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The impact of vodcast utilisation upon student learning of Physiology by first year graduate to entry medicine students

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Abstract: The current study sought to determine the effectiveness of video-on-demand podcasts (vodcasts) as a tool for facilitating the understanding of Physiology by first year undergraduate Graduate Entry to Medicine (GEM 1) students. Seventy three GEM 1 students were provided with full length vodcasts of lecture material in advance of each of nine Physiology lectures. Exam performance, using identical sample questions, was assessed against performance of the 2012-2013 GEM 1 class, which did not have access to the vodcasts. Qualitative information on students' perceptions of the vodcasts was also gathered and analysed. Analysis revealed that the study group of 2013-2014 GEM 1 students achieved significantly higher grades in various examination formats in comparison to the control 2012-2013 GEM 1 cohort. Qualitative analysis of responses to the attitudinal survey revealed that the majority of students liked the vodcasts and that previewing them before lectures did indeed facilitate understanding of the lecture material. However, only 15% of the class was able to view all nine of the prepared vodcasts prior to lectures. Notably, the majority of students indicated that they also considered the vodcasts to be valuable revision tools. This study is the first to show that the use of vodcasts can provide clear, quantifiable benefits for GEM student learning over and above lecture notes and/or lecture slides alone. Our analysis suggests that this improvement was due both to their use as a preview tool as well as facility for later revision of lecture content.

Keywords: adult learning, improving classroom teaching, interactive learning environments, media in education, teaching/learning strategies.

Introduction

The current era of rapid technological advancement has had multiple significant and direct impacts on education in terms of both teaching and learning. One of the most significant advances in this regard has been the growth in the use of digital media such as podcasts as an alternative, or adjunct, to the traditional lecture (Ravenscroft, Tait, & Hughes, 1998; Stephenson, Brown, & Griffin, 2008), a development which is broadly very popular with students (Evans, Gibbons, Shah, & Griffin, 2004; Heilesen, 2010). Importantly however, the use of digital media such as podcasts also seems to have a positive and measurable impact upon learning and teaching when used as an adjunct to the traditional didactic lecture (see *inter alia* Evans, 2008; Fernandez, Simo, & Sallan, 2009; Heilesen, 2010; Lazzari, 2009; Lin, Zimmer, & Lee, 2013; McGarr, 2009; Morris, 2010).

With the advent of higher speed bandwidths there has been a significant shift towards combined audio and video podcasts (VODcasts – where the 'VOD' acronym stands for 'video-on-demand'; Meng, 2005). Studies investigating the use of vodcasts in education have largely found that, as with audio podcasts, they are popular with students at a fundamental level as they provide them with control over their own learning environment, both in terms of where

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and when they learned (Heilesen, 2010; Jarvis & Dickie, 2010; McGarr, 2009; Stephenson et al., 2008; Winterbottom, 2007), their pace of learning (Chester, Buntine, Hammond, & Atkinson, 2011; Griffin, Mitchell, & Thompson, 2009; Stephenson et al., 2008; Winterbottom, 2007) and what they had to learn (Fill & Ottewill, 2006; Heilesen, 2010). However, the primary reason for their popularity with students was that they felt that they helped to improve their learning (for review see Kay, 2012).

However, their favourable reception by the majority of students notwithstanding, is there any empirical evidence that vodcasts actually improve students' learning performance? Although studies investigating the effect of vodcasts specifically on examination performance are still relatively limited, of those that have been conducted, the results are generally, although not always (McNulty et al., 2009; O'Bannon, Lubke, Beard, & Britt, 2011; Schreiber, Fukuta, & Gordon, 2010), positive (Crippen & Earl, 2004; Griffin et al., 2009; Traphagan, Kucsera, & Kishi, 2010; Vajoczki, Watt, Marquis, & Holshausen, 2010; Wieling & Hofman, 2010). However, one can only make extremely general extrapolations about the utility and transferability of these findings as, not only are vodcasts sometimes deployed in different formats (*e.g.* segmented *versus* full length, lecture-based *versus* worked example, *etc.* (see Kay, 2012) and different purposes (*e.g.* for lecture preparation or revision), they are also drawn from multiple educational spheres (*e.g.* humanities, law, chemistry, medicine, *etc.*) and attainment levels (*e.g.* secondary school, undergraduate and postgraduate).

This relative dearth of empirical information about the utility of vodcasts in facilitating learning and understanding equally applies to medical education in general, and, more specifically, to accelerated graduate entry medical (GEM) programs (where enrolled students are required to cover the same depth and breadth of material in one and a half years as 'direct entry' medical students cover in three, but with roughly only half the number of lectures), the subject of the current study. Indeed, to the best of our knowledge, at the time of writing only five full research articles and one short abstract have been published investigating the effects of lecture vodcasts (Jones, Doleman, & Lund, 2013; Pilarski, Alan Johnstone, Pettepher, & Osheroff, 2008; Schreiber et al., 2010; Shantikumar, 2009), or recorded live lectures (Cardall, Krupat, & Ulrich, 2008; McNulty et al., 2009), specifically on various aspects of medical training as a whole. Of these, only two examined the effect of vodcasts on exam performance, with one showing no effect compared to students who attended 'live' lectures (Schreiber et al., 2010) and the other demonstrating that individuals' frequency of use of vodcasts was actually correlated with *lower* exam scores (McNulty et al., 2009). To date, no studies have examined the effects of their usage within GEM education. We therefore sought to begin to fill this information void by both determining students' perceptions of vodcasts of lecture material, as well as empirically examining their effects on exam performance in a compulsory Physiology component of a module taken by GEM 1 students.

Study Rationale

The central aim of the current study was to investigate the hypothesis that previewing vodcasts of lecture material *prior to* attending scheduled lectures on the same topic would enhance student understanding of the material being taught and, as a result, improve exam performance relative to students who did not have access to vodcasts. The rationale underlying this approach was that students attending traditional didactic lectures are usually first exposed to the material contained within a lecture only during the lecture period itself. Thus, in terms of Bloom's revised taxonomy (Krathwohl, 2002), students will normally, at best, only be engaged in lower level cognitive work (gaining knowledge and comprehension) during an actual lecture (as this will likely be the first time that they will have encountered the material), with any higher order cognitive work (application, analysis, synthesis and/or evaluation) only likely to take place

when the lecture is 'revised' afterwards in the students' own time. Thus, those students who preview material prior to attending lectures, should theoretically be able to process that material at a deeper level than students experiencing their 'first pass' of the same information during the lecture itself (Krathwohl, 2002) and should therefore procure greater educational benefits from this face-to-face time with lecturers than their unprepared colleagues.

In addition to the primary goal of using vodcasts as a means of facilitating the understanding of Physiology by GEM students, measured empirically by performance in exams, we were also interested in gauging these students' perceptions about the vodcasts. Specifically, we wished to determine if this particular cohort of students, which is relatively distinct from other undergraduates due both to their prior higher educational experience, as well as the heavy study load that they experience relative to students enrolled upon the more common 'direct entry' undergraduate medical programs, would view the vodcasts as potentially valuable learning tools in their own right, for example, for revision purposes.

Therefore, the specific aims of the study were to:

1) Investigate the hypothesis that the deployment of vodcasts of lecture material in advance of the lectures themselves would enhance student understanding of the material being taught and, as a result, improve exam performance relative to students who did not have access to vodcasts.
2) Gather student opinions on the vodcasts in order to determine, a) if they perceived them as being useful learning tools, and b) if they did indeed utilise them as they were intended for the study, namely as preview tools before lectures, or if they were used as a revision tool, or a mixture of the two approaches.

This type of study is important due to the relative paucity of data investigating the effect of vodcast usage on student exam performance in general. However, more importantly from the perspective of the current study, in spite of the growth of accelerated graduate entry programs within Ireland and the UK, there are still very few studies investigating the impacts of utilising newly developed 'interactive' teaching tools (*e.g.* smartphones, webcasts, tablets, *etc*.) upon the students enrolled upon these courses.

Methodology

Study groups

The study was carried out at University College Cork during the autumn term of the 2013-2014 academic year. A total of 73 participants (39 females, 34 males) were full time, first year Graduate Entry to Medicine (GEM 1) students studying their first compulsory basic science module (GM1001 – Fundamentals of Medicine). All students entering this programme must possess a minimum of a second class honours, grade one (2H1 or equivalent) result in their first honours bachelor degree (NFQ level 8) and have attained an appropriate grade in either the Graduate Medical School Admissions Test (GAMSAT) or Medical College Admissions Test (MCAT).

For quantitative purposes, the 2013-2014 GEM 1 class's performance against specifically selected and identical Physiology questions in continuous assessment, end of module and end of year exams was compared with that of the preceding year's (2012-2013) GEM 1 class (who had no exposure to the vodcasts and could therefore act as a control group), which contained 69 students (30 females, 39 males).

Creating and publishing the vodcasts

Vodcasts were created using Panopto lecture capture software installed onto an office PC and used in conjunction with a webcam to record the slide narration. Vodcast slides were themselves created using Microsoft PowerPoint (MS PPT). MS PPT was utilised for this purpose primarily because, a) it is the 'industry standard' for lecture delivery, and b) it integrates well with the Panopto lecture capture software used here for the creation of the vodcasts. The Panopto software itself allows the user to record presentations in a combined audio and visual package, such that students can view the MS PPT presentation whilst hearing simultaneous commentary and seeing the relevant cursor moves. Furthermore, the user can pause, move forward and backward through the content or skip to specific slides as and when desired.

Once recording was completed, vodcast files were made available to the students on UCC's virtual learning environment, Blackboard (supplied by Blackboard Inc.), at least two weeks prior to each scheduled lecture slot, and remained available for download until the end of the academic year. From the Blackboard website, students could either directly playback the files or download them in MP4 format for playback on compatible portable mobile devices. Additionally, for both the 12-13 and 13-14 year groups, the MS PPT presentations used to prepare each vodcast, and full sets of learning outcomes accompanying each lecture (which were both identical for both years), were also posted on Blackboard for students to download as they wished.

Vodcast content

The nine vodcasts and lectures utilised in the study (out of a total of twelve Physiology lectures in the module) were all recorded and delivered by the same lecturer over the course of ten weeks in the fourteen week teaching period of module GM1001. The other three lectures in the module were delivered in traditional didactic format by one other lecturer and were not accompanied by vodcasts or additional content of any description. The mean duration of each recorded vodcast was 47.3 ± 1.9 minutes (range = 36.2 – 56.3 mins).

GM1001 lecture style

In the first week of module GM1001, the 13-14 GEM 1 students were informed that vodcasts for nine of their Physiology lectures in GM1001 had been, or would be, prepared and made available to them prior to each lecture, and that they should view each of these prior to attending the relevant lecture. Previewing of the vodcasts in advance of each lecture however was not mandatory.

In order to further facilitate higher level cognitive work by the students during the actual lecture slots, the lectures themselves, which covered broadly similar material to that contained within the vodcasts, were very loosely based upon the 'flipped classroom' teaching technique (Crouch & Mazur, 2001; Gannod, Burge, & Helmick, 2008), where students as a group (as opposed to being provided with individual response units for example), having been asked to prepare for each lecture in advance, were then asked questions about the lecture material during lecture time, thus facilitating at least limited 'active learning' (Bonwell & Eison, 1991). In this particular study the questions utilised were relatively unsophisticated, and were largely based around answering questions about material that had been removed from the original lecture slides (*e.g.* see Figure 1), but which the students could still access prior to, and during, the lectures themselves.

The same nine GM1001 Physiology lectures delivered to the 2012-2013 GEM 1 class the previous year were all delivered as traditional didactic lectures with minimal student participation, as were the other three Physiology lectures which were, again, delivered by the one other Physiology lecturer on this module.

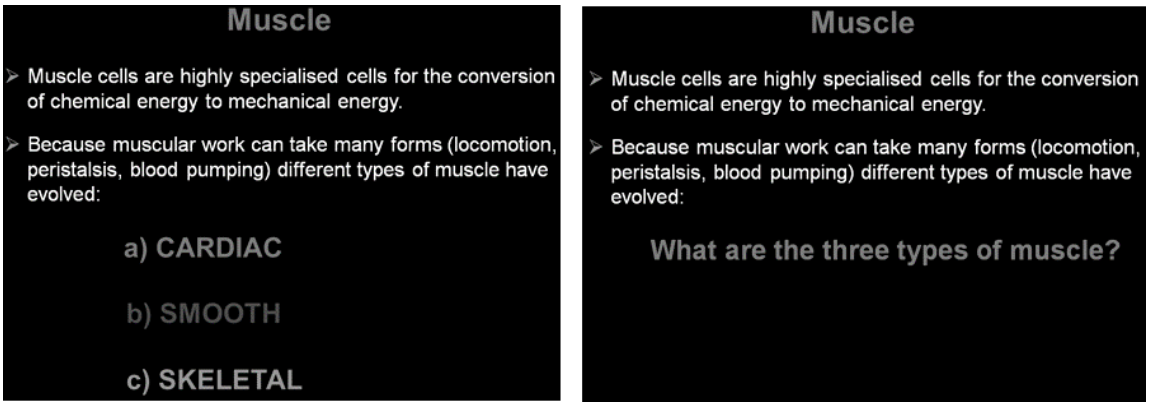

Figure 1: Sample question in a Physiology GM1001 13-14 presentation. Screen grabs of examples of the type of slide alteration utilised in GM1001 presentations. On the left hand side is the original slide as used for the vodcast. On the right hand side is a slide which has had information removed which was used for the respective lecture on the same topic. In the 13-14 lecture, students were then asked if they could name three different type of muscle.

Quantitative assessment of efficacy of vodcasts on exam performance usage using single best answer questions

In order to quantitatively assess the efficacy of vodcast usage in the 13-14 GEM 1 year group against the control 12-13 GEM 1 year group, their performance in the Physiology component of three distinct examination scenarios, continuous assessment (CA), end of module (EOM) and end of year exams (EOY), was assessed. The primary mode of assessment in all three types of examination was the use of single best answer (SBA) questions, whereby questions are formulated around a question stem and students have to select the single best answer from a list of five options.

Both the 12-13 and 13-14 GEM 1 students sat six Physiology CA exercises at regular intervals (roughly one every two weeks) throughout the GM1001 module. Each CA test was conducted electronically using a secure browser in the same proctored setting each time, with the class as a whole. Access to the CAs was restricted only to members of the GEM 1 classes and was secured by specific student identification number.

Each CA contained approximately 20 questions of which roughly half were in SBA format and *related directly to the material covered by the nine vodcasts*. This yielded a total of 63 SBA questions which were identical to those that had been answered by the 12-13 GEM 1 year group the previous year and could therefore be used for comparing performance between the two years.

For the GM1001 EOM exam, which was conducted one week after the completion of the GM1001 lectures, the number of valid identical Physiology SBA questions which could be used for comparative analysis fell to 15. For the GM1001 EOY exam, which took place approximately seven months after completion of the GM1001 module, the number of valid identical Physiology SBA questions which could be used for comparative analysis was 17. Due to the fact that the questions used for our analysis had been deployed in both CA exercises and

EOM and EOY exams, it was possible for us to monitor performance both whilst the course was still being taught as well as after all of the material had been delivered.

Statistical analysis

Statistical analyses were performed using Microsoft Excel. For analysis of success rates of the 12-13 *versus* 13-14 year groups against the questions utilised in their GM1001 CA, EOM and EOY examinations, a paired Student's *t*-test was employed with all data expressed as mean ± standard error of the mean (S.E.M.). For data which were unpaired (*e.g.* comparison of MCAT and GAMSAT scores, student ages between the two year groups, *etc.*), an unpaired Student's *t*-test (assuming equal variance) was utilised. Graphs of data were prepared using GraphPad Prism 5 (GraphPad Software Inc., San Diego, CA, USA).

Attitudinal questionnaire

At the end of the 2013-2014 GM1001 module students were asked to complete a questionnaire **(**see Appendix**)** about their experiences with, and perceptions of, the vodcasts in the month following the delivery of the final study lecture for which the vodcasts had been prepared. The survey remained available for completion for eight weeks until the day after the class's EOM exam. The survey initially determined the sex and educational background (biomedical or non-biomedical) of the students. Thereafter the survey took the form of 6, five –point Likert scale questions (strongly agree, agree, neutral, disagree, strongly disagree), two sematic differential items and one open-ended essay-type question which provided students with an opportunity to explain their answers or to add further comments.

Of the 73 students in the 13-14 class, 63 completed the survey (86% response rate), with a further four being submitted incompletely. Of the respondents, 28 were male and 37 were female. In terms of the students' educational/professional background upon entering the GEM course, 20 males described themselves as having a biomedical education, with 7 describing themselves as having a non-biomedical background. For the females, 21 described themselves as having a biomedical background, with thirteen describing themselves as having a non-biomedical background.

Survey data were manipulated to provide a read out of the class's overall percentage responses to each question/statement in the survey. However, survey data were analysed further to determine if there were any major differences in the types of responses to the survey questions between,

a) <u>all</u> males and <u>all</u> females

b) <u>all</u> students from a self-declared biological background versus <u>all</u> students from a self-declared non-biological background

c) male students from a self-declared biological background versus male students from a self-declared non-biological background

d) female students from a self-declared biological background versus female students from a self-declared non-biological background.

When the Likert options for each question were condensed by combing the 'strongly agree' with the 'agree' option, and 'strongly disagree' with the 'disagree' option, analysis revealed that, apart from relatively minor differences in the actual percentages of students selecting the various Likert options in each question, there were no differences in the overall sentiment of

each subset of students. For this reason, only the overall class response to each statement will be displayed and discussed in the text.

Results

12-13 vs 13-14 Medical College Admission Test (MCAT) and Graduate Medical Schools Admission Test (GAMSAT) scores

There was no statistically significant difference in the overall relative intellectual abilities of the 12-13 and 13-14 GEM 1 classes as determined by either their MCAT (12-13 = 31.5 ± 0.4, n=37 *vs* 13-14 = 30.7 ± 0.4, n=39) or GAMSAT scores (12-13 = 58.4 ± 0.6, n=37 *vs* 13-14 = 58.3 ± 0.5, n = 39), or between males and females either within each group or between each year group (figures 2A and 2B).

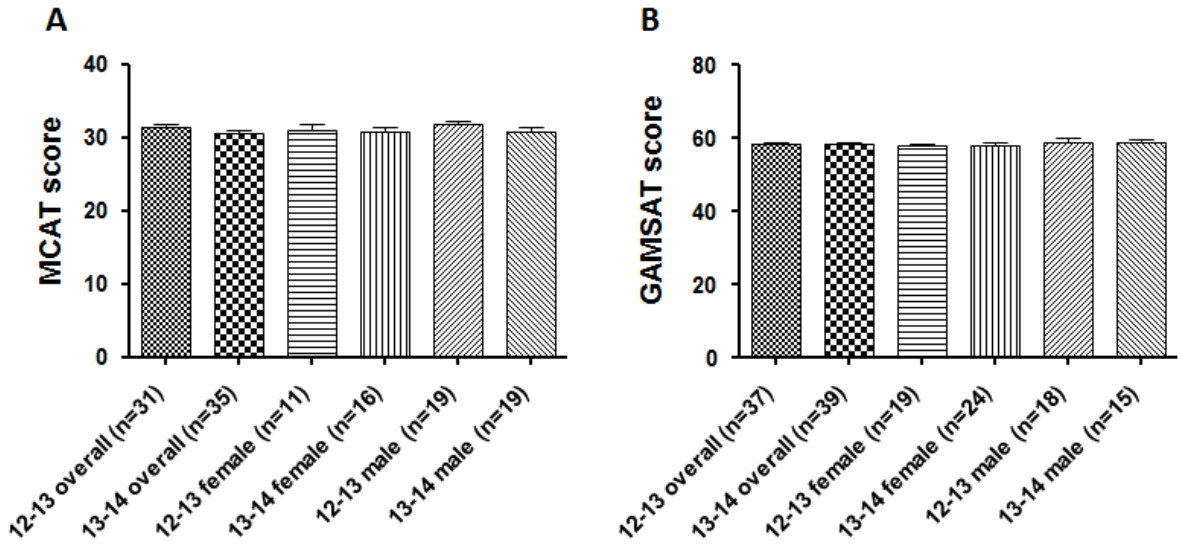

Figure 2: Comparison of MCAT and GAMSAT scores of GEM 1 students from academic years 2012-2013 and 2013-2014. Histograms illustrating the averaged absolute scores of the respective GEM 1 year groups in the MCAT (A) and GAMSAT (B) entrance exams. For comparison's sake these data were also broken down into averaged male and female scores.

Although a relatively crude measure of intellectual ability of a class as a whole, this result does provide some assurance that, broadly speaking, the intellectual levels of the two year groups investigated in the study were very similar.

One of the most important questions arising from this study was that of whether or not the students' use of vodcasts was reflected in improved exam performance which was measured in three ways that will be discussed below.

