COMMITTEE FOR THE ADVANCEMENT OF LEARNING AND TEACHING

FINAL REPORT ON UNIVERSITY TEACHING DEVELOPMENT GRANT

Title of project : Interactive Muscular Avatar of the Hand and Forearm

Project team: Yusuf Cakmak, Senior Lecturer, Department of Anatomy

Brief overview of the project

The aim of the project was to establish a research-led teaching virtual reality platform by developing an interactive tool for students to learn human body movement by practicing and using their own muscles immediately after lectures.
We built an interactive virtual reality application that uses an infrared camera data to detect the actual hand , finger and forearm movement of the users(students in our case) and extrapolates the same movement on a muscular hand avatar that labels and demonstrates the muscles related with the actual movement of the students hand on the computer screen. We collected surveys of 100 students for the hand avatar system.

Introduction

Augmented Reality (AR) systems has been experimented by many researchers in different parts of the body (Liao et al 2010, Nicolson et al 2006, Temkin et al 2006). It has been demonstrated that virtual simulations can be effective for university students to visualise and interact with interbal organs (Sugand et al 2010). Billinghurst(2002) indicated AR technology is suitable for application in education where this technology is valuable and interactive tool in the academic enviroments. Recently, Stanford University-3D4M medical and Case Western University-Microsoft Halolens Collaborated to produce a AR tool to teach human body and muscles.

All of these projects are still away from being motional interactive for students and they can not provide a feature for using a muscle and a related movement interactions. Learning by doing is an essential part of understanding human anatomy and body parts. Current pedagogical practices are limited to limiting in that they do not fully provide students with a full understanding of the biomechanical functions of the body. Furthermore, the inadequacy of cadaver limits students ability perform dissections to deeply under understand the underlying structure and function of human body anatomy. More specifically, there are limited tools available to help students practice in authentic context to learn human muscular system. It is well established that the highest retention rates of learning by Human brain is actually to learn by doing the task that needed to be learned and to some extend being able to immediate contextualise and apply the task. In addition

virtual embodiment is a powerful engagement factor. To address the highest retention rates related learning techniques, e.g. practice by doing and immediate use with AR and virtual embodiment , we developed a working hand and Arm Avatar prototype for all the muscles of the fingers, the hand and forearm muscles. In this innovative tool, whenever a user makes a hand or forearm movement, an infrared cam detects the movement and a software interprets the data and displays the actual position of the hand and arm with the skeleton in addition to highlighting and labelling the muscle/s which is related with the user's movement. In any movement of the fingers, hand and arm, hand avatar follows the user's hand position and mimics the positioning in the display as well as displaying the movement by displaying the corresponding muscle. This project will investigate this latest affordances of AR technology as an interactive form of virtual embodiment in learning human muscular system of the hand and arm.

The main purpose of the current project is:

- to develop an interactive tool for students to learn human body movement by practicing and using their own muscles immediately after lectures to increase the engagement and retention rates.
- to be able to launch a Otago University product to be used by other Universities in the world.
to establish a research-led teaching platform for the use of AR in clinical teaching
to serve an alternative option to the conventional methods of teaching and learning to increase the students' desire of self learning.

Methods or approach

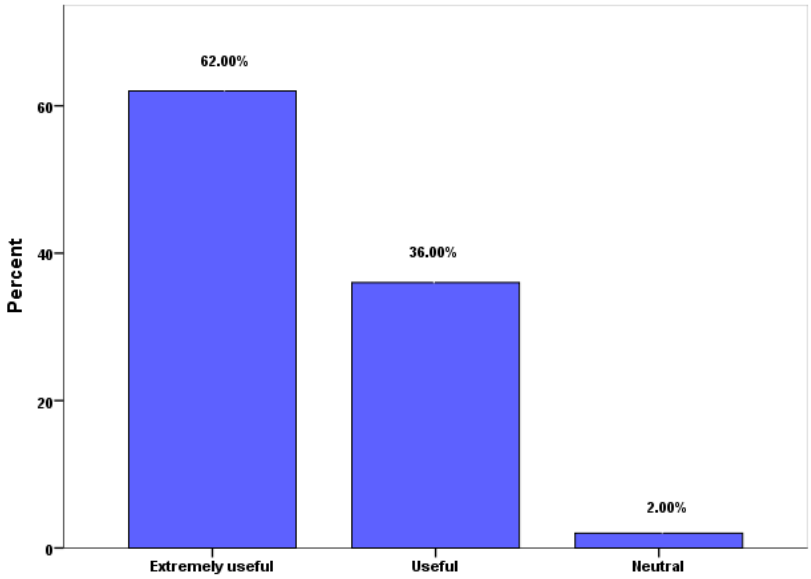
A digital software was developed to detect the finger, hand and forearm movements with a simple camera system. The innovated software interpreted the camera data and extrapolated the relevant muscle function synchronously with the actual movement on a displayed on a 3D muscular hand avatar so that only the active muscle overlaid over the digital 3D hand avatar whereas the other muscles became transparent. This unique tool also used the body ownership as a teaching/learning tool as being an hand avatar of each user. we tested this unique interactive system In the second stage with Medical School students. 100 Students tested the system and filled an online survey for their learning experience. The questions briefly designed to demonstrate to what extent does our system support student learning of hand musculature, the usefulness of the system for students and how did the students engaged with the system.

Key findings, outputs or outcomes

In the analysis of data, students reported enriched learning experience using the developed system. They particularly found the visualisation of their own body in action aspect of the tool intriguing. They also mentioned that through the tool, they were able to integrate theory to practice, and utilise the tool to learn about the human body. This particular outcomes of the study has a greater implication to teaching anatomy to students through their own body, the body ownership.

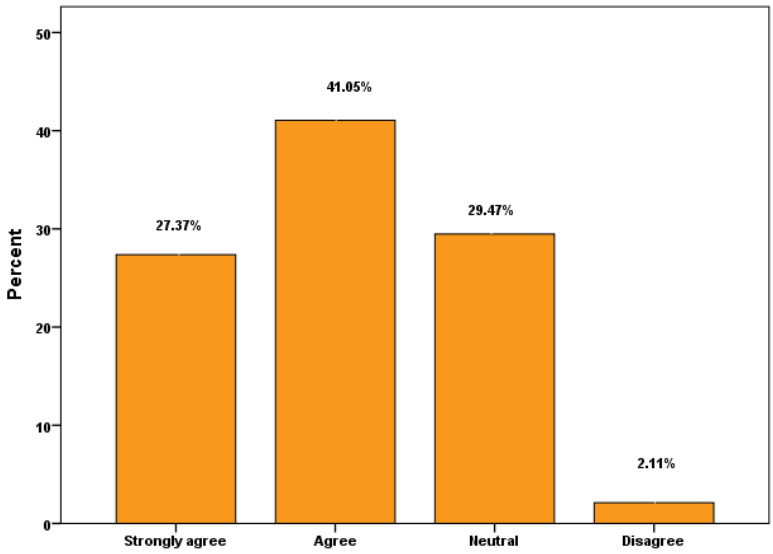
Overall **98%** of the 100 students found the developed interactive body ownership based interactive muscular avatar **useful** to their learning. In addition **62**% of the students found it **extremely useful**. (Figure 1)

Figure 1



The distribution of the student responses to "Overall the new teaching body ownership based interactive muscular hand avatar tool has contributed to my learning" (Figure 2)

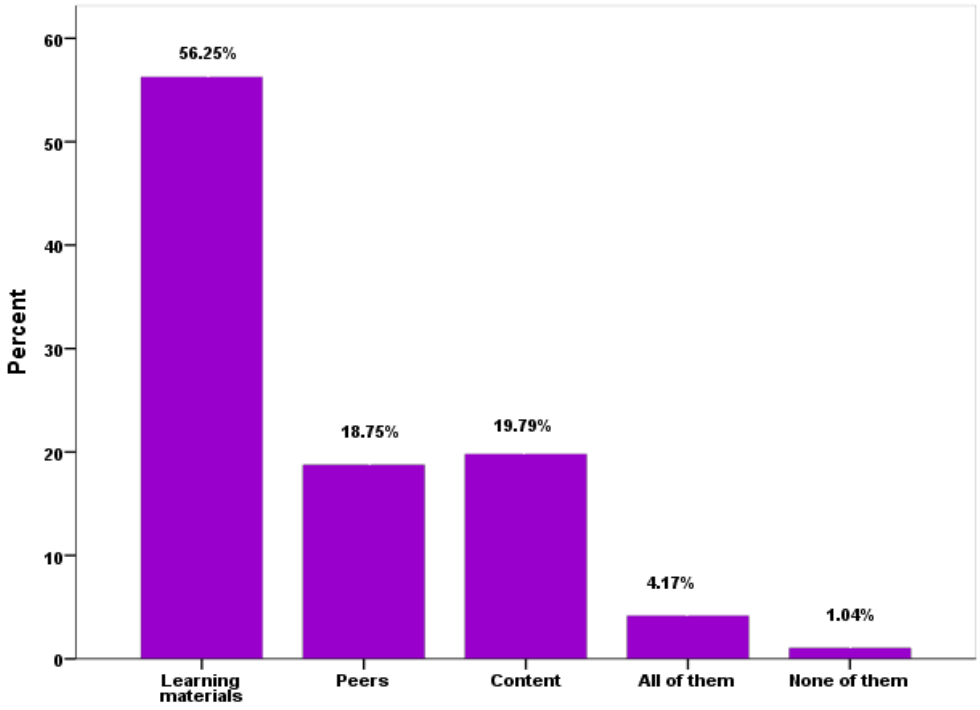
Figure 2



Statistical analysis found that students predominantly felt that the use of augmented reality based interactive teaching tool enhanced their understanding of anatomy and visualizing the movement of the human was very important in integrating contact to practice.

The students reported the interactive hand avatar helped them to engage more with Learning Materials, Peers and the content (Figure3).

