Student Preference and Perceptions of Asynchronous Online Activities for First Year Allied Health Physiology Blended Block Units

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Abstract

Foundational knowledge in Anatomy and Physiology is integral to all health courses, however, first year students often find the volume and complexity of the concepts challenging (Vitali et al., 2020). Furthermore, our typical demographic student profile comes from a low socioeconomic status with a limited Science background. To help students with their study, health science education literature supports the importance of self-directed study including the use of technology-enhanced learning in blended approaches to learning (Gagnon et al., 2013; Geng et al., 2019). In 2018, Victoria University (VU) launched the VU Block model (where students study only one unit at a time for 4 weeks, for all first year units, (McCluskey et al., 2019). Our design included a blended approach, combining pre and post class technology-enhanced online learning activities and resources supported by face-to-face workshops involving small team based guided inquiry learning with no lectures. Within a block, blended learning environment, little is known about which online learning activities and resources students prefer and engage with. We utilised surveys, student grades and learning analytics to investigate student outcomes including preference for and participation in learning activities. Students preferred and engaged the most with the asynchronous online formative quizzes and H5P learning interactives. Both the number of H5P's and quizzes utilised by students were significant (p=.001, p=.001) in predicting final grade ($F(2,1245) = 102.19$, R^2=.141, p=<.001). Student satisfaction data via the institutional unit evaluation survey was high for our traditional 12- week blended design and reduced for the intensive block mode setting. We suggest that providing students with a variety of asynchronous online learning activities and resources supported the blended design for block.

Key words: online learning activities; block model; first year; anatomy and physiology; self-directed learning; community of inquiry; H5P; active learning; flipped classroom

Introduction

Anatomy, Physiology (A&P) and Bioscience knowledge provide an important foundation for many health courses (Craft et al., 2017; McCuskey et al., 2005; Vitale et al., 2020). For example, nursing literature indicates that students are required to learn adequate bioscience to effectively inform their clinical practice as registered nurses (Craft et al., 2017; Craft et al., 2013). Furthermore, academic success in bioscience, and students perceiving bioscience as relevant to their course, are important for nursing, midwifery and applied healthcare students and ultimately for their professional practice (Andrew et al., 2015; McVicar et al., 2015; Rathner & Kettle, 2019). However, despite the importance of A&P and Bioscience, students find the topic academically challenging (Vitali et al., 2020). Student

characteristics including age at entry, self-efficacy in science, and having appropriate study skills appear to be confounding factors contributing towards the difficulty in the study of Bioscience (McVicar et al., 2015). Learning barriers identified in studying biosciences and Physiology include the lack of time allocated, lack of academic skills, varying teaching methods, failure to appreciate the integrative nature of physiological mechanisms and student anxieties (Jensen et al., 2018; Michael, 2007; Sturges & Mauner, 2013). Discipline related factors (ability to reason causally, consider dynamic systems and understand different levels of organization simultaneously) are also primary factors that make the study of Physiology difficult (Michael 2007).

Balancing the Blend

Although blended learning is a term used frequently as a mode of delivery in higher education, there has been debate about the definition and even the usefulness of the term (Oliver & Trigwell, 2005). Blended learning generally refers to a combination of face-to-face and online learning (Hrastinski, 2019) and can involve the inclusion of online teaching resources to accommodate diverse learners (Alammary et al., 2014). An affordance of the online learning component of blended learning is to provide students with the flexibility of participating in their learning from anywhere and at any time (Bernard et al., 2014). In a meta-analysis of empirical literature, blended learning studies "tended to involve additional learning time, instructional resources, and course elements that encourage interactions among learners" (Means et al., 2013), p. 2). In a review of blended learning literature, Alammary et al 2014 report on three distinct design approaches; 1) Adding extra activities, 2) Replacing activities and 3) Building a course from scratch. These approaches are classified as low, medium and high impact respectively according to the potential for change to the existing course and student learning experience (Alammary et al., 2014). Importantly, the effective integration of the face-to-face and online learning (Garrison and Kanuka 2004), needs to be considered in a "planned pedagogically valuable manner" (Picciano, 2009), p. 8).

COI framework

The Community of Inquiry (COI) conceptual framework which was originally developed as a tool to support learning in the online environment (Garrison et al., 2003), has also been established for supporting learning in blended environments (Garrison & Kanuka, 2004; Vaughan et al., 2013). The COI framework, which is consistent with constructivist approaches to learning in higher education, identifies three elements: cognitive, teaching, and social presence as contributors to an optimal educational experience (Garrison & Kanuka, 2004; Vaughan et al., 2013). Cognitive presence is defined as the extent to which students can construct and confirm meaning through sustained reflection and discourse (Garrison, Anderson & Archer, 2001). "Social presence creates the environment for trust, open communication and group cohesion" (Vaughan et al., 2013, p.11). Teaching presence is associated with the design, facilitation and direct instruction (Vaughan et al., 2013). The three elements are viewed as interdependent, developmental and cyclical in nature (Garrison et al., 2001). The COI has been previously used as a guiding framework to support online learning in a blended environment in a variety of science discipline areas including nutrition (Choy & Quek, 2016) and at least one study in nursing has shown that nursing educators highly rank the core concepts of the COI framework as applicable for online nurse education (Smadi et al., 2019). In this study, we considered the elements of the COI framework to inform the subject design.

Active Learning and Flipped classroom

A variety of science educators have reported on the potential of active learning approaches, mostly in the face-to-face learning environment. A meta-analysis of 225 studies in science, technology, engineering, and mathematics (STEM) fields that incorporated a variety of active-learning interventions reported an increase in student grades and a reduction in failure rate (Freeman et al., 2014). Active learning interventions in science education include problem-based learning, process-oriented guided inquiry learning (POGIL) and peer-led team learning (Eberlein et al., 2008). In 2019,

we previously reported that a combination of active learning strategies including POGIL style and team-based inquiry learning improved student academic outcomes in first-year paramedic bioscience (Sinnayah et al., 2019). In flipped classroom models, students are typically provided with online resources such as videos or readings to complete before class. This allows subsequent face-to face class time to be focused on student-centered activities that promote active learning (Al-Samarraie et al., 2020; Bingen et al., 2019; Ramnanan & Pound, 2017). However, few studies have considered the potential of resources with embedded active learning in the asynchronous online learning environment. This is a factor we have considered in the subject design.

