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Student Response to a Blended Radiology Course: A Multi-Course Study in Dental Education

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Abstract
Universities around the world are increasingly moving towards blended learning models to engage their 21st century learners (Alammary et al., 2014; Brenard et al., 2014; Tandoh et al., 2014). However, students' engagement and satisfaction with blended learning in dental education remain understudied. To address this gap, this study examines the effects of a blended learning approach on students' satisfaction and engagement within dental hygiene and dentistry oral radiology courses. Thirty-five students participated in a survey designed to measure two main constructs: student engagement (per Fredericks et al., 2005) and student satisfaction (per Owston et al., 2013) with the addition of one student providing interview data on each of these constructs. It was found that students were generally satisfied (67%) with the blended learning course format with 65% of students expressing a preference for the blended format. This finding was complemented by students' also expressing that they were emotionally engaged (70% engagement score), cognitively engaged (69% engagement score), and behaviourally engaged (61% engagement score). These findings suggest that blended learning may be of benefit to the engagement and satisfaction of dental students' learning the interpretation of dental radiographs.

Dans le monde entier, les universités s'orientent de plus en plus vers les modèles d'apprentissage hybride pour engager leurs apprenants et leurs apprenantes du 21e siècle (Alammary et al, 2014; Brenard et al, 2014; Tandoh et al, 2014). Toutefois, l'engagement et la satisfaction des étudiants et des étudiantes avec l'apprentissage hybride en enseignement dentaire est encore peu étudié. Pour combler cette lacune, cette étude examine les effets d'une approche d'apprentissage hybride sur la satisfaction et l'engagement des étudiants et des étudiantes dans des cours d'hygiène dentaire et de dentisterie radiologie buccale. Trente-cinq étudiants et étudiantes ont participé à une enquête conçue pour mesurer deux concepts principaux : l'engagement des étudiants et des étudiantes (Fredericks et al, 2005) et la satisfaction des étudiants et des étudiantes (Owston et al, 2013) avec l'addition d'un étudiant qui a fourni des données d'entrevues sur chacun de ces concepts. On a constaté que les étudiants et les étudiantes étaient généralement satisfaits (67 %) avec le format d'apprentissage hybride du cours et que 65 % d'entre eux ont déclaré qu'ils préféraient le format d'apprentissage hybride. Les résultats ont également indiqué que les étudiants et les étudiantes avaient déclaré être engagés émotionnellement (70 %), engagés de manière cognitive (69 %) et engagés sur le plan comportemental (61 %). Ces résultats suggèrent que l'apprentissage hybride pourrait être bénéfique pour l'engagement et la satisfaction des étudiants et des étudiantes en dentisterie qui étudient l'interprétation de radiographies dentaires.

Keywords
blended learning, oral radiology, dental education, dentistry, dental hygiene; apprentissage hybride, radiologie buccale, enseignement dentaire, dentisterie, hygiène dentaire

Cover Page Footnote
Support for the initiative was possible through the University of Alberta Provost's Digital Learning Committee Blended Learning Awards which provided funding and educational development support for the blended learning initiative at the DDS and DH Oral Radiology courses.

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The University of Alberta Centre for Teaching and Learning offers targeted funding to support the implementation of blended learning across its campus. Funding was awarded to this team of instructors to transform foundational undergraduate courses into a blended learning format for the purposes of improving student engagement and satisfaction. In this instructional approach, there is a fusion between traditional face-to-face instructional time and online learning (Alammary et al., 2014; Means et al., 2013). Universities around the world are increasingly moving towards blended instruction because of the opportunities that the model seems to offer with respect to increasing engagement in the classroom (Alammary et al., 2014; Bernard et al., 2014).

Numerous studies have addressed student engagement in blended learning courses (Bates & Galloway, 2012; Henrie et al., 2015; Montgomery et al., 2015; Osgerby, 2013), with a strong focus on ways to improve student achievement and interaction (Alrushiedat & Olfman, 2013; Poon, 2012), or promoting student engagement in the online segment of the course (S.-Y. Lin et al., 2016; Moskal et al., 2015; Tomas et al., 2015). There is also a staggering amount of research devoted to student satisfaction in blended learning environments in the post-secondary contexts such as Business and Arts education (Hernández Nanclares & Pérez Rodríguez, 2016; Lin et al., 2016; Umek et al., 2015), yet, the literature investigating satisfaction with blended learning in dental hygiene and dentistry education is lacking.

Blended learning connects online learning, assigned outside class time to the traditional in-class learning experiences (Garrison & Vaughan, 2008). Recently, it has been shown that blended learning can increase dental hygiene (DH) and dentistry (DDS) students' confidence in oral image interpretation by offering a learning environment that integrates multiple radiographic case-based studies, student-instructor discussion, online activities, and clinical translation guidance (Gianoni-Capenakas et al., 2019; Pacheco-Pereira et al., 2018). However, students' engagement and satisfaction with blended learning in DH and DDS remain understudied. Hence, this study aimed to fill this research gap by investigating students' engagement and satisfaction in DH and DH/DDS courses.