CA examination results

When the performance of the two year groups against the 63 identical questions asked of both groups in the six continuous assessment (CA) exercises that were conducted throughout module GM1001 we found that there was a statistically significant improvement in the results

of the 13-14 year group relative to those of the 12-13 year group (69.0±2.6% in 12-13 *vs* 73.2±2.3% in 13-14, n=63, *P*=0.0096, Student's paired *t*-test; figure 3).

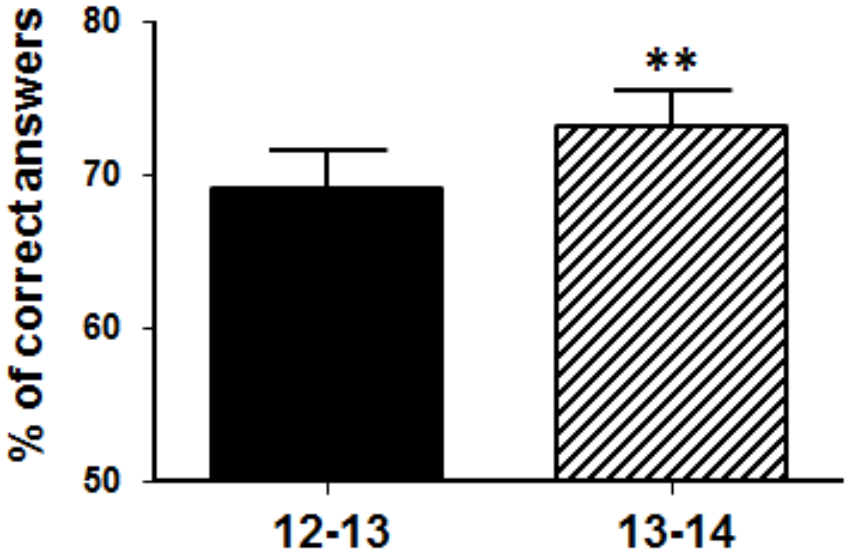

Figure 3: Comparison of performance between 12-13 and 13-14 GEM 1 students in questions in GM1001 CA exams. Histogram illustrating the averaged percentage of correct responses provided by GEM 1 12-13 (black bar) and 13-14 (hatched bar) students to 63 identical questions posed in six continuous assessment exercises spread throughout module GM1001. ** indicates *P*<0.01.

As this module was co-taught by the lead author and only one other colleague (who delivered the three other GM1001 lectures to both year groups), it was possible to control for the effects of the students' use of the vodcasts by comparing performance in the 12-13 *versus* 13-14 years on the questions within the CA exams covering material delivered by the other lecturer (21 identical questions in total). In contrast to the results shown in figure 3, this analysis revealed that there was no statistically significant difference in performance between the two year groups (61.3±6.3% in 12-13 *vs* 61.3±5.6% in 13-14, n=21, *P*=0.5, Student's paired *t*-test; *data not shown*).

It should be noted that of all the disciplines contributing to the GM1001 module (*e.g.* Anatomy, Biochemistry, Pathology/Microbiology, Pharmacology as well as Physiology), Physiology was the only discipline delivering this type of regular CA to the students during the course of the module.

EOM examination results

Students' performance in the GM1001 EOM examination, which took place one week after teaching on the GM1001 module had ended, (but seven weeks after the final 'vodcast lecture') was also examined. The results, illustrated in figure 4, show no significant difference between the results obtained by the 13-14 *versus* the 12-13 class in the 16 identical questions posed in each respective GM1001 EOM exam (65.2±3.0% in 12-13 *vs* 64.9±2.8% in 13-14, n=16, *P*=0.5, Student's paired *t*-test).

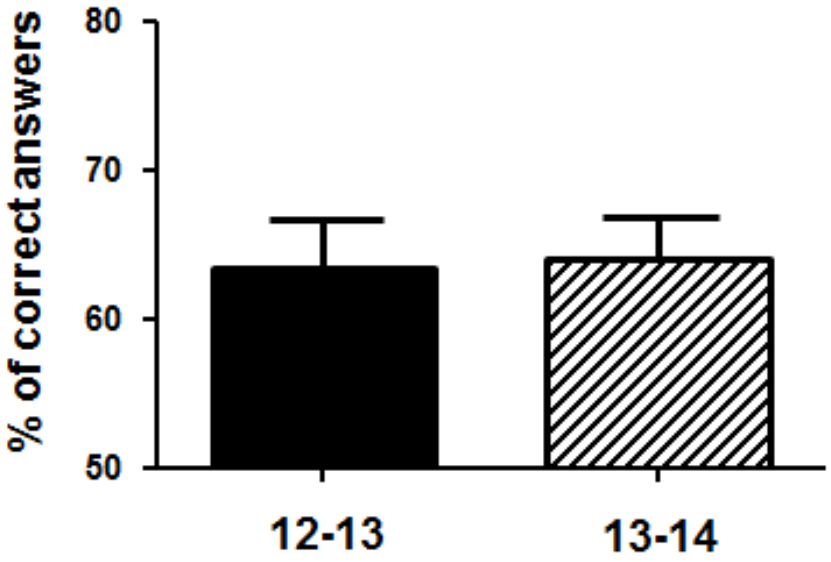

Figure 4: Comparison of performance between 12-13 and 13-14 GEM 1 students in questions in GM1001 EOM exams. Histogram illustrating the averaged percentage of correct responses provided by GEM 1 12-13 (black bar) and 13-14 (hatched bar) classes to 16 identical questions posed in each respective GM1001 EOM exam.

EOY examination results

We next examined GM1001 EOY examination performance. These exams took place nearly seven months after completion of the GM1001 module. The results of this analysis are shown in figure 5 and illustrate a significant improvement in performance for the 13-14 *versus* the 12-13 year group when performance was averaged across the 17 identical questions used for analysis (68.6 ± 4.8% in 12-13 *vs* 73.2 ± 4.1% in 13-14, $P = 0.01$; paired Student's *t*-test, n = 17).

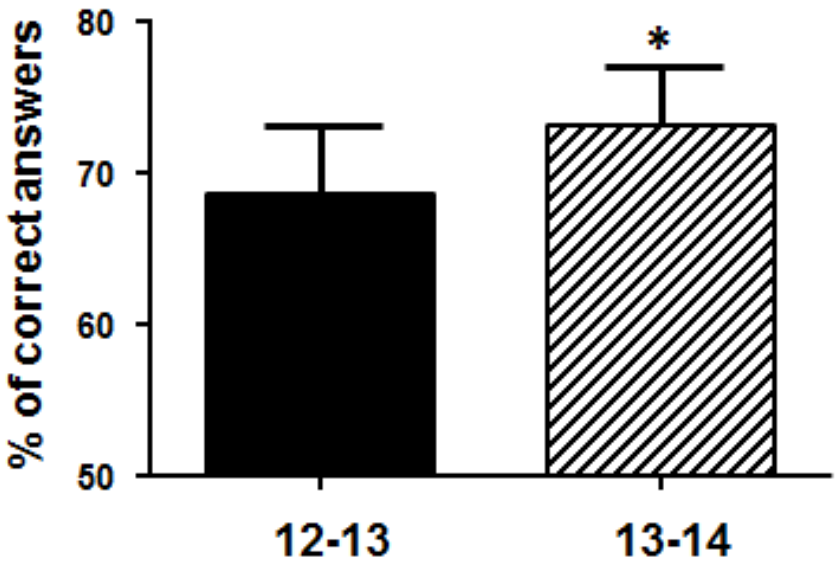

Figure 5: Comparison of performance between 12-13 and 13-14 GEM 1 students in questions in GM1001 EOY exams. Histogram illustrating the averaged percentage of correct responses provided by GEM 1 12-13 (black bar) and 13-14 (hatched bar) classes to 17 identical questions posed in each respective GM1001 terminal exam. * indicates $P<0.05$.

It is interesting to note that the performance of students against 9 questions in the EOY exam relating to material taught by the one other lecturer on the module (and not accompanied by vodcasts of that material), was not significantly improved relative to the performance of the 12-13 GEM1 year group ($P = 0.33$, n=9, paired Student's *t*-test; *data not shown*).

Attitudinal survey results

For the current study 63/73 (86%) eligible students in GEM year 1 completed the survey in the autumn term of 2013, with a further four being submitted incompletely.

Vodcast viewing statistics

As the central goal of the study was to determine if viewing vodcasts in advance of the face-to-face lectures had any significant effect on overall class exam performance, option 4 of the survey asked '**Of the nine that have been made, how many of the GM1001 Physiology vodcasts did you view/listen to *prior to* attending the relevant lecture?'**, with the responses shown in figure 6. The results indicate that 77% of respondents viewed at least one vodcast prior to attending the respective lecture, but that only 15% did so for all nine of the GM1001 vodcasts. It is also significant that over 20% of the class did not view/listen to any of the vodcasts at all prior to attending classes (overall class average = 2.6 ± 0.3, n=62).

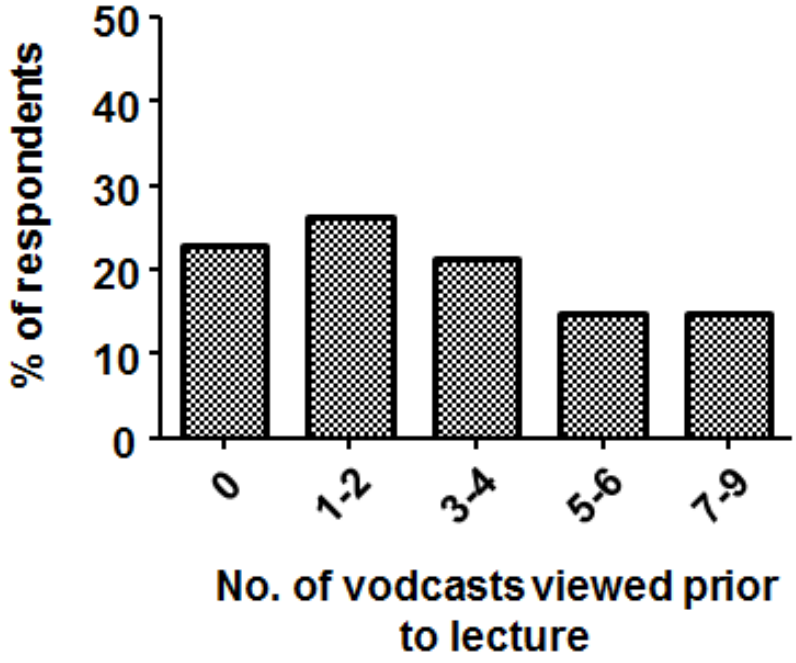

Figure 6: Number of vodcasts viewed in advance by students. Histogram illustrating responses to the statement 'Of the nine that have been made, how many of the GM1001 Physiology vodcasts did you view/listen to prior to attending the relevant lecture?'

When these data were analysed in more depth, we found that female students viewed significantly fewer of the vodcasts than their male counterparts prior to attending the respective lectures (2.1±0.5, n= 34 *vs* 3.3 ± 0.5, n=28 respectively, $P = 0.02$, Student's unpaired *t* test). Furthermore, although biomedical students on average viewed fewer vodcasts prior to the respective lectures relative to non-biomedical students, this difference was not significant (2.5 ± 0.4, n=41 *vs* 3.2 ± 0.6 respectively, n=20, $P = 0.2$, Student's unpaired *t* test).

Student perceptions of vodcasts as a preview and/or review tool

As shown previously in figure 6, although 77% of the class viewed at least one of the vodcasts prior to attending a lecture, it was clear that relatively few of the survey respondents viewed all nine prior to each respective lecture. It was therefore important to try and determine the reason for this relatively low uptake. To this end, options 7, 8 and 11 on the attitudinal survey sought students' opinions on the statements, a) '**Of the GM1001 Physiology vodcasts I have viewed/listened to *prior to* attending the relevant lecture, they have helped me to better understand the material presented during the lecture'**, b) **'I believe that the GM1001 Physiology vodcasts have enabled me to understand the lecture material better than if I was only able to view the lecture slides alone**' and c) '**In terms of the general GM1001 Physiology vodcast presentations, I like the fact that the audio is paired with the PowerPoint presentations (*i.e.* rather than hearing either the audio alone, or viewing the slides without commentary)'** respectively, the results of which are shown in figure 7.

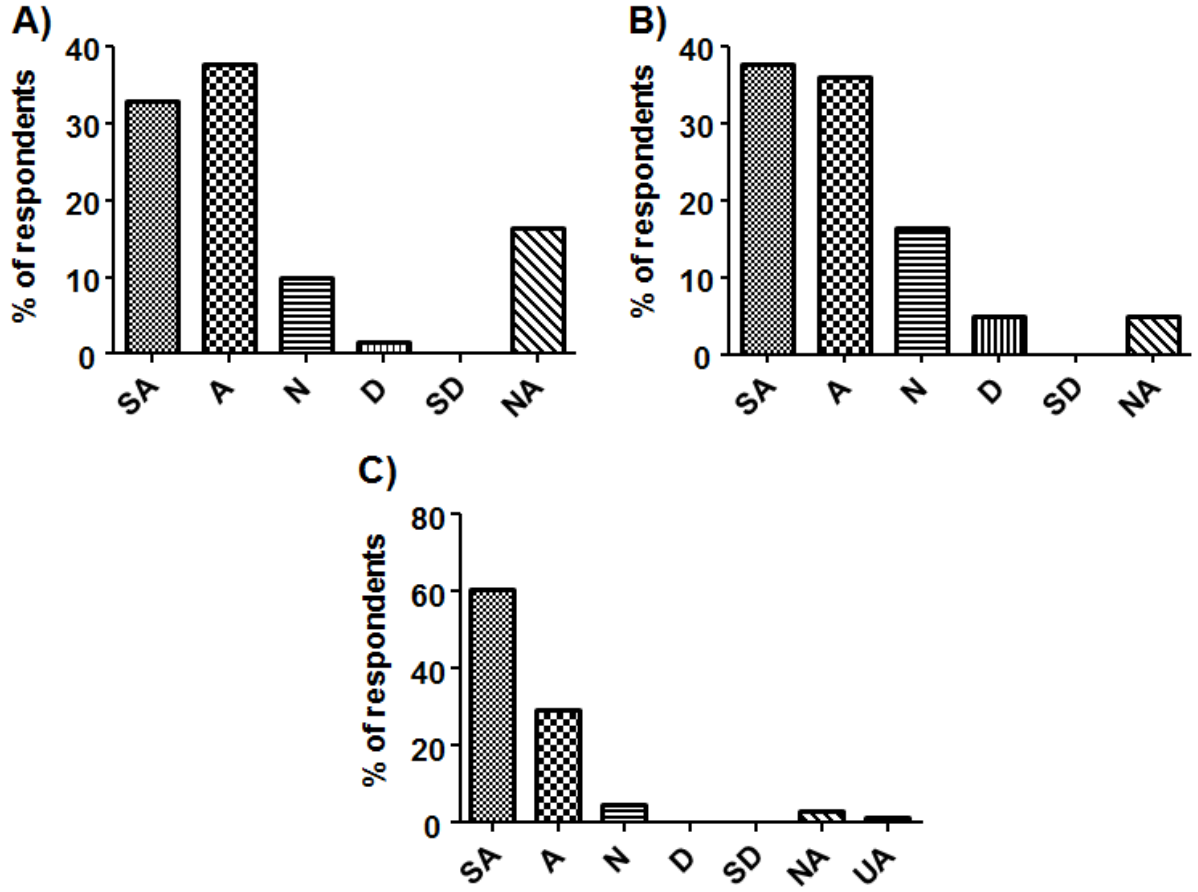

Figure 7: Student perceptions of vodcasts as a preview tool. Histograms illustrating responses to the statements *'Of the GM1001 Physiology vodcasts that I have viewed/listened to prior to the relevant lecture, they have helped me to better understand the material'* (A), *'I believe that the GM1001 Physiology vodcasts have enabled me to understand the lecture material better than if I was only able to view the lecture slides alone'* (B) and *'In terms of the general GM1001 Physiology vodcast presentations, I like the fact that the audio is paired with the PowerPoint presentations (i.e. rather than hearing either the audio alone, or viewing the slides without commentary)'* (C). SA = strongly agree, A = agree, N = neither agree nor disagree, D = disagree, SD = strongly disagree, NA = not applicable, UA = unanswered.

Figure 7A illustrates that nearly 64% of respondents either strongly agreed or agreed that previewing the vodcasts prior to attending lectures did improve their understanding of the material discussed in class, with only 6.6% disagreeing. Figure 7B indicates that over 74% of respondents believed that the vodcasts had helped them to understand the taught material better than the presentation slides alone (only 4.9% disagreed with this suggeston). Figure 7C illustrates that over 90% of respondents felt that the paired audio and visual functionality afforded by the vodcasts was also preferable to audio podcasts alone.

Although a central aim of the study was to encourage students to preview lecture material, by way of the vodcasts, prior to attending lectures inn order to improve student understanding and learning *during* lectures, we were of course aware that the vodcasts could, and probably would, also be used as revision tools and therefore wanted to acquire information about this possibility. To this end, survey options 5, 9, 6 and 10 of the survey sought students' opinions on the statements, a) **'Of the nine that have been made, how many of the GM1001**

Physiology vodcasts have you viewed/listened to only after the relevant lecture?', b) **'Of the GM1001 Physiology vodcasts I have viewed/listened to whilst reviewing the relevant lecture, they have helped me to better understand the material presented during the lecture'**, c) **'I plan to view/listen to all nine of the GM1001 Physiology vodcasts (for example, prior to sitting GM1001 exams)'** and d) **'The GM1001 Physiology vodcasts will be/have been a useful revision tool'**, respectively, with the results shown in figure 8.

Figure 8A indicates that, although a significant proportion of the respondents did not view any of the vodcasts after any of the lectures (28%), 71% of the class did view at least one vodcast afterwards and 13% viewed all nine again (class average = 2.7 ± 0.3, n=62). Figure 8B illustrates that 71% of respondents strongly agreed or agreed that viewing the vodcasts whilst reviewing the lecture material helped them to better understand the said material, with only 7% disagreeing. Figure 8C shows that the majority of the class (67%) did plan to use the vodcasts specifically for exam revision purposes prior to their exams. However, it is interesting to note that this number increased even further to 85% in response to survey option 12 (figure 8D).

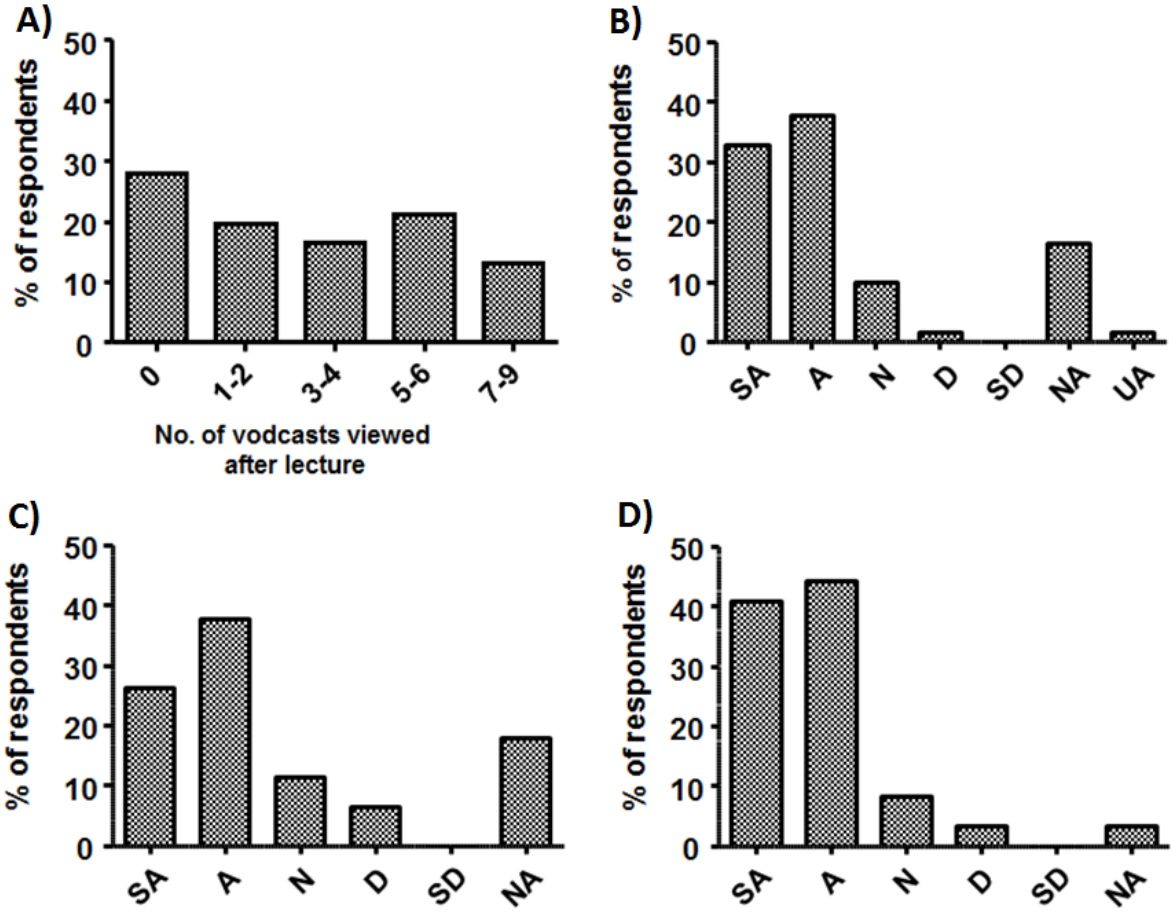

Figure 8: Student perceptions of vodcasts as a review tool. Histograms illustrating responses to the statements, '*Of the nine that have been made, how many of the GM1001 Physiology vodcasts have you viewed/listened to only after the relevant lecture?*' (A), '*Of the GM1001 Physiology vodcasts I have viewed/listened to whilst reviewing the relevant lecture, they have helped me to better understand the material presented during the lecture'* (B), '*I plan to view/listen to all 9 of the GM1001 Physiology vodcasts (for example, prior to sitting GM1001 exams)'* (C), and **'***The GM1001 Physiology vodcasts will be/have been a useful revision tool'*

(D). SA = strongly agree, A = agree, N = neither agree nor disagree, D = disagree, SD = strongly disagree, NA = not applicable, UA = unanswered.