Online Activities and Resources

Studies confirm that engaging learners with content makes the learning process active rather than passive (Zhang, 2006) and this was our intent. The importance of incorporating interactive activities to promote meaningful and active learning has been well established. For example, it has been shown that interactive learning keeps students engaged on task for longer (Stiwinter, 2013). Physiology learning activities when embedded within the learning management system (LMS) are more effective as the visibility of the resources is increased (Snowball, 2014). Indeed, utilising technology for the development of activities allows for flexible access, learners can engage with activities at their own pace and in their own time, (Martin & Martin, 2015; Zhang, 2006) and greater active learning opportunities (Jowsey et al., 2020). Previous studies have reported a variety of preferences for online learning activities including homework tasks in mathematics classes (Brown & Liedholm, 2004; Glass & Sue, 2008).

The VU Block Model and Learner Context

In 2018, Victoria University, Melbourne, Australia (VU) launched the VU Block model which involves students studying only one unit at a time in four-week blocks (McCluskey et al., 2019). The block is delivered in small group classes generally capped at 35, with no lectures with learning supported by a unit space in a LMS. The VU Block model enables students to build a sense of belonging, receive timely, regular feedback, engage in blended, active and collaborative learning with self-contained assessment and not be burdened by other competing unit demands typical of the traditional university experience (McCluskey et al., 2019). In 2020, the VU inaugural first year block model cohort led to improvements in retention and results (McCluskey et al., 2020).

In this study, we focus on the units A&P 1 (HBM1001) (Y1, Semester 1) and A&P 2 (HBM1202) (Year 1, Semester 2) which are first year introductory core units in 5 Bachelor Courses (Paramedicine, Health Science, Midwifery/ Nursing, Nursing, Dermal Science). Each unit has approximately 800 students enrolled per semester. A distinguishing feature of VU's student population is that it features the highest proportion of students who come from non-English speaking backgrounds (NESB), the second highest proportion of students arriving from a low socioeconomic status (SES) or are the first in their family (FIF) to attend university, compared with all other Universities in Victoria (McCluskey et al., 2020; Messinis & Sheehan, 2015; Samarawickrema & Cleary, 2021). Given the typical demographic of the cohort in this study includes students with a low SES and a limited Science background, we wanted to scaffold students with the provision of online, out-of-class asynchronous activities and resources. Whilst a previous study of a first year physics unit at VU in block mode has reported a correlation between student performance in assessment tasks and participation in corresponding blended learning activities (Sidiroglou & Fernandes, 2019), in this study we aim to investigate the impact of our blended block design on student satisfaction, performance and student preference and perceptions of online resources and active learning activities in first year A&P blended traditional and block units.

Research questions
R1: What is the students' preference for and perceptions of the online asynchronous resources and activities?
R2: Did the blended, block design and implementation improve student satisfaction and performance?

Methods

This study was approved by the VU Human Research Ethics Committee (HRE17-192). In 2017, we designed and developed a 12-week blended learning unit consisting of weekly 3-hour lectures, 1-hour tutorial and 2 x2 hour laboratories, supported by pre and post-class self-directed online learning activities (Table 1). We utilized a backward design approach (Wiggins & McTighe, 1998) beginning with the learning outcomes and developed constructively aligned assessments and learning activities (Biggs & Tang, 2015). The elements of the COI framework (Vaughan et al., 2013) were used to inform the subject design. Teaching staff received professional development to support their development of the online learning resources and activities. Online resources were curated and developed specifically for this study. In-class sessions, not the focus of this paper, included active learning strategies described previously (Sinnayah et al., 2019). For the 2018 teaching year of the inaugural 4-week block mode, we built upon the 2017 design by incorporating the VU Block Design Principles (McCluskey et al., 2020; McCluskey et al., 2019), including a focus on knowledge exploration and application, opportunities for early student success with all assessments completed and graded within 4 weeks (Table 1). In 2018, a design team consisting of a team lead, academic staff, learning designer, educational developer, librarian and students as staff, worked together regularly over 8 weeks to create a learning design and to develop the LMS space. Each unit was designed to have three face-to-face workshops (of three hours duration) involving small team- based guided inquiry learning, two labs (two hours each), a computer lab (supported by a facilitator) each week and pre and post class online learning activities with no lectures (Table 3). In 2019, the second iteration of the Block unit was delivered (Table 1).

Community of Inquiry

Our blended learning design approach included mapping the design elements of the A&P units to the three core elements of the COI. The teaching presence included establishing teacher and learner expectations, introducing learning strategies including the self-directed learning, facilitating learning experiences and supporting the pace of learning. With the cognitive presence, students were supported to "construct and confirm meaning" (Vaughan et al., 2013, p. 11), by the teacher monitoring learner progress and shaping constructive exchange, adjusting the lesson plan for diverse learner groups and promoting application of knowledge and concepts. The social presence "environment for trust, open communication, and group cohesion" (Vaughan et al., 2013, p. 11), was supported by teacher encouragement of open discussions in the sessions. Students were also encouraged to use these designated groups or form their own study groups outside of class.

Online asynchronous out-of-class resources and learning activities

We provided students with an opportunity to engage with asynchronous resources, (reading or listening to 'passive' content such as readings, videos, vodcasts), and learning activities (questions to promote active learning) before class. Where possible, the resources included embedded questions (multiple choice and true/ false questions) as ungraded formative practice (learning activities) and instant feedback provided to exemplify the concept of active learning (Glass & Sue, 2008).

Table 1. Units, Duration, Mode of Delivery, Key Design Inclusions, Discipline area and Student Characteristics.

Year	Unit/s	Duration	Mode of Delivery	Key Design Inclusions	Discipline area	Student Characteristics
2017	HBM1001 HBM1202	12 weeks	Blended (online self-directed learning activities + face-to-face lectures, tutorial & laboratories)	Backward and Blended design with Community of Inquiry Framework (Wiggins & McTighe, 1998, Vaughan et al., 2013)	Paramedicine, Midwifery	Mature Age No science pre-requisites but ATAR required
2018	HBM1001 HBM1202	4 weeks	Block, Blended (online self-directed learning activities + face-to-face workshops & laboratories)	As stated above plus: Block model principles (McCluskey et al., 2019)	Paramedicine Midwifery	Mature Age No science pre-requisites but ATAR required
2019	HBM1001 HBM1202	4 weeks	Block, Blended (online self-directed learning activities + face-to-face workshops & laboratories)	Second iteration of Block with updated LOS, additional online learning activities and Panopto vodcasts	Paramedicine, Midwifery, Nursing, Dermal Science, Health Science	As above First in Family, low SES, Non-English speaking background No ATAR

ATAR- Australian Tertiary Admission Rank, is an Australian entry score system for entry into undergraduate Higher Education (Baik et al., 2019).

