Does Podcasting Increase Allied Health Student Performance in Foundation Physiology Classes?

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Abstract

Recent technologies, such as podcasts, have expanded the options available to educators on how information is delivered and on how student engagement is fostered. This increase in pedagogical options may be particularly relevant to the teaching of biomedical science to allied health students as these students typically have large variations in their prerequisite discipline knowledge and in their engagement with basic anatomy and physiology. Podcasting has been shown to increase student engagement and satisfaction scores, but few studies have objectively measured the effect of podcasting on student performance. Podcasting was introduced to a cohort of 215 students enrolled in Physiotherapy, Occupational Therapy, Sports and Exercise Science degree programs at James Cook University, Australia and assessment performance was compared to the previous year in which podcasting was not available. Analysis revealed that 95% of enrolled students accessed the available podcasts during the teaching period. Clear peaks in podcast access rates occurred prior to assessment pieces, strongly suggesting the use of podcasts for revision purposes. 64% of students believed that the availability of podcasts increased their learning either moderately or greatly, although this perception was not supported by assessment performance, where there was no significant difference between students who accessed podcasts and those that did not. Additionally, there was no significant difference in mean assessment performance between the study cohort of students with access to podcasts and those in the previous enrolment year (without podcasts). This study demonstrated that while podcasting increased student satisfaction, perception of learning and flexibility it did not directly increase grade performance during intra-semester or summative assessment items.

Introduction

Podcasting involves downloading a series of audio or video broadcasts (or files) onto a digital media player or a computer (Deal 2007). These video or audio files can be watched or listened to when, where and as often as chosen (Boulos, Maramba and Wheeler, 2006; Evans, 2008) and offer the listener more control than more traditional Web-based streaming media (Educause, 2005). Recent technologies such as podcasts have enabled educators to expand their options on how information is delivered and on how to foster student engagement both within and outside the classroom (Lyles, Robertson, Mangino and Cox, 2007; Taylor, McGrath-Champ and Clarkeburn, 2012). Allied health student cohorts can have large variations in their prerequisite discipline knowledge and in their engagement with basic anatomy and physiology, thus the increase in pedagogical options may be particularly relevant for the teaching of biomedical sciences, including physiology, to this group. Introductory anatomy and physiology classes are typically delivered didactically, are content dense (Johnston, Massa and Burne, 2013) and generating high levels of student engagement can be challenging.   These courses are often considered difficult by nursing students

(Mostyn, Jenkinson, McCormick, Meade and Lymn, 2013) and have relatively high failure rates (Johnston, 2009; Spitzer and Perrenoud, 2006).

Today's generation of students have been coined *Millennial* learners, Generation Y or the *Net Generation*, because they have been raised in the media-rich environment and live in an information-centric world (Carlson, 2005; Maag, 2006). *Net Geners* (born between early 1980s- late 1990s) have been described as being digitally literate, prefer working in groups, achievement oriented, require structure and guidelines, crave interactivity, have short attention spans, are experiential, visual and kinaesthetic learners (Baron and Maier, 2005). *Net Geners* have grown up with technology which has been proposed to have changed the way they prefer to learn. In terms of learning, the *Net Gen* culture is characterised by a strong sense of independence and autonomy, emotional and intellectual openness, greater social inclusion with technology, free expression and strong views, innovation and an expectation of constant change, the ability to build or construct experiences, a need for immediacy of communications, and authentication of everything in order the establish trust (Tapscott, 1999). Prensky (2001a) claims that the digital culture and environment in which *Net Geners* have grown up has fundamentally changed the way in which they think and process information. The prevalence and rapid evolution of digital technologies and the potential for a resultant alteration in learning styles has led to the idea that the current generation of university students is fundamentally different from any that educators have seen before (Prensky, 2001a; Prensky, 2001b).

The different personality traits that appear to characterize *Net Gen* students and the growing argument that *Net Gen* students learn in fundamentally different ways to previous generations of students has led to increasing pressure on educators to adapt teaching methods. Specifically, the inclusion of digital media in the University setting has gained growing importance over the last decade with the view held by some that 'if educators do not provide digital technology in the classroom they will be left behind in the archaic dust' (Maag, 2006). However, caution has been advocated by some authors regarding the impact of digital technologies on students' learning styles (Carlson, 2005). Some authors report that the views of Prensky (2001a and b) overstate the more complex mix of technological based skills, knowledge and preferences that exist among student populations and assume that all students have a sophisticated knowledge of digital technologies (Kennedy, Judd, Churchward, Gray and Krause, 2008). In fact, Kennedy et al. (2008) found a distinct lack of homogeneity within a single year of a student population in terms of their use and confidence with digital technologies. The challenge for educators therefore becomes to cater for student diversity in levels of access to, familiarity with and preference for different technological based tools (Kennedy et al., 2008). In addition, the assumption that students support the use of technologies that they usually use for social or entertainment purposes (such as digital music players) to an educational setting has been questioned by many authors (Katz, 2005; Kennedy et al., 2008; Kirkwood and Price, 2005; Tapscott, 1999). Studies report that 14-52% of students do not want, like or use podcasts (Kennedy et al., 2008; Maag, 2006; Vogt, Schaffner, Ribar and Chavez, 2010; Walls, Kucsera, Walker, Acee, McVaugh and Robinson, 2010). Students choosing not to engage with podcasts prefer face-to-face lectures and reading textbooks to listening to podcasts (Cann, 2007; Krazlauskas and Robinson, 2012; Ormond, 2008) citing improved concentration and ability to absorb information (Krazlauskas and Robinson, 2012). These findings highlight the need for careful consideration of potential educational benefits before new technologies are included in the educational arsenal.