Discussion

Effect of vodcasts on exam performance

The results of the current study are broadly in line with several previous studies in other non-biomedical disciplines (for review see Kay, 2012) in that they revealed that the majority of GEM students like vodcasts and, for those students who previewed them prior to attending face-to-face lectures on the same topic, they felt that they did improve their understanding of said material.

Importantly however, we were also able to demonstrate that the students' positive sentiment towards the vodcasts as a tool to help them understand and follow lectures more closely, translated directly to a significant and quantifiable improvement in their exam performance relative to a previous GEM 1 cohort that did not have access to the vodcasts used in this study. Thus, by comparing the success of the 13-14 GEM 1 year against that of the 12-13 GEM 1 control group in answering a total of 96 identical questions delivered across three different exam formats, at different times of the academic year we found that exam performance on the CA and EOY exams was statistically significantly improved in the 13-14 GEM 1 year group relative to the 12-13 year. This suggests that the availability of vodcasts to these students led to a measurable improvement in learning of the taught Physiology. Indeed, this conclusion is supported by the fact that the performance of the 13-14 year group against 21 questions in the CAs and 9 in the EOY exam relating to material delivered by the one other Physiology lecturer on the same module (who did not use vodcasts) was *not* significantly improved relative to that of the 12-13 group, a finding which one would not have expected if the improved test performance of the 13-14 GEMs was simply due to a general improvement in this class's ability relative to the 12-13 year.

However, it is unclear why we did not see a similar improvement in performance in the 13-14 GEM 1 EOM exams. One possible reason for the difference between the EOM and CA exam outcomes may be that whereas the CA exams were being conducted at the same time as the students were still actively utilising the vodcasts and attending lectures, the EOM examination came some seven weeks after the final lecture for which vodcasts had been prepared. Furthermore, in contrast to the period in which the CA exams were being conducted, where Physiology was the only subject in the module being routinely examined, for the EOM exam students had to prepare for an examination in which knowledge of four further subjects besides Physiology (*e.g.* Anatomy, Biochemistry, Pathology/Microbiology and Pharmacology) would be examined. Thus, the extra study burden imposed upon the students by these additional subjects may have effectively 'diluted' the impact of the Physiology vodcasts that was seen during the CA exams. This latter proposal though does not explain why we then saw an improvement in EOY exam performance as, similar to the EOM exam, all five contributory disciplines to the GM1001 module were also examined in the EOY exam. However, anecdotal evidence from the 13-14 GEM 1 students suggested that, although the initial previewing of the vodcasts during the module itself did indeed assist with understanding and processing of material at the time of delivery, for the EOY exams the same vodcasts were subsequently used as a revision tool. Thus, in this context the vodcasts had likely served a dual purpose: initially providing a 'first pass' exposure to lecture material prior to its delivery for those students who had previewed them (Krathwohl, 2002), but then also subsequently acting as an invaluable revision resource for the EOY examination nearly seven months after the material had initially been taught. Again though, one would have expected the same to apply for the EOM exams.

One potential further explanation for this 'discrepancy' is that, again anecdotally, students felt that they had already invested too much time studying Physiology for the 6 CAs to the detriment of the other subjects taught in the module which had not been examined in any form prior to the EOM exam. They therefore spent more time studying these other subjects for the EOM exam than Physiology, which they felt they had already 'covered'.

Student perceptions of vodcasts

As shown in figure 6 of the current study, although 77% of respondents watched at least one of the nine available vodcasts prior to attending the scheduled lectures, only 15% viewed all nine. Given this overall relatively low uptake in previewing of the vodcasts, the possibility existed that students simply disliked the format of the vodcasts, or even the whole idea underlying their use. However, the results shown in figure 7 suggest that this was not the case as they show quite definitively that that not only was their introduction popular with the vast majority of respondents (in preference to more traditional methods alone) but also that most of the class perceived that the previewing of vodcasts prior to lectures had been of benefit to their learning. This positive sentiment towards the vodcasts was also reflected in responses to survey option 3 which asked students to provide constructive comments about the vodcasts. For example, of the 50/58 students who expressed view(s) about the vodcasts which could be classified as either positive, neutral, or negative, the vast majority (66%) provided positive comments (33/50 students), with 30% (15/50 students) expressing relatively neutral comments (which included four students who had not used the vodcasts at all) and only 4% (two students) expressing negative comments about the use of vodcasts. A sample of some of these comments is reproduced below.

"I thought that reviewing the vodcasts before and/or after lectures made following along during lectures much easier"

"The vodcasts allow me to go through the lectures at my own pace (starting / stopping / rewinding) and review the material at my leisure, whether that be before or after class. These vodcasts are the epitome of educational technology for me. It's essentially a personal tutor at no cost. Hearing [the lecturer's] explanations is ineffably more helpful than reading the slides alone. He's so enthusiastic in the first place, which probably has a lot to do with it. It's not a pain to use the vodcasts - it makes learning fun and interesting. I also like that [the lecturer] revises the lectures based on listening to the vodcasts beforehand, because it really solidifies a lot of the points. It's extremely helpful to have that repetitive yet engaged way of presenting the material"

"I find that they are too similar to the actual lectures to feel like a good use of my time. If they were more of a review or alternatively increased detail or shifted focus from the in-class lectures then I think I would find them more beneficial."

Therefore, given the evident popularity of the vodcasts with students, it was very likely that there must have been some other extenuating factor(s) accounting for why only 15% of respondents previewed all of the nine available vodcasts prior to their respective lectures. The likely answer emerged from comments again provided to survey option 3. Thus, of the 58 students who provided a response to this option, 17% (11 students) made a specific point of commenting upon how the particularly heavy study load these students experience precluded them from devoting 'extra' time to the viewing of Physiology vodcasts as they felt that it impacted too much upon their study of the four other basic science disciplines covered in the

GM1001 module. Clearly, such a demanding workload severely restricts self-directed study time.

Furthermore, in spite of the broadly positive sentiment towards using vodcasts as a learning tool in general (time constraints notwithstanding) there was still an undercurrent within the comments provided about the vodcasts that some students were not comfortable with the proposed change in the student-lecture dynamic that the previewing of vodcasts heralded for teaching and learning in this module. (*e.g.* "I find it frustrating that the professor expects students [to] listen to vodcasts prior to class. I believe that I come to class in order to hear the lecture"). Thus, it was of great interest to us to determine if, even after encouraging the students to use the vodcasts as preview tools prior to attending lectures (and clearly explaining the pedagogical reasoning behind this process), the students still viewed the vodcasts simply as an additional revision tool when reviewing lectures afterwards. These results, shown in figure 8, very clearly demonstrate that although, as discussed earlier, the vodcasts were viewed very favourably by the students when used as a preview tool, they were in fact used by a much greater proportion of the class as a tool for reviewing/revising lecture material. Thus, 71% of respondents strongly agreed or agreed that they used them as a revision aid (figure 8) and that they helped them to better understand the lecture material (than lecture slides alone). Indeed, 85% of students also indicated that they planned to use them specifically for revision purposes prior to examinations. It is interesting to note however that, as shown in figure 8C, about one fifth of the respondents did not use, or plan to use, the vodcasts for revision purposes, with several students stating in the open – ended survey option 4 that they much preferred to use textbooks or just the presentation slides for their revision and/or study.

Further examination of the comments provided in survey option 3 on their use of the vodcasts, showed that of the 58 students who did respond, 72% (42 students) stated specifically that they used them as a revision tool, with only eleven students referring to their use as a preparatory tool and 14% (8 students) stating that they used them both as a preparatory and a revision tool. Some of the comments reflecting this are reproduced below.

"I found [the vodcasts] very useful as a means of reinforcing understanding about particular topics. I anticipate that I will return to the vodcasts again closer to examination time to recap on any areas that I still don't fully understand"

"Overall I find [the vodcasts] to be very useful, but more so after *the lecture has happened. I know they are supposed to make the lectures more interactive but I think that's difficult to achieve just in general in an Irish classroom even if everyone had listened to the vodcast. Afterwards when going back over the material, they are useful to have on as you work through material and can pause and rewind if necessary on something that is a bit muddy. I also look forward to using them closer to exams!"*

"The vodcasts are very useful in terms of revising the material before an upcoming exam. Also, you can listen to the vodcasts wherever you may be, whether that's on the bus home at the weekends or in general off-campus"

Limitations of the current study

Clearly, one of the major limitations of the current study design was the fact that we did not block student access to the vodcasts once each lecture had been delivered as this prevented us from making definitive conclusions specifically regarding how the previewing of vodcasts may have affected exam performance. The reason for this decision was simply because we felt that

it would be unethical to prevent students from accessing the vodcasts after the study period, particularly given the substantial unsolicited feedback we received from them about how useful they found them for revision. As such, we felt duty bound to leave the vodcasts available for use by students up until their final EOY exam. Nonetheless, had it been possible to do so, it would have been interesting to determine if the 15% of students who claimed to have previewed all of the vodcasts prior to lectures performed significantly better than those students in the class who did not preview any. Unfortunately, due to the anonymous nature of the survey it was not possible to make this comparison and, further, we would still not have been able to rule out the possibility that these same students were also utilising the vodcasts for revision purposes as well.

A second limitation of the study is that it was conducted in a single school, with a relatively limited number of students, on only one component of the overall GM1001 module. Therefore, one's ability to generalize its findings to other accelerated medical degree programs is limited. However, as discussed in the Introduction, given the relative paucity of published data pertaining to these types of undergraduate courses in general, all studies in this area, limited or otherwise should still be welcomed.

Future studies

In spite of these positive outcomes favouring the use of vodcasts of lecture material as a teaching tool demonstrated in this study, it is clear that the shortage of study time that GEM students in particular experience (due to the teaching intensive and compressed nature of the GEM course) represents a significant impediment to the widespread implementation of their use as a lecture preview tool as used in the current study.

Although the time constraints mentioned above seemed to have a particular impact upon students' ability and/or desire to use the vodcasts in advance of lectures, the same did not seem to apply to their use when it came to revising the lecture material, where 85% of survey respondents indicated that they viewed the vodcasts as a useful revision tool. This is perhaps indicative of the majority of students' attitudes towards lectures whereby they are seen primarily as a means of gaining 'first pass' exposure to a topic, with higher order cognitive processing of the same information occurring only when they come to review the lectures later in their own time. This 'sage-on-the-stage'-type of teaching (Goodman, 2016) is the teaching/learning model that most students (and lecturers) the world over recognise, so it is perhaps not too surprising that this 'habit' is difficult to break, even though previewing lecture material in detail prior to attending lectures in order to institute a fully, or semi-, 'flipped classroom' approach would likely facilitate a much more efficient use of the usually relatively limited time a class has with lecturers (Crouch & Mazur, 2001; Gannod et al., 2008). One possible solution for ameliorating the time burden placed upon students, whilst at the same time still enabling them to gain first pass exposure to lecture material, would simply be to reduce the duration of the vodcasts. To this end, we are currently investigating the use of so-called 'introductory vodcasts' as a preview tool, again for use with GEM 1 students, which have an average duration of only 10-15 minutes. It is hoped that the students find this length of vodcast more palatable, and therefore they acquire more views, than the full length lecture vodcasts used in the current study.

Conclusions

A central question of the current study was to determine specifically if previewing of vodcasts prior to face-to-face lectures improved student learning. However, from the discussion

above and from student responses to specific attitudinal survey questions relating to how they utilised the vodcasts, it is clear that students used the vodcasts both as a preview as well as review tool throughout the academic year. Thus, even though the majority of students clearly indicated that when they did preview the vodcasts it improved their understanding of the taught material, the fact that only 15% of respondents viewed all nine vodcasts prior to lectures makes it impossible for us to conclude that the improvement in student learning that we observed was solely due to the students previewing of lecture material in the vodcasts. Rather, it is more probable that the statistically significant improvement in exam performance we witnessed was due to a combination of both previewing, as well as reviewing, of the vodcasts. Furthermore, the addition of a small element of 'active learning' to certain lectures for the 13-14 GEM 1 class, albeit very limited in scope and quantity, may also have had a small positive effect on learning relative to an educationally equivalent GEM 1 year group that did not experience either modification in lecture format.

Therefore, the limitations of the study notwithstanding, we would still argue that 'on demand', fully controllable vodcasts represent a valuable teaching/revision tool for students. We feel that this is particularly true for students on accelerated professional courses such as GEM that face significantly larger study demands than students on 'standard' undergraduate degree programmes.

Appendix: GM1001 Physiology Podcast Survey

1. **Are you male or female?**

2. **Would you consider your educational background to be biomedical or non-biomedical?**

3. **Please provide any (constructive) comments / suggestions / observations about the vodcasts you feel is of relevance**

4. **Of the 9 that have been made, how many of the GM1001 Physiology vodcasts did you view/listen to prior to attending the relevant lecture?**

0
1-2
3-4
5-6
7-9

5. **Of the 9 that have been made, how many of the GM1001 Physiology vodcasts have you viewed/listened to only after the relevant lecture?**

0
1-2
3-4
5-6
7-9

6. **I plan to view/ listen to all 9 of the GM1001 Physiology vodcasts (for example, prior to sitting GM1001 exams for example).**

1.Strongly Agree
2.Agree
3.Neither Agree nor Disagree
4.Disagree
5.Strongly Disagree
6.Not Applicable

7. **Of the GM1001 Physiology vodcasts that I have viewed/listened to prior to the relevant lecture, they have helped me to better understand the material presented during the lecture.**

1.Strongly Agree
2.Agree
3.Neither Agree nor Disagree
4.Disagree
5.Strongly Disagree
6.Not Applicable

8. **I believe that the GM1001 Physiology vodcasts have enabled me to understand the lecture material better than if I was only able to view the lecture slides alone.**

1.Strongly Agree
2.Agree
3.Neither Agree nor Disagree
4.Disagree
5.Strongly Disagree
6.Not Applicable

9. **Of the GM1001 Physiology vodcasts that I have viewed/listened to whilst reviewing the contents of a particular lecture, they have helped me to better understand the material presented during the lecture.**

1.Strongly Agree
2.Agree
3.Neither Agree nor Disagree
4.Disagree
5.Strongly Disagree
6.Not Applicable

10. **The GM1001 Physiology vodcasts will be/ have been a useful revision tool.**

1.Strongly Agree
2.Agree
3.Neither Agree nor Disagree
4.Disagree
5.Strongly Disagree
6.Not Applicable

11. **In terms of the general GM1001 Physiology vodcast presentations, I like the fact that the audio is paired with the PowerPoint presentations (*i.e.* rather than hearing either the audio alone, or viewing the slides without commentary).**

1.Strongly Agree
2.Agree
3.Neither Agree nor Disagree
4.Disagree
5.Strongly Disagree
6.Not Applicable

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A Theoretically Grounded Framework for Integrating the Scholarship of Teaching and Learning

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Abstract: SoTL scholars have written about the importance and utility of teaching from a guiding theoretical framework. In this paper, ecological theory and specifically Bronfenbrenner's bioecological model, is examined as a potential framework for synthesizing SoTL research findings to inform teaching and learning scholarship at the college level. A general overview of the bioecological model of human development and its application to the SoTL literature are provided. The benefit of adopting an ecologically-based framework to better understand and exploit the interdisciplinary nature of SoTL is discussed.

Keywords: ecological theory, bioecological model, college/university teaching, theory, SoTL.

Introduction

SoTL scholars have written about the importance and utility of working from a guiding theoretical framework when teaching and conducting research, yet a theoretically grounded framework for integrating scholarship on teaching and learning is absent from the SoTL literature (Felten, 2013). There is a need for a clear, systematic way of mapping out SoTL research that allows scholars to synthesize and assess SoTL literature related to their research questions and projects, identify gaps and limitations of prior work, and see how their work fits into the broader SoTL landscape. Utilizing an explicit theoretical framework to weave together studies from diverse disciplines allows for a more systematic and meaningful integration of findings from SoTL research. Moreover, an integrative heuristic tool, such as a theory-based framework, can provide a "big picture" view of interrelated studies and a deeper understanding of how research findings overlap and intersect across disciplines.

The scope of SoTL research is rather broad and diverse because of its interdisciplinary nature. As a result, it can be daunting to see how individual studies fit together particularly for scholars who are new to SoTL. Because SoTL is "happening" in so many areas of study, a theoretical framework that brings together seemingly disparate findings is needed. As Kern, Mettetal, Dixson, and Morgan (2015) noted, "…as SoTL has grown, the connections across the disciplines have blossomed, thus enriching the scholarship of integration. While some ways of knowing are unique to particular disciplines, there is much that is and will be shared across the disciplines" (p. 7). Although there has been a push for cross-disciplinary approaches to SoTL, Cassard and Sloboda (2014) pointed out that, "…not all disciplines speak in the same language", which can present an inherent challenge when scholars from various disciplines attempt to collaborate on SoTL projects (p. 48). A theoretical framework that extends across disciplines provides a starting point for collaborative work such that scholars come together with at least some

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shared understanding. Theory provides a common language for teacher-scholars to benefit from the interdisciplinary nature of SoTL such that they might be more likely to investigate and apply "lessons learned" from other disciplines.

An ecological approach to teaching and learning aligns with other "whole student" models of instruction in that it promotes inclusivity and student-centered approaches to instruction. Howie (2013), for example, discussed the application of Bronfenbrenner's ecological theory to teaching young children and its utility in promoting inclusive educational environments through promoting school-family partnerships, and attending to shared and individual needs of students from all 'ecological niches'. In this paper I propose Bronfenbrenner's bioecological model as a theoretical framework for integrating research on teaching and learning in higher education. The bioecological model is appropriate for this use because of its developmental orientation and broad applicability. Student learning is the centerpiece of SoTL and learning is, after all, a developmental process. The bioecological model is studied in many disciplines and broad enough to capture proximal and distal influences on student learning, while attending to individual variation and student-environment interactions.

The proposed application of the bioecological model to frame SoTL research has the potential to highlight the interconnectedness of research from a variety of academic disciplines, promote cross-disciplinary conversations in SoTL, and bring clarity to "best practices" discovered in multiple academic disciplines. A general overview of the bioecological model is followed by an illustration of how the model could be used to identify studies and develop an educational workshop intended to promote excellence in teaching among new faculty. Many doctoral programs place heavy emphasis on research training and mastery of content knowledge, with less emphasis on how to teach and teaching pedagogy. As a result, new faculty might come to a university with limited teaching experience and training. Colleges and universities who provide additional training and mentoring to new faculty not only improve quality of instruction but also increase confidence and reduce feelings of isolation among new faculty (Savage, Karp, & Logue, 2004). A sample (but not an exhaustive review) of current studies is provided to demonstrate the utility of the bioecological model as a framework for synthesizing SoTL research, and specifically for the development of a teaching-oriented workshop for new faculty. The benefit of adopting an ecologically-based framework to better understand and exploit the interdisciplinary nature of SoTL is discussed.

Ecological Theory in a Nutshell

According to Bronfenbrenner (1979, 1988), human development is a process that occurs as a joint function of characteristics of the individual and environmental context. In his later work, Bronfenbrenner and Morris (1998, 2006) proposed a comprehensive bioecological model of development that involved four central components: Process, Person, Context, and Time. Central to the bioecological model are *proximal processes*, or the regular interactions that occur between the developing person and his/her environment (Bronfenbrenner & Ceci, 1994). Bronfenbrenner described proximal processes as the driving forces behind development and emphasized that such interactions needed to occur on a regular basis and become increasingly complex over time in order to promote development.