Table 2: Student demographics, with all data expressed as a percentage of total unit enrolments.

	HBM1001			HBM1202		
	2017	**2018**	**2019**	**2017**	**2018**	**2019**
Age (years)	%	%	%	%	%	%
≤19 yrs	55.7	40.8	58.6	40.2	41.5	55.4
20-25 yrs	24.2	33.1	21.4	30.6	32.6	24.3
≥26 yrs	20.1	26.1	20.0	29.2	25.9	20.3
Gender						
Female	58.8	59.2	81.8	58.0	58.1	80.6
Male	40.2	40.8	18.2	42.0	41.9	19.4
Socio-Economic Status						
Low	12.3	12.9	15.9	10.5	13.0	16.6
Med	57.9	49.6	56.1	56.7	49.5	55.0
High	29.8	37.5	28.0	32.8	37.5	28.4
First in family						
First	56.0	55.0	58.0	53.0	55.0	58.0

learning was then reinforced in small, face-to-face, workshops with a facilitator led review of key concepts and a subsequent focus on team based guided inquiry learning, as previously reported (Sinnayah et al., 2019). Students subsequently had the opportunity to revise and practice these activities 'Post-class' in their own time. The resources and learning activities were made available to students via the University LMS in folders labelled as 'Pre-class', 'In-class' and "Post-class".
We created a variety of pre and post class online A&P learning resources and activities drawing upon a range of digital tools integrated or linked via the LMS. Online resources included study notes of chapter summaries from the prescribed textbook for pre-reading and to cater for students who could not afford to purchase the textbooks, content developed using H5P, Videos built using Panopto, Anatomy TV and vodcasts (Table 3). H5P is an open source interactive software integrated with the Learning Management System, that allows for creating self-paced online activities and content interactions https://h5p.org/content-types-and-applications. Interactive activities are where students can apply their learning by trialling and checking their knowledge in a simulated environment. H5P is an easy to use content creator, with multiple content types (Sinnayah et al., 2021), of which the units in this study mostly utilised course presentations, interactive videos, quizzes, multiple choice questions, drag and drop diagrams and sentences. Appropriate AnatomyTV resources were sourced from the database (Primal-Pictures, 2019). In addition, AnatomyTV clinical studies/applications were used for in-class inquiry-based learning, where application of concepts was explored. A combination of short recordings of past lecture audio/ video (vodcasts) and new vodcasts were created to support students with learning outcomes they typically find challenging.

Student performance and satisfaction
To determine student performance, we extracted student grades and learning analytics via the LMS from 2017 to 2019. In 2018 and 2019, given the units were delivered in repeated blocks, data was extracted and analysed for the two units with the largest student enrolment. In 2019, the units were available to students enrolled in an additional three degrees. Descriptive and inferential statistical analyses were undertaken aided by IBM SPSS Statistics for Mackintosh, Version 27.0 (Armonk, NY: IBM Corp). One-way analysis of variance (ANOVA) was used to determine grade differences between student cohort and delivery. When main effects were significant, Post–hoc comparisons were performed using Grams-Howell statistic for unequal sample sizes. In all instances a p value of <0.05 was regarded as significant.

Student satisfaction data was obtained from VU institutional student evaluation unit (SEU) surveys. Qualitative data from the 2017-2019 SEU surveys was analysed using thematic analysis as per previously published guidelines (Kiger & Varpio, 2020) and established protocol (Braun & Clarke, 2006). Steps undertaken to sequentially identify themes and analyse the data set involved 2 authors independently reviewing comments and generating initial codes, then agreeing on themes into which comments were categorised according to their initial code. Descriptive statistics were used to calculate the final themes generated (Table 6). Representative quotes from SEU data (3 comments for each theme) were tabulated with reference to the data set (Table 7).

Students preference for and perceptions of online resources and learning activities
We utilised student-learning analytics to determine students' participation in activities and a survey to evaluate student perceptions and preference for learning activities. Further analysis was performed on the usage rates of H5P and quiz interactive activities, as these were the two resources and activities that the students engaged with the most. Data was extracted from the LMS and collated using Microsoft excel. Correlation and multiple linear regression was performed using SPSS to assess the effect of usage rates on final grade. Correlation and regression was repeated after separating students into performance quartiles in order to determine if engagement effects on final grade were maintained.

Table 3: Extract of Design of Blend for Block Mode (2018) for HBM1001 Anatomy and Physiology Week 1.

	Week 1		
	Session 1	**Session 2**	**Session 3**
Topic	Body Organisation & Homeostasis.	Cell Structure & Function. Tissue & Skin. Basic Chemistry.	Microbes & Infection.
Learning Outcome Mapping (LO's)	• Review the structure and levels of organisation in the body (from basic chemistry to organelles to cells) to the functions of cells, tissues and organ systems. • Examine the concepts and processes of homeostatic regulation and feedback loops to describe the mechanisms underlying normal functions of the human body. • Apply knowledge and understanding of human organ systems to clinical scenarios through laboratory experiments and activities, and team based guided inquiry learning.	• Examine the concepts and processes of homeostatic regulation and feedback loops to describe the mechanisms underlying normal functions of the human body. • Apply insights of the structure and function of human organ systems to clinical scenarios through laboratory experiments and activities, and team based guided inquiry learning.	• Examine the basic concepts of microbiology, infection prevention and control in relation to the human body. • Apply insights of the structure and function of human organ systems to clinical scenarios through laboratory experiments and activities, and team based guided inquiry learning.
Pre-class activity, Online resources and active learning activities	a) Review study notes with LO's. b) Online quiz and/or c) Review H5P learning interactives.	a) Review study notes with LO's. b) Online quiz and/or c) Review H5P learning interactives. d) Pre-lab video. e) Pre-lab worksheet.	a) Review study notes with LO's. b) Online quiz and/or c) Review H5P learning interactives. d) Pre-lab video. e) Pre-lab worksheet.
In-class Workshop	1. Introduction. 2. Teacher-led presentation of key concepts. 3. Team based-guided inquiry and case studies. AnatomyTV clinical studies/applications 4. Create concept maps. 5. Kahoot polling.	1. Introduction. 2. Teacher-led presentation of key concepts. 3. Team based-guided inquiry and case studies. AnatomyTV clinical studies/applications 4. Create concept maps. 5. Kahoot polling.	1. Introduction. 2. Teacher- led presentation of key concepts. 3. Team based-guided inquiry and case studies. AnatomyTV clinical studies/applications 4. Create concept maps. 5. Kahoot polling.
In-class Laboratory		<u>Lab session 1</u> Lab Safety. 1. Diffusion and osmosis. 2. Tissue/skin.	<u>Lab session 2</u> Infection Control part 1.
Assessment		<u>Post Lab worksheet 1</u> A. Osmosis. *B.* Infection control.	
Post-Class Activity Online resources and active learning activities	Review and consolidation of pre and In-class activities. • H5P learning interactives. • Anatomy TV. • Review A & P Text.	Review and consolidation of pre and In-class activities. • H5P learning interactives. • Anatomy TV. • Review A & P Text.	Review and consolidation of pre and In-class activities. • H5P learning interactives. • Anatomy TV. • Review A & P Text.