Figure 3



Some of the students feedbacks as specific comments:

"The model allows fantastic visualization and detail of structures that would usually only typically be able to be view physically, in a very realistic manner. This is a fantastic teaching tool to aid the understanding of anatomy.

"The ability to visually see what muscles are working in what movements is largely useful."

"It helps in showing a real world application of what we are learning as well as help learn content as you can see, manipulate it in front of you."

"It is engaging and accurate. It allows the user to see the muscular consequences of movements. It was really good because you could get the 3D orientation." "Peers, learning material, content AND lectures it has huge potential. There is no reason why this technology has to exclusively increase your engagement with one of these aspects of university life."

"Lectures could use it for demonstrations, peers could use it while studying together (especially if augmented reality glasses were developed) and of course this gets you engaged with your anatomy content. Imagine if it could show a heart beating, or the lung inflating as well! It would be incredible and this technology is within our grasp if we are willing to invest in it. It can ALSO engage health professionals and help them understand pathology and anatomy better in the clinic."

Learning the muscular system often involves memorising details about each muscle, like where a muscle attaches to bones and how a muscle helps moving a joint. In textbooks and lectures these details about muscles are described using specialised limited vocabulary that is hard to understand and imagine. But this project makes it all much easier as you are seeing your forearm and the muscles inside on the screen simultaneously.

"It encourages active learning, because the ability to visually see what muscles are working in what movements is largely useful."

"It was fun. It means you can actually link a useful and physical stimulus for learning i.e. I can flex my wrist and see what happens under the skin."

"Helped with understanding of real world application of what we are learning as well as help learn content as you can see, manipulate it in front of you."

"Interesting seeing muscles in 3D and what are used in normal movements."
"Great to see all the active muscles night in front of my eyes."

"In using a programme like this it makes it easier to visualise the anatomy on yourself. I am somebody who finds concepts easier to remember if they are portrayed in a way that I can relate back to a real life example and I feel that this software allows this."

Offers practical learning

"Anatomy is best learnt in 3D - AR allows better understanding of the function. It is really useful and good for demonstration of the concept of muscles."

Support effective revision

"So easy and clear, makes learning much easier and can remember in revision."

Real-time Interactive learning

"I think it would provide a good way to learn anatomy without only relying on textbooks. Allowed me to visualise anatomy in real time and would be a great learning tool."

"Interactive and different way of learning anatomy lots of different options for learning muscles individually or altogether."

"It is much more interesting to see it in an interactive way rather than from a textbook -Gives a better representation of the 3D nature."

"Being able to use AR as a learning tool is a brilliant idea."
"Able to relate my own movement to active muscle

“It lets me look at my own anatomy and combine it with reference materials so I can look at movements instead of a static image in a textbook.”

Support different learning styles

“I am a very visual learner. This combines visual input with practical activity.”
“It was interesting seeing stripped back anatomy and muscle involvement first hand while using the arm.”
“It provides a more realistic way for us to visualise muscles. We can learn about them in 3D' in action rather than just memorising wrist they should look like what they do.”

It allows to learning through manipulation of objects

“Very easy to visualise the muscles causing the movements. Great to be able to individually select muscles that are highlighted when active.”

“I like it because you can move it around easily and get all aspects of the specimen. More realistic than anatomy books. Labelled structures are very useful and you don't often have this on the plastinated real specimens. Useful labels and information is just a mouse click away.”

“Extremely useful to see which muscles are active and producing different movements. Great visualizing 3D rather than 2D textbook.”

Useful to see the muscles in 3D and how they work and interact in different movements

Knowledge integration and application

“Visual way of integrating anatomical knowledge with movements. It helps relate structures to movements, helps to understand muscle function.”

“More versatile than just looking in a book, can appreciate the 3D nature of anatomy nerve
Amazing way to visualize interact with anatomy.”

“Able to relate movements to muscles. Exciting tool for both learning and the clinic. The future is now.”

Clinical settings

“I like how you can visualize the muscles -so useful for learning and for patient education.”
“The immediacy of information and action having muscles highlight on activation was very interesting.”
Seeing information in motion means I can engage with it and see active changes as they occur.

Self-directed learning resource

“Students can use them independently or as part of an in-class lesson, and teachers can use them to supplement or replace a traditional textbook. It would be more beneficial for both students and lecturers than any other traditional method of learning anatomy.”

“Learning anatomy without boring books with such an entertaining device is quite usefull and you do not realise how much time you spent on learning this useful and futuristic way of learning.”

“It enables you to associate the movements you are doing with the muscles displayed on screen in real time, as you are moving them. It provides a visual aid to the learning process.

Because it shows exactly what you need to see in order to understand the muscles. More of a detailed whilst a Fun experience in terms of learning.”

“I'm someone who takes time to study because it takes a while to picture what I'm interested in, this is very useful for its enable to show what I'm looking for visibly. Therefore making it easier to visualise vividly.”

“Helps apply learning and knowledge to reality. The model allows fantastic visualisation and detail of structures that would usually only typically be able to be view physically, in a very realistic manner.

“This is a fantastic teaching tool to aid the understanding of anatomy.”
“Its often difficult to visualise the three dimensional movements of muscles at a joint - this made picturing these movements and the muscles involved much easier!”

Discussion and implications

Research output from this work underlines the potential and significance of the new high technological approaches in the form of interactive and body ownership to teaching Anatomy. Overall students responses were very positive to our system. 98% of the students described the new developed tool as useful. The survey results demonstrate a clear improvement in engagement with learning materials, peers and the content. Furthermore, the system developed has been extended to other papers within the anatomy. It has also motivated new research-led teaching initiatives within anatomy. The system had been presented in Science Expo, Anatomy department teaching day in addition to Physical education and Psychology departments. Potential collaborative projects with the system is under discussion. In addition we still improving the system for future applications including mixed reality with Augmented reality(HTC vive) and mixed reality systems (Hololens).

The students feedbacks was also asking for future implementations:
"*The best format to appreciate this technology will be through augmented reality glasses where you could appreciate somebody else's anatomical structure.*

1. Summary of spending –

I also transferred 335NZD from PBRF account for the overspent and the account appeared as zero in March.

UNIVERSITY OF OTAGO
Research Project Report for the period ended 31 December 2016
CALT 2016 Cakmak ¿ Muscular Avatar - 112074.01.S.LA

Full Year Last Year Actual	Full Year Budget This Year			Month Actual	Month Budget	Month Variance		Year to Date Actual	Year to Date Budget	Year to Date Variance		Year to Date Last Year Actual
			INCOME									
			Internal Income									
-	-	7126	Central Committee Grants Received	-	-	-		18,000	-	18,000	F	-
-	-		**Total Internal Income**	-	-	-		18,000	-	18,000	F	-
-	-		**TOTAL INCOME**	-	-	-		18,000	-	18,000	F	-
			Salaries - General									
-	-	2341	Sub-Contractor - General Staff	(7,956)	-	7,956	F	-	-	-		-
-	-		**Total Salaries - General**	(7,956)	-	7,956	F	-	-	-		-
			Consumables & General									
-	-	3216	Equipment Purchases (Minor)	-	-	-		2,677	-	2,677	U	-
-	-	3281	General Materials	-	-	-		1,000	-	1,000	U	-
-	-	3475	Subcontracted Services	7,956	-	7,956	U	7,956	-	7,956	U	-
-	-	7775	Internal General Expenses Other	4,699	-	4,699	U	4,699	-	4,699	U	-
-	-		**Total Consumables & General**	12,655	-	12,655	U	16,332	-	16,332	U	-
-	-		**TOTAL EXPENSES**	4,699	-	4,699	U	16,332	-	16,332	U	-
-	-		***Operating Surplus/(Deficit)***	***(4,699)***	-	***4,699***	U	***1,668***	-	***1,668***	F	-
			FIXED ASSET ADDITIONS									
-	-	8848	Additions - Computers	-	-	-		2,003	-	2,003	U	-
-	-		**TOTAL FIXED ASSET ADDITIONS**	-	-	-		2,003	-	2,003	U	-
-	-		***Surplus/(Deficit) after Fixed Asset Additions***	***(4,699)***	-	***4,699***	U	***(335)***	-	***335***	U	-
			CARRY FORWARD									
-	-		**TOTAL CARRY FORWARD**	-	-	-		-	-	-		-
			OTHER BALANCE SHEET ITEMS									
-	-		**OTHER BALANCE SHEET ITEMS**	-	-	-		-	-	-		-

9961 and 9962: Brackets mean that at the end of the previous year, there WERE funds available to use (i.e. savings).
No brackets mean that at the end of the previous year, there were NO funds available to use (i.e. overspent)

9963: Brackets mean that carry forwards are expected to be USED (i.e. spent).
No brackets mean that carry forwards are expected to be GENERATED (i.e. saved).

Project #	11207401SLA
Division	Division of Health Sciences
Cost Centre	Anatomy
Principal Investigator	Yusuf Cakmak
Funder Body Name	
Total Amount Awarded	$0
Start Date	
End Date	

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2. Other outputs.

a. Teaching or learning resources (digital or paper-based)

Hand Avatar VR Application is distributed in the University of Otago, Science Expo . 9-10 July, at St David Complex and it has a great interest from the public.

A photo of the system in action at Science Expo.

Hand Avatar Application is also set as a working self learning system for the students and visitors to work and play on it in the Trotter's Anatomy Museum.

It was introduced in the departmental web page:
http://www.otago.ac.nz/anatomy/news/otago576405

We are going the present the hand avatar system in ANZACA congress at 2017 Auckland.

It is also submitted as a teaching application to Leap Motion online applications platform.

We shared the application with the anatomy departments of the Columbia University and Koc University.

We are also going to share and implement our application to Samoa University in 2017.

We are preparing the survey results manuscript for Anatomical Sciences Education Journal (2.3 IF) and technical approach to as an another paper to neuroprostetics section of Frontiers in Neuroscience Journal.