Theoretical Background

In order to explore student engagement in these various blended learning courses, this study distinguished types of engagement using three different levels: behavioural, emotional and cognitive engagement (Fredricks et al., 2005). Behavioural engagement refers to course participation and includes all the academic, social, and extracurricular activities that are considered critical for achieving positive academic outcomes, such as asking clarifying questions about the materials if needed, being able to pay attention, following the course schedule consistently, and completing the assignments. Emotional engagement is concerned with the various reactions to instructors, classmates, or institution that are supposed to influence willingness to complete the different activities, like thinking the amount and quality of interaction with both instructors and classmates is appropriate, valuing the relationships built with peers, and generally enjoying taking the course. The cognitive dimension refers to student investment and their readiness to put in the work to understand the complex ideas in the course and to master the skills that are being taught, for example by going back to the course materials or asking themselves questions to make sure they understood, reading extra materials to learn more about the concepts taken up in the course, and thinking the course has helped to improve their understanding of key concepts and skills. Using these three definitions, this study asked how students are engaged in a blended learning course on radiology in a DH and DH/DDS course.

Likewise, in this study, student satisfaction encompassed both satisfaction with the course format and preference for blended learning after taking the course (Owston et al., 2013). It was important to assess whether students believed the online and face-to-face (F2F) course components enhanced each other, the web resources were helpful, or if they would take another blended learning course in the future if given the opportunity. Owston and colleagues (2013) mentioned that students in blended courses potentially benefit from the time and spatial flexibility that the model brings for their studies, the broader and easier access to the learning resources, as well as the higher level of autonomy when regulating their learning. Moreover, having both F2F and online components allows students to communicate directly with instructors, receive immediate faculty guidance and support if needed, and get involved with other students in the class (Owston et al., 2013). Given these benefits of blended learning, this study also asked how satisfied are DH and DH/DDS students with their experience in a blended oral radiology course.

The findings of this study contribute to the research base on approaches to developing blended learning courses and their influence on student experience and may be informative to other institutions. Finally, this research seeks to add to the growing bodies of SoTL literature investigating blended learning, student engagement, and student satisfaction by exploring these constructs in a DH and DDS setting.

Material and Methods

The Research Ethics Board at the University of Alberta approved this study, project number 00048272. An observational cross-sectional study using a survey was planned with the purpose of corroborating the way students expressed their satisfaction with and engagement in blended learning courses.

Context

This study used data from two different course contexts. The first course combined DH students and DDS students to learn the basics of radiology. Second year DH students (n=42) and first-year DDS students (n=32) participated together in a combined undergraduate course lasting 30 weeks. This pre-clinical theory and laboratory-based oral imaging course deals with the production of x-rays, their interactions with matter, radiation biology and protection, the appearances of normal and abnormal anatomy on radiographs and radiographic techniques including hands-on practice.

In previous iterations of the course, students had shared that they felt underprepared to interpret radiographic images and wanted more practice. As a response to this, new blended learning materials were created to provide students more guided practice outside of class time; this practice was optional for students. Prior to blending this aspect of the DH/DDS course, F2F time was spent primarily with an instructor-led lecture where students were presented with radiographic images and the instructor reviewing each image to explain the pathology. In an effort to move toward student-centered learning, the blended format also required students to watch content-focused videos (built based on the previously used lectures) prior to coming to the class; F2F time was now focused on the interpretation of radiographic images. In most cases, this meant F2F time was redesigned to integrate discussions of interesting cases (including some unfolding case activities) and group activities focused on radiographic image interpretation. In-class time for this section of the course was reduced from 11 hours to six with approximately 3 hours of pre-

lab/classwork to be completed; a ratio of approximately 0.5 hours prep-work for every lecture was expected and another 0.5 hours review. All changes aimed to promote a mix of physical and digital learning.

The second course involved in this study was for third-year DH students (n=40). This is a practical course aimed at strengthening DH students' competency in (1) taking intraoral and extraoral radiographic images on mannequins and patients, and (2) interpreting intraoral and extraoral radiographic images. This course was entirely changed to a blended learning format, and blended learning materials were used extensively. The blended learning format consisted of diverse online activities redesigned to review concepts learned in previous courses and laboratories. For example, in previous years, to promote students' competency taking radiographic images students would observe their instructor take bitewing images and then use designated clinic time to practice taking these images; if students were unsure about any step of the process, they had to wait to ask one of their instructors for assistance. In the new, blended format, students viewed videos explaining the techniques and safety used when taking bitewing images prior to coming to the clinic. During their clinic time, these students would then have opportunities to practice taking bitewing images properly and safely on mannequins and their fellow classmates. Should the students need to review any step of the process, they could reference the video at any time, freeing the instructor to assist with more in-depth questions. Students also had shifts in the clinic; when there were no patients, students were able to progress onto the more advanced techniques instead of completing tasks unrelated to their learning. Students no longer had formal lecture time for this course (up to 10 hours in previous years) since this was replaced with blended content; lab and clinical hours remained the same (approximately 13.5 hours) as in previous years.