Person-environment interactions were theorized to vary as a function of individual characteristics (i.e., the Person dimension of the model). Person characteristics affect proximal processes and subsequent development by interacting with one's environment in a number of

ways. For example, genetically-based factors such as personality traits, sex, ethnicity, and physical attractiveness can elicit different responses from one's environment. Those same characteristics may bring with them resources or deficiencies that place individuals in a position of social advantage or disadvantage. Individuals, by virtue of their unique qualities, are attracted to different aspects of their social, psychological, physical, and symbolic environments. As individuals self-select into different environments, their knowledge and skills are uniquely shaped; similarly, as individuals become increasingly complex beings, they begin to actively structure or shape aspects of their environments in more complex ways.

Proximal processes are shaped directly and indirectly by various ecological systems (i.e., the Context dimension of the model). Individuals' immediate environments, or microsystems, include their families, workplaces, and academic institutions. The interaction of two or more microsystems, such as the overlap between school and home contexts, is called the mesosystem (Bronfenbrenner & Ceci, 1994). Exosystems involve indirect effects of the environment on development, such as the effect of parents' workplace on their children. The broadest and most distal context from the developing individual is the macrosystem, which includes the effects of culture on development.

Bronfenbrenner conceptualized time in a number of ways, from the moment-to-moment exchanges that take place between individuals and their environments (i.e., proximal processes) to events that occur over longer periods of time, including how person-environment interactions are shaped by the historical time in which they occur.

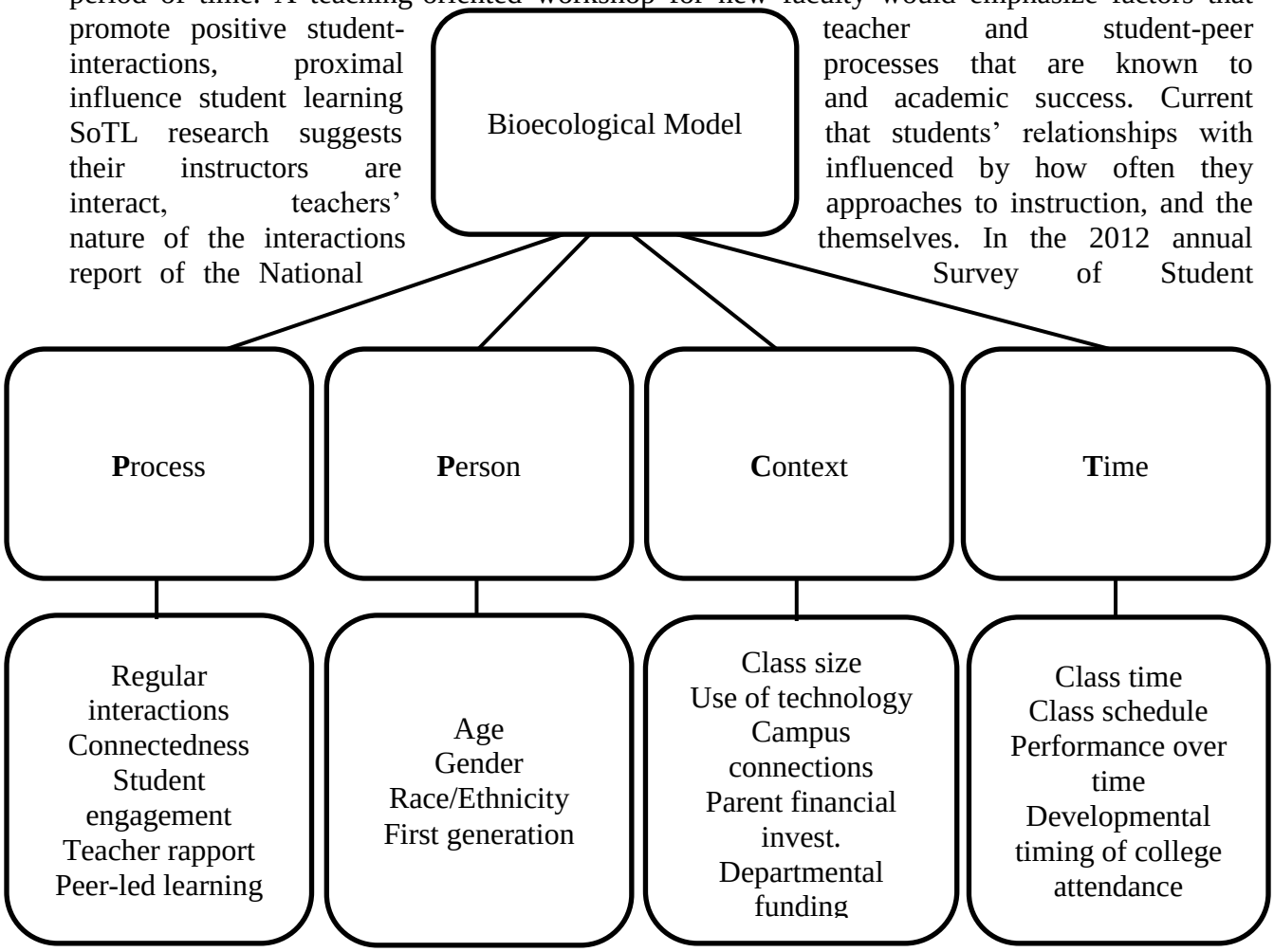
Taken together, the bioecological model is a framework for understanding human development that includes unique characteristics of individuals, the regular interactions they have with their environments, the contexts in which they are directly and indirectly situated, and time. The model integrates both proximal and distal influences on human development, taking into account how personal and contextual factors interact to produce varied results. In other words, this theoretical perspective considers the "whole person" situated in context.

The Bioecological Model as a Framework for Integrating SoTL Research

The bioecological model was originally proposed as a theoretical framework for empirical research on human development from an ecological perspective (Bronfenbrenner & Morris, 1998, 2006). Scholars across various academic disciplines continue to use parts of Brofenbrenner's theoretical work to frame their research questions and methodologies. For example, ecological theory has been used to frame research questions that examine factors associated with academic success (e.g., Stewart, 2006). In addition, ecological systems theory and the bioecological model are taught to undergraduate and graduate students in many academic programs. Because scholars from a variety of disciplines are likely familiar with an ecological approach, broadly speaking, the bioecological model can be a user-friendly tool for synthesizing SoTL literature and provides some "common language" for collaborative work in the scholarship of teaching and learning. The bioecological model is a useful framework for integrating SoTL research studies as it calls attention to multiple influences on teaching and learning.

The bioecological model is proposed as a general framework for integrating SoTL findings in a meaningful and theoretically relevant way. This contextual and cross-disciplinary framework can be used to provide a cohesive look at students' personal and collective educational experiences, with a consideration for the broader contexts that may have a bearing on student learning (directly or in conjunction with other factors) over time. Figure 1 provides a visual depiction of the bioecological model and its four components (Process, Person, Context, and Time). Below each component I've listed variables that are identified in current SoTL research as relevant to student learning and could be included in a workshop geared meant to foster excellence in teaching among new faculty.

Figure 1. A visual depiction of the Bioecological Model used as a framework for organizing SoTL topics relevant to excellence in teaching.



The Process Dimension

Proximal processes refer to ongoing, regular student-environment interactions that occur over a period of time. A teaching-oriented workshop for new faculty would emphasize factors that promote positive student-teacher and student-peer interactions, proximal processes that are known to influence student learning and academic success. Current SoTL research suggests that students' relationships with their instructors are influenced by how often they interact, teachers' approaches to instruction, and the nature of the interactions themselves. In the 2012 annual report of the National Survey of Student Engagement (NSSE, 2013), regular student-teacher interactions were found to be valuable to student learning. Students feel more confident and perform better in classes where they feel a

connection to the professor (Micari & Pazos, 2012). Active and collaborative approaches encourage student-peer interactions and promote higher-order thinking and complex reasoning (Driscoll, 2000; Michel, Cater, & Varela, 2009). Student learning is enhanced when instructors promote small and large group discussions, and some studies suggest benefits of student-led group discussions over teacher-led discussions (Yoder & Hochevar, 2005).

University instructors who have been highly regarded for their teaching attend to and care about their students and the multiple factors that influence their learning (Jenkins & Speck, 2007). Christenbury (2011) contended that instructors are at their best when they are flexible, attending to the classroom context and students' needs, instead of operating from a rigid teaching plan. In a recent study of instructional effectiveness, graduate students identified the emotional context in which learning takes place as being as important as professors' content knowledge (Hill, 2014). The positive effects of teacher-student interactions on student learning are to some degree facilitated by the degree to which students are emotional engaged in their coursework (Sagayadevan & Jeyaraj, 2012).

Informed by the literature, a teaching-oriented workshop could highlight ways in which faculty can be intentional about building rapport with their students through attentiveness, efforts to build trust, courtesy, and being relatable (Frisby & Myers, 2008). In addition, the workshop would emphasize the importance of regular student-teacher interactions and the value of active learning opportunities.

The Person Dimension

The Person dimension calls attention to individual sources of variability. In this example, a teaching-oriented workshop for new faculty would highlight student characteristics that are salient to their learning. Inclusive teaching practices that attend to individual sources of variability promote mutual respect within the classroom, increased awareness of diverse perspectives, and prepare students for a world that is indeed diverse (Bigatti et al., 2012; Wentzell, Richlin, & Cox, 2010). Therefore, instructors must be aware of student characteristics that are meaningful for their academic experiences such as their year of study (e.g., freshman, sophomore …), age, gender, sexual orientation, family history (e.g., parents' educational attainment), ethnicity, religious background, English fluency/ literacy, exposure to diverse populations prior to college, and socioeconomic status, to name a few. A teaching-oriented workshop might prepare new faculty to work with specific subgroups of students such as millennials and first generation college students (McGlynn, 2008; Pascarella, Pierson, Wolniak, & Terenzini, 2004). In addition, new faculty would benefit from some guidance around adopting a multicultural approach to education, given its potential to increase cultural sensitivity among all students and reduce race-related stressors (e.g., racial stereotyping) among ethnic minority students (Bigatti et al., 2012; Harper, 2009).

The Context Dimension

Context refers to the environments in which learning takes place and that (directly or indirectly) impact classroom performance. The microsystem refers to students' immediate learning environments, which includes their classrooms and living spaces. Larger class size has been linked to poorer student and teacher performance, which suggests that teaching and learning challenges increase in proportion to the number of students in a given class (e.g., Bedard & Kuhn, 2008; Chapman & Ludlow, 2010). Advances in modern technology have had a dramatic impact on the

structure and setting of college classrooms. Studies of online learners suggest that they might need some additional accommodations in order to be successful such as technological help and sample assignments (Mupinga, Nora, & Yaw, 2006). On campus, students' use of smartphones during class time is a distraction and has the potential to compromise grades (Synnott, 2015). Challenges in on-campus and virtual classrooms further underscore the significance of the emotional tone set by the instructor and its potential to influence student learning. While instructors have limited authority over some aspects of the immediate environment in which they teach (e.g., the classroom location, classroom size, seating, and available technology), they do have some influence over the emotional and intellectual context of the classroom. Thus a teaching-oriented workshop for new faculty might include activities to strengthen instructors' ability to develop positive connections with their students, or proximal processes, as mentioned previously.

The mesosystem includes the interactions that take place between two microsystems (i.e., teacher-to-teacher communication that takes place on behalf of a student) and their influence on student learning. A recent review of 38 studies suggested that instructors collaborate with student support services on campus as one step in practicing inclusive education and improving the educational experiences of students with disabilities (Orr & Hammig, 2009). Disability services is just one example of a context that instructors might have to interact with on behalf of their students. Campus organizations, internship sites, and health services are other examples. Although newer faculty might know that these resources exist on campus, they might not know how or under what circumstances they should reach out to them.

The exosystem is a context that students are not directly situated, but has an indirect effect on their learning in the classroom nonetheless. Exosystem influences could also include environments not directly associated with the university setting. For example, Hamilton (2013) examined the effect of parents' financial contributions on students' academic success. Results from that study suggest that students who receive greater financial investment from their parents tend to receive lower grades, but are more likely to graduate than their peers. By acknowledging exosystem influences on students' performance in the classroom, teaching-oriented workshops promote greater sensitivity among new faculty.

The Macrosystem includes broader cultural forces, such as funding for academic programs and state and national priorities. Funding or lack of funding can impact course offerings, classroom size, access to technology, instructors' workload and their ability to effectively mentor students – all of which affect student learning outcomes (Hearn & Holdsworth, 2002). This too might be something new faculty know about, generally speaking, but with which they have little firsthand experience. As faculty gain experience and eventually tenure, they could find themselves serving on university committees and in leadership roles. Knowledge about macrosystem influences within an academic setting can assist instructors in making wise career-related decisions, being fiscally responsible, and navigating internal and external funding opportunities.

The Time Dimension

Time in Bronfenbrenner's theoretical work takes many forms. Human development and student learning are both fluid concepts that occur over time. In an academic setting we can consider the amount of time students spend in the classroom, how many days per week a class meets, the regularity with which teachers interact with individual students over time, or the time of day a class takes place. Some research suggests, for example, that optimal cognitive performance occurs in the afternoon for college students (Allen, Grabbe, McCarthy, Bush, & Wallace, 2008). New

instructors whose classes fall outside that time frame might want to encourage students to adopt specific strategies that enable them to stay awake and engaged during class. The timing of students' college experience in their own developmental trajectory matters as well. For example, the learning needs and level of confidence in the classroom may be different for traditional and nontraditional students (Bishop-Clark & Lynch, 1992). One study tracked students' academic goals, decision making, and self-evaluations across the first year of college, which might be useful information for new faculty in their mentoring/advising roles (Galotti & Clare, 2014). Teachers often track students' performance over time and many programs have accountability measures in place that examine cohorts of students in particular classes over time. We can also consider how our teaching takes place within a historical time. The "state of education" looks differently today than it did 30 years ago. Priorities change, funding mechanisms change along with shifts in the economy, opportunities for international students change with the political landscape, and the expectations of instructors change, for example. Thus, the time component of the bioecological model prompts a consideration for what has already happened, what is happening now, and the potential for changes in the future with respect to both teaching and learning.

Conclusion

The scholarship of teaching and learning has been gaining momentum over the past two decades. As SoTL gains more recognition and support at academic institutions, scholars are expanding and possibly redefining their research agendas to examine teaching and learning within their own disciplines. In this paper the bioecological model is proposed as a theoretical framework for integrating SoTL research findings and facilitating interdisciplinary collaborations among faculty. An ecological theoretical framework is appropriate for synthesizing SoTL research because it draws attention to the dynamic interplay between students' individual characteristics and their learning environments, and how multiple factors (both inside and outside of the classroom) are important to consider as instructors prepare for a productive academic year.

The example provided in this paper demonstrates the utility of this type of framework for the development of a teaching-oriented workshop for new faculty. There are virtually endless suggestions one could give new faculty about how to be an effective instructor. By situating current SoTL research within a bioecological framework, the vast studies about "how to teach well" and "what matters" suddenly become more digestible, user-friendly, and theoretically grounded. It is noteworthy that the studies collected for the example application came from SoTL, economics, psychology, and Black studies journals. I've provided just one example of how this framework could be implemented; the application is not limited to the development of a new program or workshop. Scholars interested in specific topics, such as the use of technology in the classroom, or specific outcomes such as academic self-esteem, could explore how extant research fits into each of the four components of the model. This works as a starting point for scholars embarking on topics that are new to them, or a way of examining familiar literature from a new point of view.

Of course there are other frameworks that may be a useful heuristic for pulling together SoTL research; this is just one suggestion that seems to work. Many instructors are already referencing Bronfenbrenner's work in their research and the classes they teach, and therefore this theory may provide teacher-scholars from a variety of academic backgrounds with a common ground for collaborative work. Additionally, this framework could be useful for teacher-student collaborations on SoTL projects particularly if students are exposed to Bronfenbrenner's theorizing as part of their coursework. Because this is a developmental and contextual theory, it

can be applied to understand studies of teaching and learning across multiple settings and disciplines. This framework could be particularly useful for budding scholars who are considering SoTL as a main line of research but might have limited familiarity with learning theories. The bioecological model can also be used to evaluate seasoned instructors who may be looking for a way to monitor and improve their teaching. Instructors could provide evidence of how they attend to Process, Person, Context, and Time dimensions when teaching their courses. Indeed, it is easy to fall into a rut of teaching within one's comfort zone. The bioecological model sensitizes instructors to proximal and distal influences on student learning and this model can accommodate the ever-changing contexts in which learning takes place.

The bioecological model provides a comprehensive and contextual framework for understanding student development and academic success and can be applied to virtually any discipline because it directs our attention to the *whole* student and the many factors that influence student learning. Beyond a heuristic tool for promoting collaborative SoTL research, the application of the bioecological model as a framework for integrating SoTL studies may also be useful for the development of a comprehensive teacher training program.

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The Assessment and Mentoring Program (AMP): Final year pre-service physical education peer mentors' perceptions of effective mentoring

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Abstract: *In the teacher education context, most peer mentoring programs have focused on pre-service teachers and a qualified teacher mentor within schools (Hobson, et.al., 2009; Ambrosetti, Knight & Dekkers, 2014). Few studies have focused on mentoring between pre-service physical education teachers. Therefore, we describe the Assessment and Mentoring Program (AMP): a four-way collaborative learning community. Mentoring occurs between final year physical education students (mentors), reciprocally between mentors and their year two mentees, and in collaboration with lecturers. Prior to the commencement of the AMP, to understand the pre-service mentors' perception of effective mentoring, they were asked to annotate an A3 poster with the characteristics they perceived were required to be the 'perfect' mentor and complete the AMP successfully. We present data of their perceptions. De-identified data were transcribed verbatim, coded and analyzed using NVivo (Version10) software to explore themes of the mentor's perceptions of effective mentoring within the context of Le Cornu's (2005) critical mentoring framework including interpersonal skills, a mentoring attitude and critical reflection. The AMP mentors identified characteristics in all three categories; organization was also identified as an essential mentoring characteristic. Students' perceived a diverse set of mentoring skills were required. Given that many key skills developed through mentoring are important for pre-service teachers when they graduate, the challenge is how to provide relevant, authentic and context specific experiences for students that enable them to become collaborative reflective practitioners who can provide quality learning and assessment opportunities for their own diverse students within the constraints of a university environment.*

Keywords: *assessment, mentoring, physical education, pre-service teachers, effective mentoring*

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Diverse student populations in universities have prompted the development of mentoring programs aimed at supporting first year students to successfully perform academically and to reduce attrition rates (Heirdsfield, Walker, Walsh, & Wilss, 2008). Many universities are attempting to foster a sense of engagement through such programs (Egege & Kutieleh, 2015). This support is usually received only during this first year transition period and students may be provided with any number of different mentoring approaches including: discipline specific programs, peer mentoring and tutoring or online support and academic support programs (Ashwin, 2002; Heirdsfield et al., 2008; Krause, Hartley, James, & McInnis, 2005; O'Regan, Geddes, Howe-Piening, & Quirke, 2004; Rittschof & Griffin, 2001). Following this year of transition, students are left to navigate the remainder of their degree and expected to become independent, self-regulated learners (ten Cate, Snell, Mann, & Vermunt, 2004).

The continually contested operational definition of 'mentoring', the assumed rather than demonstrated success of mentoring, the lack of rigor in this research area and broad contexts that mentoring occur in (Crisp & Cruz, 2009; Egege & Kutieleh, 2015; Jacobi, 1991) make it difficult to decipher and compare findings. Despite this, some reported outcomes of mentoring in undergraduate programs have included for the mentor or mentee: increased satisfaction, fulfillment, productivity, work-related benefits, recognition from others, respect, emotional support, behavior and classroom management skills, interpersonal skills, critical reflection and leadership capacity (Crisp & Cruz, 2009; Eby, Durley, Evans, & Ragins, 2006; Ehrich, Hansford, & Tennent, 2004; Hobson, Ashby, Malderez, & Tomlinson, 2009).

Within teacher education, peer mentoring programs have often focused on the relationship between the pre-service teacher and the mentor who is a qualified teacher within a school setting (Hobson et al., 2009). In contrast to the experienced teacher providing feedback, Le Cornu (2005) described the use of peer mentoring between students during their final teaching practicum experience. This peer mentoring process which involved a collaborative peer partnership, where neither held a position of power over the other, enabled three critical mentoring skills to be developed which Le Cornu (2005) highlights are crucial components in a pre-service teacher education mentoring program. These critical mentoring skills requiring development include: a *mentoring attitude* which values the learning of both parties, *interpersonal skills* to communicate across multiple stakeholders and *critical reflection skills* to challenge ideas and beliefs (Le Cornu, 2005).

