Use of role play and LEGO™ to teach first year physiology- Does active learning really work?

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Abstract

Meaningful engagement within biomedical science subjects continues to be an obstacle to success for students enrolled in allied health professional courses. Historically, the perception that these subjects are difficult has contributed to a relatively high fail rate often accompanied by subsequent course withdrawal. To address this we designed creative and innovative student centred interactive learning activities that give learners the required confidence to engage with complex physiological mechanisms. To assess the impact of these learning activities we analysed subject fail rates, exam performance and numbers of positive responses in subject experience surveys over a four year period. Our results show an overall 7% decrease in subject fail rates accompanied by improved exam performance in questions aligned with learning activities and an increase in positive responses from subject experience surveys. We have shown that these learning activities promote active learning in a challenging environment and promote a deeper learning experience for students.

Introduction

An ongoing challenge when teaching first year physiology subjects to allied health students is that they are content heavy and are delivered to large numbers of students with varying levels of preparedness for University. A typical subject cohort will consist of students enrolled in several different courses. Some students have prior knowledge that they can build on but many have never studied biological sciences. Classes are usually in the format of a conventional 1-2 hour lecture where information is delivered and the student is expected to listen, absorb and remember most of it. In addition, lectures are usually very text heavy which does not suit visual learners and this further decreases the ability of the learner to process and understand (Ayres, 2015; Schrand, 2008). In reality, this type of passive learning is pedagogically counter-productive and the complete opposite of the types of conditions that are essential to student learning (Wolff, Wagner, Poznanski, Schiller, & Santen, 2015). In our experience the overall net effect of the didactic lecture is that it does little to promote deep learning. Students often become overwhelmed with the amount and perceived difficulty of content which further leads to subject dissatisfaction, subject failure and in many instances withdrawal from the course. However, given university budget constraints, it is unlikely that class sizes will decrease to cater to every students learning needs so the challenge of providing an enriched learning experience for every student remains.

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In contrast to passive learning, the constructivist view of learning actively engages the learner in activities which place the student at the centre of the learning process allowing them to develop critical learning skills within the classroom (Carey, 1985; Prince, 2004). Moreover, active learning involves knowledge construction in contrast to knowledge absorption and builds on existing knowledge and experiences with every day phenomena (Anthony, 1996; Michael, 2006). Within this active learning environment the constructivist teacher becomes a facilitator, constantly inquiring about students' understanding of concepts before sharing their own understandings of those concepts (Suneetha, 2014).

Using this active learning model, in a face-to-face 2 hour class, we sought to transform the classroom into an active learning environment with the incorporation of fun active learning experiences aligned with specific subject outcomes. Specific strategies included role play, Lego and other interactive activities. The aim of this initiative was to see if this type of class: (i) enhanced the overall student learning experience within first year physiology subjects; (ii) assisted students to understand difficult physiological concepts when they could relate them to everyday analogies; (iii) contributed to improved performance in exams; and (iv) increased subject pass rates.

**Strategies implemented**

It is important to note that many learning activities have been incorporated into our first year physiology classrooms so that students are constantly being challenged but this paper will focus on two specific initiatives. The first of these activities, introduced in 2014, involves role play with a carefully designed in-class play where each character in the activity is aligned with a molecule involved in a physiological process.

**Design of learning activity to explain the processes of Transcription and Translation.**

In this play students learn how the body builds new proteins. Twelve volunteers act out a role in a play. Costumes and props are provided for each volunteer. The class spends some time setting the scene for the play which is in a restaurant, i.e. the class collectively names the characters and the restaurant. Briefly, the restaurant correlates with the nucleus of the cell where transcription occurs. A student who plays the proprietor (DNA) decides to order a cupcake. A second student plays a waiter who makes a copy of the DNA (mRNA). The play then moves to the kitchen (cytoplasm) where a chef (ribosome) reads out the ingredients for the cupcake and several kitchen hands (tRNA) bring these ingredients to the chef (translation). The result is that we make a cupcake (protein - the final step in the process) in the class to explain the lecture objective.