The performance quartiles were determined for each study block to account for any differences between blocks. The first quartile consisted of students with final scores equal to and below the 25th percentile, the second quartile consisted of the middle 50% grouped 25% either side of the median,

and the third quartile consisted of students who scored equal to and above the 75th percentile in each study period. Students who withdrew from the unit were manually removed from the data set and excluded from analysis of LMS data.

Results

Student performance

Overall, 1248 students were included in the data set for the three-year period. In 2017 paramedicine and midwifery/nursing students (n=237) had an average final grade of 75% ± 11 (Table 4). In 2018 and 2019, across the 5 cohorts students had an average final result of 80±8 (n=399) and 74±12 (n=672) respectively (Table 4).

There was a main group effect of block delivery on final grade, F_{Welch} (4,546.01)=24.219, p=<.001. Post hoc Grams-Howell test for multiple comparisons revealed that both delivery blocks in 2018 scored higher than 2017 and 2019 by an average of 5.4±0.9 grade points. The 2018 block 2 scored higher then 2017 (p<.001, C.I = [3.1,8.0]), 2019 block 2 (p<0.001, C.I = [3.8,8.2]), and 2019 block 3 (p<.001, C.I.= [4.0,8.9]). Similarly, 2018 block 3 scored higher then 2017 (p,.001, C.I.= [1.6,6.9]), 2019 block 2 (p<0.001, C.I.= [2.4,7.1]), and 2019 block 3 (p<0.001 C.I.=[2.6,7.8]). There was no significant difference between delivery block in 2018 (p=1.0 C.I = [-1.1,3.6]).

There was a significant main group effect for student cohort on final grade, F_{Welch}(4,89.42)=45.02, p=<.001. Grams-Howell post hoc test for multiple comparisons found the final grade score for Paramedicine students was 3.4 points higher than Nursing/Midwifery (p=.002,95%C.I.=[0.88,5.79]), 5.0 higher than Nursing (p<.001, 95%C.I.=[3.09,6.96]), 13.8 higher than Health science (p<.001, 95%C.I.=[10.55,17.16]), and 14.02 higher than Dermal sciences (p=.002, 95%C.I.=[5.15,22.89]. Midwifery/nursing scored 10.5 points higher than Health science (p=<.001, 95% C.I = [6.67,14.37]), and 10.68 points higher than Dermal science (p=.016, 95% C.I =[1.67, 19.70]). Nursing students scored 8.8 points higher than Health science (p<001, 95% C.I =[5.27,12.39]) and 9.0 higher than Dermal science (p=.048, 95% C.I = [0.64, 17.92]). There were no significant differences between Health sciences and Dermal sciences (p=1.00, 95%C.I=[-9.03,9.35]) or between Nursing and Midwifery/nursing (p=.465, 95%C.I=[-1.11,4.48]).

Student Satisfaction

There was an average response rate of 40% for SEU data received across years 2017-2019 spanning the traditional and block offerings. Students were satisfied with the units (average 85% from Qs1-5 HBM1001 and HBM1202) (Table 5). In 2017, students were highly satisfied with the unit (average 90% from Q1-5 HBM1001 and HBM1202). There was a decline in satisfaction levels in the first instance of the block mode delivery in 2018 (first block for each semester with an average of 66% from Q1-5 HBM1001 Block 2 and HBM1202 Block 1) with improvement in subsequent iterations. Overall, students were satisfied with block mode delivery which improved from 2018 to 2019 (Q1-5 HBM1001 and HBM1202: average of 71% for 2018, compared with average of 84% for 2019). Despite high student satisfaction with various aspects, such as, 'the activities helped me to learn' and the "learning resources were relevant and up to date', for the block units students rated the question "the workload in this unit was reasonable" poorly (Q6: average 51% for block units compared with average 73% for 12 week units Table 5).
The issue of workload was also seen as an emerging theme in the qualitative analysis (Table 6 & 7).

Table 4: HBM1001 average final unit grade (n=1248). Grade data for HBM1202 were comparable and are not shown here.

Year	2017	2018		2019	
Delivery	12 Week	Block 2	Block 3	Block 2	Block 3
Final Grade (%)	75 ± 11	80 ± 8*	79 ± 8†	74 ± 11	74 ± 12
Paramedicine	76 ± 11(n=179)	81 ± 8 (n=140)	79 ± 8(n=130)	79 ± 8(n=95)	79 ±9(n=98)
Midwifery/nursing	71 ± 11 (n=58)	79 ± 8 (n=65)	75 ± 7(n=4)	77 ± 11(n=22)	67 ± 0(n=1)
Nursing	-	-	-	73 ± 12(n=249)	75 ± 11(n=118)
Health	-	-	-	64 ± 9(n=13)	65 ± 10(n=60)
Dermal	-	-	-	65 ± 15(n=7)	64 ± 7(n=8)

Mean ± SD grade of students in each Block.
*Note: * P value <0.001 between 2018 Block 2 and 2017, 2019 Block 2, 2019 Block 3. † P value <0.001 between 2018 Block 3 and 2017, 2019 Block 2, 2019 Block 3.*

Table 5: HBM1001 and HBM1202 2017-2019 Institution Student evaluation of unit (SEU) data