The above examples of mentoring models which exist between the same year level students' or between first and final year students are quite commonly found across universities in Victoria, Australia. Examples of mentoring programs specifically in teacher education are few (Heirdsfield et al., 2008) and there are even fewer studies focusing on peer mentoring between students within physical education pre-service courses. One such study reported on the Student Teaching Experience in Mentoring (STEM) program focusing on outcomes for final year physical education mentors who acted as peer mentors to first year students (Mooney & Gullock, 2013). Outcomes such as the development of a mentoring attitude and critical reflection were reported in the Assessment for Learning tasks completed. To our knowledge, studies of mentoring between other year levels, other than first and final year students, within physical education pre-service teaching courses have not been investigated. Therefore, this study investigates the effective mentoring characteristics perceived to be required in a pre-service physical education teaching context between final year (4^{th} year students) mentors and second year mentees where the intention

is not about 'surviving' the transition to University and teaching practice, but rather the development of teaching, planning for teaching, assessment and mentoring skills which are work ready skills that are transferable to future teaching environments.

The Assessment and Mentoring Program (AMP)

Collaboration with students is a goal for the Scholarship of Teaching and Learning (SoTL) and it has the potential to transform teaching and learning in higher education (Allin, 2014). In an attempt to provide authentic learning opportunities and develop work ready attributes through collaboration, the Assessment and Mentoring Program (AMP), a four-way collaborative learning community underpinned by social constructivism (Bruner, 1996) was developed. The AMP was designed to provide opportunities for final year mentors to offer feedback on their second year mentee's teaching experiences and for discourse between mentors. The four-way collaboration is operationalised with mentoring occurring between final year physical education students as mentors, reciprocally between mentors and their second year mentees, and in collaboration with their lecturers. Furthermore, mentors develop, test, implement and moderate a lesson plan assessment tool. This scaffolded process of assessment design, implementation, and critical reflection is a unique attribute of the AMP that enables mentors to work collaboratively with each other and their lecturers to develop these skills in a supportive environment.

Method

Participants

All final year (Year 4) pre-service physical education students (n=102) during the 2014 and 2015 academic years were invited to apply to participate in the AMP study. The study only required between 8-10 mentors each year as the maximum ratio required was one final year mentor to work with 6-8 Year 2 mentees from a mentee cohort of between 55-65 students each year. University Human Ethics approval was granted and informed consent obtained from a total of 17 applicants aged 19-23 years (M=10; F= 7). It was not required that mentors had to participate in data collection to be part of the AMP. The mentors met in February of each year prior to the commencement of the academic year to begin the AMP preparations. Prior to the commencement of the AMP the requirements of the program were outlined and students were asked to reflect on mentoring and the attributes of effective mentors. The mentors were then asked to annotate an A3 poster of a figure with the characteristics they perceived to be the 'perfect' mentor that could complete the demands of the AMP successfully.

Data Analysis

De-identified data were transcribed verbatim, coded and analyzed using NVivo (Version10) software. Immersion and familiarization of data (Grbich, 2013) was followed by the exploration of themes within the context of Le Cornu's (2005) three critical mentoring components. Using the three constructs (attitude, interpersonal skills, critical reflection skills), this provided a framework for a code book (DeCuir-Gunby, Marshall, & McCulloch, 2011) with inclusion and exclusion criteria and examples from the data to

ensure accuracy. A word frequency query was performed to gain insight into the key themes; this enabled sub-categories to be identified under each theme, with one key theme additional to Le Cornu's (2005) framework identified.

Findings

The 17AMP mentors reported diverse characteristics were going to be required to successfully complete their mentoring roles. Examples of annotated posters from the mentors can be seen in Figure 1.

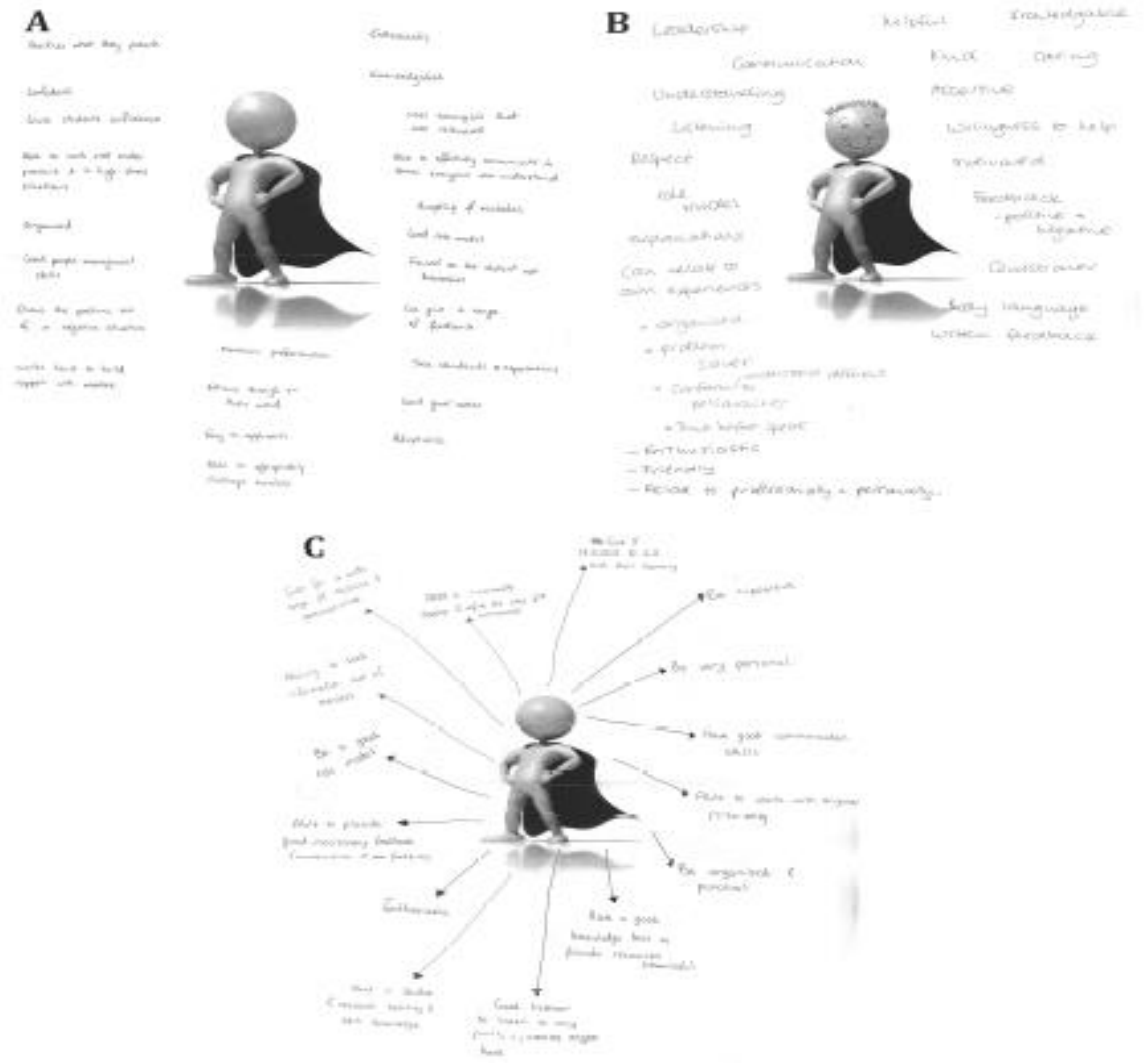

Figure 1: An example of an AMP students annotated poster of their perception of important characteristics of the 'perfect' mentor prior to the commencement of the AMP program

The AMP mentors identified characteristics in all three categories that Le Cornu (2005) described as important attributes to develop for successful peer mentoring in pre-service teacher education and an additional theme was also identified (Table 1).

Table 1: Attributes identified by final year pre-service physical education peer mentors as important for successful mentoring prior to the commencement of the AMP

Requirements of mentoring in pre-service teacher education courses	**Sub-categories**[2]	**Examples of perceived requirements of a 'perfect' mentor**
Mentoring attitude[1]	*Attitude and effort*	"having a positive attitude" "applying effort" "being motivating and passionate" "engaged" "practice what you preach"
	Content knowledge	"knowing more than them, being knowledgeable"
	Leader/Role model	"being a leader, approachable, role model, solid and build respect"
	Valuing others and own learning	"develop a partnership" "share information" "focus is on the mentee not the mentor"
Interpersonal skills[1]	*Communication skills*	"deal with conflict, display empathy, be understanding and patient, listen and be assertive" "effectively communicate so everyone can understand"
	To develop relationships	"develop trust" "bring personal experiences to share" "persistent" "consistent" "productive" "flexible, adaptable" "approachable" "open minded" "relatable" "ability to create unity" "acceptable of mistakes" "work hard to build a rapport" "helpful, kind, supportive" "gives mentees confidence"
	Perceived by others	"responsible/respectable" "relaxed but not too relaxed" "stoic" "enthusiastic" "friendly" "good body language"
Critical reflection[1]	*Professional behavior*	"being involved in professional dialogue" "strong ethics/morals" "use relevant examples" "sets standards and expectations, set appropriate goals" "think before speaking" "cater for a wide range of abilities and personalities"

	Feedback	"taking feedback from mentees" "critiquing others and giving feedback" "giving quality feedback" (written and verbal) "providing feedback in different ways to meet student needs"
Organization	*Being challenged and challenging mentees*	"challenging own ideas and beliefs" "justify yourself " "draw positives out of negative situations" "follow through" "challenge mentee" "get mentee to use initiative" "solve problems" "draw information from mentee" "prepared"
	Time	"time management skills" "available" "reliable" "reachable" "punctual" "work well under pressure and in high stress situations"

[1]Previously identified by Le Cornu, 2005 as important attributes of mentoring in pre-service teacher education programs; [2] Note all subcategories were developed in our attempt to further explain Le Cornu's (2005) framework.

Discussion

Understanding the key skills required is necessary before embarking on mentoring in any context (Heirdsfield et al., 2008). This recognition of skills is important as it provides mentors the chance to reflect through a 'mentoring lens' and assess their own ability to mentor others and consider the commitment ahead. Whilst Le Cornu's (2005) mentoring framework was previously applied to peer-to-peer mentoring when completing a classroom-based teaching placement in a school, the different context of the AMP resulted in some notable differences in the perceived mentoring attributes. The AMP provides mentoring that occurs across different year levels (final year to second year), it includes the assessment of lesson planning and there was no actual observation of their mentees teaching every week. The context specific attribute that final year physical education students additionally identified as important for a 'perfect' mentor to possess was organization.

Le Cornu (2005) describes the *mentoring attitude* as valuing "both one's own and the learning of others" (pg. 359). The AMP mentors perceived that they would need to share and value their mentee's insights and would need to be a positive role model whilst motivating others, being passionate and engaging. Mentors also perceived an opportunity to demonstrate leadership skills. These findings are partially in support but also in contrast to the Le Cornu's (2005) framework where leadership and role modelling are not identified as important mentoring attributes due perhaps to the peer mentoring relationship in that study having the same hierarchical status where students were both in the final year of their degree. However, Crisp and Cruz's (2009) critical review of mentoring outlines role

modelling occurs within many higher education mentoring programs involving 'experienced' and 'lesser-experienced' participants. If AMP mentors perceived they were going to be a role model, it was not surprising that "knowing more than them" was considered an important attribute to possess and exemplifies the mentoring attitude of "valuing one's own learning". Studies specifically on mentoring in pre-service teacher education which have focused on the hierarchical mentoring relationships in different contexts have discussed the importance of mentors being able to perform roles such as: supporter, role model, and facilitator amongst others (Ambrosetti & Dekkers, 2010; Ambrosetti, Knight, & Dekkers, 2014).

Interpersonal skills or characteristics of effective mentors in mentoring programs have included: honesty, empathy, empowering, trustworthiness, active listing, being altruistic, engaged, experienced and accessible (Crisp & Cruz, 2009; Straus, Johnson, Marquez, & Feldman, 2013). Terrion and Leonard (2007) found for stable relationships to develop, mentors must be perceived as trustworthy. To achieve this trusting relationship, key attributes to generate trust are vital. The AMP mentors identified the following skills required they perceived were to be important in their future roles to communicate and develop relationships: empathy, understanding, speaking and listening, assertively communicating and provide reciprocal learning opportunities by sharing of experiences. The awareness by the AMP mentors of their entire responsibility, including assessment of their mentees lesson plans, was evident with the identification of the need for consistency during assessment. Previously described by Ambrosetti and Dekkers (2010), the role of the 'assessor' involves the mentor assigning a grade or marks criteria. This aspect of the AMP role is undertaken weekly by the AMP mentors when analysing lesson plan content and providing feedback on areas for improvement.

In schools, the mentoring of others promotes the greatest amount of learning through self-reflection or *critical reflection* of their own practices (Hobson et al., 2009).Within this mentoring program in an undergraduate degree, the AMP mentors recognised the importance of feedback in this reflective process. In particular, drawing attention to the need of a 'perfect' mentor to be receptive to feedback from their mentees and the mentor's abilities to critique others work and provide appropriate, high quality feedback. Importantly, some also perceived that feedback should be provided in different ways to meet different mentees needs as all students learn and respond to feedback differently. This feedback process is something the AMP mentors have been participants in throughout their own teaching placement experiences (from school supervisors, university supervisors and peers of their own year level). The mentors identified that it is imperative that 'perfect' mentors are well versed in justifying how they have assessed and critiqued their mentee's lesson plans during meeting times. However, they also recognised that the 'perfect' mentor needs to be open to mentees challenging their ideas and that they need to have the ability to engage in professional dialogue.

Not identified in Le Cornu's (2005) framework, organization was considered a key attribute for a 'perfect' mentor to possess to undertake the AMP effectively. Ehrich, Hansford and Tennet (2004) report that the most commonly cited difficulty in mentoring in education was the lack of time, thus supporting the perceived need by AMP mentors to develop time management skills to balance their own study and role in the mentoring program. Difficulties contacting mentees was also discussed by Enrich et al., (2004) as a limiting factor in mentoring success and is supported in this study as AMP mentors

identified that they (as the 'perfect' mentor) would need to be available, reachable, punctual and contactable to complete their roles.

Conclusions

Crisp and Cruz (2009) suggest there are up to 50 identifiable functions associated with the mentoring role. By using Le Cornu's (2005) mentoring framework relevant to pre-service teacher education we have found that the AMP mentors have identified the requisite skills required to be a 'perfect' mentor and opportunities can then be provided for them to develop such skills through training and participation in the AMP. We have also identified an additional skill, organization, required when physical education pre-service teachers mentor each other, across different year levels, in a combined academic and teaching context. The attributes identified as important for the 'perfect' mentor are also those necessary to produce work ready graduates. Given that we know many key skills developed through mentoring are important for pre-service teachers when they graduate, the challenge is how to provide relevant, authentic and context specific experiences for students that enable them to become collaborative reflective practitioners who can provide quality learning and assessment opportunities for their own diverse students within the constraints of a university environment.

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Registration Delay and Student Performance

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Abstract: Tracking the difference between the time a first-year student is allowed to register for a course and the time he or she does register for a course (a student's registration delay), we notice a negative correlation between registration delay and final grade in a course. The difference between a student who registers within the first two minutes they are allowed to and one who waits three weeks to register is approximately a full GPA point (on a 9 point scale). Registration delay may be a useful factor in helping to identify at-risk students, and should be taken into account as a confounding variable when doing educational studies on multi-section courses.

Keywords: college education, registration, learning analytics.

Introduction

In 2012, the Mathematics and Statistics Department made a change to the format of their introductory calculus sequence. While the section size for each lecture was increased to 250 students per lecture, the weekly tutorial sections were reduced in size to 20 students per tutorial. This meant approximately 40 tutorial sections, all scheduled on the same day, and consequently, many TAs.

After a grueling day of leading 6 tutorials, the TAs would gather to discuss how their students were doing. Most complained about the aptitude of their students, but a couple of TAs had no complaints at all. After the first midterm, some evidence started to build—the TAs that had no complaints had students that performed better. Not only that, but it appeared that there was a relationship between tutorial number and tutorial performance.

Tutorials were divided into 8 sections per lecture, and as it turned out, tutorial section 1 and 2 for each lecture section did better than all other tutorial sections and tutorial section 8 for each lecture did worse than all other tutorial sections. We hypothesized that it was not the section number that made the difference but rather that the sections, presented in numerical order in the online registration system, filled up in order, and that the correlation was actually between how quickly students registered for the course and their performance—if they took their time to register, they would be forced to select a section with a higher section number because the previous sections would be full.

This paper explores the question of whether the time a student registers for a course and his/her final mark in the course are correlated and to what extent. Our underlying assumption is:

> *The amount of time a student delays in registering for a course is a measure of diligence that in turn correlates with his/her final mark.*

Further, we will analyze whether a section's fill-rate (how quickly a section fills to capacity) and a section's average mark relate. This last question may have implication for future education work: if a section of a course is added to be taught with an alternate teaching method, the fact that this

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section will be last to fill may be a confounding variable when analyzing the success of the alternate method.

Related Work

Both the personality trait of conscientiousness and various measures of procrastination have been linked to student performance. Procrastination itself has been divided into several subcategories including decisional and avoidant procrastination (Effert & Ferrari, 1989; Milgram & Tenne, 2000). Decisional procrastination involves putting off a task because of the stress involved in making a decision; avoidant procrastination involves delaying the start of a task because of a fear of failure. Diaz-Morales, Cohen, and Ferrari have shown that these forms of procrastination are distinct and relate to whether a person is future-goal oriented or present-goal oriented (Diaz-Morales, Cohen, & Ferrari, 2008). It seems likely that both forms of procrastination might impact registration delay, but that avoidant procrastination might more severely impact academic performance.

In a meta-study combining the results of 33 individual studies, Kyung and Eun found a negative correlation between a student's level of procrastination and their performance in a course (Kim & Seo, 2015). Vianello, Robusto, and Anselmi found that conscientiousness is positively correlated with performance (Vianello, Robusto, & Anselmi, 2010). Though the tendency to procrastinate surely influences registration delay, the studies we reviewed did not look at the influence that procrastination has on very short time delays. In particular, it is unclear whether procrastination tendencies would cause differences in registration delays of under five minutes, and it would be interesting to investigate whether measures of procrastination affect time-delay continuously at all scales or whether different factors contribute to delays < 5 min vs. > 20 min vs. > 1 day.

Diligence has also been studied in relation to student performance. Galla et. al. define diligence as a willingness to stay focused on menial tasks and found that diligence positively correlates with student performance (Galla et al., 2014). In this paper, we do not use diligence in such a narrow sense, but instead use diligence colloquially to encompass dedication, motivation, and timeliness when it comes to academics.

Tangentially related is research on time-of-day effects and student performance. Hartley and Nicholls report that research on how diurnal preferences affect the performance of university students is scarce, but that "morning" and "evening" students do perform better during their preferred times (Hartley & Nicholls, 2008). Indecision procrastination due to the lack of ideal course offerings (courses not offered in preferred timeslots or misaligned with diurnal preferences) may be a contributer to registration delay. Further research could help tease out the psychological factors that influence registration delay.

Experimental Procedure

We obtained data from the university database for the largest 20 first-year courses for the years 1998–2014. This includes 60,000 records, with possibly multiple records per student (if a student took multiple first-year courses).

For each student, there is a time when their registration window opens (when they are allowed by the online system to register) and there is a time when they actually become registered for a course. However, if a course is full, they will be wait-listed for that course instead of being

registered for it. Further, if a student switches sections of a course, their official registration time will be different than the time they initially registered for their original section. Because we do not think being wait-listed or switching sections are indicative of a student's diligence, we define *registration time* in the following way.

> **Definition.** A student's *registration time* is the minimum of the time they became officially enrolled in the course, the time they were put on a wait list for the course, and the time that they first registered for some section of the same course.
> A student's *registration delay* is the difference between their registration time and the time the online system would allow them to register.

A further complication in using registration time as a measure of a student's diligence is that some students change their mind. There are many reasons to register for a course long after you are permitted. For example, a student may change majors mid term and add courses accordingly; a student may drop a course and register for the same course next term; a student may re-register for a course upon learning his/her previous grade do not meet requirements. For these reasons, we will only analyze registration delays that are at most 19 days. This number is somewhat arbitrary, but accounts for 71% of all registrations. We have also run statistics with a cutoff of 38 days and noticed no qualitative difference in results. We will use median statistics instead of means to estimate the typical registration delay of a student who has taken multiple courses in our dataset.

How Students Register

Each student has a *registration window*, a timespan in which they may register for a course, which is computed from a formula involving class standing and GPA. Each student is categorized into (1) exchange student, (2) new first-year student, (3) fourth and fifth-year student, (4) graduate student, (5) third-year student, (6) first and second-year student. Registration windows are opened for category 1 first, category 2 second, and so on. Within each category, the start of a student's registration window is determined by his/her class rank. Students are informed of their registration window via email, and a registration window may open between the hours of 8:00AM and 6:00PM.