To promote students' competency in interpreting radiographic images, a blended learning guided-laboratory with pre and post online activities was also developed for this DH course. Students were expected to watch videos that reviewed content from their radiographic imaging course taken the previous year (the DH/DDS course) and complete skill-testing quizzes prior to coming to the laboratory. This ensured students had sufficient review before entering the radiographic image interpretation laboratory. In the past, students had viewed radiographic images entirely on film and viewed with light tables during this laboratory. In blending this course, tablets and digital resources were used and increased the number of radiographs to which the students were exposed as they were not limited by the number of viewing stations. In the laboratory, the instructor was also able to spend time discussing interesting cases with the students instead of focusing on reviewing the basic skills learned the previous years. Laboratory and clinic times were optimized giving the students increased access to and feedback from the radiology faculty and instructors.

These two, year-long radiology courses used online videos and practice activities designed to refresh students' previously learned materials as well as introduce new ideas to be discussed in class. The F2F time in class was rededicated from lecture to case-based learning and increased interaction with different types of radiographic findings.

Participant Recruitment

At the last session of the Dental Radiography courses, all the third-year DH diploma and first-year DDS students (n=114) from the Faculty of Medicine and Dentistry, University of Alberta, Edmonton, Canada were invited to participate in the 57-item survey. During class, one of the research team members (who was not an instructor) described the research and informed

students that their participation was completely voluntary, that if they chose to participate their information would always be kept anonymous and confidential, that their instructor(s) would not know whether they had participated and would not see any results until after final course grades had been submitted and approved.

Survey data was collected through a web-based survey system (SurveyMonkey Inc. Palo Alto, CA, United States). Students followed a link available on their course page on the University of Alberta Learning Management System (LMS) using their own devices and outside of class time. Participants responded to demographic questions, evaluated statements related to their reactions to the course, engagement, satisfaction, and preference for F2F, blended, or online coursework. Survey items were developed by the researchers, some were drawn or adapted from Owston and colleagues' survey (2013), and others were inspired by Fredericks and colleagues' (2005) list of behavioral, emotional, and cognitive engagement items.

Statistical Analysis

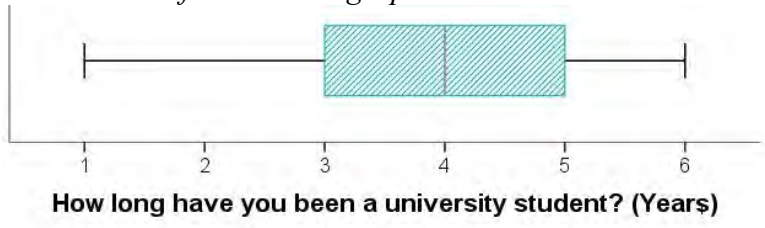
Descriptive statistics were produced to observe distributions of students' responses. Kolmogorov-Smirnoff's and Shapiro-Wilk's tests of normality were computed and reported when statistically significant. Pearson's correlations (r) for normally distributed variables and Spearman's rank (*Spearman r*) correlations were used to test whether there was a relationship between students' responses to demographic, reaction, engagement, satisfaction, and type of teaching and learning preference. Student satisfaction and engagement scales were formed according to the referenced instruments (Owston et al., 2013; Fredericks et al., 2005) and improved to maximize their measures of internal consistency (*Cronbach alpha,* α). Statistical Package for Social Sciences (SPSS for Windows, version 24.0, IBM, Armonk, NY, USA) was used for statistical analysis.