There are many potential applications for podcasting in the tertiary educational setting. One common approach is to provide the students with audio copies of traditional lectures (Copley, 2007; Read, 2005a). This method has the benefits of giving students a second chance to listen to lecture material, which is particularly appreciated by students whose first language is not English (ESL) (Bell, Cockburn, Wingkvist and Green, 2007; Read, 2005b). Podcast versions of traditional lectures also provide a means by which students can catch up on material that they may have missed by skipping lectures. Some authors, however, recommend against providing full length lecture podcasts which were considered disconnected and boring (Fose and Mehl, 2007; Harris and Park, 2008; Mikat, Martinez and Jorstad, 2007) and prefer short 3-5 minute summaries (Lee and Chan, 2007; McGarr, 2009; Taylor et al., 2012).

Advocates contend that podcasting is attractive in an educational setting because it potentially offers students geographical and temporal choice in terms of their study (Evans, 2008; Heilesen, 2010; Hill, Nelson, France and Woodland, 2012) and enables students to increase the number of hours they spend studying without necessarily having to remove another activity from their schedule (Bell et al., 2007). Students can listen to course related material while they are engaged in other activities such as exercising, travelling or completing household chores. However this appears to be contrary to research in cognitive psychology which shows that multitasking diminishes performance with each additional task undertaken (Idux, Ivanof, Asplun and Marois, 2006; Strayer and Johnston, 2001). Furthermore, studies have shown that students do not multitask listening to podcasts with other activities (Evans, 2008; Heilesen, 2010; Lee and Chan, 2007; Van Zanten, Somogyi and Curro, 2012). Podcasting may offer greater support to auditory learners which may comprise at least 30% the student cohort (Boulos, Maramba and Wheeler, 2006) and to ESL (English as second language) students, allowing them the opportunity to replay lectures multiple times potentially enhancing learning (Evans, 2008). Some authors believe that podcasts can encourage the development of a more active style of learning compared to textbooks and traditional lectures which tend to foster a more passive learning style (Evans, 2008). Though others argue that students associate listening with recreation not learning (Krazlauskas and Robinson, 2012) and that podcasts foster a passive, transmission mode of learning (Lee, McLaughlin and Chan, 2008), that does not necessarily translate into improved learning performance (Ng'ambi and Lombe, 2012).

Some authors advise caution regarding the use of podcasts in educational environments (Johnston et al., 2013; Krazlauskas and Robinson, 2012; Vogt et al., 2010; Zanussi, Paget, Tworek and McLaughlin, 2012). In some studies, listening to podcasts was not regarded as the most effective use of time nor were they perceived as useful by all students and as such podcasts were deemed useful only for supplementary roles in education (Krazlauskas and Robinson, 2012; Vogt et al., 2010). It has been assumed that students have the skills and background to enable them to judge which learning tools will best support their learning (Johnston et al., 2013) and the validity of this assumption may impact the effectiveness of podcasting in different student populations. Concerns such as the lack of visual content, the difficulty of taking notes while engaged in other activities, and the divided attention of the listener between environmental distractions and the material on the podcast (Bell et al., 2007) should all be considered when evaluating the value of educational podcasting.

Many educators have also raised the issue of demonstrating a clear educational benefit to implementing podcasting before expending the time necessary to learn and create these new resources. Some authors warn that podcasts in themselves are not learning objects, and that

podcasts only become learning objects if they include learning objectives and have educational value (Andersen, 2011; Cebeci and Tekdal, 2006; Ng'ambi and Lombe, 2012; Zanussi et al., 2012). Some staff have developed clear guidelines for evaluating the usefulness of new technologies such as podcasting (Kidd, 2012; Lyles et al., 2007; Villano, 2008; Zanussi et al., 2012). Lyles et al. (2007) proposes that three main criteria should be considered before the inclusion of any new technology; "the tool must integrate with or enhance an existing teaching style, there must be clear purpose for adopting the tool and there must be an indication that the tool will have added benefits in terms of teaching and learning" (Lyles et al., 2007). This evaluation process includes some of the basic elements of the Learning Development Cycle, in which scope and object of learning design, the creation of learning resources, the user experience, the determination of effectiveness, and the evaluation of the learning experience are all considered (Siemens, 2005). The need for podcasts to be scaffolded and anchored by instructors has been highlighted (Hill et al., 2012) in order for students to advance along the affective learning domain (Krathwohl, Bloom and Bertram, 1964) and thus promote progression through the cognitive learning domains (Bloom, Engelhart, Furst, Hill and Krathwohl, 1956). Thus, despite the advantages of podcasting that educators and students report, there is a need for research that focuses on the use of podcasts as learning objects. There is currently very limited research on the effectiveness of podcasts in terms of educational outcomes such as student performance on assessment tasks (Heilesen, 2010; Hill et al., 2012), particularly for health students in tertiary environments (Johnston et al., 2013). As learning is unlikely to be improved by the mere application of a new technology (Abt and Barry, 2007; Kirkwood and Price, 2005), the adaptation of podcasting technology and its widespread implementation should be informed by empirical research in order to maximise the impact of this mobile media revolution in terms of instructional design and learning outcomes (Maag, 2006).

