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Enhancing laboratory experience through e-lessons

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ABSTRACT

This paper describes the development and use of e-lessons in an undergraduate level laboratory course. The pilot study involved creating e-lessons for two bioanalytics experiments: polymerase chain reaction and high performance liquid chromatography. Each e-lesson consisted of two screencasts and a self-assessment quiz. No e-lesson was prepared for the bioanalytic experiment on surface plasmon resonance and served as a control to evaluate the efficacy of the e-lessons on student performance, as well as students' perceptions of the value of the resource. Student feedback showed that majority of the students perceived e-lessons as a valuable pre-laboratory resource, which provided them with the opportunity to better prepare themselves for the laboratory by gathering the necessary theory for the experiment, as well as familiarize with the instrument at their own pace.

1. Introduction

Over the years, the pharmaceutical industry has grown dramatically. With industrial growth comes the challenge to develop manpower equipped with knowledge and skills that match the present and future needs of the industry. The role of chemical engineers in the pharmaceutical industry is varied, ranging from process design and scale-up to process modeling, quality control and optimization. To meet these needs of the pharmaceutical industry, the Chemical Engineering curriculum has constantly evolved with introduction of pharmaceutical-related modules and laboratory courses. The objective of these is to increase cognizance among Chemical Engineering undergraduates of the new technologies brought in by the fast growing pharmaceutical/biopharmaceutical sector. In 2005, several bioanalytics experiments were introduced to a Year-2 undergraduate laboratory module at the Department of Chemical and Biomolecular Engineering at National University of Singapore. The laboratory tasks were designed to familiarize students with bioanalytical instruments, including polymerase chain reaction (PCR), high performance liquid chromatography (HPLC) and surface plasmon resonance (SPR). For the practical sessions, the traditional approach to conducting the experiments was adopted, i.e. students were required to follow the instructions/protocol provided in the laboratory manual/during the session itself to conduct the experiment. While such an approach allowed students to complete the laboratory task, the methodology suffered from drawbacks as evinced by feedback from the students. Review of student feedback suggested that students faced two general difficulties with regards to bioanalytical experiments: large amount of information to be processed during the 4 hour-laboratory session and the fact that they often lacked the background theory of the experiment they were about to perform. Limited or no background knowledge, in combination with overload of information in a short period, hindered students' learning, often restricting their learning to mere observation. With the intent to enhance students' laboratory experience, several possible solutions were discussed. We anticipated that providing pre-laboratory training could offer a viable solution to the challenges faced by the students. Pre-laboratory training would permit students to learn the necessary theory for the

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experiment, acquire practical information, and provide them with a holistic picture. In so doing, it would also facilitate the following broader goals:

- Create a positive learning environment; and
- Prepare undergraduates for the growing pharmaceutical/biopharmaceutical sector.

Various forms of pre-laboratory training are reported in the literature. Traditional approaches such as pre-laboratory sessions consisting of short lecture presentations at the beginning of the experiment are still prevalent at several universities. Researchers have investigated the use of pre-laboratory activities, such as writing summaries of the experiments (Rollnick et al., 2001), preparing action research plan (Lyle and Robinson, 2002). While adequate for small class-sizes (less than 50), successful implementation of these techniques for large number of students (greater than 100) is difficult owing to manpower, time and space constraints. To tackle these difficulties, several researchers have proposed the use of online platform for pre-laboratory training (Swanson and Lynch, 2003; Limnioua and Whitehead, 2010; Gregory and Trapani, 2012; Boulay et al., 2013). The present project is an attempt in this direction and investigates the effectiveness of e-lessons as a pre-laboratory training tool to augment students' learning experience for the bioanalytical laboratory sessions.

2. Approach

Each e-lesson incorporated two screencasts (hereafter referred to as Part 1 and Part 2) and a self-assessment quiz. Screencasts, as defined by Falconer et al. (2012), are recordings with accompanying narration. Many academicians across the world have adopted screencasts to accomplish one or more of the following: review difficult topics, address students' doubts, solve example problems and explain homework, or test problems (Falconer et al., 2012). In the present project, screencasts were used as a platform to:

(i) impart students with theoretical understanding of the principles governing the experiment;
(ii) discuss equipment and operation details;
(iii) illustrate real-world applications of bioanalytical instrument; and
(iv) share practical tips and provide safety instructions.

Table 2 – Links to e-lessons.

Resource	URL
PCR Part 1	https://breeze.nus.edu.sg/p46nef65i8q/
PCR Part 2	https://breeze.nus.edu.sg/p9cqw3azvmc/
Self-Assessment Quiz for PCR	https://breeze.nus.edu.sg/p3fct3y6rym/
HPLC Part 1	https://breeze.nus.edu.sg/p6wu6gq5ghh/
HPLC Part 2	https://breeze.nus.edu.sg/p1i8fch0cgo/
Self-Assessment Quiz for HPLC	https://breeze.nus.edu.sg/p4a70cvx0lj/

Prior to preparation of the e-lessons, four rounds of dialogue sessions (each session comprised 18–20 students) were held with Year 3 students. The participating students had performed the bioanalytical experiments following the traditional approach one semester before. The dialogue session provided a valuable opportunity to understand the challenges faced by the students when performing the bioanalytical experiments. During the dialogue session, the idea of e-lessons, its objectives and intended content were shared with the students. A short survey was conducted to gauge students' acceptance and expectations of the proposed e-lessons. The findings of the survey are summarized in Table 1.

Among the qualitative comments provided by the participants, the following were the most frequently provided:

"*E-lessons should not be too technical, which could otherwise make them difficult to understand.*"
"*E-lessons should provide a bigger picture.*"
"*Try to include more animations and make them interesting.*"
"*Should not be too long.*"

Following the dialogue sessions, the task of e-lesson preparation was undertaken. E-lessons for two bioanalytical instruments: PCR and HPLC were created using Adobe Presenter 10. No e-lesson was prepared for SPR, and served as a control to evaluate the efficacy of the e-lessons on student performance, as well as students' perceptions of the value of the resource. In addition to screencasts, each e-lesson consisted of a self-assessment quiz, which gave the students

Table 1 – Responses to survey questions asked during the dialogue session.

Question	Strongly agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly disagree (%)
E-lessons would enhance students' theoretical and practical readiness for the experiment	48	51	1	0	0
E-lessons would help students' better understand equipment operation and associated operational challenges	33	50	12	5	0
E-lessons would enhance students' knowledge of the real world application(s) of the instrument	38	51	11	0	0
Concept of learning through e-lessons prior to performing the experiment would provide students' with improved learning experience	38	61	1	0	0