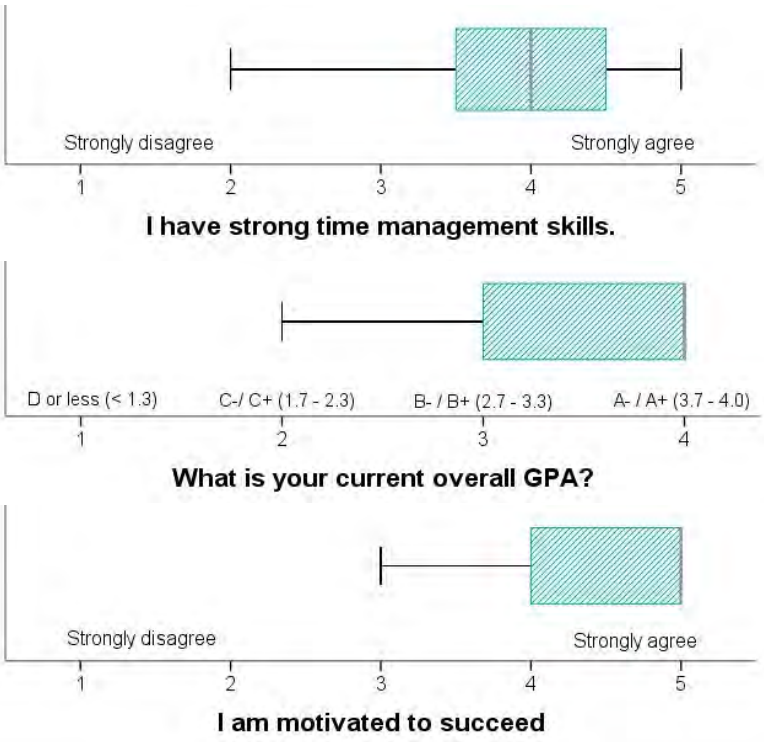
Results

A total of 35 students completed the survey (n = 27 course 1, n = 8 course 2). As shown in Figure 1, on average, students reported not working at the time of the survey (response 1, M = 1.3, SD = 0.6), having a current overall GPA between 3.7 and 4.0 (response 4, M = 3.7, SD = 0.5) and taking six or more courses at the time of the course (response 6, M = 5.85, SD = 0.5). On average, respondents were in their fourth-year at university (M = 4, SD = 1.4, min = 1, max = 6+, see Figure 1), were women (response 1, M = 1.25, SD = 0.5), moderately agreed to have "strong time management skills" (M = 3.9, SD = 1, min = 2, max = 5), and strongly agreed being "motivated to succeed" (M = 4.6, SD = 0.6, min = 3, max = 5).

Figure 1

Distribution of Four Demographic Variables



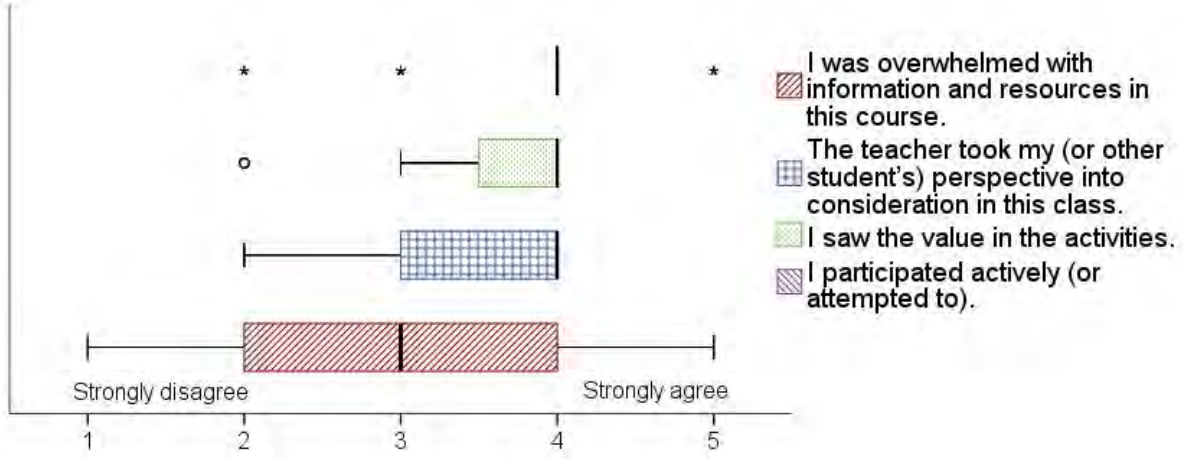


Reactions

Students indicated how often they reacted in certain ways during their course by rating statements from strongly disagree (1) to strongly agree (5). Results for four of these ten statements can be viewed in Figure 2. Among other reactions, on average, students neither agreed nor disagreed with the statement "I was overwhelmed with information and resources" (M = 3.1, SD = 1) and slightly agreed that "the teacher took [their] perspective into consideration in [their] class" (M = 3.5, SD = 0.6) and that they "saw the value in the activities" (M = 3.6, SD = 0.7) or "participated actively (or attempted to)" (M = 3.7, SD = 0.7).