Final Report on University Teaching and Learning Development Grant

Developing an AR App for pharmacology teaching

Snapshot:
We have developed an augmented reality app to teach students pharmacodynamics, or how receptors work. The app was designed to highlight the link between common over the counter medications and lecture material. Students use the app (Morpheus) to view a drug packet like paracetamol and a layer of digital augmented reality information appears. This includes a 3D chemical structure of the active ingredient and several quiz questions relating to the lectures. The app was designed to supplement and enhance lecture material rather than replace content. We found that some students really enjoyed using the app but many were too busy with other course commitments to interact with it. A survey was run but a poor response rate (around 2%) limited the usefulness of the responses. From here, we plan to continue development so that it has value beyond NZ (a current limitation) and also increase its educational value for students.

Introduction:
The aim of the project was to develop an augmented reality app for BIOC192 students and investigate it's utility in teaching complex pharmacological topics (drug receptor theory). One of the fundamental concepts in biology is understanding how receptor systems work. This is particularly relevant to the teaching that the Pharmacology and Toxicology Department conducts as receptors are key in the action of many clinical drugs. Therefore, we teach the theory of receptor action at all levels from first to fourth year and across disciplines including medicine, dentistry, science, physiotherapy and pharmacy. However, the initial focus for this grant were three lectures that we provide for the Health Science First Year paper Foundation of Biochemistry (BIOC192). The aim of these lectures is to establish a basic understanding on what a receptor is and how drugs interact with receptors to mediate a therapeutic effect. Receptor theory is the underlying theory that connects the drug to receptor to the clinical effect and is important to the health of the public. For future clinical (medical, dental etc) students, understanding the core concepts of receptors and drug action are fundamental to their study and clinical year. Furthermore, establishment of a core receptor theory concepts in first year allows our lecturing staff at second and third year to investigate more challenging aspects of therapeutics and drug development rather than having to revisit basic material.

Due to the challenging nature of teaching receptor theory: that is describing how a drug binds to a receptor and activate it (a phenomenon that occurs on the sub-microscopic level and cannot be shown in real-time) students often struggle to grasp some of the important nuances of receptor theory. In the lecture setting, the lecturer is trying to engage the student's imagination so that the students 'see' the drug bind to the receptor and activate it. That is, the development of the student's own mental models; a key component of science learning[1]. We ask the students to test these models by turning them into

[1] 1 Gilbert, J. K., & Boulter, C. (Eds.). (2012). Developing models in science education. Springer Science & Business Media.

dynamic, responsive systems[2]. When we test a student's knowledge of receptor theory through exams, we are testing the mental model of a system that they have developed themselves on an event that cannot be seen in real life. Often these mental models take many years to construct and over time students add complexity, however the fundamentals are important. When students first start to construct a mental model of a system it is important that it is correct. Correcting misconceptions in the second and third year is often harder than constructing it in the first place[1]. Therefore, when students are first encountering receptor theory, we want to help them construct accurate mental models of the system. Something they are currently not doing to our satisfaction. We think that using augmented reality may be extremely beneficial in helping students develop their understanding of this complex, dynamic system.
Previous work by researchers and educators in Hungary has demonstrated that students are keen to engage with augmented reality resources and that this engagement can elevate test scores in chemistry[3]. Including augmented reality into our teaching of receptor theory will, therefore, increase both the student's interest in the material and also their overall achievement in this section of the course. From the perspective of the teaching staff they would like to have the opportunity to extend the material and concepts that they teach at second and third year which requires students to have a better overall understanding of receptor theory and its complexities. Many of the teaching staff in Pharmacology and Toxicology would also welcome the opportunity to use the resources that we develop in their teaching modules at a range of levels as they help students understand how drugs act and how molecules disrupt signalling systems.

Methods
Morpheus is downloadable at both the iTunes (https://itunes.apple.com/us/app/morpheus/id1134857192?mt=8) and Google play (https://play.google.com/store/apps/details?id=com.plattar.Morpheus&hl=en).

The Augmented Reality app development was provided by Platter. 3D chemical structures of drugs were provided by Associate Professor Joel Tyndall, New Zealand's National School of Pharmacy.

Due to the app being available via google play and iTunes, anyone could download it so it is difficult to determine the number of the students that can engage with the app. However, the number of downloads that were in Dunedin, the location of the University, at the time of the teaching programme was 431.

Figure 1 illustrates the real world that the students are in (need to get photo). The landing page is illustrated by the second image and is clearly branded by the University of Otago

[2] White, B. Y. (1993). ThinkerTools: Causal models, conceptual change, and science education. Cognition and instruction, 10(1), 1-100.

[3] Pasaréti, O., Hajdú, H., Matuszka, T., Jámbori, A., Molnár, I., & Turcsányi-Szabó, M. (2011). Augmented Reality in education. INFODIDACT 2011 Informatika Szakmódszertani Konferencia.

logo. Students tap on 'let's play. The next page informs the students to find and scan a product. As you can see in the next photo, the 'real world' of where the students are in is clearly seen and superimposed over this is a grid 'tablet' box and text underneath saying 'find and scan a product'. The money available through the Teaching Development Grant allowed us to choose 13 packages for Morpheus. We included both drugs that were taught during the lectures and additional relevant examples of each drug class (Table 1) so that Morpheus could be also be used at a second and third year level. For example, paracetamol was included because the mechanism of action is not known. Considering paracetamol an 'old' drug and its use is widespread we thought that the students would find that not knowing the mechanism of action of paracetamol surprising.

[Figure 1 near here]
[Table 1 near here]
Following scan the product, the chemical structure of the active drug in the package is seen. Furthermore, a multi-choice question is shown – 'Which receptor does [active drug] the active drug in [product], bind to? (Table 1). To answer this question, the students need to consider if the drug binds to a ligand-gated ion channel, G protein-coupled receptor, nuclear receptor or other. In certain cases, the information can be obtained from the lecture notes. For example, in the ligand-gated ion channel lecture, nicotine was discussed acting on the nicotinic receptor which was defined as a ligand-gated ion channel. In other cases, the receptor type was not discussed in class and the student needed to guess or find the information out. If the student tapped on the wrong answer, the phone generated a sound (need name of sound). The student can attempt the answer as many time as possible. When the student answers correctly, a computer animated movie played. This used the same symbols for receptors that were used in the lecture to reinforce key concepts and ideas (right image). The students were then prompted to answer an additional multi-choice question which was 'what type of drug is ….".

Key findings
Two weeks following the release of Morpheus, students were set a link to a questionnaire. Response rates to this were very low (2%) but a summary table of responses is included for reference (Table 2). We worked alongside staff at HEDC to prepare the questionnaire and the plan was to hold focus groups with interested students. However, the low response rates meant that this was not feasible.

[Table 2 near here]

Informal feedback suggests that actually the students valued the app and the novelty factor but lacked the time and motivation to fully engage. We will be trialling the app further with our second year cohort (PHAL211) in the upcoming months which will allow us to gather more data on the learning outcomes linked to the use of the application.

Discussion and implications

Overall, we believe that augmented reality app is a valid educational tool that will expand in scope and application, however, it implementation needs to be carefully thought out. While the lack of survey data hampers detailed analysis of the learning outcomes, informal feedback suggests that the students were excited to see educators experimenting with new technology. Conversations with students confirmed that they wanted to see how the technology was being used, play with it and explore it's learning potential. However, in many cases the students felt that they could not afford the time to "play" with a tool that was not directly assessed and was relevant to such a small portion of the course. During the development, we learned a great deal about the frustrations of this new technology (e.g. having to interact with a screen while holding it fixed on an image, you can't move the camera away from the trigger image or the augmented reality component is lost), however this has lead us to adapt and change the material we use to make it a better fit with the technology. As development tools allow for easier content revisions and more user-friendly experiences we think that the teaching applications will become wider and more interesting. However, we think that what teachers do with the technology is more important than the technology itself. Only good teaching will lead to good augmented reality applications.

Summary of spending

	Month					**Year to Date**				**Year to Date**
	Actual	**Budget**	**Variance**			**Actual**	**Budget**	**Variance**		**Last Year Actual**
INCOME										
Internal Income										
Central Committee Grants Received	-	-	-			18,715	-	18,715	F	-
Total Internal Income	-	-	-			18,715	-	18,715	F	-
TOTAL INCOME	-	-	-			18,715	-	18,715	F	-
Salaries - Academic										
Academic Salaries	-	-	-			4,182	-	4,182	U	-
Total Salaries - Academic	-	-	-			4,182	-	4,182	U	-
Staff Related Costs										
ACC Levy	-	-	-			21	-	21	U	-
Total Staff Related Costs	-	-	-			21	-	21	U	-
Consumables & General										

Sundry Administration Expenses (payment to developers)	-	-	-			14,400	-	14,400	U	-
Total Consumables & General	-	-	-			14,400	-	14,400	U	-
TOTAL EXPENSES	-	-	-			18,603	-	18,603	U	-
Operating Surplus/(Deficit)	**-**	**-**	**-**			***112***	**-**	***112***	F	**-**
FIXED ASSET ADDITIONS										
TOTAL FIXED ASSET ADDITIONS	-	-	-			-	-	-		-
Surplus/(Deficit) after Fixed Asset Additions	**-**	**-**	**-**			***112***	**-**	***112***	F	**-**

Other outputs:
The Morpheus app is available for free download through iTunes or Google Play. We are currently seeking further funding to expand the use of the app so that it can be used worldwide as we have had requests for information from several institutions worldwide. Dr Gliddon is now working at the University of Cardiff and is looking to use the app with her students.
The app has been featured as part of the medical teaching programme in Samoa, in conjunction with curriculum support offered by the School of Medical Sciences.
The app has led to the development of an augmented reality scientific poster (Cows Killed By Swedes) which recently featured at the Society of Toxicology Meeting in Baltimore, USA, and will be shown at both the South Island Field Days and National Field Days in conjunction with Ag@Otago.
Drs Gliddon and Cridge are currently preparing a manuscript on this project for publication in the Journal of Medical Education.