The aim of this study was to quantitatively evaluate if podcasting improves student performance in foundation physiology classes delivered to allied health students enrolled in physiotherapy, occupational therapy and sports and exercise science degree programs. James Cook University has a typically high enrollment of low socioeconomic (19.6%), mature age (32.2% of students are 26 years or older), and indigenous students (3.7%), as well as a high proportion of students for whom they are the first university student among their family (though some students cohorts, include those used in this study, contain predominantly *Gen Y* school leavers). This, combined with large class sizes in lectures (approx 200) and the content dense nature of typical introductory anatomy and physiology classes, create many challenges for both biomedical science content delivery and student engagement and performance. Podcasting of traditional, live lectures was introduced and assessment performance was analysed to determine if podcasting increased student engagement and translated into increased assessment performance in intra-semester quizzes and end of semester summative exams.

Methods

Podcasting was implemented, in addition to traditional face to face lectures, in the physiology components of three foundation anatomy and physiology subjects taught into the Bachelors of Occupational Therapy, Physiotherapy and Sports and Exercise Science degree programs at James Cook University, Townsville, Queensland, Australia in 2008. The lectures for these subjects were held jointly, but separate practical classes were provided. Content areas covered by podcasting represented 81.25% of physiology content and 40.6% of the subject.

The combined cohort receiving podcasting (podcasters) contained 215 students consisting of those enrolled in physiotherapy, occupational therapy and sports and exercise science degree programs. The assessment performance of these students was compared to the previous year's 2007 cohort (for whom podcasting was not provided, non-podcasters) containing 205 students. The mean tertiary entrance rank (OP score) for these students was not significantly different from that in 2008 (Table 1). Most students were enrolled full time; 89% were aged 17-21 years old, with a 72% female bias in enrolment.

Table 1: Student numbers and tertiary entrance scores (OP) for Bachelor of Physiotherapy, Bachelor of Occupational Therapy and Bachelor of Sports and Exercise Science. There was no significant difference in tertiary entrance scores between the cohorts of students in 2007 and 2008. Data are mean ± standard error.

	2007	2008	
	Tertiary Entrance Rank (OP)	Tertiary Entrance Rank (OP)	*P* value
Physiotherapy	5.45±0.37 (n=60)	6.19±0.40 (n=65)	0.20
Occupational Therapy	8.85±0.31 (n=71)	9.70±0.38 (n=80)	0.11
Sports and Exercise Science	11.92±0.49 (n=74)	13.02±0.44 (n=70)	0.14

Traditional didactic lectures were recorded and released as audio only files via Blackboard™ supported LearnJCU (student learning management website). The files were compressed so that final file size was between 4-7MB, thus maximizing the probability that even students with slow dial-up internet connections could access the files. Evaluation of the effectiveness of podcasting took the form of access data analysis, a student feedback questionnaire and comparisons of subject assessment performance. This study was approved by the James Cook University Human Research Ethics Committee (H2959).

Access data
The Blackboard™ LearnJCU site was enabled with statistics tracking to collect data on the access profiles of available podcasts from the start of the teaching period up to the final examinations. Access data was collated on either an hourly or daily basis.

Questionnaire
At the end of the teaching period (2 weeks prior to the final exam), students were asked to voluntarily and anonymously complete a survey on the use of podcasts and the perceived effectiveness of podcasts for their learning (see appendix 1).

Assessment performance
The assessment performance was compared between podcast users and non-users within the podcasting cohort, as well as between podcasting and non-podcasting cohorts. The assessment pieces were either identical (where feasible) or of matched content and difficulty. Assessment pieces included 2 intra-semester physiology quizzes (multiple choice questions) and the final written exam (multiple choice questions and short answers questions). Empirical data was statistically analysed using ANOVA (*P*<0.05) or Student's t-tests (*P*<0.05).

Results

Access Data

Access rates for podcast were high; 95% of students (205 of 215) accessed the podcasts at least once prior to the final exam, creating a total of 5308 hits across the 13 week teaching period (Table 2). Of the 4.5% of students that never accessed podcasts only 50% passed the subject overall. There was a mean 25 hits per student across the teaching period, with each student accessing each podcast an average 2.5 times. Some students showed very significant podcast usage, creating a maximum of 61 hits overall, with one student accessing one lecture 28 times (Table 2).

Table 2: Access patterns for podcasts implemented into foundation physiology classes for Bachelor of Physiotherapy, Bachelor of Occupational Therapy and Bachelor of Sports and Exercise Science. Data are ± standard error where indicated.

