



PROJECT OVERVIEW
(~ 2 min)



CLINIC FLY THROUGH
(~ 6 min)



STUDENT VOICES
(~ 4 min)



BACKGROUND

THE PROBLEM

Globally, students identify physiology as challenging¹, requiring mastery of complex, interrelated biological pathways

AN INNOVATION

On-campus clinics to support mastering of physiology threshold concepts² were extremely popular and improved learning outcomes from 2009-2014³

THE NEW PROBLEM

By 2018, clinic attendance fell below 5%. Students cited personal factors (e.g. work, caring responsibilities) as barriers to engagement

OUR QUESTION

Will re-conceiving physiology clinics for online, self-paced delivery support diverse students to engage with and master physiology?

EDUCATIONAL CONTEXT

- Murdoch seeks to educate students who would not traditionally have had access to university
- Commercial products are great, but unaffordable for many students
- Physiology is taught to biomedical, chiropractic, veterinary and medical students
- Cohorts vary widely in career aspirations (clinical/non-clinical), preparedness for university (ATARs from 70-98), and experience (undergraduate & Masters level)



MURDOCH UNIVERSITY SOUTH ST CAMPUS

ONLINE CLINIC DESIGN

- Five key features were central to the design of online physiology clinics:

Threshold Concept Focus

Clinics were focused challenging concepts that open windows to new ways of thinking (threshold concepts²)

Adaptive Structure

"Choose-your-own-adventure" structure enabled different paths through material depending on student understanding

Rich visuals

Image-based content was used to remove barriers provided by specialist terms and aid pathway visualisation

Rich feedback

Detailed, immediate feedback on student responses to promote active learning and correct misperceptions^{4, 5}

Staff Presence

Conversational language was used to create a "human touch" and build a sense of connectedness with staff^{6, 7}

- The Moodle Lesson tool enabled creation of adaptive, self-paced online clinics, enriched with interactive, visually-rich content created in H5P
- 6 online clinics were modified and embedded in 3 units (BMS206 biomedical physiology, VET271 veterinary physiology and NDM100 medical physiology) between 2019 and 2020

THRESHOLD CONCEPTS COVERED IN ONLINE CLINICS

Threshold Concept	Troublesome Elements	Windows Opened
Equilibrium & membrane potential	Interaction between chemical and electrical gradients; dynamic properties; current, voltage & numbers	Graded & action potentials; synaptic integration; neural network function
Muscle contraction	Dynamic interplay between contractile filaments and elastic elements during contraction and relaxation; interpreting force vs time recordings	Generation of force in skeletal, cardiovascular and other body systems
Efferent nervous system	Gross anatomy and transmitters of autonomic and somatic nervous system (appears incoherent in its complexity)	Control of cells / organs / body systems; homeostasis
Cardiac cycle	Temporal and causal relationships between electrical and contractile activity of the heart	Cardiac output; regulation of mean arterial pressure
Starling Forces	Interaction between hydrostatic and osmotic gradients, conceptualisation of fluid compartments in the body, numbers	Cardiovascular/renal link; flow between fluid compartments; blood pressure maintenance
Acid Base Balance	Concepts around pH and buffers; timeframe of responses to blood pH imbalances; require students to engage with numbers	Interactions between body systems, in context of blood pH homeostasis

FIGURE 2 PROPOSED "THRESHOLD CONCEPTS" COVERED IN ONLINE CLINICS

SAMPLES OF ONLINE CLINICS

On the diagram below, select THREE structural features that enable the somatic nervous system to transmit signals very quickly.

Target Organ

Yes, myelin around somatic axons will increase the speed of signal (action potential) conduction.

1 of 3 structural features.

AUTONOMIC NERVOUS SYSTEM CLINIC

Using the normal values as a reference, drag the blue labels below to show whether each parameter is too high, too low or normal.

PARAMETER	NORMAL	HIGH	NORMAL	LOW
pH	7.35 - 7.45			
pCO ₂	35 - 45 mm Hg			
[HCO ₃ ⁻]	22-28 mmol/L			

pH 7.49
pCO₂ 48 mm Hg
[HCO₃⁻] 35 mmol/L

ABID BASE BALANCE CLINIC

On the diagram below, where is the volume of blood in the ventricle (red line, see arrow) increasing?

CARDIAC CYCLE CLINIC

Have a look at the figure below. How will the series elastic elements (represented by the springs) look in each scenario? (drag the springs)

MUSCLE CONTRACTION CLINIC

In the cell below, which way will the ion move down its chemical gradient?