Figure 2

Distribution of Student Reactions

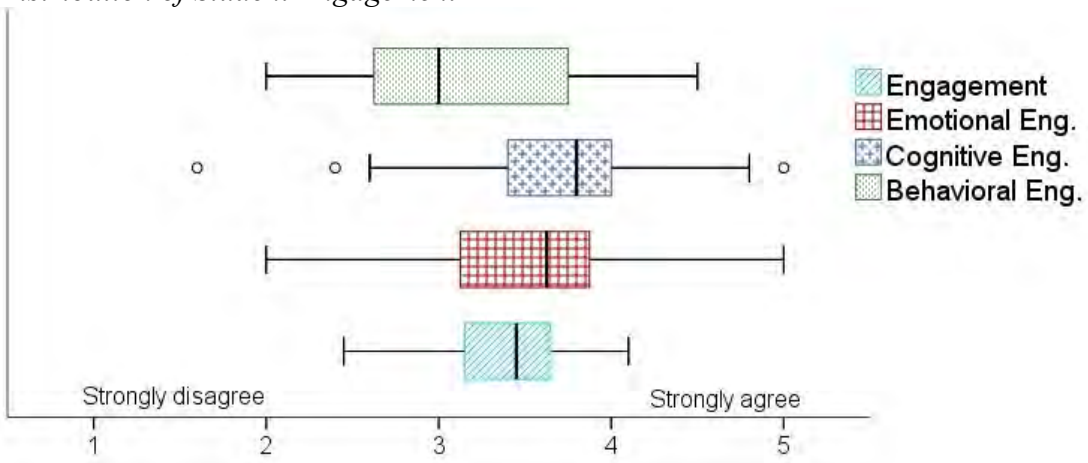


Engagement and Satisfaction

Student engagement was measured by 20 items (α = 0.83) from Fredericks et al. (2005) scale on the survey used. On average, students slightly agreed having been engaged (*M* = 3.4, *SD* = 0.4, *min* = 2.4, *max* = 4.1). Three engagement subscales were also produced (Figure 3): emotional (8 items, α = 0.89), cognitive (5 items, α = 0.81), and behavioral (4 items, α = 0.67). Students neutrally agreed to having been behaviorally engaged (*M* = 3, *SD* = 0.7) and moderately agreed to being cognitively (*M* = 3.6, *SD* = 0.6) and emotionally engaged (*M* = 3.5, *SD* = 0.6).

Figure 3

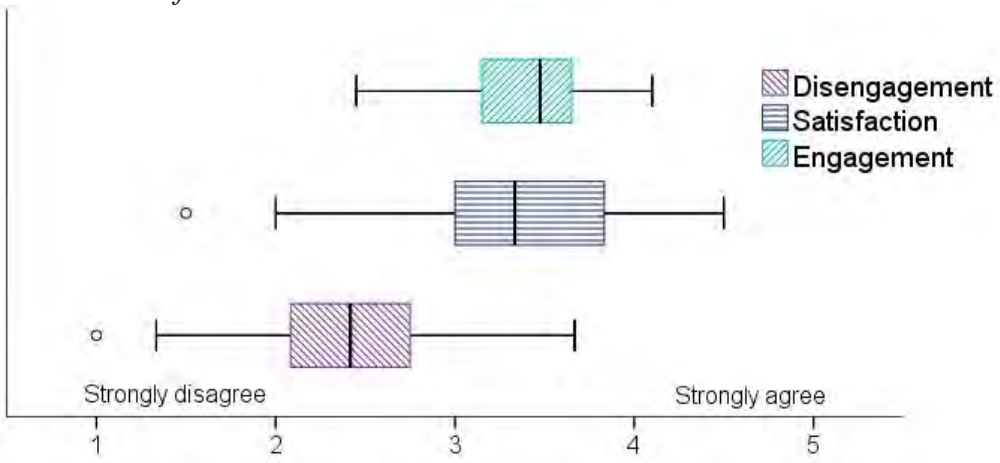
Distribution of Student Engagement



Students' engagement was found to be normally distributed (KS = 0.14, SW = .95, both *p* > .05), but its three subscales failed the Kolmogorov-Smirnov's general test; however, two were normally distributed according to Shapiro-Wilk's more powerful test: emotional engagement (KS = 0.19, *p* = .003; SW = .94, *p* > .05), behavioral engagement (KS = 0.18, *p* = .004; SW = .95, *p* > .05), not cognitive engagement (KS = 0.17, *p* = .011; SW = .93, *p* = .024).

Figure 4

Distribution of Student Outcomes

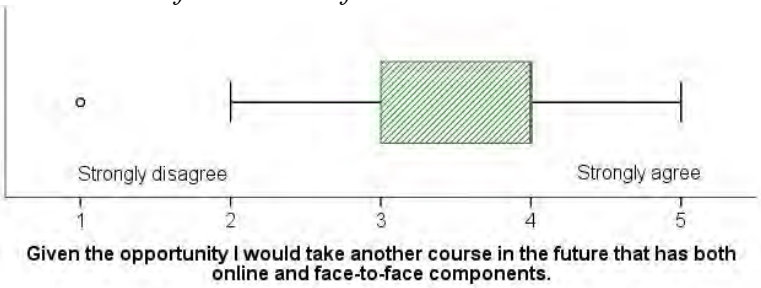


Several reaction items reflected students' disengagement (6 items, α = 0.79), e.g., not participating or pretending to participate, distracting peers or themselves, or giving activities