Total no. hits	5308
Total no. students	215
Mean no. hits per student	24.7±0.8 (range 0-61)
Mean no. hits per student per podcast	2.5±0.1 (range 0-28)
% students accessing podcasting	95.5
Peak access day	Monday
Peak access time	14-16:00 hrs

Podcasts were accessed by students throughout the day, with only brief periods of zero access between 02:00-04:00hrs. Peak access times were between 14:00hrs and 16:00hrs. The days of the week preferred by students to access podcast material was also spread throughout the week with a slight preference for Mondays (lectures were held Monday 8am, 5pm and Tuesday 8am). The podcast access patterns across the entire teaching period clearly show peaks in access prior to assessment pieces (Figure 1).
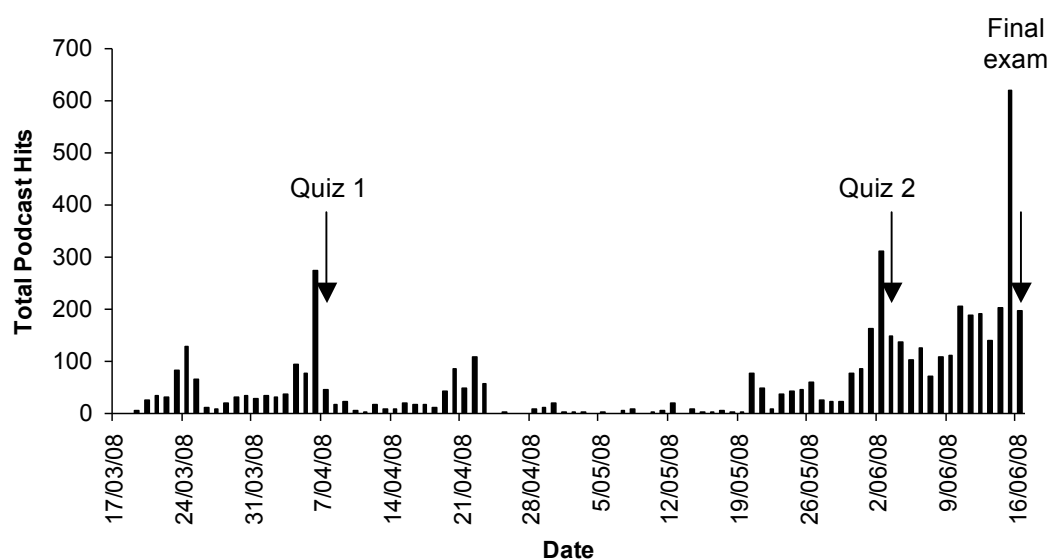

Figure 1: Total number of daily podcast hits. Sampling period was from 17th March to 16th June. Dates for the 3 assessment items are indicated. Low access rates between 24th April and 21st May reflect when the anatomy component of the subject was taught.

Questionnaire

All students were asked to complete a voluntary and anonymous questionnaire relating to their use of podcasting two weeks prior to the final exam (week 13 of semester). 179 students completed the survey, representing 83.3% of the enrolled students (Appendix 1).

The majority of students in this study either owned a digital music player (81%) or had plans to purchase one (16%). A high number of students had listened to some type of podcast before commencing this subject (79%) but only 21% reported that they had previously listened to podcasts regularly. 21% of students reported that they had not listened to any type of podcast previously because they either were not interested (9%) or did not know how (12%).

Two weeks prior to the final exams (when the questionnaire was delivered), 82% of students reported that they had listened to at least one of the subject's podcasts, with 18% reporting that they had listened to all the available podcasts. The actual podcast usage determined after the final exams (2 weeks after the questionnaire was completed) indicated that 95.5% of students had accessed the podcasts and reflects the high usage of podcasts during the revision period prior to the final exams. Students stated that the main reason that they had not listened to podcasts was that they were too busy (18%), or that they had technical difficulties accessing the podcasts (11%). Only 6% of students did not perceive any educational value to listening to podcasts and 4% were not aware that podcasts were available.

Most students (58%) reported that they used the subject's podcasts for study and revision before assessments and 20% of students used podcasts to supplement their lectures notes after classes. Only 4% of students reported that they used the podcasts to catch up on missed classes and no student reported that they used podcasts as an alternative to attending scheduled classes. Interestingly, 76% of students reported that they used the available podcasts in addition to the recommended textbook, and only 6% reported that they used the podcasts as an alternative to reading the textbook.

When asked how the students used the podcasts the responses were varied; 22% of students listened to the entire podcast once, 20% listened to the entire podcast more than once. 11% of students just listened to segments of the podcast once, and 29% listened to the segments multiple times. Despite the availability of podcasts, the most valuable learning resource, as reported by students, were traditional lectures (46%) followed by practical classes (20%). Only 11% of students rated the podcasts as their most valuable learning tool. Most students (64%) students believed that the availability of podcasts increased their learning either moderately or greatly (Figure 2). There was overwhelming support for the continued and expanded use of podcasts in this subject, with 86% reporting that they would like to see all lectures available on podcasts and only 13% undecided and 1% against further podcasting.