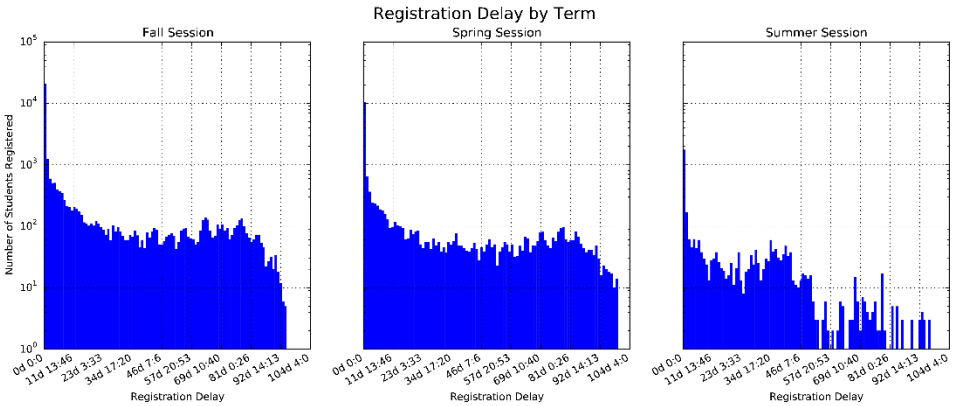

Figure 1. Histogram of how students register by term for the first 100 days after their registration window opens.

Registration patterns are similar for Fall and Spring terms, but Summer registration times are moderately different. Students may register for both their Fall and Spring courses simultaneously. Most students (52%) register within 24 hours of the opening of their registration window. The registration *time* data shows that students primarily register during the day. Since the opening of a student's registration window only varies between 8:00AM and 6:00PM, we would expect to see a time-of-day effect in the aggregate registration *delay* data from Fall and Spring terms. This is illustrated in Figure **2**.

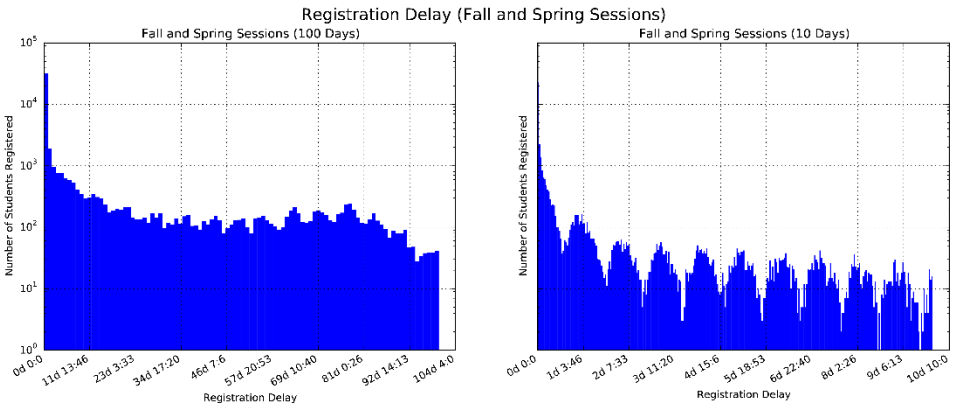

Figure 2. Aggregate histogram for Fall and Spring terms of how students register showing a clear effect of time of day.

Ignoring the time-of-day effect, the registration data for Fall and Spring appear to follow a power-law distribution with exponent −1. Since a student may appear multiple times in the dataset, the distribution of registration delays may be influenced by an individual student's tendency to register early or late. However, looking at median registration times by student (with each student represented only once), this effect appears to be negligible, as shown in Figure **2**.

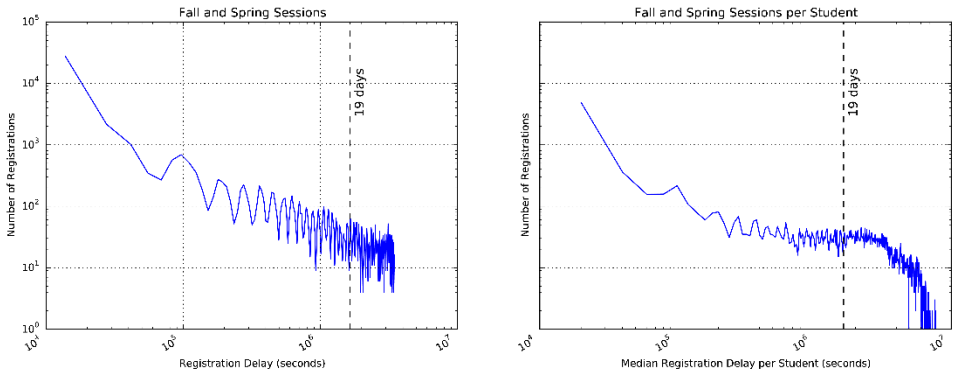

Figure 3. Log-log plot of the empirical distribution of registration delay (left) and median registration delay (right) truncated at a 40 day registration delay.

Registration Delay and Grade

Since a student may be in the dataset multiple times, we will analyze per-student statistics using a student's grade point average (GPA), computed as the mean of the final mark for every course he/she took in the dataset with letter grades converted to numbers by the following nine point scale:

F: 0, D: 1, C: 2, C+: 3, B-: 4, B: 5, B+: 6, A-: 7, A: 8, A+: 9.

We will restrict our analysis to Fall and Spring terms and further to registration delays less than 19 days (though lifting this restriction gives only marginally different results). Further, we will use a student's median registration delay as a representative registration delay for that student. The dataset contains 14088 records of distinct students whose median registration delay is less than 19 days.

Dividing the dataset into eight quantiles based on registration delay, we see a consistent relationship between registration delay and GPA as illustrated in Figure **4**. Figure **4** shows strong skewing affects of the GPA distributions per quantile, and the GPA distribution for the first quantile (those students whose median registration time was less than two minutes) is quite skewed towards A-.

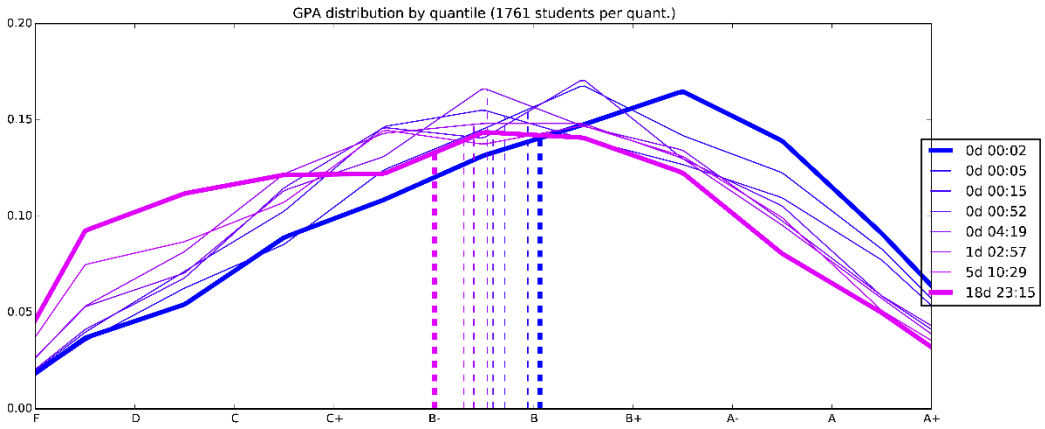

Figure 4. Distributions of 14088 records of per-student GPA divided into 8 quantiles by registration delay. Dotted lines indicate the mean GPA of each quantile. The legend indicates the maximum registration delay for each quantile. The first and the last quantile are in bold.

The relationship between mean GPA and quantile is surprisingly linear, with a least-squares line of best fit given by

$$\text{mean GPA} = -0.968\frac{\text{quantile}}{8} + 5.06$$

for 8 quantiles. The correlation coefficient for this regression is $r^2 = 0.97$. This means that the expected grade in a course of someone whose registration delay is less than two minutes vs. someone whose registration delay is three weeks differs by one point or 3%–5%. This model explains approximately 2% of the variance in student grades.

Considering the data from Figure 4 in more detail, the standard deviation for the GPA distribution for each quantile ranges from 2.2 to 2.35 points. Grouping into two halves, quick registerers (those that registered within 52 minutes, 7044 students) and slow registerers (those that took longer than 52 minutes, 7044 students), we see that 59% of A+'s, 57% of the A/A-/A+'s, 51% of the B/B-/B+'s, 46% of the C/C+/D's, and 36% of the F's are quick registerers.

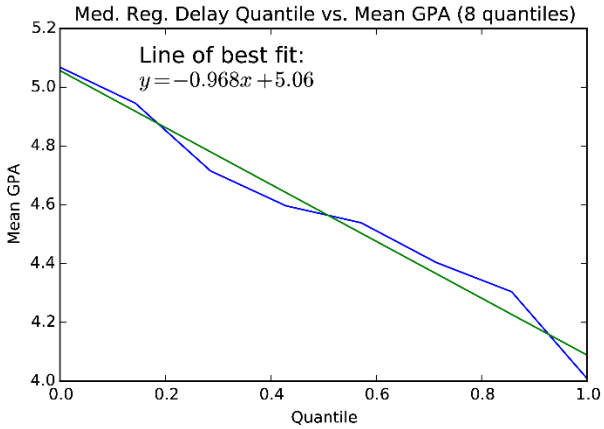

Figure 5. For 8 quantiles determined by registration delay, the mean GPA vs. the quantile. A least squares regression is also shown.

How Classes Fill

A relationship between sections of a course that fill up early and the mean grade of a course is difficult to discern from the data and may be confounded by a variety of factors. Figure **6** shows a scatter plot of the time until a section of a course is 70% full vs. the mean grade in that section. This analysis was limited to courses with at least five sections in a given term.

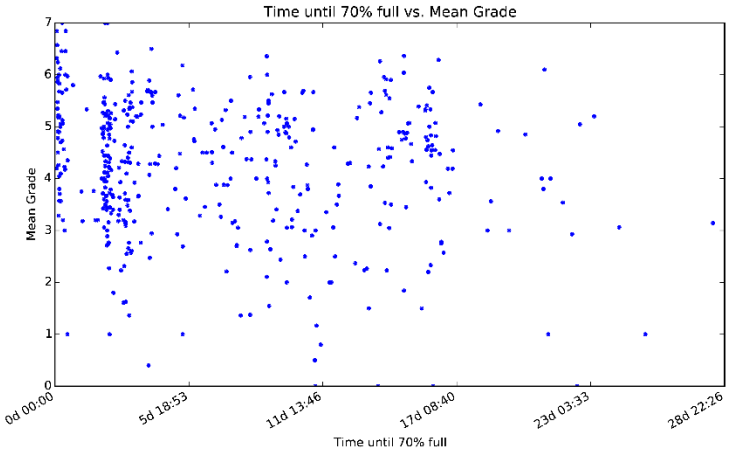

Figure 6. For courses with at least 5 sections a term, the time until a section is 70% full vs. the mean grade for that section.

The plot suggests that there is a cluster of sections that fill up quickly and a spread out cluster of sections that take longer to fill. The sections that fill up earliest have a slightly higher mean grade, but there appears to be no correlation between when the slower-to-fill sections fill and the mean grade in those sections. A course-by-course analysis of the top-scoring section of each course in a given term shows that of the 26 courses, the top-scoring section had a 75% chance of being in the top 50th percentile, and a 42% chance of being in the top 15th percentile (compare this with the expected 50% chance of being in the 50th percentile and a 15% chance of being in the 15th percentile for uncorrelated data). The statistics for the worst-scoring section of a given

course tells a similar story. However, besides the best and worst sections, there does not seem to be much of a relationship between when a section becomes full and the mean grade in that section.

Confounding Factors

Our analysis of when a section becomes full as an indicator of mean grade is complicated because different multi-section courses are handled in different ways. Sometimes many sections are opened at once, and as they fill, the maximum number of students allowed to register is increased. This ensures an even fill rate and a mixture of students with a low registration delays and high registration delays. At other times, as sections fill, new budgets are approved and entirely new sections are opened. These new sections are likely to be composed entirely of students with high registration delays. Our data does not distinguish between these two cases, but future research could evaluate the significance of this effect.

How a student's registration window is opened could also affect how sections fill. A student's registration window is partially determined by his or her GPA; students with higher GPAs are allowed to register earlier. The courses we have analyzed are primarily first-year courses so the effect of this should be less pronounced than in second-year courses. Correlating the absolute time of when a student's registration window opens and the student's registration delay, we notice a slight relationship showing that students whose registration window opened first tend to delay less when registering. Further research is needed to see if this effect is significant and if it becomes stronger for second and third year courses (as intuition would suggest). Additionally, whether a student's registration window is opened in the morning (8AM) or afternoon (4PM) might systematically impact registration delay, but this was not analyzed.

Conclusions

There indeed appears to be a correlation between a student's registration delay and that student's GPA, with the difference between the fastest-to-register students and the slowest-to-register students being a full GPA point on a 9 point scale.

We do not propose a causative relationship between student performance and registration delay, but instead propose that a student's registration delay is correlated to the student's diligence. Consequently, we predict that training students to register quickly will not affect how they do in a course, and in fact may render registration delay useless as a predictor of student performance and a learning-analytic tool.

Though registration delay and student performance are likely not causally linked, considering registration delay might help universities identify at-risk students. Many institutions attempt to identify at-risk students by requesting information from course instructors about their progress in class, and registration delay may be a useful factor in the formulas used to determine if a student should receive extra attention.

Further, registration delay may be a previously unaccounted for variable in many educational experiments. Though registration delay should have no impact on a statistically randomized sample of students, at our institution (and likely other universities), we run non-scientific pilot courses to evaluate new teaching methods or curricula. If an experimental section of a course is opened last and is filled primarily with delayed registerers, the effect of the experiment may be hidden by the effect of the sample bias. If homogeneity of sections is important for departmental or institutional analysis, we suggest a best practice: Ensure all sections of a course

are opened at once with a reduced maximum number of students per section (the sections *cap*). As the sections fill, incrementally raise each sections cap. Doing so should ensure an even distribution of slow registerers and quick registerers across all sections. Alternatively, if one wishes to have a section distinguished among the others, a section could be opened early and then closed early to ensure only quick registerers make it in.

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Student Off-Task Electronic Multitasking Predictors: Scale Development and Validation

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Abstract: In an attempt to better understand factors contributing to students' off-task electronic multitasking behavior in class, the research included two studies that developed a scale of students' off-task electronic multitasking predictors (the SOTEMP scale), and explored relationships between the scale and various classroom communication processes and outcomes. The first study inductively developed initial typologies for the SOTEMP scale, refined the scale item pool, and explored the dimensions of the scale. Subsequently, the second study validated the scale through a confirmatory factor analysis and by assessing different concurrently existing communication processes as well as students' perceived learning outcomes. Four factors were found: Lack of Class Relating, Technology Dependence, Class Easiness, and Overwhelmed feeling. Reliability and validity were established for the scale. Results indicated the SOTEMP scale was positively related to students' cognitive absorption, and negatively related to students' perception of their affective learning. However, the SOTEMP scale was not related to students' perceived cognitive learning. Limitations and implications for future research are discussed.

Keywords: off-task electronic multitasking, scale development, teaching, learning, technology

Multitasking is commonplace in the classroom. Easy access to electronic devices such as cell phones and laptops gives the "net generation" ample opportunities to engage in multitasking activities, such as text messaging, Internet surfing, and checking emails; This is increasingly associated with the use of electronic devices for both class-and non-class-related activities. The scope of the current study focuses on off-task electronic multitasking(OTEM)—the use of electronic devices for non-class-related activities while attending class.

Even though the use of electronic devices could potentially enhance learning when it is directed toward on-task activities in class, it is recommended that teachers encourage judicious use of technology (Grinols & Rajesh, 2014). Evidence indicates that our ability to engage in simultaneous tasks ranges from limited to virtually impossible (Hembrooke & Gay, 2003). Since human ability to process information is limited (Best, 1986; Bourne, Dominowski, & Loftus, 1979; Lang, 2000), off-task multitasking may moderate the attention to on-task activities. Research has found that people engaged in multitasking took longer to finish two tasks than had they concentrated on one task at a time (Rubenstein,

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Meyers, & Evans, 2001). Off-task electronic multitasking (OTEM) is especially problematic in the classroom as it distracts students' attention from lectures and participation in classroom activities, thereby diminishing students' learning (Young, 2006). Recent experimental research also has discovered that multitasking using a laptop impedes classroom learning both for users and nearby peers (Sana, Weston, & Cepeda, 2013). Therefore, OTEM in the classroom is often viewed as a major type of student misbehavior.

The current research examines factors that contribute to students' OTEM behavior. More specifically, it aims to develop a scale of student off-task electronic multitasking predictors (SOTEMP) through two areas of study. The first study inductively developed initial typologies for the SOTEMP scale, refined the scale item pool, and explored the dimensions of the scale. Subsequently, the second study validated the scale through a confirmatory factor analysis and by assessing different concurrently existing communication processes.

Literature Review

Although research has largely focused on the relationship between electronic multitasking and academic performance, a few studies have explored the predictors of student OTEM. These studies divide the predictors in two general categories: internal forces and external forces. The distinction between internal and external forces reflects the long-term nature-nurture debate, which attributes one's behaviors to innate characteristics/needs or to environmental factors. External factors that can predict OTEM are teacher immediacy, student learning motivation, awareness of instructor monitoring, distraction by other students, and social norms. Internal factors include the degree to which OTEM can gratify the individuals' needs, the habit of using information and communication technologies, and technology dependence/internet addiction.

External Forces on OTEM

One commonly examined external factor is teacher behavior. Wei and Wang (2010) proposed that teacher immediacy might moderate students' texting behaviors in the classroom. Since high teacher immediacy could enhance the effectiveness of teacher-student interactions and motivate students to engage in on-task learning activities, it might decrease students' off-task behaviors, such as text messaging in class. However, their result showed that teacher immediacy alone does not moderate students' texting behaviors during class. Gerow, Galluch, and Thatcher (2010) investigated another aspect of teacher behavior—student awareness of teacher monitoring. They hypothesized that this would negatively influence student intent to cyber-slack. They argued that teacher monitoring could lead to student compliance because students are aware of their behaviors being observed and the subsequent consequences of non-compliance. However, their results did not support the hypothesis.

Despite the lack of empirical support with regard to teacher immediacy and student awareness of teacher monitoring, teacher behavior in a more positive manner could affect OTEM through an impact on student engagement. Skinner & Belmont (1993) found that teacher behavior which includes the two facets of behavioral and emotional engagement plays a large role in student engagement. Engaged students tend to show "sustained

behavioral involvement in learning activities accompanied by positive emotional tone" (Skinner & Belmont, 1993, p.572). The lack of engagement, or disaffection, is marked by passivity, withdrawal, and distraction in behavior and boredom, anxiety, and frustration in emotion (Skinner, Furrer, Marchland, & Kindermann, 2008). OTEM is one manifestation of lack of engagement in class. With easy access to electronic devices, a disengaged student is more likely to become distracted and engage in OTEM during class. However, studies are limited in the area of examining the effect of student engagement on OTEM, as well. Lee, Lin, and Robertson (2012) suggested that multitasking interferes with student engagement in their knowledge acquisition since "extraneous cognitive load…burdens the working memory" (p. 102). Hassoun (2015) observed that students, who sat at the front of the class and used electronic devices less, did better in class. Wei and Wang (2010) studied a related concept—student learning motivation and its relationship with texting behaviors in class. The results did not show a significant relationship between the two variables.

Another recurring theme in the literature is the role of social influence on electronic multitasking. For example, based on Lewin's Field Theory (1939), Gerow and colleagues (2010) found that social norms positively influence students' intent to cyber-slack—the intent to use the Internet for non course-related activities. When peers and friends think cyber-slacking is acceptable, individuals are more likely to report the intent to cyber-slacking. The study also found two other external predictors—distraction by other students and awareness of instructor monitoring. Distraction by other students occurs when a student sees other students cyber-slacking and gets distracted, which comprises the observational aspect of social influence. Therefore, students are not only influenced by what other students think but also by what other students actually do.

Consistent with the findings of the above study, another study by Stephen and Davis (2009) confirms the role of social influence on electronic multitasking. Based on social influence model (Fulk, Schmitz, & Steinfield, 1990), Stephen and Davis examined the predictors of electronic multitasking in organizational meetings. The result indicated that organizational norms for engaging in electronic multitasking offer a unique and significant contribution to electronic multitasking in organizational meetings above and beyond individual-level predictors. They mentioned that observation of others' behaviors and perceptions of others' thoughts concerning electronic multitasking will predict individuals' own multitasking in organizational meetings.

Stephen and Davis (2009) also considered another situational factor—communication overload and its effect on electronic multitasking in organizational meetings. They maintained that people who believe they are overloaded might engage in electronic multitasking to compensate for the effect of being overloaded. The results did not show a significant relationship between communication overload and electronic multitasking.