SEU data HBM1001 2017-2019		% AGREE					
		2017	2018			2019	
		Sem 1	Sem 1			Sem 1	
Question Order No.	**QUESTION**	**12 Week**	**Block 2**	**Block 3**	**Block 2**	**Block 3**	**Block 4**
1	Overall, I'm satisfied with this unit.	92.5%	47.9%	75.0%	80.9%	84.7%	86.8%
2	The expectations were clear.	92.5%	57.5%	72.2%	83.3%	84.7%	88.7%
3	The activities helped me to learn.	83.0%	59.2%	77.8%	78.6%	82.0%	90.6%
4	The learning resources were relevant and up to date.	92.5%	77.5%	88.9%	89.8%	88.7%	90.6%
5	The assessment tasks clearly evaluated the learning outcomes.	88.7%	62.0%	80.6%	87.9%	88.0%	86.8%
6	The workload in this unit was reasonable.	66.0%	28.2%	58.3%	53.5%	57.3%	67.9%
SEU data HBM1202 2017-2019		% AGREE					
		2017	2018			2019	
		Sem 2	Sem 2			Sem 2	
Question Order No.	**QUESTION**	**12 week**	**Block 1**	**Block 2**	**Block 2**	**Block 3**	**Block 4**
1	Overall, I'm satisfied with this unit.	84.1%	48.0%	67.3%	81.4%	81.0%	80.0%
2	The expectations were clear.	93.2%	79.2%	75.0%	89.0%	81.0%	80.0%
3	The activities helped me to learn.	86.4%	80.0%	67.3%	86.2%	76.2%	80.0%
4	The learning resources were relevant and up to date.	90.9%	76.0%	76.9%	89.0%	81.0%	80.0%
5	The assessment tasks clearly evaluated the learning outcomes.	95.5%	68.0%	75.0%	86.9%	85.7%	60.0%
6	The workload in this unit was reasonable.	79.5%	32.0%	40.4%	68.3%	61.9%	40.0%

Qualitative analysis was performed on Student Unit Evaluations data for HBM1001 and HBM1202 A&P units from 2017-2019. Common themes were extracted (Table 6) and examples of student comments for the most prevalent themes (learning resource, content and block model/time) were chosen within a positive and negative context (Table 6). Results indicated that students had a positive experience with various learning resources provided within the unit, enjoyed the content and facilitators teaching into units. Results also indicate strong, negative student attitudes correlated to the amount of theory content delivered during the time intensive block model experience (Table 7). Resounding themes evident in data included students' negative perception of a high workload throughout the units due to too much content within a short period of time (block model) (Table 7).

Table 6: Total Number of Positive and Negative Comments and percentage (%) coded for Themes.

THEMES	DESCRIPTION OF THEME	# Positive coded COMMENTS	% Positive coded per theme	# Negative coded COMMENTS	% Negative coded per theme
1. Learning Resources	study manuals, online quizzes, H5P modules, pdf notes	185	25.5%	88	9.4%
2. Content	subject topics, organ systems	302	41.6%	397	42.4%
3. Group Work	collaborative tasks in class	41	5.6%	9	1%
4. Facilitators	academic teaching staff	124	17%	51	5.4%
5. Class Size & Schedule	student numbers and timetable	7	1.3%	49	5.2%
6. Block Model/Time (2018-2019	intensive 4-week learning mode	23	3%	302	32.2%
7. Assessments	tests, team quizzes, lab worksheets	43	6%	41	4.4%

Qualitative analysis was performed on Student Unit Evaluations data for HBM1001 and HBM1202 Anatomy & Physiology units from 2017-2019. SEU comments often contained both negative and positive feedback and pertained to several themes. Common themes were extracted and total positive comments (725) and total negative comments (937) were calculated according to themes.

Table 7: Examples of Positive and Negative Student Comments for the Most Common Themes

THEMES	POSITIVE COMMENTS	NEGATIVE COMMENTS
1. Learning Resources (2017- 2019)	1. "The best aspects were all of the information available. There are so many resources that gave me lots of extra help." 2. "I really appreciated having the learning interactives. They were a great way to get a little extra clarification on difficult content. Weekly quizzes were a great way to make sure we stayed up to date with the content. I think the lecturers for this unit really went above and beyond for us students and I really appreciated it." 3. "All the support with the learning interactives was amazing, they really helped integrate the learning." 4. "I really enjoyed the H5P interactive parts of the unit, they helped to consolidate the knowledge learned from the slides."	1. "More practice quizzes and more h5P activities as they are the only thing that helped me learn properly. Anatomy TV was confusing and slow." 2. "Giving more resources such as quizzes and more practice test could be beneficial in learning." 3. "More practice tests and quizzes. More involvement with other people in the class." 4. "I found the collaborate page was hard to navigate due to the large amount of resources. rather than putting every link in, perhaps use the first class to go through anatomy TV and then its the student's responsibility to use it or not."
2. Content (2017- 2019)	1. "The best aspects of this unit were how well the content and information learnt relates to everyday understanding of how the body works and how intertwined it is in daily life not just in the medical field. I enjoyed learning about the cardiovascular system and the different online tools that we had access to help the studying of these difficult subjects." 2. "The best aspects were the quality of most lectures, the quizzes were fantastic as were the Labs, the recordings have been a life saver for me so I can watch them again the consolidate my learning. I think it is a fantastic model having a lecture, Lab, tute to all consolidate the weeks topic. Most people would find 2-3 helpful with their learning." 3. "Plenty of relevant subject material provided for each component of the unit. Laboratory work was engaging and interesting. An abundance of quizzes to assist with learning." 4. "The content itself was very engaging and it was clear that an obvious effort had been made to tailor this to both a Paramedic and Nursing perspective, rather than assuming we were all going on to study Anatomy or Physiology as a major."	1. "Unsure - most of my learning was self-directed at home." 2. ". It could be improved better by relating as much content and workload to real life scenarios to further benefit nursing and paramed students to help get their minds into thinking how relatable and important the content is." 3. "More online interactive learning will help." 4. Teaching staff taking lab classes could be more understanding and patient, not everyone has been in a lab before so explaining what the session will be doing*step by step and clearly would be helpful."
6. Block Model/Time (2018-2019)	1. "Loved being able to do the unit in the block model. It allowed me to focus on one subject without being distracted by other units. Even though there was a significant amount of content for the four weeks, I felt it was managed and taught well, and the assessments were fair. I'd love to see the whole degree being offered in the block format." 2. "I loved the block model for this unit because I think I would have struggled to concentrate on any other subject at the same time as focusing on A&P." 3. "As A&P has such a heavy content load, it was nice having the first-year model to help with studying and concentrating just on A+P. Also having only 3 days at uni helped, as I had days off where I could catch up on study." 4. "I loved that we had three hour workshops. I think that's the perfect amount. 2 hours would have been too little and 4 hours far too long. I loved that it was 3 days a week rather than spread out across the week even more."	1. "I still think A&P would work better over two blocks, so it isn't as rushed. Maybe pairing it with an easier subject to do at the same time." 2. "Less rush and need to put as much work into 4 weeks as they can. Anatomy and Physiology is something that needs longer than 4 weeks to grasp." 3. "There was a lot of content to cover within a small amount of time." 4. "For this subject in particular I feel less than 4 weeks is an inadequate time to learn the content well. I personally struggled with this and struggled to take in the information. Whereas if the subject stretched over a longer period I feel that the information will have been better absorbed."