One potential detractor from the use of podcasting is the risk that it may increase absenteeism. Most students in this study (60%) reported that they had attended all scheduled lectures for this subject, and 35% of students had missed less than 5 lectures, 4% missed approximately one lecture every two weeks and 1% missed more than one lecture every two weeks. The reasons for missing scheduled classes were varied and included family or work commitments (19%), claiming that they learned better on their own (8%) or other reasons (14%) including illness and sleeping in (lectures at 08:00 and 17:00hrs). Implementing podcasting did not appear to increase absenteeism with 97% of students reported that the

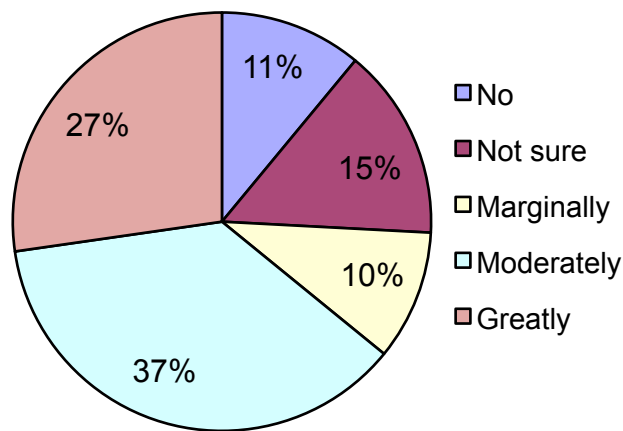availability of podcasts either did not encourage their absenteeism (72%) or did not make a difference (25%).

Figure 2: Student responses to the question: Have podcasts increased your learning? N=209 responses.

A total of forty students supplied additional comments on their questionnaires relating to podcasting. 39 of these comments contained positive statements relating to the support of podcasting, with 1 respondent discussing a problem with accessing the podcasts. Of the 39 respondents:

- 28% provided general positive comments regarding podcasting, such as "*I loved the podcasts*" and "*the podcasts were excellent*".
- 26% referred to podcasts being useful for revision, "*Great for revision*" and "*I use them around exams and quizzes for study*".
- 28% commented that they used podcasts for adding/clarifying details they missed in lecture, "*I am able to listen to confusing sections over and over until I understand*"
- 15% commented on the usefulness of podcasts to their learning, "*I have found that podcasts are very useful when combined with lecture notes and readings, they have definitely increased my performance without this I believe I would be finding this subject a lot harder*".
- 21% wished that more lecturers would use podcasts, "*I'd like all subjects to have podcasts*" and "*please encourage other lecturers to use them*"
- 8% wrote that they used podcasts for catching up on missed lectures, "*they are great if you missed a lecture to catch up*"

Assessment Performance

Intra-semester quizzes
There was no correlation ($R^2 = 0.0148$) between the number of times a student accessed the podcast material and the assessment performance intra-semester Quiz 1 (Figure 3). Students who did well did not appear to have a consistently higher podcast usage. Similarly, students who scored poorly did not appear to have a significantly lower podcast usage. A similar lack of correlation between podcast usage and quiz performance was measured in Quiz 2 ($R^2 = 0.001$, Figure 4).
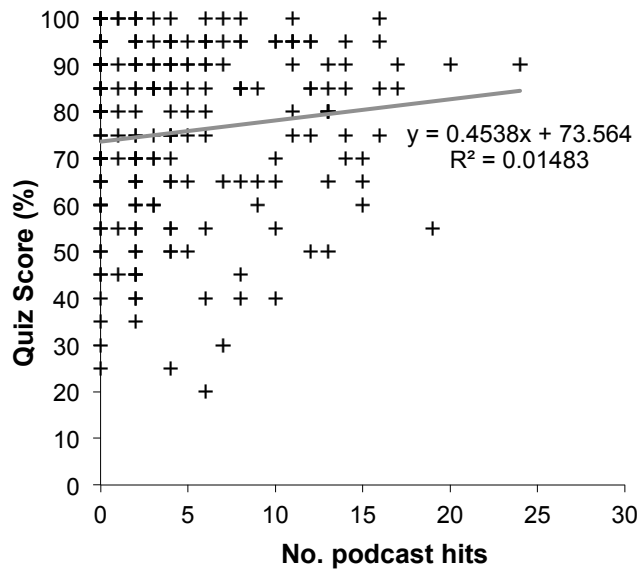
Figure 3: The distribution of grades from intra-semester Quiz 1 compared to the total number of podcast hits prior to the Quiz (n=204).
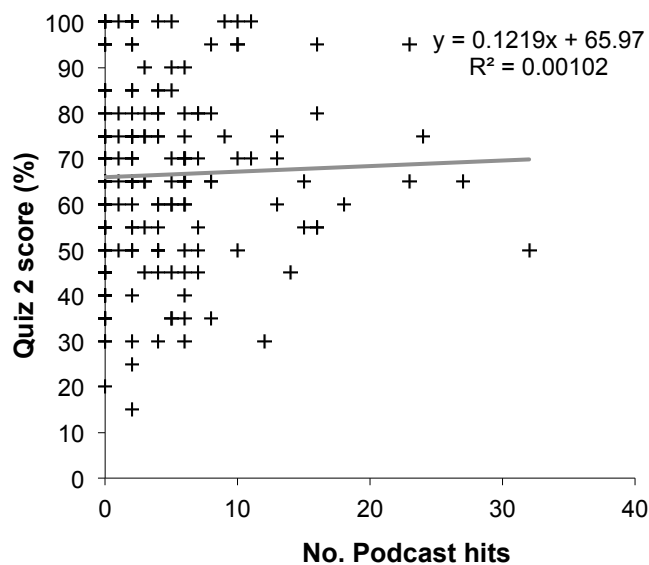