COMMITTEE FOR THE ADVANCEMENT OF LEARNING AND TEACHING

FINAL REPORT ON UNIVERSITY TEACHING DEVELOPMENT GRANT

1. Web-based Report

Project Title: Assessing Medical and Nursing curricula for best practice infection prevention and control: ready for a post-antibiotic era?

Project Team: Linda Gulliver (P.I), Heather Brooks, Joy Rudland, Linda Kinniburgh, Jo Stodart, Rebecca Aburn (Research Nurse) and Kiri Miller (Research assistant)

Project Overview

The World Health Organisation warns of entering a "post-antibiotic era" where multi-drug resistant bacteria and no new antibiotics mean even common infections may prove fatal, as happened prior to penicillin discovery. Our research question: "How prepared are NZ trained doctors and nurses to practice in such an era, where the quality of clinician infection prevention and control (IPC) practice could dictate survival?" We aimed to investigate NZ medical and nursing curricula to map teaching and assessment of asepsis, hand hygiene and patient isolation technique, three key IPC areas. Secondly we aimed to document current methods used to monitor safe IPC practice in the clinical setting. Thirdly, we aimed to perform peer observation of IPC practice on 120 doctors and nurses including undergraduate, early career and experienced practitioners. Clinicians self-evaluated their IPC practice and patients evaluated clinician performance. Recruitment of clinicians and patients continues at this time, with other data sets complete.

Introduction

This study will establish how three key areas of infection control are taught, assessed and monitored in medical and nursing education, with the aim of promoting best practice through curricula and clinical practice innovation.

In his 1945 Nobel Prize acceptance speech for discovering penicillin, Sir Alexander Fleming warned of the potential for antibiotic resistance. Over the ensuing 70 years, the world has been of the view that antibacterial drugs will always cure infections, and that as bacteria developed resistance to one antibiotic, another efficacious alternative would simply take its place. However, only two new classes of antibiotic have been discovered in the last 30 years, while increasingly "last resort" antibiotics, such as the carbapenems, are required to treat common microbes that have become

multi-drug resistant, resulting in severe infections and death (1-4). Furthermore, there is growing concern for increased and unregulated antibiotic use despite measures aimed at curbing such practice (e.g. requesting physicians not over-prescribe and educating patients on correct use of antibiotics)(4). Consequently, the 2014 World Heath Organisation (WHO) report on the global surveillance of antimicrobial resistance has warned that the world is now poised to enter a post-antibiotic era (2). An urgent alternative approach is needed to control rates of all infection and the first step involves the re-examination of some basic but important infection control measures taught to medical and nursing students.

Hand hygiene is central to infection control, so most published studies have concentrated on compliance of nurses and doctors in this area alone when assessing rates of hospital-acquired infections (5)(6). Using the 2009 WHO guidelines on hand hygiene in healthcare (7) such studies consistently report that hand hygiene is poor amongst doctors. Furthermore there is a lack of knowledge in health care professionals as to what constitutes 'safe practice' when it comes to protecting themselves and their patients from transmissible infections (8). This is despite some evidence in medical and nursing curricula for explicit teaching of subjects critical to infection awareness, such as *prevalence* and *transmission*. Research also suggests that education around healthcare-associated infections as a health and safety issue receives little attention in medical curricula (9). Furthermore, assessment of this important component of students' learning is restricted mainly to multiple-choice questions and a small part of the Observed Structured Clinical Exams (OSCE), where time given over to reflective analysis of practice is negligible. Of the limited nursing studies into the teaching and assessment of infection control with respect to hand hygiene, gaps have been also been identified (10-11), however nurses consistently perform better than doctors in practice.

Hand hygiene is only part of the equation, however, albeit a critical part. Patients are also vulnerable to the consequences of health practitioner ignorance of good aseptic technique* and effective patient isolation technique*. A sound procedural knowledge of isolation and aseptic protocols and techniques is essential for safe practice in the 21st century. Procedural knowledge represents the in-practice application of theoretical knowledge gained during health practitioner training/education. In the present study, we propose to simultaneously inquire into the teaching, assessment and monitoring of isolation technique, asepsis and hand hygiene in medical and nursing education and practice. We further propose to identify gaps in nursing and medical curricula that can be addressed to better serve healthcare professionals and their patients in an unprecedented time of microbial threat.

Aseptic techniques are used when performing surgeries and all invasive procedures. *Isolation technique can be both **protective (where the patient's immune system is compromised; e.g. a cancer patient undergoing chemotherapy where common infections can be fatal) and **barrier** (where ignorance of isolation protocol has the potential for the patient, who has a transmissible disease, to infect the health practitioner, who then either becomes sick themselves or becomes a carrier, infecting others)*

Methods

1. **Curriculum mapping** was used to investigate the methods used and the time allocated by two New Zealand tertiary institutions (Otago Polytechnic (OP) and the University of Otago (UO)) to **teach** and **assess** nursing and medical students on the theory and practice of asepsis, hand hygiene and patient isolation, and to provide a comparison across the two curricula.
2. **Southern District Health Board Infection Prevention and Control staff documented all methods used in the clinical setting to monitor practice** of asepsis/aseptic technique, patient isolation/isolation technique and hand hygiene in: nursing and medical undergraduates; early career nurses and doctors (up to 5 years postgraduate); and experienced (> 10 years postgraduate) nurses and doctors.
3. **A Registered Nurse with expertise in IPC performed all peer observation in the clinical setting and documented** levels of practitioner compliance, demonstration of correct procedure and factors impacting on both.
4. **A paper-based questionnaire** was used to collect the same information from **practitioner self-evaluations**)
5. **A second paper-based survey collected information from patients whose student/nurse/doctor underwent peer observation while performing a procedure involving them**. The aim is to gain the patient perspective on perceived levels of hygiene/infection control, and the extent patients feel empowered to request a higher level of practitioner compliance where they feel it is wanting (e.g. request that the doctor wash his/her hands if the patient perceived this was not done)

Results

As outlined in the overview of this study, the third arm of the research (peer observation of clinicians and patient evaluation of practice) is yet to be completed and data analysis will begin at this point. Nevertheless, some information is already apparent. First, we discovered that many of the doctors in our hospital are overseas trained. Secondly, we had to alter the inclusion criteria for our 'early career doctors and nurses from 2 years postgraduate to up to five years postgraduate. This was necessary to capture enough NZ trained doctors and especially, NZ trained nurses, many of whom spend only 1 year in NZ post-graduation and then go overseas, returning after a year or two (or often more). Problems with recruitment have significantly slowed the progress of the study, but as the Project Leader I have been assured that our goal of 120 participants is possible and in time, will be reached. We have also identified a degree of reticence from some clinicians to take part in the study (perhaps fearing a "policing" of their practice, but very likely also due to being in a work environment with stressful working conditions and staffing shortages meaning that staff are time poor). Senior staff have appeared more relaxed in their practice and willing to become participants in the study (especially senior nurses), although many senior doctors perceive themselves as not doing a lot of hands on IPC practice. Curriculum mapping and documentation of the assessment and monitoring of IPC practice in the clinical setting will require in depth analysis and we have engaged Dr Andrew Gray (biostatistician) to assist us with this.

Summary of spending

Please refer to the attached document outlining our expenditure to March 31st. Professor Vernon Squire has given us permission to continue to employ clinical research staff until the end of June to complete recruitment. For this we will require the surplus presently shown.

Outputs

An abstract has been submitted to the Association for Medical Education in Europe (AMEE) conference to be held in Helsinki, Finland at the end of August 2017. We expect to be able to present this data at that time as either a short communication or a poster.

A research paper will be submitted to the journal 'Academic Medicine' or similar, revealing the results of this study, which we see as having potentially far reaching implications for Medical, and Nursing education and practice.

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Clinical Reasoning Peer Assessment: acceptability and comparability of student and tutor ratings

Research Team
Dr Roshan Perera: Principal Investigator
Dr Peter Gallagher: Co-investigator
Zena Lichtwark: Researcher
Dr Estelle Jaine: Tutor/marker

Project overview

Students have limited opportunities to formally undertake peer assessment and provide peer feedback. This project utilized a mixed-methods approach to investigate the reliability, acceptability and utility of peer marking in Y5 medical students undertaking a complex written assignment in Clinical Decision Making.

74% of students awarded higher marks than the tutor, particularly potential distinctions and merit. However, 14% of peer marks were within 1 mark of that awarded by the tutor, and 47% of peer marks were within 5 marks of that awarded by the tutor.

Students' attitudes reflected the uncertainty and lack of confidence in doing something for the first time. The timing of the task close to final exams, and misunderstanding the reasons for its introduction also had a negative impact.

Strategies for skill development include inclusion of greater opportunities for providing peer feedback, with gradual escalation in complexity.

Introduction: context and rationale

Peer-assessment skills are important features of professional life for a doctor. Peer-assessment is described as: "the process whereby participants of similar status evaluate the performance of their peers"(1). A peer can be defined as: " a person who is equal in any stated respect"(2).

The literature acknowledges that the formation of professional behaviours, particularly with regard to interpersonal dimensions, is facilitated and encouraged by peer-assessment and feedback(3). Assessment in undergraduate medical education is, however, largely focused on tutor appraisal, and effective strategies for educating medical students in the necessary skills are not well documented or studied. Peer assessment in education involves: "students looking at each other's work and assessing it against pre-agreed criteria"(6). Peer feedback occurs when students offer advice about their work with respect to what has been done well, what still needs to be done and how to achieve improvement(7).