Student access of online resources and learning activities

There were 10 online quizzes available to students and an average of 83±11 H5P learning interactives for each unit. Analysis of the LMS learning analytics data for HBM1001 revealed 96% of all students accessed at least one quiz with an average access rate of 96±3 percent across the 5 teaching periods. 75% of all students accessed at least 1 H5P with 76%, 90%, 84%, 75%, & 70% in each period respectively (semester 1; 2017, 2018 B2, 2018 B3, 2019 B2, 2019 B3). Whilst there were many H5P interactives available to students the single most popular H5P activity in each period was accessed by an average of 57±10 percent of students and the top 10 most used H5P each study period received an average of 43±11 percent of students attention (not shown). We were unable to track student access of the vodcasts reliably within our LMS and we do not report any analytics with these resources here, however student preference of resources and learning activities are described below.

There was a weak positive correlation between the number of H5P's a student utilised and their final grade, r(1246) =.34, p=<.001, [95%CI=.28,.38] (Figure 1a). Similarly, there was a weak positive correlation for number of quizzes utilised and final grade, r(1246) = .27, p=<.001, [95%CI=.22,.32] (Figure 1b). The correlation of combined number of quizzes and H5P's on final grade was r(1246)=.35, p=<.001,[95%CI = .31,.40] (Figure 1c). When distributed into quartiles, all three quartiles showed weak positive correlations between final grade and the number of H5P's utilised (Figure 1d) the first quartile (1stQ = bottom 25%) had a weak positive correlation r(314)=.25, p=<.001, [95%CI=.14,.35], the second quartile (middle 50%) had the weakest correlation of r(614)=.15, p=<.001, [95%CI=.07,.22], and the third quartile (top 25%) has the strongest correlation r(314)=.28, p=<.001, [95%CI=.17,.38].

Multiple regression analysis was performed to assess the degree to which, the number of H5P's or quizzes affected the outcome of the final grade. Both the number of H5P's and Quizzes utilised by students were significant (p=.001, p=.001) in predicting final grade, F(2,1245) = 102.19, R^2=.141, p=<.001. For each H5P utilised, final grade increased by 0.16 (β=.28,[95%CI=.13,.19] and for each quiz final grade increased by 0.66 (β=.18,[95%CI=.46,.86].

When assessing the degree final grade was affected by number of H5P or quizzes for the three quartiles each of the three regression models were significant at predicting final grade; first quartile F(2,313)=10.94, R^2= .065, p=<.001., Second quartile F(2,613)=8.78,p=<.001, R^2=.167., Third quartile F(2,313)=14.65, p=<.001, R^2=.293. However, in all three multiple regression models only the number of H5P's accessed was a significant variable; first (β=.237, [95%CI=.08,.21]), p=<.001, second (β=.127,[95%CI=.01,.05]), p=.002, third (β=.250,[95%CI=.02,.06]) p=<.001. The number of quizzes accessed was not a significant variable in the models for any quartile; first (β=.052), p=.353, second (β=.079), p=.058, or third (β=.089), p=.123 respectively. In summary the greater the number of H5P's learning interactives a student accessed the greater their final grade relative to their quartile.

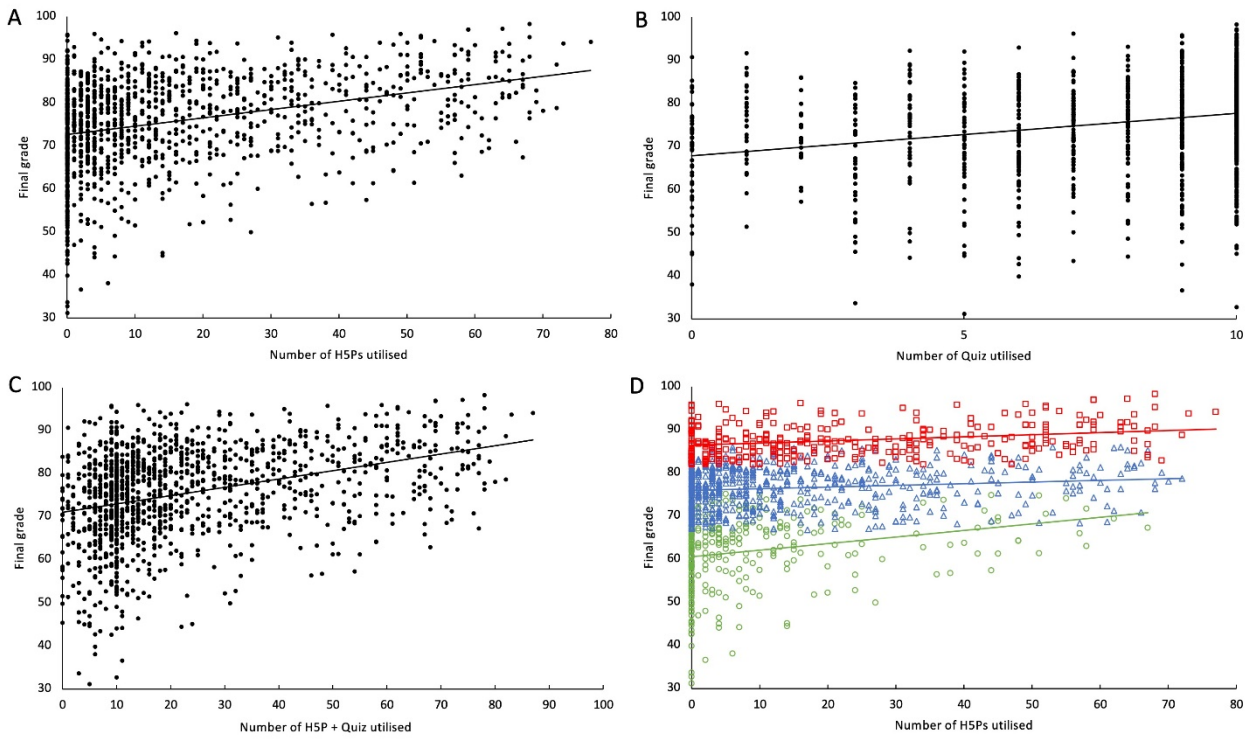

Figure 1: Student utilisation of H5P learning interactives and Quiz on final grade. (a) Relationship of the number of H5P's accessed and final grade. (b) Relationship between quiz interactions and final grade. (c) The relationship between the sum of H5P and Quiz interactions on final grade. (d) The relationship between H5P and final grade relative to quartiles; 1st quartile (open circles), 2nd quartile (open triangles), and 3rd quartile (open squares)