Figure 4: The distribution of grades from intra-semester Quiz 2 compared to the total number of podcast hits prior to the Quiz (n=210).

The mean scores achieved by students on the two intra-semester Quizzes across two consecutive cohorts (2008 vs. 2007) were not significantly affected by the availability of podcast material (Table 3). Within the podcasting cohort, the mean score podcast users on quiz 1 was 76.28±1.30% compared to non-users who achieved a mean score of 74.38±1.43% (P=0.54). The mean scores for Quiz 1 were not significantly different (*P*=0.51) from that achieved by the non-podcasting cohort (73.93±1.38%). Similarly, the mean score achieved by students on Quiz 2 was not significantly affected by the availability of podcasts (*P*=0.41). Mean scores for podcast users was 67.46±1.66% compared non-users 64.86±2.66%. Despite the high access rates, the availability of podcasts did not significantly increase the average grade on this assessment piece when compared to the non-podcasting cohort (*P*=0.62).

Table 3: Mean (%) assessment score for 2 intra-semester Quizzes for cohorts that had access to podcasts (2008, separated into users and non-users) and cohorts that did not have access to podcasting (2007). T-tests compared users and non-users within a cohort, and ANOVA compared all three groups across cohorts.

	% scores ± SE		*P* value
Quiz 1	User	Non-user	
Podcasting available cohort	76.28±1.30	74.38±1.43	0.54
Podcasting not available cohort		73.93±1.38	0.51
Quiz 2			
Podcasting available cohort	67.46±1.66	64.86±2.66	0.41
Podcasting not available cohort		61.31±1.39	0.62

Final Exam

Analysis of access patterns (via the Blackboard™ LearnJCU site) revealed that 95% of students used the subject podcasts at some point during the semester; however, this very high access rate did not translate into improved exam performance. Due to the very high percentage of students accessing podcasts, statistical comparisons between podcast users and non-users within the podcasting cohort was not possible. Final exam performance was analysed separately for each degree student cohort. The physiology sections (short answer questions and multiple choice questions, (MCQ)) for each student cohort were compared to the results from the prior, non-podcasting year. In all three degree programs there was no significant difference in student assessment performance on the physiology MCQ or short answer questions between the podcasting cohort and the non-podcasting cohort (Table 4).

Table 4: Mean (%) assessment score for the multiple choice question (MCQ) and short answer sections of the final exam for cohorts that had access to podcasts (2008, separated into users and non-users) and cohorts that did not have access to podcasting (2007). T-tests compared scores across cohorts.

	% scores ± SE		
MCQ	Podcasting available	Podcasting not available	P value
Occupational Therapy	68.51±2.03	69.79±2.04	0.66
Physiotherapy	84.90±1.54	81.06±1.31	0.06
Sports and Exercise Science	62.59±2.05	61.50±1.87	0.69
Short Answer			
Occupational Therapy	44.71±1.24	50.31±1.30	0.25
Physiotherapy	71.41±0.85	71.04±1.06	0.92
Sports and Exercise Science	41.31±1.15	40.82±1.21	0.91

Discussion

The teaching of biomedical sciences, including physiology, to large classes of allied health students can be challenging. Students often have varying degrees of exposure and mastery of prerequisite discipline knowledge and their focus on clinical objectives may lead them to question the relevance of the biomedical sciences unless careful attention is paid to the relevance of such material to their specific degree program. At James Cook University, foundation anatomy and physiology lectures are given to a combined cohort of

physiotherapy, occupational therapy and sports and exercise science students, creating a large class size of students with mixed professional interests and tertiary entrance ranks. Podcasting of traditional lectures was introduced in an effort to increase student engagement and performance on assessment tasks.

The students in this study self-reported high levels of access to the relevant technology required to process the learning tool tested (podcasts) with 81% owning a digital music player. Similar results have been found previously indicating that student have extensive access to the technology required to play podcast files (Bell et al., 2007; Evans, 2008). However, despite the high numbers of students with portable digital media players, many studies report that the majority of students use personal computers to access podcasts, suggesting that mobility is not a motivating factor for podcast use (Bell et al., 2007; Brittain, Glowacki, Van Ittersum and Johnson, 2006; Lane, 2006; Lonn and Teasley, 2009; Walmsley, Lambe, Perryer and Hill, 2009). The high percentage of students accessing podcasts prior to exposure in this subject (79%) was similar to the high levels of non-academic podcast usage found in other studies (Bell et al., 2007). Though students in this and other studies did access educational material at times when it would otherwise have been unavailable, overall, podcasts did not offer substantial benefits in terms of multitasking, with most students reporting that they did not undertake any other activities while listening to podcasts (Copley, 2007; Evans, 2008; Lee and Chan, 2007; O'Bannon, Lubke, Beard and Britt, 2011).