minimal effort. Students moderately disagreed to having been disengaged on the average (M = 2.4, SD = 0.6, min = 1, max = 3.7). Satisfaction was formed by 7 items (α = 0.85); Students slightly agreed to having been satisfied (M = 3.3, SD = 0.6, min = 1.5, max = 4.5). Students' disengagement (KS = 0.11, p > .05, SW = .95, both p > .05) and satisfaction (KS = 0.13, p > .05; SW = .93, p = .033) were found to be normally distributed (Figure 4).

Figure 5

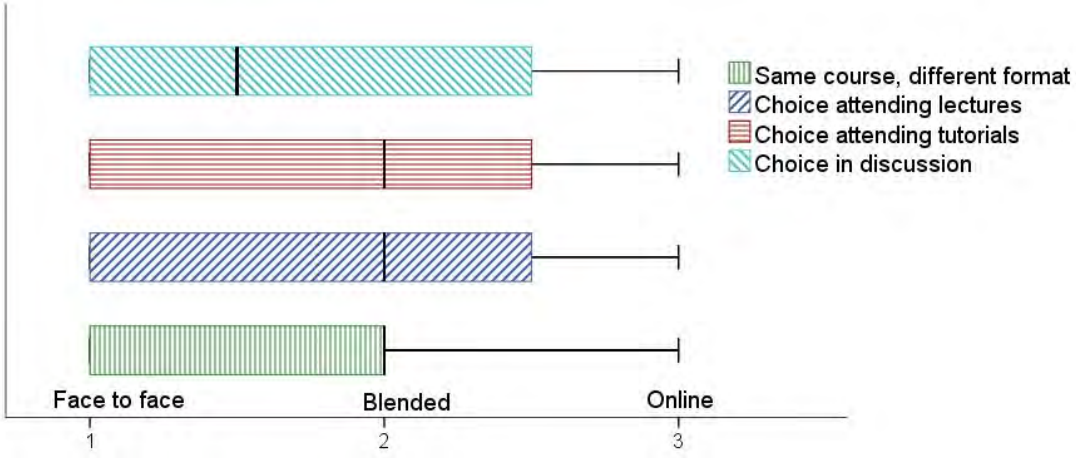
Distribution of Student Preference



In terms of preference, on average students slightly agreed they would take another blended learning course in the future (M = 3.5, SD = 0.95, Figure 5). When asked if the same course was being offered in different formats (M = 1.75, SD = 0.7, Figure 6), on average most students (50%, answer 2) preferred a blended course with some F2F activities replaced with online activities, with a large group of students preferring an entirely F2F course format (37%, answer 1) and a smaller group preferring an entirely online course format with no F2F class time (12%, answer 3). Similarly, for lectures (M = 1.94, SD = 0.8), a larger proportion of students indicated preference for a combination of F2F and online lectures (44%, answer 2), followed by students who would only prefer attending lectures F2F (31%, answer 1) and only accessing online videos of lectures (25%, answer 3).

Figure 6

Distribution of Student Choice



For tutorials and discussions, on average, students indicated preference for a combination of F2F and online tutorials (M = 1.78, SD = 0.83) or discussions (M = 1.75, SD = 0.84). However, in both cases the majority of students preferred F2F tutorials (47%, answer 1) and discussions

(50%, answer 1), followed by blended and online tutorials (28% and 25% respectively) and discussions (25% each).

Associations

Engagement and Satisfaction

Overall, students who were more engaged were also more likely to be satisfied with the course (r = 0.62, N = 32, p < 0.001). More specifically, students who reported higher levels of emotional (r = 0.67, N = 32, p < 0.001) and behavioral engagement (r = 0.45, N = 32, p < 0.05) were more likely to be satisfied with the course (Figure 7). The relation between satisfaction and cognitive engagement was non-significant (*Spearman* r = 0.28, N = 32, p = 0.126). However, students with higher emotional engagement also tended to be more cognitively engaged (*Spearman* r = 0.43, N = 35, p < 0.01).

Relationships between students' engagement, satisfaction and key reactions to the course were explored in Table 1. Students who were more engaged (1) also more highly thought the teacher took their perspective into consideration (3), thought the blended components of this course enhanced each other (5), the time used for the activities was beneficial (6), the course LMS site was well organized and easy to navigate (8).

Students who were more highly engaged also enjoyed the activities (4), enjoyed going to class (9), and, given the opportunity, would take another course with blended components (7). Students' satisfaction (2) was also positively related to these student reactions (3 through 9) and was also related to students seeing the value in the activities (10) and perceiving that the web resources in the course were helpful (11).