In undergraduate medical education, students have limited opportunities to formally undertake peer assessment and provide peer feedback. Thus, the required skills need to be developed at a later stage, and arguably, the opportunity to acquire these skills, together with appropriate guidance, should be provided during undergraduate education(3, 8). However, students' ability for critical analysis, their understanding of the criteria and scoring

systems of the assessment instrument, and potential for lenient "friendly" marking, are considerations that make tutors wary of the regular use of peer-assessment, particularly within more advanced aspects of the medical curriculum. Empirical data on the level of agreement between tutor-assigned and student-assigned grades, and student attitudes to, and understanding of, peer-assessment, would facilitate informed consideration of the use of peer-assessment, and serve to inform the assessment choices made by medical educators.

Project aims and objectives

The aims of the study were to investigate:
1) the acceptability of peer marking within a medical student cohort;
2) the utility of peer marking for professional development including self-reflection, and ability to both provide and accept feedback from peers; and
3) the reliability of peer marking.

Methods

The peer-assessment task involved the marking of a complex, clinical reasoning written assignment during the Y5 Clinical Decision Making module. This task was introduced for the first time in the Y5 Clinical Decision Making module at the University of Otago, Wellington, during 2015 (i.e. the year preceding the project).

A qualitative approach was used to explore students' perceptions of the acceptability and utility of the peer-assessment task. A quantitative approach was used to assess the reliability of students' assessments. The qualitative interviews were conducted by a research assistant who was not associated with teaching students, to encourage students to be more open and frank in their responses.

The assignment, peer-assessment task and the planned study were described to the 2016 Y5 cohort at the start of the Clinical Decision Making module, and a description of the study and information sheets were also placed within the CDM Moodle site.

Students submitted their completed assignments electronically via a Moodle Dropbox. All identifying information was then removed by the research assistant, and assignments re-named using a unique identifier code. Separate marker identifier codes were also generated to ensure marker anonymity, and were designed to ensure that students were not sent their own paper to mark. Marker codes were then scrambled and randomly matched with an assignment. Each assignment, together with a marking grid and marking template, were then sent to a student marker. All assignments were also sent separately to an independent tutor for marking. Once the student marking was completed, marking sheets were returned electronically, and identifiers were matched with the appropriate student, and results returned to each student.

Quantitative data

All assignments were marked by an independent academic tutor who was not aware of the identity of the student being marked. For each component of the assignment the scores given by the student marker and the academic marker were compared, and degree of concordance ascertained.

Qualitative data
All 85 students in the cohort, who completed the assignment and peer marking, were personally invited by the research assistant, via email, to participate in the qualitative interviews.

Students were provided with an information sheet and consent form. Interviews were conducted by the research assistant, guided by a semi-structured interview schedule. Student participation was voluntary. Interviews were recorded and varied in length between 10 and 40 minutes. Interviews were summarised, with relevant quotes transcribed verbatim.

Thematic analysis of interviews was conducted independently by all 4 team members and discussed in depth as a group to reach a consensus of themes. Thematic information was sorted using a matrix.

Key Findings

Quantitative: Reliability
Students in general, gave higher marks than the tutor (74%). This was particularly apparent in the awarding of potential distinctions (PD) and merit (M). For assignments where the peer marker had awarded a PD, the student mark was higher than the tutor mark in 26 instances (30.5%), and where the peer marker had awarded a M the student mark was higher than the tutor mark in 31 instances (36.5%). By contrast, where the peer marker had awarded a pass, the student mark was higher than the tutor mark in 6 instances (7%), while the tutor mark was higher than the student mark in 13 instances (15%).
The peer marker and tutor awarded equivalent grades (P,M, PD) in 26 instances (30.5%).

In only 2 instances, were the marks awarded by a student, identical to that awarded by the tutor. However, in 12 instances (14%), the peer mark was within 1 mark of that awarded by the tutor, and in 40 instances (47%) the peer mark was within 5 marks of that awarded by the tutor. Where the tutor mark was higher than that awarded by the peer marker, the difference was greater than 5 marks in 9 instances (10.5%). Where the student mark was higher than the tutor mark, the difference was greater than 5 marks in 36 instances (42%). The highest mark awarded by the tutor was 47/50; the highest mark awarded by a peer marker was 50/50.

Qualitative: Acceptability and Utility
31 students (approximately one third of the class) participated in the interviews over a 4 week period. 17 students participated in one-one discussions, and 14 students participated in groups of between 3 and 4 students per group.

Four overarching themes that impacted on students' perceptions of their ability to provide and accept feedback, were apparent from the analysis of the interviews. These themes were: Experience/ Confidence; Competence/Consistency; Integrity/Fairness; and Legitimacy/Authority.

1) Prior Experience in Marking and Confidence in providing feedback

Many students had little or no prior experience of marking. Thus, while most students felt capable of marking a peer's work, they expressed uncertainty about, and felt they needed reassurance regarding, whether or not they had completed the task appropriately, and/or provided adequate feedback.

Many students expressed an underlying recognition that in order to build confidence in marking and providing feedback, they required practice. Most students found the assignment itself challenging, and felt that completion of the assignment was the most important part of the task and noted that, although somewhat daunting, the process was invaluable. However, the level of insight regarding the utility of peer marking as a teaching exercise to build professional skills in feedback provision varied, with some students regarding it as a useful learning experience, which had given them both an insight into the marking process and into the assignment itself, and others simply as an annoyance with no learning value, which was assumed to have been introduced as a time and cost saving measure.

2) Competence in, and Consistency of peer marking

Completion of the CDM assignment itself required students to demonstrate skills in both Clinical Reasoning and the integration of Evidence Based Medicine skills within clinical decision making.

Students themselves were aware that there would be a range of abilities in either or both skills within the class, and thus there was some doubt as to the validity of the marks either given or received in peer marking. Students who marked an assignment they considered to be of a higher standard than the one they had themselves completed, felt that their peer was someone who had greater ability than themselves, and questioned whether they were themselves sufficiently competent to award marks appropriately. Conversely, students also questioned whether their own assignment may have been marked more harshly by someone who was more highly skilled in the required competencies, than by someone who was less competent.

3) Integrity/Fairness

Many students expressed an expectation that their peers would undertake both the assignment and the marking in good faith, be fair and supportive of each other's learning, and expend their best efforts in the completion of the task. A few students, however, suggested that there was a "feeling in the class of what's the point in trying hard, its just being marked by our peers. It doesn't really matter", and described the assignment and task, in general, as "a waste of time".

These conflicting views were reflected in the very different approaches to marking that were taken by students, with some taking a superficial approach, spending around 20 mins marking the assignment, and providing little or no feedback, and others spending upto 2 hours, using a more thorough approach, and putting in considerable effort to provide constructive comments and point out areas for improvement.

This dichotomy was epitomised in one marker, who, when confronted with the task of giving a failing grade, noted how they struggled with feelings of concern for the failing student for not having developed crucial skills, versus annoyance that the student may have, in fact, put in very little effort, hoping for an easy pass from a peer.

4) Legitimacy/Authority

While many students did believe that the peer marking would be undertaken by most students with a sense of integrity, their confidence in the ability of their peers to mark competently, and provide valid feedback, was in general, not high. Students observed that "when you are marking its actually harder than writing", and although they did not discount the feedback received from a peer, they believed that they would place greater value on the marks and feedback received from a tutor, who was seen to have greater authority in relation to the subject matter, than a peer. Awareness that the marking was moderated was felt to be reassuring, and some were interested in seeing how the marks correlated, in general terms, with a tutor's marking.

Most of those who participated in the interviews, were however, happy with the mark they received, and considered it to be comparable with the amount of effort they had put into the assignment. Receiving constructive feedback from their peers prompted comments from some that perhaps they had not provided sufficient feedback to the person they had marked.

Acceptability of peer marking

The timing of the assignment (towards the end of the year, and close to final exams), influenced student's attitudes and approach towards both the assignment and the extra phase of marking. The views among interview participants was that they would have appreciated the exercise more, and put greater effort into the marking, if the task had occurred earlier in the year.

Additionally, despite the peer marking being introduced in a previous year (2015), and undertaken by the previous cohort of Year 5 students, a number of students in the 2016 Year 5 cohort that participated in the study, appeared to believe (despite the information sheet) that the only reason for introducing peer marking was for the research study. This assumption appeared to increase the negative feelings of students towards peer marking.

<u>Discussion</u>

Overall, the nature of the students' responses with regard to both acceptability of peer marking and their perceived ability to provide appropriate feedback to a peer, reflected the uncertainty and lack of confidence that comes with doing something for the first time. Despite guidance for marking being provided by a marking grid, the complexity of the assignment and the judgement required from students, meant that many felt challenged by the task and uncertain about the accuracy of their feedback.

The criteria in the marking grid provided the only point of reference for students to guide their judgement in marking and providing feedback. This raises the question of whether reliance on these criteria is sufficient to ensure consistency in marking, given that each student only marks one assignment. The tutor in this project, by contrast, marked 85

assignments. Any marker, irrespective of experience would need to establish their own benchmarks according to the marking criteria. Marking more than one assignment would allow students to establish that benchmark. Time and curricular constraints would, however, limit this as a possible option. The level of inter-rater reliability between experienced markers, if more than one tutor marked each assignment, would also be of interest.

Nevertheless, the quantitative results showed that nearly 50% of peer markers were within 5 marks of that awarded by the tutor. Students, however, showed greater leniency towards the upper end (M, PD) of the scoring, most likely reflecting their lower levels of content knowledge and critical analysis with respect to discriminating the finer nuances of the content. This point was echoed in the interviews where students identified their difficulty in providing feedback when the assignment was of high quality.

Some students acknowledged the need for experience in providing feedback, however, many students failed to recognise, until prompted by the interviewer, that the peer marking task could be considered a part of the clinical decision making teaching and learning process, suggesting a need for greater explanation of why peer marking is being used, and how it contributes to student learning and professional development.

Implications and Conclusions

Within the Clinical Decision Making module per se, identifying specific learning outcomes in relation to the assignment and the peer marking process is one aspect that can readily be addressed. In addition, rescheduling the assignment to occur earlier in the year, would remove some of the time constraints identified by students.