The results from the questionnaire (appendix 1) and the daily access data (Fig 1) strongly indicate that students were using podcasts for revision purposes prior to assessment pieces with 29% of students reported listening to segments more than once, creating an average of 25 hits per student and 2.5 hits per student per podcast (Table 2). These data indicate that a student accesses each podcast multiple times and supports the idea that students value the ability to review material at their convenience. The preference for using podcasts for revision purposes is also supported by the increase in podcast usage from 82% reported in the questionnaire two weeks prior to the final exam to 95.5% measured via access data on the day of the final exam. The use of podcasts for revision purposes prior to assessments has been shown in similar studies (Brittain et al., 2006; Evans, 2008; Lane, 2006; Lonn and Teasley, 2009; Schlairet, 2010; Van Zanten et al., 2012) with some studies showing increased download rates immediately prior to assessment items (Copley, 2007). The link between high access rates prior to assessments and the lack of improved student performance in nursing students studying first year anatomy and physiology has lead to the suggestion that the availability of podcasts encourages "cramming" rather than fosters ongoing engagement with subject content, and thus, while podcasts may provide effective revision tools for engaged students, they can disadvantage students who use podcasts to replace lecture attendance (Johnston et al., 2013). The number of students accessing podcasts in this study was similar to the high levels (80-91%) found in some studies (Copley, 2007; Lyles et al., 2007; Tynan and Colbran, 2006) and significantly exceeded the lower access rates (34-47%) found in other studies (Bell et al., 2007; Maag, 2006; Schlairet, 2010).

Despite the high podcast usage and popularity, and the belief by 64% of students that podcasting had increased their learning (Fig 2), an increase in assessment performance was not measured, either between podcast users and non-users within the podcasting cohort, or between the podcasting and non-podcasting cohorts for any assessment item (Fig 3&4, Tables 3&4). Similar studies report that students believed that podcasts improved their grade (Brittain et al., 2006; McKinney and Page, 2009) but few studies have measured assessment performance in response to podcast implementation. In one study, students who received

podcast lectures had higher overall grades than those from a previous cohort who received traditional lectures (Kurtz, Fenwick and Elllsworth, 2007). However, enhanced podcasts did not produce a significant difference in examination scores when compared to the traditional lecture format of the same content (Ogawa and Nickles, 2007). Similarly, podcasts were found to have no effect on students' grades (Baker, Harrison, Thompson and Yates, 2008; Barco, Gebregziabher and Fitzharris, 2010; Cook, Levison, Garside, Dupras, Erwin and Montori, 2008; Deal 2007; Hill et al., 2012; Hodges, Stackpole-Hodges and Cox, 2008; Lazzari, 2009; Powell and Mason, 2013), a negative effect (Fernandes, Maley and Cruickskank, 2008; Johnston et al., 2013) or only had a benefit if the students took notes while listening and listened to the podcasts more than once (McKinney, Dyck and Luber, 2009). In a cohort similar to this study (first year undergraduate exercise physiology), the provision of supplemental material did improve performance scores, but podcasting was found to have little additional quantifiable benefit when compared to the provision of matched written text material (Abt and Barry, 2007). Further, there was no significant difference in assessment performance when comparing podcasting over traditional didactic presentations in a study of ten anesthesiology residents (Bernsalem-Owen, Chau, Sardam and Fahy, 2011) or in two junior nursing classes (Vogt et al., 2010).

Although a significant difference in assessment performance was not measured in this study it should be noted that some benefits to student learning may have occurred that did not translate to assessment performance. Studies have reported that podcasting may foster greater student engagement and interest in teaching activities (Belanger, 2005), provide support for ESL students (Brock, 2005; Bull, 2005) and allow learning to have an increased degree of geographical and temporal flexibility. Students have reported that they were more receptive content material delivered as podcasts compared to material delivered in the form of a revision lecture or from the textbook (Evans, 2008).

There was overwhelming support for the continued and expanded use of podcasts in this subject, with 86% reporting that they would like to see all lectures available on podcasts. The strong support for continued use of podcasting parallels the findings of other studies who report that 77-93% of students are in favour of the use of podcasts in their subjects (Baron and Maier, 2005; Copley, 2007). Students also indicate that they learn and retain information better if they are able to hear the lecture material more than once (Maag, 2006). However, Zanussi et al. (2012) argued that rater satisfaction is not a meaningful outcome in terms of evaluating podcasting and instead it represents student satisfaction with the technology rather than its educational effectiveness. Despite the availability and popularity of podcasts, the most valuable learning resource as reported by students in this and other studies were traditional face-to-face lectures (46%) (Barco et al., 2010; Cann, 2007; Ormond, 2008) followed by practical classes (20%). Only 11% of students rated the podcasts as their most valuable learning tool.