Student perceptions of online resources and learning activities

Independent Survey Data

On the independent survey, students were asked to rank the value of H5P interactives, online quizzes, in-class workshops, AnatomyTV, Panopto videos and vodcasts. A single ranking for each resource was determined by calculating the weighted average response at a particular rank (expressed as a percentage: weighted average was calculated by assigning a top ranking the value of 5, and a bottom ranking a value of 1, and multiplying the percentage of respondents at that rank by the assigned value) (Sinnayah et al., 2019). Online quizzes were the most highly rated online activity by students (87%), followed by H5P interactives (66%), vodcasts (52%) and AnatomyTV (30%). Student preference was also high for in-class workshops (72%, figure not shown). Students felt that H5P interactives required effort to complete (64% of students (Likert 5 point scale on survey with strongly agree), with 58% of students attempting H5P interactives more than once (Figure 2a). Student perceptions of in-class activities was valued highly (Figure 2b), where 80% of students (strongly agree + agree) felt that a significant amount of learning was achieved as a result of workshop activities. Students reported that there was an alignment of learning outcomes to the resources provided (94% strongly agree+ agree), an important aspect of the unit design.

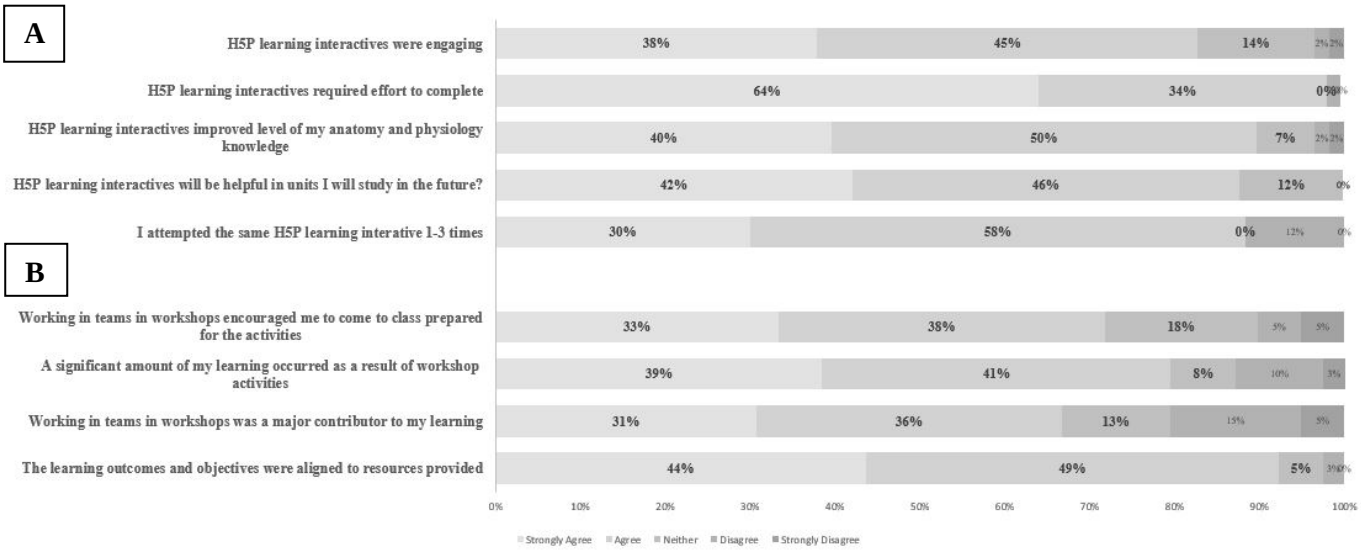

Figure 2a: Student responses (n=120) to questions from qualitative survey regarding H5P learning interactives 2b: Student responses (n=120) to questions from qualitative survey regarding in-class team based workshops

Discussion

This paper reports on the implementation of our blended design in a diverse cohort of first year students for both a traditional 12-week semester and a 4-week block design for A&P units. We have shown that a planned blended learning design overall produced positive student results with high student satisfaction in traditional 12-week units. This is supported by a study in first year physiology which shows that significant improvements in student outcomes can be achieved with a blended learning approach (Page et al., 2017) and one which correlates with student satisfaction (Page et al., 2017). We applied a high impact strategy for developing the units (Alammary et al., 2014). Building on our previously reported study (Sinnayah et al., 2019), we applied a backward (Wiggins & McTighe, 1998) and blended design approach with consideration of the COI framework (Vaughan et al., 2013), including resources and activities built from scratch, suggesting the possibility for the most impact to the learning experience (Alammary et al., 2014). We thought it was important to incorporate all elements of the COI in the design given the COI framework has been well established in blended learning environments (Garrison and Kanuka 2004,Vaughan 2013, Choy & Quek 2016).

A systematic review of the literature has identified key challenges in the online component of blended learning ranging from students, teachers and educational institutions perspectives (Rasheed et al., 2020). Firstly, they show that it is imperative for students to have self-regulation skills and technological competence since they are required to manage and carry out their studies independent of their instructor, at their own pace, and using online technology beyond their face-to-face sessions. Secondly, teachers need to be technologically competent, to effectively use and manage technology for teaching, and creating and uploading learning materials for students. Thirdly, it is the responsibility of educational institutions in providing the necessary training and technological support for both teachers and students in order to ensure the efficient and effective utilization of the online learning materials (Rasheed et al., 2020). With the introduction of the VU Blended strategy during 2017 (Victoria-University, 2017) and the VU block model in 2018, there were strong institutional policy drivers behind the use of active learning in the design of both online and in-class delivery. This driver enabled the professional development and support of staff to develop their skill base to design and implement the blend and subsequent block model. This professional development was provided via the First Year College (Konjarski et al., 2019), at a teaching team level and through design teams (McCluskey et al., 2019).