Figure 7

Relationship between Student Engagement and Satisfaction

Student Demographics

Table 2 shows the relationships between student demographics and some other key reactions to course. Students who were more motivated to succeed (12) were less disengaged (r = -0.44, N = 32, p < 0.05), less overwhelmed with information and resources (18), less prone to distract peers during the activities (19), give the activities minimal effort (21), and had stronger management skills (13). Students with stronger management skills (13) also had been university students for longer periods of time (14), had higher overall GPAs (15), and were less likely to give minimal effort (21). Students with more years as a university student (14) were also less prone to feel overwhelmed with information and resources (18) and generally participated more in the activities (20).

Table 1

Relationship between Engagement, Satisfaction, and Reactions to the Course

	1	2	3	4	5	6	7	8	9	10	11
Engagement and Satisfaction											
1. Engagement		.616**	.600**	.558**	.557**	.529**	.394*	.389*	.384*		
2. Satisfaction	.616**		.399*	.775**	.664**	.490**	.540**	.688**	.685**	.406*	.524**
Reactions to the Course											
3. Perspective considered	.600**	.399*		.405*	.579**	.520**		.423*			
4. Enjoyed the activities	.558**	.775**	.405*		.444*	.478**	.606**	.426*	.606**	.402*	
5. Enhanced each other	.557**	.664**	.579**	.444*		.682**	.426*	.513**		.514**	.440**
6. Time was beneficial	.529**	.490**	.520**	.478**	.682**		.455**	.411*		.542**	
7. Blended course	.394*	.540**		.606**	.426*	.455**			.371*		.406*
8. LMS was organized	.389*	.688**	.423*	.426*	.513**	.411*				.389*	.339*
9. Enjoyed going to class	.384*	.685**		.606**			.371*				
10. Saw value in activities		.406*		.402*	.514**	.542**		.389*			.614**
11. Web resources helpful		.524**			.440**		.406*	.339*		.614**	

** Spearman correlation is significant at the 0.01 level (2-tailed).

* Spearman correlation is significant at the 0.05 level (2-tailed).

Table 2

Relationship between Student Demographics, Reactions, and Preference

	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Demographics														
12. Motivated		.444**					-.344*	-.389*		-.475**				
13. Management	.444**		.422*	.336*						-.367*				
14. University student		.422*					-.436**		-.448*					
15. Overall GPA		.336*			-.386*					-.384*	.366*			
16. Hours employed				-.386*										
17. Courses taken												-.360*		
Reactions to the Course														
18. Overwhelmed	-.344*		-.436**						.477**		-.414*		-.630**	
19. Distracted peers	-.389*									.516**				
20. Did not participate			-.448*				.477**			.500**				.355*
21. Minimal effort	-.475**	-.367*		-.384*				.516**	.500**					
Preference														
22. Format same course				.366*			-.414*					.718**	.434*	
23. Format lectures						-.360*					.718**			
24. Format tutorials							-.630**				.434*			
25. Format discussions									.355*					

** Spearman correlation is significant at the 0.01 level (2-tailed).

* Spearman correlation is significant at the 0.05 level (2-tailed).

Students with higher overall GPA (15) also worked fewer hours or were not employed (16) were less prone to give the activities minimal effort (21) and had a stronger preference for a blended or online course format (lower preference for face-to-face, 22). Students who were taking a larger number of courses at the time of the survey (17) also had a lower preference for blended or online lectures (higher for F2F lectures, 23). Likewise, students who were overwhelmed (18) were also more likely to be disengaged ($r = 0.37$, $N = 32$, $p < 0.05$), to not participate in the activities (20), to have a lower preference for blended or online tutorials / a stronger preference for F2F tutorials (24), and a stronger preference for a F2F course format (22). Finally, students who reported not actually participating in the activities (20) were also more likely to feel overwhelmed with information and resources (18), to give a minimal effort (21), and more likely to prefer a blended or online discussion format (25).

Discussion

Our findings indicate that students in these courses were generally engaged with the blended learning components of the course, and most of them agreed that this course improved their understanding of key concepts. Specifically, students were somewhat engaged behaviourally ($M = 3$) and somewhat more engaged cognitively ($M = 3.6$) and emotionally ($M = 3.5$). Notably, students typically agreed on these statements with small standard deviations in each of these categories ($SD = 0.7$, 0.6, and 0.6, respectively).

This research supports authors advocating for blended learning such as Garrison and Vaughn (2008) by showcasing the ability for blended learning to engage students. Our findings also extend those of previous studies such as Ginns and Ellis (2007), Henrie and colleagues (2015), and Montgomery and colleagues (2015) by indicating that blended learning, in this context, engaged students cognitively and emotionally more than behaviourally. This might imply that instructors of blended learning courses in DH and DDS courses consider how they might encourage behavioural engagement since student autonomy and participation both inside and outside of the classroom are key tenets of blended learning (Garrison & Vaughan, 2008). As it has been shown that students' perceptions of their sense of engagement with the blended learning experience are highly connected to their achievement in a course (Owston et al., 2013), perhaps future studies could consider how each of cognitive, emotional, and behavioural engagement with blended learning impact student performance and this could provide some motivation for students to engage with learning from each of these aspects.