Internal Forces on OTEM

In comparison with external factors, most research suggests that internal factors influence electronic multitasking to a greater extent (Gerow, et al., 2010; Wei & Wang, 2010). A few studies adopt the Uses and Gratifications Theory (UG Theory) to examine the internal motives/needs for electronic multitasking (Jeong & Fishbein, 2007; Wei & Wang, 2010). The UG Theory holds that social and psychological needs and motives drive audiences to

make use of different media to derive gratification (Jamal & Melkote, 2008; Rubin, 1994, cited in Zhu & He, 2002). For example, with a UG perspective, individuals use media to satisfy their needs and the most common gratifications they obtained from watching TV programs are to escape, to be entertained, to relieve boredom, to reduce loneliness, and to learn (Abrams & Giles, 2007). Based on UG theory, research supported that internal gratifications of text-messaging are positively related to the frequency of text-messaging in class (Wei & Wang, 2010). Five constructs of internal gratifications were measured in the study: affection, escape, inclusion, pleasure, and relaxation.

Similarly, Gerow, et al. (2010) identified five aspects of cognitive absorption as the internal factors of cyber-slacking. Cognitive absorption was defined in the study as a state of deep involvement with a particular task. The concept of cognitive absorption (Agarwal & Karahanna, 2000) is composed of five dimensions: temporal dissociation (the loss of sense of time while a person is engaged in a particular activity); focused immersion (the experience of total engagement while other demands are ignored); heightened enjoyment (the pleasure from an activity); control (the perception of being in charge); and, curiosity (the extent the experience arouses an individual's curiosity). The five dimensions tap into the internal needs, which an activity/medium can meet. When individuals are cognitively absorbed with modern technologies, they tend to lose track of time and thereby reduce their on-task learning activities. The results showed that the overall construct of cognitive absorption positively influences intent to cyber-slack with only one non-significant dimension—control. Another internal motive/need that predicts multitasking with media in general is sensation-seeking—the need for varied, novel, and complex sensations and experiences (Jeong & Fishbein, 2007).

Besides internal gratifications, habit or previous experience with electronic devices use was also identified as a significant internal predictor of electronic multitasking. Wei and Wang (2010) use the automaticity theory to argue that frequent use of text-messaging might become a habit over time, which may be defined as "automatic behaviors triggered by minimum consciousness" (p. 482). Students' daily texting usage significantly predicts text-messaging in class. For example, Olmstead and Terry (2014) found that one's frequency of texting in other contexts such as while driving or studying predicts texting in class. Based on social influence model, Stephen and Davis (2009) found that people's previous experience with technology will positively affect their electronic multitasking during organizational meetings.

The habit of technology use could even go to the extent of addiction. Researchers use such terms as "technology dependence" and "compulsive internet use/internet addiction" to describe such a condition (Byun, et al., 2009; Chang, 2012). Chang (2012) posited that modern information and communication technologies (ICTs) have evolved from once single-purpose oriented to general-purpose oriented, allowing users to perform a variety of tasks simultaneously. The nature of modern ICTs further fosters students' multitasking behaviors. Studies have shown that heavy users of ICTs are more likely to engage in multitasking behaviors (Garrett & Daziger, 2008). Experimental research even revealed that most college students are not only unwilling but also unable to live without the Internet connection with the external world, thus becoming "technology dependent" (Moeller, et. al., 2010). Chang (2012) proposed that there is a positive relationship between technology dependence and student multitasking behaviors, yet this proposition has not been tested in empirical studies.

Although the topic of electronic multitasking has begun to gain research attention, there are few studies on the causes of electronic multitasking. For example, Wei and Wang (2010) pointed out one of their study limitations of not assessing whether or not students' self-control and self-efficacy have any influence on texting behaviors in class. Self-efficacy is defined as individuals' belief in their ability to perform a specific task in a given situation or context (Bandura, 1986). Previous research suggested that self-efficacy and sense of personal control could contribute to the further use of mobile text messaging (Mahatanankoon & O'Sullivan, 2008). In the case of electronic multitasking, it can be reasoned that individuals are more likely to multitask if they believe they have the ability to perform a variety of tasks simultaneously without much difficulty.

Another limitation of the few existing studies on causes of electronic multitasking is that they used the theory-driven hypotheses testing approach. Each study includes only a few predictor variables from its own particular theoretical lens, and thereby giving an incomplete picture. No known studies have investigated the causes of electronic multitasking by inductively collecting empirical data from the participants themselves and testing them among the participants. This study intends to fill the literature gap by developing a scale to predict electronic multitasking in the classroom.

Study 1

Method of Stage 1

Participants. A total of 116 students (50.9% females; 49.1% males) from two U.S. universities took part in the study. The mean age of the participants was 21.51 years (*SD* = 5.86). Participants reported predominantly as Caucasians (80.2%) with African American as the second largest racial and ethnic group (9.5%).

Design and Procedure. After the approval of Institutional Review Board, we emailed our colleagues in two universities in the U.S. to recruit their students to complete paper-based questionnaires. All students earned a small amount of extra credit for their participation. On each questionnaire, we defined classroom electronic multitasking as students' use of electronic devices such as cell-phones, laptops, I-pads, etc. to conduct activities that are not related to the course being taught at the time. We also listed some behaviors such as checking email, browsing Facebook, and text messaging. We then asked participants to think about factors/situations that might lead them to be engaged in electronic multitasking behavior in class. We asked each participant to record up to five factors or situations. At the end of each questionnaire, we asked participants for related demographic information.

Generation of initial scale items. Altogether, 484 messages describing the factors for engaging in electronic multitasking were generated from the participants. Using the constant comparative method (Glaser & Strauss, 1967), two researchers met several times to discuss each message and were able to identify 53 student multitasking predictors. The process of refining the categories was iterative to establish validity. Face validity was established by using the participants' actual wording examples to phrase the predictors. Meanwhile, since all the predictors were created and grounded from the participants'

messages, the predictor pool achieved internal validity as well.

Method of Stage 2

Participants. Another groups of 199 students (males: 38.2%; females: 60.3%; 1.5% unreported) at two U.S. universities participated in the study. The average age of the participants was 20.53 years old (*SD* = 3.60). The vast majority of the participants were Caucasian (*n* = 169, 84.9%), with no other ethnic group accounting for more than 7% of the total.

Design and Procedure. An online survey including 53 student multitasking predictors was created to ask the participants to indicate the likelihood of each of the initial predictors to contribute to students' multitasking behavior in class. Specifically, we asked the participants to check the level of likelihood of each predictor on a scale of 5 (1 = very unlikely, and 5 = very likely).

The data were screened for missing values and outliers. Missing values (1.08%) were imputed by the "multiple imputations" procedure in the LISREL 8.80 analysis program. Furthermore, Mahalanobis Distance is a standard procedure to detect multivariate outliers, which are unusual or extreme values and often distort a statistical result. To calculate Mahalanobis Distance for each case, the case ID was put as the independent variable with the predictors as the dependent variables. "Mahalanobis Distance is evaluated as χ^2 with degrees of freedom equal to the number of variables" (Tabachnick & Fidell, 2007, p. 99). The predictors scale includes 53 variables and thus all 53 Mahalanobis variables must be examined against 90.573, which was the critical value of chi-square at $p < .001$. Four cases' Mahalanobis Distance values exceeded 90.573, and therefore they were removed from the data file. The final predictors data set contained 195 cases.

Initial Development of the Instruments (EFA). Three major methodological issues are typically considered to test the dimensionality of a scale in EFA: a) method of factor extraction, b) the type of factor rotation, and c) the number of factors to be retained.

First, the decision was made between the two most used factor extraction methods in communication research: Principal Component Analysis (PCA) and Principal Axis Factoring (PAF). PCA focuses on the total variation that is shared among all the variables. It is therefore an appropriate procedure to "reduce the measured variables to a smaller set of composite components that capture as much information as possible in the measured variables with as few components as possible" (Park, Dailey, & Lemus, 2002, p. 563). PAF emphasizes the unique variation specific to each variable. It helps locate the latent dimensions of observed variables. Hence, PAF is a preferable factor extraction method for scale construction (McCroskey & Young, 1979; Park, et al., 2002). Therefore, PAF instead of PCA was used in the current project to refine the scales.

Second, a decision had to be made to choose between orthogonal and oblique rotation methods. Oblique rotation procedures (e.g., promax, oblimin, quartimin, etc.) differ from orthogonal procedures (e.g., varimax, equimax, quartimax, etc.) in that oblique analysis assumes the existence of correlations between all variables (McCroskey & Young, 1979). Since it has been suggested that many constructs in communication research are expected to be correlated (Costello & Osborne, 2005; McCroskey & Young, 1979; Park,

et al., 2002), an oblique rotation method was applied to the current study for more accurate results.

Third, five criteria were used to determine how many factors to retain in the Principal Axis Analysis: the eigenvalue test (i.e., eigenvalue > 1), the total variability close to 50-70% that can be counted by the factors, the Parallel Analysis, visual inspection of the scree plot, and the interpretability/face validity of rotated factors.

The Student Off-Task Electronic Multitasking Predictor (SOTEMP) Scale

Since a factor analysis procedure explores the underlying correlational structure for a data set, the communality of a variable should be above .50. Fifteen predictors were eliminated from the current scale due to the failure of not meeting the criterion.

Five criteria were used to determine how many factors to retain in the Principal Axis Analysis: the eigenvalue test (i.e., eigenvalue > 1), the total variability close to 50-70% that can be counted by the factors, the Parallel Analysis, visual inspection of the scree plot, and the interpretability/face validity of rotated factors.

An initial Principal Axis Factoring with a Promax rotation procedure (a typical oblique rotation procedure) was applied to the data. The KMO and Bartlett's Test showed that some significant correlations existed between the items in the multitasking predictor typology ($\chi^2 = 2149.04$, $df = 253$, $p < .05$). Meanwhile, the Kaiser-Meyer-Olkin test of sampling adequacy (.876) larger than a value of .60 indicated that factor analysis was the appropriate procedure for the data in the scale established preliminarily.

Four factors' eigenvalues were greater than 1.0. According to Kaiser's rule of eigenvalues greater than 1, those four factors should be kept. The four-factor structure explained a variance of 66.12%. A Parallel Analysis was performed by using "the Parallel Analysis Engine to Aid Determining Number of Factors to Retain" (Patil, Singh, Mishra & Donovan, 2008) to use the mean and the 95^{th} percentile approaches with 1000 replications with the sample size and number of variables being 195 and 38 respectively. Both the means and 95^{th} percentile approach showed that four factors could be kept since only the first four factors' eigenvalues were higher than the random data eigenvalues. Meanwhile, a Scree Plot showed that from the first four factors, there was a comparatively sharper bend.

The above information all suggested a four-factor structure. Fifteen items met the .60/.40-loading criterion advocated by McCroskey and Young (1979). Goodboy (2011) suggested that items with borderline loadings (close to .60) with a secondary loading not exceeding 50% of the primary loading should be retained. Therefore, item 10 met that threshold. The final scale included 16 items, maintaining a sufficient number of items in any particular factor (Table 1).

Table 1. **Rotated Factor Structure of the Scale**

	Factor			
	1	2	3	4
1. There is a lack of teacher-student interaction.	**.812**	.044	-.147	-.073
2. The class is large.	**.781**	-.121	.032	-.099
3. The teacher does not seem to pay attention to what I am doing.	**.711**	-.017	.018	.084
4. The teacher has a relaxed policy on using electronic devices in class.	**.676**	.004	.130	-.087
5. The class topic is boring.	**.655**	.059	-.013	.159
6. The class content is not going to be on the test	**.611**	.000	-.045	.136
7. I am addicted to using my laptop, phone, ipad, or other electronic devices.	-.092	**1.011**	.005	-.137
8. I am addicted to some Internet social networks, such as Facebook, twitter, etc.	-.012	**.834**	-.051	-.039
9. I feel restless when I cannot use the internet/cell phone.	.058	**.608**	-.049	.193
10. It's my habit to check the internet or my cell phone frequently.	.070	**.495**	.180	.193
11. The class material is easy to understand.	.239	-.004	**.756**	-.187
12. I can easily understand the knowledge presented in class.	-.019	.057	**.752**	-.019
13. It is easy to understand the teacher.	-.231	-.078	**.696**	.190
14. I am too tired.	-.013	-.043	.052	**.715**
15. I need a mental break from class.	.128	.043	.015	**.636**
16. There is too much information presented in class.	-.049	-.022	-.074	**.633**
Eigenvalue	5.12	2.49	1.78	1.19
% of Variance	31.99	15.54	11.15	7.45
Alpha	.86	.85	.76	.70

Note. Principal Axis Factoring with Promax rotation was used.

The four factors had strong face validity when analyzed in comparison to literature on student in-class electronic multitasking behavior. Factor 1, *lack of class relating* (*M* = 2.91, *SD* = .89, *r* = .86), consisted of six items related to students' inability to see that the class is relating to them, thus there is a lack of behavior control and engagement in class. Factor 2, *technology dependence* (*M* = 2.88, *SD* = 1.04, *r* = .85), included four items describing ways in which students are addicted to technology. Factor 3, *class easiness* (*M* = 3.48, *SD* = .84, *r* = .76), contained three items related to students' perception of lack of intellectual challenge in class. Factor 4, *overwhelmed feeling* (*M* = 2.96, *SD* = .91, *r* = .70), included three items that indicated students being overwhelmed. The four factors were partially significantly correlated (see Table 2). The scale's overall reliability was .86.

Table 2. Correlation Matrix of Scale Dimensions

Factors	*2*	*3*	*4*
1	.309**	.127	.350**
2	-	.265**	.490**
3		-	.214**
4			-

** $p < .01$

Study 2

Study 1 provided initial evidence of validity, reliability, and dimensionality of the SEMP scale. To add further evidence of validity, Study 2 reported a confirmatory factor analysis and also assessed relationships between students' perceptions of SEMP, their cognitive absorption with modern technologies, and their affective as well as cognitive learning.

To test the model fit of the scale's four-factor structure, a confirmatory factor analysis procedure was performed with maximum likelihood estimation (ML) using LISREL 8.80 on predictors dataset (*N* = 215). Five popular model fit indices were used: (a) the normal theory weighted least squares chi-square, (b) the root mean square error of approximation (RMSEA), (c) comparative fit index (CFI), (d) the non-normal fit index (NNFI), and (e) the standard root mean square residual (SRMR). Model fit is generally considered acceptable if RMSEA statistics does not exceed .08 (and preferable less than .05), the values of CFI and NNFI are above .90, and SRMR value is less than .08 (Kline 2005; MacCallum, Browne, & Sugawara, 1996). Ideally, the chi-square statistics should be non-significant. However, considering the large sample size involved in the CFA data analysis, the index was seldom non-significant; thus, it was not considered in the current data. To confirm the four-factor structure of the scale, an adequate model fit should be observed.

H_1: The four-factor structure observed in the first study will have adequate fit with the data set in Study 2.

Based on UG Theory, previous literature indicates that students' electronic multitasking is heavily influenced by their internal needs gratification. Similar to the internal gratifications, cognitive absorption captures "a broad range of feelings including control, curiosity, heightened enjoyment, focused immersion, and temporal dissociation"

(Gerow, et al., 2010, p. 9). The five dimensions of cognitive absorption are correspondent with several aspects of internal gratifications. In addition, cognitive absorption was defined as a state of deep involvement with a particular task. The definition shares a common characteristic with technology dependence: the deep level of involvement and focused immersion in technologies. Since both internal gratifications and technology dependence are internal forces driving electronic multitasking, it is expected that SOTEMP scale is positively related to students' cognitive absorption. Previous research also supported that cognitive absorption with modern technologies could lead to cyber-slacking (distractive internet use in class). Therefore, we proposed our second hypothesis as:

> H_2: SOTEMP in the classroom are positively related to students' cognitive absorption with their electronic technologies.

As the common practice of instructional communication research, cognitive learning and affective learning were explored in the current study. Cognitive learning was defined as students' knowledge retention and knowledge in terms of learners' abilities and skills, such as comprehension, application, analysis, synthesis and evaluation of course information (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956; Mayer, 1998, 2008). It is widely acknowledged that teachers' primary and ultimate goal is to facilitate their students' cognitive learning (Ellis, 2004; Kearney, Plax, Richmond, & McCroskey, 1985). Different from the knowledge emphasis of the cognitive learning, affective learning emphasizes students' "interests, attitudes, appreciations, values" (Krathwohl, Bloom, & Masia, 1964, p.7). Accordingly, scholars suggest that teachers should focus on teaching valuing process, clarifying attitudes, preferences, motivation, values, building relationships between students, materials and teachers, etc. (Shechtman & Leichtentritt, 2004). Affective learning objectives are widely regarded to lead to students' excellence and positive classroom environment. Students who are engaged in OTEM pay less attention to class lectures and activities. As a result, they tend to gain less from the class and have less cognitive learning. In addition, the students' act of engaging in non-class-related activities hinders the relationship building between teachers and students in class, which, in turn, influences the affective learning of students. Research has shown that OTEM negatively affects classroom learning and student performance (Sana, Weston, & Cepeda, 2013). Therefore, we posited the following hypotheses:

> H_3: SOTEMP in the classroom are negatively related to students' perception of affective learning.
> H_4: SOTEMP in the classroom are negatively related to students' perception of cognitive learning.

Method

Participants

A third group of student participants took part in the study. A total of 217 students (68.5% females; 26.9% males; 4.6% unreported) from two U.S. universities participated. The mean age of the participants was 19.64 years (*SD* = 2.27). Participants reported predominantly

as Caucasians (77.8%) with no other ethnic groups reporting be more than 6% of the sample.

Design and Procedure

The data were again screened for missing values and outliers. The missing values (.69%) for the SEMP Scale were computed by the "multiple imputations" procedure in the LISREL 8.80 analysis program. We opted to employ Mahalanobis Distance again to detect multivariate outliers. As the predictors scale includes 16 variables and thus all 16 Mahalanobis variables must be examined against 39.252, which was the critical value of chi-square at $p < .001$. Two cases' Mahalanobis Distance values exceeded 39.252, and therefore they were removed from the data file. The final predictors data set contained 215 cases.

Instruments

Cognitive Absorption Scale. Cognitive Absorption Scale (Agarwal & Karahanna, 2000) consists of five dimensions: temporal dissociation, focused immersion, heightened enjoyment, control, and curiosity. The scale includes 10-items with the 5-point Likert response format ranging from strongly disagree to strongly agree. Sample items include, "I have fun interacting with the Internet while I'm in class" and "the class flies by when I'm using the Internet." The Cronbach Alpha for the scale in this study was .89.

The Revised Cognitive Learning Indicators Scale. The Revised Cognitive Learning Indicators Scale (RCLIS; Frymier & Houser, 1999) includes seven items assessing learner behaviors or activities associated with learning course content. This scale makes use of a 5-point Likert response format ranging from 0 (never) to 4 (very often). In this study, numerical values of the responses were changed to the format ranging from1 for "never," and 5 for "very often." Sample items include ''I review the course content'' and ''I think about the course content outside the class.'' Previous findings have demonstrated construct validity and satisfactory reliability, with alpha coefficients ranging from .83 to .86 (Frymier & Houser, 1999; Hsu, 2012). In this study, Cronbach's alpha was .84.

The Affective Learning Scale. The Affective Learning Scale (ALS; McCroskey, 1994; McCroskey, Richmond, Plax, & Kearney, 1985) includes 24-items measuring students' attitude towards the course, subject matter, and the teacher, as well as the likelihood of students' related behavior. Each of these dimensions is evaluated through four 7-point bipolar adjective subscales (good-bad, worthless-valuable, fair-unfair, and positive-negative). The scale has been repeatedly used and has shown a high reliability of .90 (McCroskey et al., 1985; Plax, Kearney, McCroskey, & Richmond, 1986, Hsu, 2012). In this study, the scale's overall Cronbach's alpha was .97. Specifically, the reliability for the subscales were: affect towards the behaviors recommended in the course ($\alpha = .95$), the class' content ($\alpha = .95$), the instructor ($\alpha = .97$), likelihood of taking future courses in the content area ($\alpha = .97$), and likelihood of actually attempting to engage in behaviors recommended in the course ($\alpha =. 98$).

Results

Results of the CFA indicated that the four-factor model fit was acceptable: $\chi^2 (98) = 199$,

$p < .01$; CFI = .95, NNFI = .94, SRMR = .072, RMSEA = .069 [90% CI = .055: .083]. An inspection of the λ loadings and accompanying *z*-scores indicated that all 15 items loaded significantly (factor loadings ranged from .53 to 1.05) on their respective factors (see Table 3).

