions for improving student performance and learning. E-learning is believed to play a critical role in improving higher-education and life-long learning.<sup>12</sup> This teaching method involves the reconceptualization of learning that makes use of both instructor-led pedagogy and the flexibility of multi-party involvement.<sup>13</sup> E-learning contributes to the theory of cognitive constructivism.<sup>14,15</sup> When delivered appropriately, the use of e-tools can scaffold student learning, supporting students' construction of their own ideas and understanding of the content being presented.<sup>16</sup> Advantageously, e-learning can exist alone or can be adapted to different pedagogical models, including blended learning.<sup>17</sup> The model of blended learning has been shown to enhance student perceptions of learning, satisfaction, and cognitive presence.<sup>18</sup> Blended learning models often rely on the incorporation of e-tools to deliver content due to their accessibility and promotion of student-controlled learning.<sup>19–21</sup> E-learning tools can include various media such as videos or animations and be delivered in multiple modes, including offline or via the internet. The tools provide a self-directed approach to study for students that is both time- and location-independent.<sup>22</sup> However, the usefulness of e-learning tools for improving student performance in chemotherapeutic pharmacology education has not been fully evaluated.

### **Rationale and objectives**

This study was designed to assess the benefit of a suite of e-learning tools, focused on drug mechanism of action for chemotherapy treatments, in two cohorts of undergraduate pharmacy students from Griffith University, Gold Coast, Australia. The study aimed to evaluate the benefit of the e-learning tools by measuring marks awarded for exam questions relevant to the chemotherapy drug mechanisms.

### **Materials and methods**

This study was conducted in a tertiary institution in Australia. A suite of 65 e-learning tools was designed for the third-year pharmacology course in semester two in 2012. The e-learning tools covered the mechanisms of action for the majority of drug classes looked at over the entire pharmacology course. Of the 65 e-learning tools created for the pharmacology course, 14 addressed cancer

chemotherapy drugs. The pharmacologies of three chemotherapy drugs were assessed in the end of semester exam, in the form of short-answer questions. These short-answer questions were focused on drugs with different mechanisms of action (cytarabine, mitomycin C, and trastuzumab), thereby considering both cytotoxic and targeted chemotherapeutic treatment. The short-answer questions relating to cytarabine, mitomycin C, and trastuzumab contributed 15% of total short-answer marks for the exam.

To evaluate the educational benefits of the e-learning tools relating to cancer treatment, a comparative study was conducted that consisted of two academic cohorts. The first comprised of third-year pharmacy students who studied the standard pharmacology curriculum in 2011 without supplementation (control group) and the second consisted of students who studied the standard curriculum in 2012, but with the e-learning tools supplementation as well (intervention group). The curricula were delivered by the same lecturers and were nearly identical in both years, as were the exams. The questions relating to chemotherapeutic drug mechanisms were identical in both exams. Student participation was voluntary (opt-in) and no extra credit was awarded for participation. Students who expressed interest to participate in the study were instructed to tick a designated box that appeared on their exam paper. This box indicated their consent for the research team to evaluate their exam answer booklets for the pharmacology course. The data were de-identified by the course convenors before analysis. Demographic data were obtained for participating students from university records. The grade point average (GPA) was also collected to compare the overall academic achievement between the control and intervention cohorts. Ethical approval was granted by the tertiary institution ethics committee (protocol PHM/05/10/HREC).

### *E-learning tool design and implementation*

Custom animations were sequenced in Microsoft PowerPoint 2010 and iSpring Pro 6.1.0 (iSpring Solutions, Inc United States) was used to add narration, produce the embedded animation, and convert the animations into a Flash format (swf file) for ease of delivery through Blackboard.<sup>TM</sup> The first advantage of the e-learning tools is that they were designed and developed incorporating established educational theories, including that students learned better from a combination of words and pictures presented simultaneously, but only when extraneous words, pictures, and sounds are excluded; when multiple source of information are integrated; when animation and narration are combined, and, when students can interact with learning materials; these principals are related to the cognitive load theory and Mayer's dual-channel assumption.<sup>23</sup> The second advantage of the custom e-learning tool is that the content and delivery are structured and molded to the specific requirements of our pharmacology curriculum and learning and teaching needs. The third advantage of the custom

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