At campus level, strategies for skill development would include the provision of opportunities for providing peer feedback, escalating in complexity, to allow students to gain experience and confidence in this vital skill. At the end of Y5, students may potentially be in situations involving “real” patients where peer review and feedback to a peer may become necessary. Greater familiarity and confidence in providing peer feedback would, thus, provide students with skills that would help to promote quality in clinical practice.

Summary of spending

Spreadsheet attached

Outputs

Abstract accepted for oral presentation at ANZAHPE Perth July 2017.

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COMMITTEE FOR THE ADVANCEMENT OF LEARNING AND TEACHING

FINAL REPORT ON UNIVERSITY TEACHING DEVELOPMENT GRANT

Web-based report

Title: Students as co-designers of a Think Aloud (Clinical Reasoning) learning resource

Project Team: Assoc. Prof Ralph Pinnock, Dr Steve Gallagher, Megan Anakin, Gala Hesson, Kate Marsh.

Case snapshot

The purpose of this grant was to co-construct an online learning resource with students to support the development of their clinical reasoning at the Dunedin School of Medicine (DSM). In this project, fourth- and sixth-year students reviewed a resource to identify the features that would be beneficial to their learning, and suggested enhancements, which included the addition of new video-based cases. A prototype resource has been created that includes existing and new clinical reasoning scenarios. Fourth-year students will evaluate this resource later this year.

Introduction

Clinical reasoning is the cognitive processes clinicians use to arrive at a diagnosis based on information from history, physical examination, and investigations (Eva, 2005). Clinical reasoning is crucial to effective clinical practice. However, methods to teach this skill to future doctors are still being developed (Trowbridge, Rencic, & Durning, 2015). To learn this skill, students must transition from taking a history with a comprehensive and highly structured approach to a process that uses focused questioning and involves analysing information while it is being gathered. Errors that occur in diagnosis have been identified and include premature closure, anchoring and confirmation bias (e.g., Scott, 2009). Teaching students about sources of error does not necessarily help to improve their clinical reasoning (Schmidt & Mamede, 2015). Therefore, to assist students in learning clinical reasoning, we involved them in developing resources that would target their learning needs at different stages of their education and demonstrate how to apply a structured process to help avoid errors through video examples.

Methods

The project team began by reviewing the content in a previously developed pilot learning module, and defining the features that they thought might be useful to students in an online learning resource. This process took some time and developed iteratively as the research team's thinking about the best ways to teach clinical reasoning progressed. Two focus groups were conducted with fourth- and sixth-year students. Their opinions were gathered about what would work well in a learning resource about clinical reasoning. This involved critiquing the pilot resource and identifying how to enhance it.

The focus group interviews were recorded, transcribed, and then analysed thematically using a general inductive approach (Thomas, 2006). The themes extracted from the data were used to inform the design and new content required for the online learning resource.
A designer worked with the project team to develop a visual approach to the resource that aligned with student requests. In addition, the designer edited existing video and prepared interactive questions with feedback. These components were built into a prototype online learning resource using Adobe Captivate software. A new video resource has been designed and will be integrated into the resource in the future.

Outcomes and Dissemination

Outcomes of this work include a greater understanding of the learning needs of students in relation to clinical reasoning, and how this can be reflected in an online learning resource. Furthermore, this project has increased engagement among staff members about this process and associated projects. For example, a framework that represents the components of clinical reasoning has been developed to assist students moving from the familiar Calgary-Cambridge style of history-taking learned in their pre-clinical years of study to a focused and context-specific history taking approach that students experience in clinical settings in the later years of their programme. The online resource will be used explicitly in the fourth-year teaching programme at DSM and be made available to students thereafter for independent study and review.

Other Outputs

Conference presentations on the use of the learning resource are planned, and the resource itself will soon be available. Some screenshots are presented below for reference.

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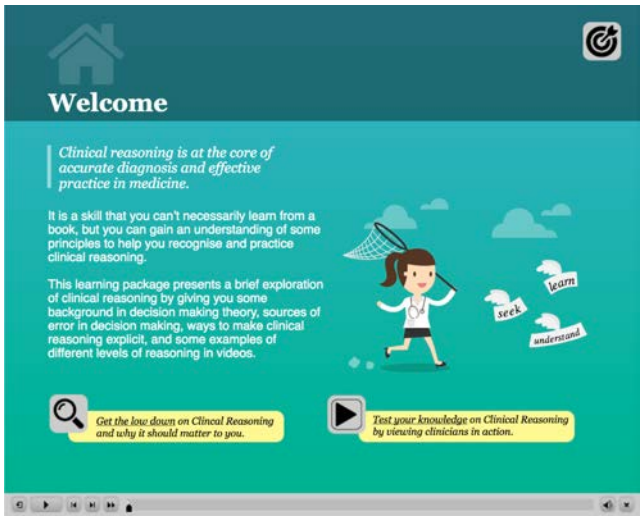
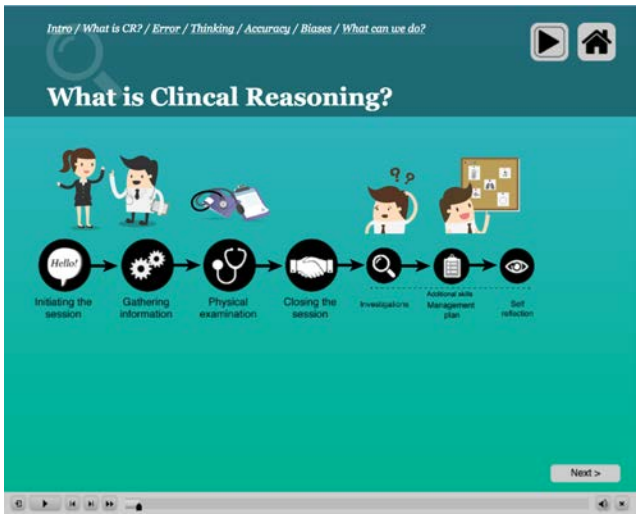
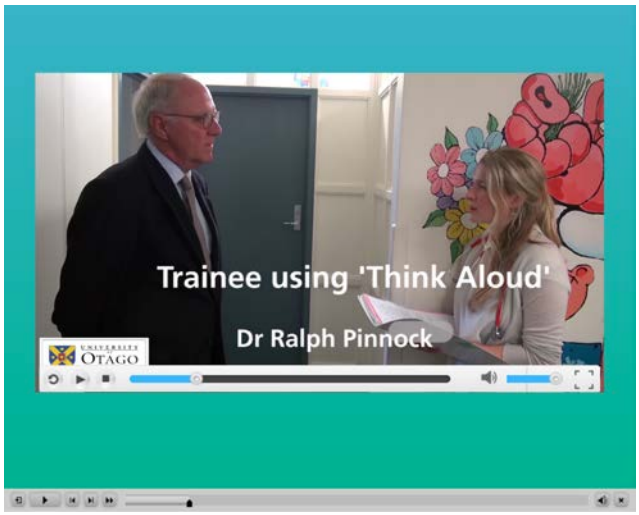
Summary of Spending

See attached report.


Welcome
Clinical reasoning is at the core of accurate diagnosis and effective practice in medicine.
It is a skill that you can't necessarily learn from a book, but you can gain an understanding of some principles to help you recognise and practice clinical reasoning.
This learning package presents a brief exploration of clinical reasoning by giving you some background in decision making theory, sources of error in decision making, ways to make clinical reasoning explicit, and some examples of different levels of reasoning in videos.
learn
seek
understand
Get the low down on Clincal Reasoning and why it should matter to you.
Test your knowledge on Clinical Reasoning by viewing clinicians in action.


Intro / What is CR? / Error / Thinking / Accuracy / Biases / What can we do?
What is Clincal Reasoning?
Hello!
Initiating the session
Gathering information
Physical examination
Closing the session
Investigations
Additional skills
Management plan
Self reflection
Next >


Trainee using 'Think Aloud'
Dr Ralph Pinnock
University of Otago

COMMITTEE FOR THE ADVANCEMENT OF LEARNING AND TEACHING

FINAL REPORT ON UNIVERSITY TEACHING DEVELOPMENT GRANT

Your Final Report to CALT has three main elements: a web-based report (available to the public), a summary of spending, and other outputs.

1. Web-based report.

Title of project and project team:

Cracken Reflexive Thought through Bracken
Steven S. Sexton, Senior Lecturer, College of Education
Sandra Williamson-Leadley, Lecturer, College of Education

Snapshot of the case:

The Master of Teaching and Learning (MTchgLn) programme represents a paradigm shift in the epistemology of initial teacher education (ITE). Student teachers engage with the challenges and issues of practice in a sustained and targeted manner, drawing on research and data acknowledging that the student teachers are competent and capable adult learners who are preparing to be teachers. This approach leads to outcomes that are quantitatively and qualitatively different from those in current ITE programmes. Specifically, this programme addresses the disconnect currently seen between ITE providers and schools. Video capture allowed the MTchgLn student teachers to engage in a community of practice, not to practice skills but to take a data gathering and data informed approach to teaching. Student teachers used videos of own teaching practice data to observe, evaluate, critique and then adapt own teaching to be more effective teachers. Student teachers demonstrated and commented on how they now know more about how students learn, about the learning needs of different communities, and about effective curricular, instructional, and assessment approaches to improve student learning.

Introduction:

Four student teachers agreed to participate in this study (Sexton & Williamson-Leadley, In Press) as they were all in the same partner school, which was an early adopter of using video capturing. Their partner school provided the students time to meet each week to discuss their teaching practice. For this study, the student teachers also meet with supervising lecturers in focus groups prior to sustained placements and then at the end of their ITE programme. These student teachers commented on how through video capturing of own teaching practice they were able to systematically integrated research and evidence-based decision-making into their teaching. They acquired the cultural and pedagogical knowledge, understanding, skills and commitment to teach students in ways that were responsive to diverse needs and backgrounds. Through sharing videos of teaching practice with each other in a community of practice, the student teachers challenged and supported each other to develop deep levels of thinking and understanding of ethical issues,

application and adaptive expertise to engage with learners, not to practice skills, but to take a data gathering and data informed approach to teaching. These videos of practice allowed the student teachers not only to implement the curriculum's inquiry-based approach but also the more intensive and extensive practice with a focus on reflexive practice lead to enhanced learning of their students. These student teachers were able to become teacher researchers as they prepare to move into the profession.