MEMBRANE POTENTIAL CLINIC

RESULTS

(1) LEARNING BENEFITS OF ONLINE CLINICS

- In 2021 students' final marks were more strongly correlated with clinic use ($r = 0.47$) than with lecture use ($r = 0.32$)
- This suggests clinics provide a stronger learning benefit than traditional resources
- Student comments directly identify clinics as a bridge to higher level understanding:

[clinics] were hard concepts made simple and practical; helped explain concepts I was struggling with BMS206 2018

helped me fill in holes; extremely useful in helping to understand the more challenging concepts BMS206 2021

- Put simply, students credit clinics with their success in BMS206:

clinics developed and solidified my understanding of every topic covered to a level I believe I wouldn't've (sic) achieved had they not been available BMS206 2019

Online clinics are amazing and the only reason I did well BMS206 2018

Without the online clinics I probably would have failed BMS206 2019

Clinics were the most helpful online resources I have ever come across at university BMS206 2018

(2) ONLINE OFFERINGS HAVE HIGH APPROVAL ON STUDENT SURVEYS

- 2019 BMS206 University Unit Survey (US) showed 98.3% overall satisfaction overall ($n = 58$, response rate 30%)
- 100% of 2019 survey respondents found online materials helpful to their learning
- Overall approval has remained well above Discipline and University averages in subsequent years
- Student comments identify flexibility, use of repetition to promote mastery and interactive, engaging presentation as particular benefits:

awesome, repetitive and helped to drill into my brain BMS206 2010

[clinics] explain why the responses I picked were either correct or wrong BMS206 US 2019

[I] used clinics multiple times to practice and understand the concepts thoroughly BMS206 2019

[clinics] not only reinforces (sic) my understanding the concept but [makes the] BMS206 unit so much fun!! BMS206 2019

I found the visual (animated) diagrams easier to understand BMS206 2018

[clinics] provided a way to deeply understand the concepts that could not be conveyed through lecture material alone NDM100 2019

clinics were also great to hammer home understanding as well as work out any kinks of understanding the basics that I wouldn't otherwise have any way of knowing VET271 2022

(3) ONLINE CLINICS BUILD CONFIDENCE AMONG DIVERSE STUDENTS

- Diverse students from different units over multiple years have spoken to IMEAB clinics' impact on their confidence and motivation when faced with challenging material:

As someone who is finding this unit quite difficult already... this clinic was super helpful. It really boosted my confidence when I completed it ... because I actually understood a lot of the questions! BMS206 2021

The reassurance and confidence boosts come from the fact that "ok I've just read this info, now I'm applying it to answer the question. Yes! I've understood, that means I'm learning, I'm not dumb after all and wow look at that I can apply it to the next question NDM100 2021

Even if you get a question wrong, the explanations and opportunity to try again is an excellent self-confidence boost and is also motivating to then keep learning beyond the clinic NDM100 2020

The Clinic is a god send, absolutely genius. I was dreading BMS206 as I felt my knowledge gap between 107 and 206 would be too great, however I am already feeling far more confident about the unit and positive I will [achieve] a much higher mark BMS206 2022

[the clinic] really helped clear my doubts and ... put everything we have learnt into practice VET271 2022

I found [BMS206] the most engaging and interactive of my units... the interactive clinics [were] the most beneficial... [they] helped break the information down for me whilst keeping me engaged and not mentally checking out as my brain does having ADHD BMS206 2022

I have never studied science before, literally didn't even know what is in a cell before this week, so this is all quite brand new and challenging for me. The clinic really helped. Especially having to give answers with reasoning, which meant that I didn't just guess but really thought about it. I also appreciated the "I have no idea" options. NDM100 2021

(4) ONLINE CLINICS DRAMATICALLY IMPROVED ENGAGEMENT

- In 2019, one online clinic was accessed by 141 out of 190 BMS206 students (~ 75%, cf. 5% on-campus attendance in 2018)
- Medical and veterinary science and medical students showed even higher engagement (77% and 83% respectively)
- Many students re-attempted online clinics multiple (2-6) times, despite clinics being optional and not assessed

(5) ONLINE CLINICS CREATE ONLINE STUDENT-STAFF CONNECTION

- Most excitingly, IMEAB clinics have created a sense of connection with staff in a self-paced, asynchronous learning environment:

If this was written by someone else, in a different style, I don't think it would be as effective. I have found all clinics incredibly valuable. NDM100 2022

It was like a digital tutor for the unit. BMS206 2018

Online clinics have been more than excellent. They have provided me with guided assistance to understand key concepts of the course. BMS206 2019

I only used the online clinics once because I went to them in person, but when I used it it was as if I was in the room with Sarah. BMS206

It was as if attending an actual clinic. BMS206 2019

I found [clinics] extremely helpful. It was like having a tutor to work through the concepts. BMS206 2019

TAKE HOME MESSAGES

Today's students are swamped with online materials

Focusing on challenging threshold concepts can focus their attention and be transformative

If students see real value in something, they will do it (without marks or compulsion)

As long as resources are adaptive, feedback-rich and accessible

Many commercially available online resources are excellent

But, if commercial products are inaccessible in your context, in-house versions can be just as powerful

Recognise your role as a curator of, and the voice for, online content

It is possible, and important, to connect with students through online, self-paced resources

FEEDBACK PLEASE

Please use the QR code below to provide feedback or post questions about this work



REFERENCES

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