This simplified way of explaining a complex mechanism using real materials not only engages students but can easily be used to scaffold learning with worksheets that address the correlations between each role and what is actually occurring at a molecular level. These worksheets can also be adapted to facilitate advanced learning for students with prior science knowledge. This type of learning not only stimulates student curiosity, lifelong learning and enables students to discover answers for themselves but it also facilitates teaching to a large group of students where there might be a wide range of ability (Sharkey & Weimer, 2003). The major benefit of this activity however is that it not only allows for student-to-student, student-to-content and student-to-expert learning but it rewards students for understanding and motivates learning at a deeper level (Ramsden, 2003).

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Design of learning activity to explain the interaction between ligands and cellular receptors

The second activity uses LEGO™ blocks to explain ligand/receptor interactions. This activity not only helps students to understand normal physiology, but prepares students for a more advanced second year pharmacology subject which is considered by many to be the most difficult biomedical science subject. This content is challenging for many students but as some of our graduates will have limited prescribing rights, it is essential for them to have a good understanding of how ligand/receptor interactions occur before they can understand pharmacodynamics. In this activity, small groups of students are given various LEGO™ blocks. They decide which coloured/shaped blocks substitute for ligands and receptors. With guidance and through playing with the blocks, students can get a hands on understanding of the consequences of various interactions between the ligand and the receptor. These active learning tasks according to Salter, Pang & Sharkey (2009) not only assist initial understanding, but also promote further motivation to learn.

Outcomes of initiatives

Subject Experience Surveys

Student feedback on subject experience surveys over a three year period was analysed to assess the impact of the learning activities on the overall student learning experience within first year physiology subjects. Overall satisfaction with the most recent offering of the subject was high with 91% of respondents responding positively. Of real interest were the 94% and 86% of students respectively, strongly agreeing or agreeing with the statements “The learning activities in the subject extended my knowledge” and “The learning activities in the subject helped me to learn effectively”. These high scores were supported by the following student comments:

“The interactions and role play carried out during the lectures. Making things fun, helped names and processes easier to remember”.

“The effort she goes to in order to make lectures/tutes more enjoyable and meaningful (from the work on overhead projector, to LEGO creations, transcription/translation cooking demos etc)”.

“I find this subject particularly hard & extremely overwhelming... The class was fun to attend & she had unique ways to get us involved”.

Examination performance and subject pass rates

Knowing that these learning activities extended students’ knowledge and helped them to learn effectively, we then assessed student performance in two exam questions of similar difficulty. One of these questions was aligned with the transcription and translation play and the other question was aligned with the conventional didactic form of teaching. Figure 1 shows the percentage of the class that achieved a pass mark or higher for these two questions. In a class of 80 students, two thirds successfully achieved a pass mark or higher for the exam question that was aligned with the play whereas one third of the class achieved a pass mark or higher for the exam question that was aligned with the conventional didactic form of teaching. We also examined the impact of the introduction of our active learning strategies on overall subject fail rates. Interestingly, there was a downward trend in the subject fail rates over a four year period following the introduction of these active learning strategies (Figure 2). Over this four
year period, the subject was taught by the same academic with the only major change being the introduction of active learning in 2014. Furthermore, additional improvement in student pass rates were seen in 2015 and 2016 as additional active learning strategies were introduced.

![Graph showing percentage of students achieving a pass grade or higher for exam questions linked to transcription play or didactic lecture.]

**Fig 1: Percentage of students achieving a pass grade or higher for exam questions that were aligned with the transcription play or with the conventional didactic form of teaching.**

**Fig 2: Overall percentage class fail rate for the 1st year physiology subject for the years 2013-2016.**

**Conclusion**

We have clearly demonstrated that when classes are transformed into active learning environments, students benefit not only in terms of satisfaction and enjoyment but also in terms of success within a subject.

**Questions for discussion**

1. Is the success of the active learning strategies like role play mostly/entirely dependent on the teaching academic?
2. Can these active learning strategies be effectively introduced into an online classroom?
3. How could these active learning strategies be further developed or expanded into other disciplines?
References