To better understand how students engage in a blended learning environment, their participation in online activities must be considered. One study (Baragash & Al-Samarraie, 2018) elucidates that the LMS time and tools usage was considered an indicator of students' engagement, an observation supported by previous studies (Guy et al., 2018; Saqr et al., 2017). In this study, students preferred and mostly completed asynchronous online quizzes with inbuilt feedback and interactive HP5s compared with other provided resources and online learning activities (Panopto vodcasts and AnatomyTV). The H5P learning interactives and online quizzes were available as formative tasks for self-study and review. It is suggested students who spend more time using the LMS tend to be more engaged with their learning activity and this hinges on the quantum of available online resources and tools to them (Guy et al., 2018; Saqr et al., 2017) . Mogus et al 2012 have examined students' online activity from the LMS database to determine whether their activity logs correlated with their final marks and observed a strong correlation between students' activity logs and their final marks (Mogus et al., 2012). This observation was apparent in a block mode of delivery (Sidiroglou & Fernandes, 2019). This is also evident from our results, which show increased engagement with the H5P interactives impacted positively on student grades (Fig 1a and d).

There is literature that supports the importance of self-directed study including the use of technology-enhanced learning such as digital interactives in blended approaches to learning (Geng et al., 2019). Self-directed learning (SDL) is defined in this study as an approach where learners gradually assume personal responsibility and control of the cognitive (self-monitoring) and contextual (self-management) processes in constructing and evaluating meaningful and worthwhile learning outcomes (Garrison, 1997). The learner takes responsibility for the construction of meaning from the learning materials. SDL allows students to work in their own time, own pace and in our context, the online activities created in this study, such as, the H5Ps serve this purpose well and also provide feedback and allow reflection for students.

Feedback is critical at the first-year level to encourage learning (Kift, 2018; Kift et al., 2010). In this study, the formative and immediate feedback included in the online quizzes and H5P learning interactives provided the opportunity for students to monitor and check their progress, self-reflect and adjust their own learning, which are key characteristics of SDL (Garrison, 1997; Knowles, 1975; Marden et al., 2013). Most of the H5P learning interactives allowed learners to check their immediate understanding related to a particular concept. This availability of immediate feedback guides and reinforces student learning (Martin & Martin, 2015; Mayer, 2019). Both the online quizzes and the H5P learning interactives provided the opportunity for students to attempt each question multiple times. For incorrect options, students were provided with feedback, and where applicable links to further resources to direct the student to bridge their knowledge gaps.

We have shown that student engagement in the online interactives such as quizzes and the H5P learning activities predict higher performance when all results are considered. The unique aspect of this study is that when students' are divided according to performance quartiles, only H5P's continue to predict performance. Whilst this may be affected by the relatively few quizzes (10) and high number of H5P's (~84) available, we suggest the availability of these H5Ps can have an important contribution to student understanding leading to better outcomes regardless of the level of achievement. Indeed, studies have reported on the use of H5P learning activities in a flipped design, across science based subjects with positive outcomes of student participation (Carr & Barry, 2020; Chen et al., 2021; Reyna et al., 2020; Wehling et al., 2021). The vast majority of students perceived online quizzes as a valuable learning tool showing a significant relationship between performance in quizzes and end-of-course examination scores, as shown by Marsden et al., (Marden et al., 2013). Importantly, students who performed poorly in quizzes were more likely to fail the final examination,

suggesting that formative online quizzes may be a useful tool to identify students in need of assistance (Marden et al., 2013). This observation was also seen in our study indicating a positive correlation of student engagement with quizzes and their final grade.

The VU Block Model has shown to significantly reduce student failure rates across a number of parameters such as high versus low ATAR, SES, and male versus female students (Samarawickrema & Cleary, 2021; Winchester et al., 2021). Furthermore, it has been demonstrated that students with a low SES had a greater reduction in failure rates compared with students with a high SES (McCluskey et al., 2019; Winchester et al., 2021). Similarly, the greatest gains in marks were for younger, lower ATAR, non-English-speaking and low SES students (Loton et al. 2022).This significant closing of the gap between lower and higher SES students studying under the block model suggests that enabling low SES students to learn in an active learning environment, within small classes while studying one unit at a time can increase their chances for success to almost the same level as that achieved by higher SES students. For block mode blended delivery in 2018 in our study, we report on a significant improvement in the final student result compared with traditional 12-week delivery 2017 in our cohort which includes low SES and lower ATAR students. A similar increase in student results was reported across VU (Loton et al., 2022; McCluskey et al., 2020), however our result improvement was not maintained in 2019. This could be attributed to the large additional cohort of students from Nursing, Dermal Science and Health Science that enrolled in our A&P units in 2019. We report on an initial decline in student satisfaction in the first year of implementation with a subsequent improvement from 2018 to 2019 delivery. Loton et al., (2020) have previously reported on a mixed picture of student satisfaction across VU in the first year of implementation of the VU Block model (Loton et al., 2022).

With the introduction of the VU Block model, students reported a high perceived workload due to too much content within a short period of time (Table 5 & 7).This has been previously reported where a pre- block VU cohort (2016-2017) experience was compared to an intervention block mode cohort (2018) (Loton et al., 2022). Simple inferential mean comparisons indicate marks increased substantially in block mode but most SEU items did not, except for increased SEU5 and decreased SEU6 (Loton et al., 2022). It has been suggested that intensive mode universities should communicate with students about the workload and the need to work intensively from the first day to minimise falling behind (Trinh et al., 2022). Student's perceptions of workload in block appeared to have improved from 2018 to 2019 potentially due to revisiting the LOs and re-aligning with the learning outcomes. Block scheduling of 3hr x3 workshops a week enables students to build stronger peer to peer relationships and connections with their teachers (Trinh et al., 2022). This supports a study in a blended approach, were students felt that the face-to face workshops enabled the development of social bonds and collaborative learning (Keeling & Haugestad, 2020). Our face-to-face sessions which involve team based inquiry learning, have been shown previously to impact positively on student learning (Sinnayah et al., 2019). In this study, we maintain that the collaborative learning in the workshops contributed significantly to students perceptions of learning.

We conclude that our planned blended learning strategy produced positive student results with high student satisfaction for traditional 12-week units and increased grades with reduced, but improving student satisfaction for block mode units. Regarding the online component of the blend, students preferred and mostly completed online quizzes with inbuilt feedback and HP5 learning activities compared with other provided resources and online learning activities. Furthermore, student engagement in the online quizzes and H5P's predicted higher grade performance. The provision of abundant online resources and active learning activities with feedback, provided students with greater opportunity to self-engage in learning. Finally, this study provides an opportunity to identify aspects of our block design that we could improve and reflect further on, for future students and continued success.

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No conflict of interest is reported

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