In response to our second question, our findings indicate that students were generally satisfied with the blended learning components of the course, and most of them agreed that they would take another blended course in the future after this experience. It has been shown that the use of videos in dental education increases students' satisfaction with their learning experience (August et al., 2018). Our study extends this finding by noting that, in general, the DH and DDS students in this study were satisfied with blended learning in general (which often includes the use of videos). This supports studies in other subject areas such as Hernández Nanclares and Pérez Rodriguez (2016), Lin and colleagues (2016), and Umek and colleagues (2015), whom all found that students in higher education courses (in various countries and subjects) were generally satisfied with blended learning experiences.

Students in these courses were generally satisfied and, specifically, enjoyed the style of the laboratories and the in-class lectures. Similar to previous studies (e.g., Gianoni-Capenakas et al., 2019), our research found that laboratories and clinic hours provided a good opportunity for dental

students to practice the material they were learning, and in-class lectures allowed them to have direct access to instructors to ask them for help. Participants saw value in the online activities and appreciated how the online and F2F course components enhanced each other; reflecting findings from Rahman and colleagues (2015) who found that students who felt that the aspects of blended learning were useful to them were more likely to be satisfied with their course.

Our findings suggest the use of blended learning in future DH and DDS courses may both engage and satisfy students. If a DH or DDS course aims to blend their content, we would suggest they ensure materials provide students with a variety of learning opportunities (in this case, extra practice images, cases, etc.), are coherent and connected with each other and in-class interactions (e.g., the clinic preparation videos before in-clinic practice) and be prepared to offer additional assistance as required by students. This may require instructors to re-think their time distributions to both in-class and out-of-class interactions (Alammary et al., 2014). Our results show that students who are more emotionally and behaviourally engaged tend to be more satisfied, enjoy the course more and are be more likely to prefer taking another blended course.

Our findings also indicate that engagement and satisfaction are related in complex ways to a variety of student background factors such as students' motivation, management skills, years of experience as a university student, hours dedicated to other responsibilities such as employment, and the number of courses taken. These findings align with studies of academic motivation (Usher & Morris, 2012; Schunk et al., 2012), self-regulated learning (Boechler et al., 2017; Zimmerman & Labuhn, 2012), active cognitive processing (Clark & Mayer, 2016; Sweller, 2012), and other internal and external conditions and states that learners bring to the learning context (Roehrig et al., 2012). Our study also shows how some of these background factors are related to students feeling overwhelmed with information and resources, which in turn possibly contributes to their disengagement and, not surprisingly, leads them to have a lower preference for blended or online activities or courses.

Students in blended learning courses are expected to be actively involved (Dzuiban et al., 2004) and will find it very hard to make sense or learn actively on their own without certain conducive skills such as self-regulation (Azevedo et al., 2008). Overwhelmed and disengaged students might prefer a F2F format because, in this setting, instructors and teaching assistants traditionally assume a greater responsibility for students' learning (e.g., deciding for and preparing a lecture) making students' task of learning less overwhelming, more predictable and manageable. This strongly suggests that it is also important to ensure that students have access to essential resources or skills that enable them to actively participate and take greater responsibility for their own learning in order to promote students' engagement and satisfaction in blended or online learning experiences.

A significant limitation of this study was the representativeness of the sample. A challenge of any survey research is finding and recruiting participants from the target population and it was no different for this research group (33% response rate). It is unknown whether those who volunteered to participate in this project were inherently different from those who did not. Hence, our results should not be freely generalized.

Conclusion

Our findings suggest that student-centered blended learning guided activities may engage and satisfy DH students' as they learn to interpret dental radiographs. Students were generally satisfied with the blended learning components of the course, and most of them agreed that they

would take another blended course in the future after this experience. Moreover, students enjoyed the style of the laboratories and the in-class lectures. Laboratories provided a good opportunity for students to practice the material they were learning, and in-class lectures allowed them to have direct access to instructors for help. Participants appreciated how the online and F2F course components enhanced each other. They were able to see the connection between lectures, quizzes, and laboratories.

The students were generally engaged with the blended learning components of the course, and most of them agreed that this course has improved their understanding of key concepts. Students appreciated the support received from the instructors. Furthermore, they appreciated the interactions they had during the laboratories with other students that also provided a sense of support in the course. However, to ensure that all students are fully engaged and satisfied, more attention is required to ensure all students have the resources and skills to actively learn on their own.

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