One of the main criticisms of podcasting traditional lectures is that it encourages absenteeism and enables students to delaying listening to material, with few realising the intention to catch up on missed material (Bell, Cockburn, McKenzie and Vargo, 2001). Findings from this study indicate that 39% of students had missed at least one scheduled lecture, but only 5% regularly missed classes. The main reason for missing classes was reported as family/work commitments, illness or sleeping in. Some studies have found that attendance at lectures decreased by 9-16% when podcasts were available (Brittain et al., 2006; Copley, 2007; Lyles et al., 2007). However the overwhelming response from students in this study was that the availability of podcasts did not increase their absenteeism (96%) and that only 4% of students

reported that they used the podcasts primarily to catch up on missed material. Students have previously reported that podcasting did not increase absenteeism (Lonn and Teasley, 2009) and no increase in absenteeism has been measured in empirical studies (Walls et al., 2010). Taken together, these findings suggest that podcasting did not increase absenteeism in this study beyond that which would normally be expected.

Debate exists over the most effective length for educational podcasts and is confounded by the different ways in which podcasts are used in higher education, be that to support or replace live lectures, provide supplementary or preparatory material or short content summaries. Despite the preference by some authors for short 5-20 minute podcasts (Evans, 2008; Jalali, Leddy, Gauthier, Sun, Hincke and Carnegie, 2011; Kidd, 2012; O'Bannon et al., 2011) podcasts of live lecture are the most common (Chester, Buntine, Hammond and Atkinson, 2011; Zacharis, 2012), the easiest to implement and are the most requested by students (Deal 2007). In this study, 42.4% of students listened to the entire live lecture podcast (50mins) either once or more than once. Podcasts of live lectures require little additional effort on the part of the academic (Vajoczki, Watt, Marquis and Holshausen, 2010) when compared to producing shorted, scripted content summaries. Given the high overall usage rate of podcasts, the high numbers of students listening to the full duration of the live lecture podcasts and the lack of any measureable increase in student assessment performance with podcast implementation, the use of live lecture podcasts may be the best compromise between student demand for this technology and high academic loads.

In conclusion, despite high access rates and strong student satisfaction with podcasting, assessment performance was not significantly increased by the implementation of podcasting. This finding is reassuring for the critics of podcasting who argue that podcasting decreases student attendance and thus may decrease student performance, but it does not support those who argue that podcasting increases student learning and thus assessment scores. The availability of podcasts appears to increase student levels of comfort with subject material and acts to decrease anxiety prior to assessments by providing ready 24hr access to the instructor (in a pre-recorded format), but this does not appear to translate into increased performance in assessment tasks. Thus, while podcasting does have some significant benefits in terms of student satisfaction and learning flexibility, a direct relationship between the implementation of podcasting and increased student learning (as evidenced by assessment performance) could not be established in this study.

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Appendix 1:

Responses from student questionnaire on podcasting into foundation physiology classes for Bachelor of Physiotherapy, Bachelor of Occupational Therapy and Bachelor of Sports and Exercise Science, n=179.

	% response
Do you own an iPod or other type of MP3 player?	
Yes	81.4
No, but I plan to within 6 months	15.7
No and I don't plan to	2.9
Have you listened to podcasts before?	
Yes regularly	21.0
Yes sometimes	24.8
Yes just a few times	32.9
No not interested	9.0
No don't know how	12.4
How many of this subject's podcasts have you accessed?	
All	18.1
Most	21.9
Some (4-5)	22.4
A few (<3)	19.5
None	17.6
What is the main reason that you use podcasts?	
Don't use	17.1
Study/Revision prior to assessment	56.7
Supplement lecture notes	19.5
Catch up on missed classes	3.8
Instead of attending lectures	0.0
Do you use podcasts in place of other resources?	
Don't use podcasts	17.6
Instead of textbook	5.7
Instead of attending lectures	0.5
In addition to textbook	74.3
When you listen to podcasts do you.	
Listen to entire podcast once	21.9
Listen to entire podcast more than once	20.5
Listen to segments once	11.0
Listen to segments more than once	29.0
Don't use podcasts	17.1
Have podcasts increased your learning?	
No	11.0
Not sure	14.8
Marginally	10.0
Moderately	36.7
Greatly	27.1

The most valuable learning tool for you was?

Lectures	44.8
Practical sessions	18.6
Podcasts	9.5
Online quizzes	11.9
Textbook and CD	10.0

Would you like to see all lectures podcast?

No	1.4
Undecided/Don't care	12.4
Yes	84.8

I didn't access the podcasts because?

I did access podcasts	57.1
Not relevant for my learning	5.2
Technical difficulties	10.0
Did not know they were available	3.8
Too busy	16.2

How often do attend lectures?

I attend all lectures	59.0
Missed a few (<5)	34.3
Sometimes miss lectures (1 per fortnight)	3.8
Often miss lectures (more than 1per fortnight)	1.4
Miss most lectures	0.5

Why do you miss lectures?

I don't miss lectures	58.1
Learn better on my own	8.1
Family/Work commitments	18.6
Not interesting	1.0
Other	14.3

Do you think that podcasting encourage absenteeism?

Yes	3.3
No	71.4
No difference	25.2