Methods or approach:

This programme's inquiry-based approach in combination with more intensive and extensive professional experience focusing on informed reflexive practice better positions its student teachers to challenge assumptions. Both their own assumptions and those of their students. Student teachers built from difference rather than accommodated for difference. The emphasis on developing reflexive and adaptive practice provided the grounding for these student teachers to think, know, feel and act like teachers.

Key findings, outputs or outcomes:

Student teachers noted the benefits of being able to review their own practice after the fact rather than just remembering what they thought happened. They reported the extra tools included in Bracken were not necessary. Most students saw the greatest benefit of being able to talk to colleagues and supervising lecturers about what happened, what was intended and what assumptions they made, how their students experienced the teaching as they were reviewing the actual teaching experience. This allowed them to critically comment and receive constructive comments on how their adaptions of practice did and did not work as they learn the art and science of being a teacher. They will continue to do this using their own devices. Those students who did use video capturing saw the benefits of being able to go back and review the changes in their teaching presence and how they had adapted their practice. Several student teachers who did not take up this offer, stated they wished it had been mandatory rather than voluntarily.

Discussion and implications:

These student teachers commented in their final focus group on how they will take this practice of videoing own teaching practice to engage in critical dialogues with each other and colleagues in their new schools. As they enter a new environment, they will continue to implement this technology not only to meet the Education Council of Aotearoa New Zealand's Register Teacher Criteria for full teacher registration but also to be more effective in impacting on students' learning. They recommended that this should be a part of their course with video sessions taken at the beginning and end of each block experience to document their development over the course of the year.

2. Summary of spending – see attached.
3. Outputs.

Sexton, S. S. (2016). Cracken reflexive thought through Bracken. Paper presented at the International Council for Associations of Science Education, WorldSTE2016 Conference, Antalya, Turkey (1 – 5 November). p. 119.

Sexton, S. S. & Williamson-Leadley, S. (In Press). Promoting Reflexive Thinking and Adaptive Expertise Through Video Capturing to Challenge Postgraduate Primary Student Teachers to Think, Know, Feel and Act Like a Teacher. *Science Education International, 28*(2). (Accepted for publication in the June 2017 issue – Volume 28, Issue 2)

P**lease return to Ruth Taylor by email and in paper form no later than 31 March 2017.**

Final Report CALT Grant 2016.

Title of Project: Developing the Evidence Base: Learning Outcomes from a High Fidelity Simulation of General Practice.

Project team: Dr Martyn Williamson, Dr Jim Ross, Ms Jessica Young, Mr Tony Egan

Snapshot: The project further developed a thematic analysis of students' reflections of learning from a simulation of General Practice, the Safe and Effective Clinical Outcomes (SECO) clinic. The aim was to validate the findings of the original analysis and to explore the impact of the learning on clinical practice in Trainee Intern (TI) 6thyear. We used an online Delphi technique involving 11 medical education academics from the four medical schools in New Zealand and international. The Delphi group achieved consensus over learning themes of Professional Identity, Self-Awareness, Outcomes/Safe Practice, Relationships, Clinical Ability, Learning Setting, and Engagement/Motivation. We ran six focus groups with TIs throughout 2016. The focus group results showed that students used specific SECO cases to inform practice, incorporated principles of safety netting and searching for red flags into practice, and applied case-specific lessons more generally. The findings confirm the deep and broad learning available from authentic simulation and its retention for use.

Introduction: The Safe and Effective Clinical Outcomes (SECO) clinic is a unique authentic simulation of a General Practice clinic run by the Department of General Practice and Rural Health since 2004. SECO focuses on the clinical outcomes for each patient rather than the process of getting there, and achieves authenticity by allowing access to information resources of the student's choice, phone contact with a colleague for advice, and flexibility over time taken to achieve the outcome for each patient in keeping with the requirements of safe clinical practice [1]. Students are scored against the outcomes to be achieved for each scenario. SECO has both a formative and summative function. Students value the clinic highly because they are able to practice taking responsibility for a patient's care in its entirety [2]. This opportunity is generally unavailable via traditional use of simulated patients, where the focus is typically on parts of the consultation and feedback from the tutor is typically on the process not the outcomes [2]. It is also generally unavailable in the real clinical situation for reasons of patient safety, which prevents students from experiencing the crucial decision making processes involved in patient care.

The SECO clinic has operated as an integral part of the general practice curriculum in the Dunedin School of Medicine since its commencement. We have developed 70 cases covering a wide range of typical general practice problems. Typically students would to do eight clinics over two years, seeing on average three patients per clinic.

We completed an analysis of student reflective essays (Insights into student learning from exposure to a high fidelity simulation of general practice where performance is measured by achieving a safe and effective outcome for patients, 2012 CALT project) in which they reflect on their learning from the clinic. This generated a publication in *Advances in Health Science Education* [2] about the safety of the learning environment, and presentations at international conferences. Additional manuscripts are under development. Our goal in this project was to extend the SECO program to other disciplines across the Otago clinical schools, based on requests from student feedback and backed by evidence from research. During the past 18 months we have we have worked with Keele Medical School, which has trialled SECO for primary and secondary care teaching and Leeds Medical School which has used SECO to train Physician Assistants. We have an ongoing project that adapts SECO for use in training rural nurse practitioners on the West Coast.

This study is part of the larger SECO project (unfunded) which has goals of: maintaining and developing the patient database; developing a secure database for data sharing and analysis with collaborating institutions; promoting the use of SECO in other disciplines and schools; researching the learning and clinical reasoning processes of the students, and the longer term impact of SECO on clinical practice.

HEDC evaluation reports for the Department of General Practice undergraduate teaching in 2010 showed that 93% of students gave SECO clinics the maximum score for value for learning on a 1-5 scale, compared to 62% for sessions with a general practitioner, and 66% for the run overall. We believe that it is essential to be able to demonstrate the value of the SECO technique to other colleagues, over and above the student rating in order to help promote its use in other disciplines as the students regularly request. Faculty who have not experienced SECO for themselves have great difficulty in comprehending the powerful learning which the students report. In addition to providing a mechanism to successfully simulate clinical work, previously not possible, the focus on outcomes for patients which underpins SECO

offers the possibility of subtly but importantly shifting the focus of medical education and assessment onto this important area, which is otherwise very difficult to access.

Project Aims: 1. Validate student learning themes from SECO identified in 2012 study using a Delphi process involving academic faculty (Otago, UK, Netherlands). **2.** Explore the impact of this learning on students' clinical practice in the subsequent TI year.

Delphi Methods: The aim of this part of the project was to validate the student learning themes from SECO identified in 2012 study by using a Delphi process involving national and international academic faculty. The data for the analysis comprised the 58 codes generated from a thematic analysis of 77 4th year medical students' reflective essays. This inductive qualitative methodology has been described fully elsewhere [2]. The research team met to discuss the approach and decided to use an online component to facilitate international participation in grouping the codes into themes. A design thinking exercise was undertaken to identify and understand the challenge of helping students to become doctors who will help patients. This involved divergent ideation and synthesising, refining and evaluating ideas to make the methodological decisions. MW and JY then trialled a grouping process themselves to assign themes to the 58 codes. MW and JY agreed through discussion upon six overarching themes that captured the codes. The six themes were professional identity, self-awareness, outcomes/safe practice, learning setting, relationships and clinical ability. Inter-coder reliability was calculated and found to be a high agreement in MW and JY's coding ($p = 0.08$) Total codes = 61; Total disagreement in coding = 12. These six themes were tested with the others in the research team and the themes adopted for the Delphi tool. An invitation was sent to potential participants that had a brief video describing the SECO clinic and an information sheet. Fifteen medical education experts agreed to take part in the study and they were sent a briefing document about the codes and their definitions plus a link to the online form. Thirteen completed the first round and 11 completed the second round. The online form asked the participants to assign each code to the most appropriate theme. An 'other' theme was available to participants if they deemed additional themes were required. We asked participants to limit the number of additional themes to two and to list the codes associated with these new themes. Participants could also modify the title of an existing theme however no one suggested renaming any themes. Following the results of the first round codes were sorted into three sections under each theme according to how many participants agreed on their inclusion. Section 1. Agreement, more than 50% of participants assigned this code to one theme. Section 2. Disagreement, less than 50% of participants assigned this code to various themes. Section 3. Alternative, more than 50% of participants assigned these codes to a particular alternative theme.

The aim of the second round of the Delphi was to confirm the validity of the codes that were assigned to each theme. We asked participants to indicate if they agreed or disagreed that the codes were a good fit within each theme (accepting that codes can be applied to more than one theme). The results of round two were judged as having consensus if more than 50% of participants agreed.

The additional themes that participants suggested in round one were included in round two. Themes put forward were self-actuation, intra-personal qualities, engagement/motivation, communication, synthesis of multiple components and experience. Three participants suggested one additional theme each. One participant suggested four new themes. Two themes were similar (personality and intra-personal qualities) so they were combined. Participants were asked to consider whether these new themes added to our understanding of student learning in the SECO clinic. If they thought yes, they were asked to confirm the codes assigned to that theme and to add any other codes they thought belonged to this theme. Over 50% of participants thought that the additional themes of self-actuation and engagement/motivation were required. We incorporated the two themes into engagement/motivation because the definition given for self-actuation, "these seem to speak to students driving their own learning, engaging with it and pushing forward. This seems more active than 'student centred learning'" and contained similar elements to literature-based definitions of engagement/motivation. They also both themes had motivation included as a code.

Focus group Method: The aim of the focus groups was to explore the impact of student learning in the SECO clinics and the application of that learning on students' clinical practice in the subsequent TI year. At the end of each quarter in their conclusion week, all students in the group were sent an email invitation and given an information sheet regarding the study on Monday by their administrator. On Thursday before the conclusion session began, we were introduced by their teacher and gave them a paper copy of information sheet in person and asked them to consider staying on to participate. At the end of their session, after a quick break we introduced ourselves as JY was

unfamiliar to most of the students and started the discussion using the following script: "*I'm going to more or less read from the script here because we're doing several TI groups, and we want to keep the instructions the same for everybody. We want to be quite careful about this because we don't want to put words in your mouth. We're not looking for you to please us, or give us the right answers, or anything like that. We're genuinely interested in what works and your thoughts. You have the information sheet and consent form and I'm happy to answer any questions you may have before you sign. If you haven't signed, please sign the consent now, including the demographics questions [age, gender, ethnicity identified with, entry pathway into medical school]. We don't have any role in your assessment so you can speak freely and anything you say will be anonymised. We are audio-recording the discussion to ensure accuracy and the recording will be transcribed.*"
The focus group began with a general discussion about what was useful from their clinical years to prepare for their TI year; then were then told that we were interested in what stuck with them and carried through from ALM into TI year and what's had an impact on their learning. They were given two written questions so we could evaluate what students recalled unprompted. These were then discussed by the group. Participants were then asked "*The clinics emphasised patient outcomes: safety and clinical effectiveness. Have these figured in your thinking while working as a TI? Did those words, concepts occur to you in any of your patient interactions, apart from what you've already mentioned? What I'm asking there is, did you have a kind of raised sensitivity to issues of safety or what might be the outcomes, what's likely to happen here? Did you have any opportunities to apply something you learned in SECO but that you didn't take for some reason or another e.g. didn't occur to you at the time or you didn't have enough say in a patient's care.*"

Students were also asked if there were anything negative things they were left with or feedback they wanted to share with us. Lastly, a written list of selected themes from the essays was provided to students to indicate if they held some meaning or if they recognised them. In the wrap-up students we said "*if you have any concerns about things you said, please let us know now so that we can edit it out*"; no students wanted anything edited out. We asked the participants "*please don't talk in detail about this session to students who have yet to complete this attachment. Chat amongst yourself obviously but we're seeing the other TI groups so we would prefer that you cue them into this stuff. We really are keen to get honest ideas, thoughts that aren't contaminated by suggestions, or anything like that. We want to be sure that when we say, 'Students remembered this,' that that's a truthful statement.*"

Key Findings:

The Delphi group process identified the themes listed below as representative of the codes generated from the original student reflections, and are shown with the relevant codes.

Table of themes and associated codes produced in Delphi study.

Professional Identity	Outcomes/Safe practice	Self-awareness	Learning setting	Clinical ability
Professional identity	Safety	Recognising limitations	Safe supportive environment	Pattern recognition
Transformation	Safety netting	Self-awareness/assessment	Range of cases	Clinical reasoning
Moral engagement	Assessing urgency	Appraisal of knowledge	Simulation	Red flags
Professional behaviour/Boundaries	Checking patient understanding	Embodiment/Self awareness	Learning through experience	Responsiveness to specifics of patient
Responsibility/autonomy	SECO for patient	Emotional response	Debrief	Whole consultation
Coping under pressure	Impact of decisions	Confidence	Feedback	Competence
Performance	Usefulness of outcomes	Learning needs	No supervision	Putting it all together
Impact of decisions	Learning from error	Challenge	Observer role	Notes
Communicate w senior colleagues	Notes	Coping under pressure	Psychological authenticity	Performance
Competence	Putting it all together	Learning from error	Resources when required	Clarity of communication
Motivation	Clarity of communication	Resources when required	Time	Impact of decisions
Uncertainty	Resources when required	Competence	Whole consultation	Uncertainty
Learning from error	Responsiveness to specifics of patient	Fun enjoyment	Fun enjoyment	Challenge
Notes	Strategy	Strategy	Learning needs	Responsibility/autonomy
Purposeful practice	Uncertainty	Usefulness of outcomes	Zone	Zone
Putting it all together	Red flags	Impact of decisions	Purposeful practice	Learning from error
Strategy	Clinical reasoning	Performance	Usefulness of outcomes	Coping under pressure
Collaboration	Collaboration	Purposeful practice	Challenge	Resources when required
Confidence	Feedback	Debrief	Putting it all together	Assessing urgency
Embodiment	Moral engagement	Moral engagement	Learning from error	Feedback
Learning through experience	Trust from patient	Observer role	Motivation	Checking patient understanding
Psychological authenticity		Professional behaviour/Boundaries	Notes	Safety netting
Self-awareness/assessment		Professional identity	Responsibility/autonomy	Appraisal of knowledge
		Empathy	Communicate w senior colleagues	Learning through experience
		Rapport	Competence	Recognising limitations
		SECO for patient	Coping under pressure	SECO for patient
		Transformation	Performance	
			Responsiveness to specifics of patient	
			Strategy	
			Uncertainty	
			Safety	
			Safety netting	
			Clinical reasoning	
			Confidence	
			Emotional response	
			Pattern recognition	
			SECO for patient	
			Transformation	

Relationships	Engagement/motivation
Rapport	Fun, enjoyment
Trust from patient	Purposeful practice
Empathy	Learning through experience
Collaboration	Motivation
Clarity of communication	Learning from error
Communicate w senior colleagues	Recognising limitations
Responsiveness to specifics of patient	Transformation
Checking patient understanding	Debrief
Professional behaviour/Boundaries	Feedback
Moral engagement	Responsibility/autonomy
Emotional response	Usefulness of outcomes
	Challenge

These findings are being used to generate a tool to measure learning these themes in other environments, and also the outputs of learning from SECO when its being applied in other settings with further funding from CALT for which we are grateful.

The results of the focus groups reflected the diversity of learning which could occur for different students from the same simulated case. The table below shows what percentage of students from the focus groups identify learning from selected features or principles of the SECO clinic.

SECO feature/principle	% of students recall
Asking for advice when uncertain	100
Confidence	100
Doing the whole consultation	100
Learning from mistakes	100
Safety netting and red flags	100
Usefulness of having patient outcomes as feedback on your performance	95
Hearing the patient's perspective on your performance	90
Having to make decisions	88
Summarising clearly (for phone doctor or patient)	88
Benefit of not being observed	84
Feeling the responsibility	72
Feeling safe	65
Checking literature/internet	64
Checking patient understanding	60
Thinking about what happens to the patient-best outcomes	56
Becoming aware of differences in values, preferences, between you and the patient	20

Themes emerging from analysis of focus group transcripts are:

- The value of processes students had to use-such as having to synthesise knowledge to work through the case, learning to problem solve to work through case
- The value of the structure of the simulation- such as whole consultation, seeing patient on own, feedback methods
- The value of specific experiences- such as cases and memorable instances within cases
- Students' incorporation of new concepts-such as red flags, safety netting-into their practice.

They expressed the value of learning from experience for the TI year of which SECO was a focussed example. SECO provided specific case exemplars which were particularly memorable if an error occurred and a lesson learnt. Students learnt from the requirement for developing more general but valuable skills such as safety netting, identifying red flags, writing salient notes while maintaining the consultation, asking questions and performing examinations relevant to the needs of the case not by rote, and managing relationships with patients in challenging circumstances.
The importance of practical early learning experiences came through. The simulation provided the same or similar learning to real life and offers the advantage of structure. There were some comments about the potential value of extending the process to other disciplines or environments.

There were examples of new learning related to the transition to practice which were not evident in original essays and there were differences between what students valued immediately afterwards

and then valued later on. The focus groups confirmed that the psychological authenticity of the simulation providing a 'real' experience was important. They were able to reflect upon whose responsibility it was to achieve SECO for patients in real life when working in teams. They reported *safe practice techniques* of looking medication dosages up to be sure, asking for help, (including getting comfortable with that even when discouraged) and applying key lessons learnt such as important aspects of examination even when rushed. They valued their experience of managing specific common presentations. They valued the opportunity to create their own learning which the simulation allowed. Key learning regarding patients was evident in appreciation of the value of understanding patients and also on the impact of how the patients perceives the clinician.

Discussion: The key elements of the findings relate to the value which students place on practical learning experiences which can help them subsequently in practice. An authentic simulation is able to provide this experience in a way which allows individual learning appropriate to the individual, and which is able to be retained and applied when needed. Simulated cases and experiences within the cases provide exemplars which students are able to recall in similar situations to inform practice. Medical education academics are able to agree upon the range of learning available from such simulation. The findings support the role of experiential learning early in medical education. They offer the opportunity to develop further educational tools which incorporate the key features identified and which can be applied to learning diverse topics such as developing professional identity through to clinical ability.

Outputs:
Two presentations from this study have been accepted for the 2017 Australia New Zealand Association for Health Professional Educators conference. The Delphi findings have formed the basis for further work on developing a validate tool for general use. The research team is currently in the process of constructing articles for publication.

Conclusion

This study offered the opportunity to consolidate our previous understanding of what students gain from the SECO clinic and why they value it so much. It provided insights into how useful the students find their learning from the SECO clinic when they are working more independently in the clinical setting, in their TI year. It generated research-informed clinical teaching that engages students in understanding complex clinical problems in authentic environment [3].

References

1. Williamson, M., Walker, T., Egan, T., Storr, E., Ross, J., & Kenrick, K. (2013). The safe and effective clinical outcomes (SECO) clinic: Learning responsibility for patient care through simulation. *Teaching and Learning Medicine*, 25, 155–158.

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3. Working group on the Otago Teaching and Learning Action Plan. (2011). University of Otago Teaching and Learning Plan 2013-2020. Dunedin: University of Otago. Retrieved from http://www.otago.ac.nz/staff/otago027123.pdf