Table 3. Confirmatory Factor Analysis

Latent Construct Item	*M*	*SD*	λ	*SE*
Factor 1. Lack of Class relating				
1	2.89	1.17	.92	.08
2	3.14	1.23	.60	.08
3	2.74	1.09	.84	.07
4	2.94	1.19	.53	.08
5	3.03	1.11	.71	.08
6	2.47	1.28	.83	.09
Factor 2. Technology Dependence				
7	2.66	1.20	.1.05	.08
8	2.73	1.27	1.04	.09
9	2.38	1.08	.65	.07
10	3.41	1.24	.85	.08
Factor 3. Class Easiness				
11	3.36	1.10	.94	.08
12	3.49	1.05	.99	.07
13	3.20	1.11	.79	.08
Factor 4. Overwhelmed Feeling				
14	2.87	1.23	.85	.08
15	3.22	1.05	.58	.07
16	2.29	.97	.57	.07

Note. All factor loadings are standardized and significant at $p < .01$

The second hypothesis stated that SOTEMP are positively related to cognitive absorption with modern technologies. Simple correlations were run to test the second hypothesis as well as hypotheses 3 and 4. The second hypothesis was supported, with r=.597, $p < .001$. The third hypothesis predicted that SOTEMP in the classroom are

negatively related to students' perception of affective learning. Hypothesis 3 was supported, with r = -.206, p < .001. More specifically, among the four factors of SOTEMP scale, only factor 1(*lack of class relating*) and factor 4 (*overwhelmed feeling*) were negatively related to students' perception of affective learning, with r = -.174 and r = -.294 respectively at the significance level of .001 (p < .001). Factor 2 (*technology dependence*) and factor 3 (*class easiness*) were not significantly related to students' perception of affective learning, with r = -.095 and r = -.007 respectively, p < .001. Hypothesis 4 predicted that SOTEMP are negatively related to students' perception of cognitive learning. Hypothesis 4 was not supported, with r = -.128, p = .068. The statistic reports also showed that none of the four factors was significantly related to students' perceived cognitive learning.

Discussion

Despite the popularity of OTEM in the classroom, there are no existing scales to assess the predictors of student OTEM. This is the first study to develop such a scale. Four factors were retained from the SOTEMP scale: *lack of class relating, technology dependence, class easiness, and overwhelmed feeling.* The four dimensions reflect both internal and external forces that drive OTEM in the classroom, which is consistent with the literature.

Technology dependence and *overwhelmed feeling* are the internal factors; whereas, *lack of class relating* and *class easiness* are the external factors. *Technology dependence (also labeled as internet addiction in the literature)* describes the state that individuals are highly dependent on or even addicted to technology, which further fosters their electronic multitasking behaviors. The result is consistent with literature since similar concepts, such as cognitive absorption and media use habit, have been found to be significant predictors of electronic multitasking. In addition, individuals who are highly dependent on technology tend to always keep their electronic devices within easy access. In addition, easy access to media devices could lead to media multitasking (Jeong & Fishbein, 2007). *Overwhelmed feeling* depicts the sense of feeling overwhelmed due to information overload or tiredness. The overwhelmed feeling could easily trigger a need for escape that can be satisfied through electronic multitasking and media consumption. The finding is consistent with the Uses and Gratification theory. To date, no studies have been found to indicate *overwhelmed feeling* as the cause of electronic multitasking. This is a new finding in our study. This finding also indicates that there is probably no clear-cut division between external and internal forces of electronic multitasking. Some situational factors, such as information overload, might trigger an internal need, which leads to electronic multitasking.

Lack of class relating refers to teacher behaviors of lack of involvement and monitoring of students' activities. Contrary to previous empirical studies, *lack of class relating* was found to be a significant predictor of OTEM in our study. Despite the lack of empirical support, this finding is supported by the student engagement theory since disengaged students tend to get distracted easily and conduct misbehaviors. OTEM is one manifestation of student misbehaviors in class. *Class easiness* as one of the causes of electronic multitasking hasn't been investigated before in the literature. However, it can be reasoned that class easiness could lead to students' self-efficacy of electronic multitasking in class. When students perceive the class content as easy or not challenging, they tend to have heightened self-efficacy of electronic multitasking—the belief that they have the ability to perform off-task activities simultaneously. Self-efficacy could contribute to the

actual electronic multitasking behaviors in class. The two class-related external factors are the new findings that our study brings to the literature of student electronic multitasking.

In validating the SOTEMP scale, our study also supported the literature that students' electronic multitasking behaviors are heavily influenced by internal needs and individual characteristics. The study found that SOTEMP were positively related to students' cognitive absorption with their electronic technologies. The concept of cognitive absorption reflects both internal gratifications from and deep involvement with a particular task. The five dimensions of cognitive absorption taps into the internal needs for control, curiosity, and enjoyment. At the same time, the concept also captures the features of technology dependence in terms of deep involvement and focused immersion.

Although literature showed that electronic multitasking is only slightly influenced by external factors (Gerow, et al., 2010), our study suggested that students' affective learning is negatively related to SOTEMP scale. As affective learning reflects students' interests and attitudes toward the course and instructor, higher level of affective learning could lead to a positive classroom environment in which disruptive behaviors, such as electronic multitasking, are less likely to occur.

Surprisingly, our hypothesis that students' electronic multitasking predictors are negatively related to students' perception of cognitive learning was not supported. The surprising result might be related to the self-reported survey method. Discrepancies might exist between perceived cognitive learning and actual cognitive learning.

Limitations and Future Directions

The current program of research also has several limitations. First, the vast majority of the participants were Caucasian with an average of 20 years old. The findings might not be generalized to other age or ethnic groups. Future studies might incorporate a more diverse population. Secondly, this study used students' self-reports to measure their cognitive absorption with technology as well as their perceived affective and cognitive learning, which might be different from their actual behaviors. Future studies might report the frequency and duration of technology use in class and measure students' learning by assessing their actual performance in class. Thirdly, self-reports were also used to solicit the initial pool of scale items. The participants might be unaware of certain situations that could lead to electronic multitasking, whereas these situations could be quite visible to outside observers, such as teachers in the classroom. For example, in the literature, social influence has been identified as one of the causes of electronic multitasking, but this factor was not reflected in our initial pool of items. Future studies could also solicit teachers' reports on students' OTEM causes. In addition, experimental studies can also be conducted to monitor some particular situational factors that might contribute to students' electronic multitasking behaviors. Finally, the current research focused on off-task electronic multitasking, which distracts students from actively participating in class activities. However, with the advance of instructional technology, electronic devices can be used in many positive ways to enhance classroom learning experiences. For example, Lysne & Miller (2015) examined ways to use mobile devices to engage students in evolutionary thinking. Ekanayake and Wishart (2015) discussed ways for teachers to integrate mobile phones into teaching and learning. Future studies could be conducted to examine on-task electronic multitasking and its positive effect on student learning.

Conclusion

Students' OTEM has been viewed as one of the major distractions from learning in the classroom (Fried, 2008). The current research makes an important contribution to student electronic multitasking by developing the first SOTEMP scale. This study has significant implications for both researchers and practitioners. First, previous research tends to attribute students' electronic multitasking to internal factors (Wei & Wang, 2010; Gerow, et al., 2010). In the current study, we found external factors as well, such as lack of class relating and class easiness. To reduce OTEM, teachers might involve students more by having close interactions, paying more attention to student behaviors in class, and making the lectures more relevant to students' life and more entertaining. Just as Ferguson, Philips, Rowley, and Friedlander (2015) pointed out, to enhance classroom management, teachers need to work on encouraging student on-task behaviors by "teaching in ways that clarify, captivate, and challenge instead of merely controlling students through intimidation or coercion" (p. 12). Second, class easiness was also found to be a predictor of students' electronic multitasking. While trying to make the class materials easily understandable, teachers should also make the class topics intellectually challenging so that students would be more occupied in the lectures and class activities, and thereby leaving little room for multitasking. At the same time, teachers could vary their teaching formats in class so that students do not feel overwhelmed from information overload. Finally, technology dependence is one of the major factors in student electronic multitasking. Once forming the habit, students want to be connected all the time. They tend to engage in multitasking whenever they are given the chance. With easy access to various modern technological devices, it has become more common for students to engage in electronic multitasking. Thereby, it is unrealistic for teachers to monitor all off-task multitasking behaviors in class. Other than merely enhancing teacher monitoring, researchers and practitioners could generate various creative ways to productively integrate the technology use into on-task teaching and learning activities in the future.

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Using Multiple High-Impact Practices to Improve Student Learning in an Undergraduate Health Science Program

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Abstract: Problem-based learning can be an effective educational approach for students entering the health care field. While broadly used in graduate and professional education in the health sciences, it is less widely used in undergraduate programs. We discuss the use of problem-based learning as part of an approach to address failure rates in select Health Sciences courses and poor critical thinking skills. While our results were mixed, we saw an overall improvement in student outcomes. Problem-based learning experiences prepare students better for demands of the real world.

Key Words: problem-based learning, case-based learning, high impact practices, student learning outcomes, health sciences

The Health Sciences program is one of the largest at California State University, East Bay (CSUEB). The program has grown by 68 percent from 838 students in 2011 to 1,411 students in 2016 (Institutional Research, Analysis, and Decision Support [IRADS], 2016). The Health Sciences program is also one of the smaller programs with respect to full-time faculty, with 8 full-time tenure-track faculty in 2016. The shortage of faculty and growth of students is an example of the pressures and challenges facing the California State University (CSU) system. In this article, we describe our experience in transforming the health sciences curriculum, by specifically focusing on courses with high failure rates and those that serve as bottlenecks for student graduation. Bottlenecks in graduation occur when students are unable to either enroll in required courses and/or are unable to graduate because they did not complete the required courses successfully. A recent CSU survey found that there were many reasons for bottleneck these problem courses, such as: deficiencies in funding, space, and qualified faculty; students repeating classes; and other factors (Kiss, 2014). In this case study we examine one cause: failure rates in select courses that are critical for graduation. We also demonstrate the improvement in student outcomes and student success as a result of curriculum redesign.

Curriculum transformation is challenging when the change will impact a large group of students with only few full-time faculty available to manage the ripple effects. We were able to embark on this transformation, in part, due to a generous grant awarded in 2014 by the Chancellor's Office at California State University. The Promising Practices grant from the Chancellor's office which provided an opportunity for us to redesign select courses to improve student success and learning. Specifically, we focused on a sequence of interdependent courses with high failure rates.

In CSUEB's Health Sciences program, students are required to take three related courses: Health Care Systems (henceforth referred to as Health Systems), Health Legislation and

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Government Programs (henceforth referred to as Health Policy) and Health Care Law and Ethics (henceforth referred to as Health Law). The Health Systems course provides an overview of the systems and organization of health care in the US; the Health Policy course explores current state and federal legislation and the historical developments of health programs; the Health Law course provides an overview of legal and ethical issues encountered by health care practitioners. Students take the courses in the order listed above, with the latter classes having the earlier courses as prerequisites. Since CSUEB is on the quarter system, students generally complete the series within one year. Failing even one of these classes can jeopardize a student's timely graduation.

Evidence of the Problem

We used institutional data on student grades from 16 consecutive quarters: Fall 2012-Summer 2016 for our analysis (IRADS, 2016). We piloted the redesign and transformation in Summer 2015 and implemented it in Fall 2015. We refer to the data from Fall 2012 to Spring 2015 quarters as "pre-redesign", and refer to data from Summer-2015 to Summer 2016 quarters as "post-redesign". Pre-redesign, there were 18 sections of the Health Systems course, 19 sections of Health Policy course and 15 sections of the Health law course. In all, 3031 students enrolled in the 3 courses combined prior to redesign. We have completed 12 sections of the Health Systems course, 13 sections of the Health Policy course, and 11 sections of the Health Law class post-redesign. In all, 1454 students enrolled in the redesigned course sections.

There were two issues that confronted us in the failure rates for these courses. First, the high percentage of students who did not pass the courses. Second, a high variability among the grade distributions among various sections of courses. Closer examination of data also showed that, prior to the transformation, failure rates for these courses varied unpredictably between zero percent and 37 percent depending on the instructor teaching the courses. As shown in Table 1, over the three-year period (Fall 2012-Spring 2015), an average 11 percent of the students repeated the Health Systems course, 13 percent repeated the Health Policy course and 9 percent repeated the Health Law course. Taken together over three years, on average, 11 percent of our enrolled Health Sciences students were repeating one of the 3 courses.

Table 1. Grade distribution of students prior to redesign (Fall 2012-Spring 2015)

	Health Systems	Health Policy	Health Law	ALL 3 combined
N	1090	1111	830	3031
% Passing Grade (A-C)	86%	86%	88%	87%
% Failures (C- and below)	10%	11%	8%	10%
% Others (Withdrawal, Withdrawal-Unauthorized)	3%	4%	4%	4%

After a review of syllabi from the courses, we found that most of the courses used a traditional lecture-based model. In class, the primary focus is on the instructor and the lecture content, while student engagement is restricted to discussions based on material presented in class. In this approach, assessment of learning outcomes is primarily through quizzes and exams, and

occasionally through group presentations and point papers. We believe that this approach is valuable for short-term retention of content. Previous work has shown limited gains in critical thinking through lectures and quizzes (Stanger-Hall, 2012; Tiwari, Lai, So & Yuen, 2006).

At CSUEB, critical thinking is both a program learning outcome and an institutional learning outcome. All students in the Health Sciences program are required to complete a 90-hour supervised training internship/volunteer position in a health care or social service organization. In addition to completing their 90 hours successfully, they write an internship report that integrates their field experiences with their health sciences coursework. When we examined the failure rate in our capstone course, we found that, from 2012 to 2015, approximately 8 percent of students enrolled in the class did not pass the internship report component. We were concerned that graduating students were struggling to integrate theory with practice and would be entering the health care field with a superficial knowledge of health care topics, rather than a deeper application of learned concepts.

Our Goals

There were three problems we wanted to address: (1) failure rates in the select Health Sciences courses (2) poor critical thinking skills and (3) bottlenecks in enrollment. We addressed these problems using specific tools in pedagogy and curriculum management. First, to reduce failure rates we replaced quizzes, midterm and final exams with team work projects as well as a wide range of writing assignments. Next, to develop critical thinking skills we implemented problem-based learning instruction as a pathway to understand and solve complex problems in health care. Finally, we reduced bottlenecks in enrollment by enforcing prerequisites and tweaking course offerings to fit with the curriculum road map. While all three measures are equally important, we do not discuss bottleneck issues and enrollment management in this article, as they are more administrative in nature and would necessitate a larger discussion of enrollment management and policy and their effect on pedagogy. In this project we focused on implementing pedagogical changes in the redesigned courses. We believe that implementing problem-based learning in these courses would not only help to mitigate some of the existing the problems, but also create a future generation of critical thinkers in health sciences.

Problem Based Learning: Linking theory to viable solutions

Problem-based learning (PBL) has its origin in health care and is a particularly effective method for teaching medical students and students entering the health care industry. PBL is student-centered and provides relevant learning opportunities that incorporate real-world challenges common in the discipline of instruction. This approach introduces students to the content through the process of problem-solving, instead of first learning the content and then applying it to the problem. Emphasis is on critical-thinking as well as multidisciplinary learning. Health care is fraught with complex scenarios and problems that do not have one “right” answer. Such complex problems don’t have a defined trajectory and solutions to these problems are not true-or-false but good-or-bad. Often the solutions themselves have unintended consequences which lead to additional problems (Rittel & Weber, 1973).

PBL is the mainstay in many graduate schools including specialized programs such as medicine and nursing (Agbeh, 2014; Hoffman, Hosokawa, Blake Jr, Headrick, & Johnson, 2006; L'Ecuyer, Pole, & Leander, 2015). Problem-solving abilities and critical thinking are much needed

skills in the workforce as well (Flores, Matkin, Burbach, Quinn, & Harding, 2012). One could say that undergraduate schools are committing a disservice to their students by not preparing them for this transition. This makes a strong case that undergraduate students would benefit from early introduction to PBL, irrespective of their future career trajectory: graduate school or employment.

The PBL approach presents a real-world problem built into the content of the lecture, thereby challenging the students to work through and come up with as many solutions as possible, by using their experiences. This is in contrast to traditional lecture-based learning, where the lesson is introduced in advance of the problem (Agbeh, 2014). When students are only lectured to, they fail to make sense of the content and are unable to find ways to apply the newly learned content to real-life scenarios. PBL can reach far beyond simply teaching future clinicians; it has also proven to help clinicians with patient interactions and other multidisciplinary demands of health care work as well (Bate, Hommes, Duvivier, & Taylor, 2014). Coaxing students to develop ideas and come up with solutions to a problem they may know little of, helps them become "flexible" thinkers (Dolmans, De Grave, Wolfhagen & Van Der Vleuten, 2005). This becomes a resource from which they can draw from, once they enter their chosen clinical fields. The inverted manner in which PBL presents the expected learning content, challenges students to escape their comfort zone in order to make advances in their learning capacity, based on their personal and professional interests (Alessio, 2004).

One of the tenets of the PBL process is cognitive engagement and reflection, where students reflect on their previous experiences after reading through a specific problem. This reflection helps the students come up with questions they may need answered before moving forward (Hemlo-Silver, 2004). The transition from traditional learning to PBL is smoother and entices positive reactions from students when they are given ample opportunities to practice and develop their critical thinking abilities (Alessio, 2004).

Group work is a mainstay of PBL and helps with the reflection process because some undergraduate students may lack life experiences or may not have discipline-specific professional experience. PBL also helps students develop a sense of community, and, as they progress through the curriculum in a group, they become comfortable with one another making it easier for them to express many out-of-the-box suggestions without fear of being rejected (Agbeh, 2014; Bate et al. 2014). Ultimately both the individual and the group benefits from their shared experiences, further reinforcing their future as lifelong learners.

Course redesign using Fink's backward design framework

We redesigned the select Health Sciences courses primarily using Dee Fink's model for creating significant learning experiences using backward design (Fink, 2013). First, we identified the results desired in the Student Learning Outcomes. Next we incorporated the activities that would help us in measuring these outcomes (Assignments). Finally, we incorporated acceptable levels of evidence that would support that student learning has occurred (Assessment). Since students take the three Health Sciences courses one after another (with earlier courses as prerequisites for the subsequent ones), we redesigned the courses such that skills will be Introduced in the first course, Developed/Practiced in the second course and Mastered in the third course in the series. As shown in Table 2 and Table 3, the three main skills we focused on were: Critical Thinking skills, Research and Writing skills, and Teamwork Skills.

Table 2. Progression of Skills in the 3 Health Science Courses

Course	Health Systems	Health Policy	Health Law
Progression of Skills	→	→	→
	Introduce	Develop	Master
Health Care Content	Identify Common and/or Well-Defined Problems in the Health Care Context	Analyze and Solve Common and/or Well-Defined Problems in the Health Care Context	Analyze and Solve Uncommon and/or Ill Defined Problems in the Health Care Context
Research & Writing	Learn and Practice Basic Research Skills	Conduct Basic Legal and Policy Research	Independently Conduct Legal and Policy Research
Teamwork	Work Effectively in Teams	Work Collaboratively in Teams	Work Seamlessly in Teams

Our goal was to ensure that when students in the Health Sciences program complete the third course in the 3-part series (i.e. Health Law), they should be able to analyze and propose solutions to uncommon and complex health care problems presented to them. These problems are often ill-defined with many causative factors and generally, solutions to these problems have unintended consequences. Analyzing these *ill-defined* problems requires higher-order critical thinking and problem-solving skills. Working backwards, we designed the Health Policy course such that students were able to hone their critical thinking skills by developing experience in analyzing and solving *well-defined* problems in health care.

Similarly, in the Health Care systems course, the first in the series, students were expected to be able to *identify* common problems in health care. When we implemented problem-based learning in these courses, we realized that students, especially those in the introductory Health Systems course were unprepared and did not have a good learning experience. As this was their first exposure to problem-based learning techniques, they were constantly anxious about the open-ended format of the course. While PBL alone can be effective, it can be challenging for both students and faculty who have predominantly experienced the didactic method of instruction. So, we decided to use a case-based approach first and then transition students to PBL. There are two important reasons for doing this. First, case-based learning helps to break down complex material into manageable parts. Second, it fosters critical thinking and pushes students towards the path of problem-solving (our overarching goal). Hence, in the Health Care systems and Health Policy course we used case-based teaching to discuss complex real-world scenarios in class, so students can develop analytical and critical thinking skills. We introduced PBL strategies in the Health Care Law course.

We also expected that by the end of the third course (Health Law), students should be able to work seamlessly in teams and also *independently* conduct basic research required to complete their writing deliverable. Using this as a benchmark, we designed the courses such that there is greater instructor involvement and handholding in the introductory course, with greater student independence in the final course. For example, in the Health Care Systems course, for the main writing component (Literature Review), we scaffolded the deliverables such that students receive feedback on their research strategy, outline, annotated bibliography and their literature review draft

before the final submission is due. Instructors also "check-in" weekly or bi-weekly with teams in class to ensure effective team communication. In the Health Policy course, for the main writing component (Policy Memo), students are encouraged to use scaffolding techniques for completing the policy memo, and instructor feedback is provided only for the full draft. The onus is also on team members to meet regularly and to resolve conflicts with limited instructor involvement. We believe that this method better prepares students to complete both the team project and research paper in Health Law course, the final course in the series.

Table 3. Student Activities in the 3 Health Science Courses

Course	Health Systems	Health Policy	Health Law
	Case based learning →	Case-based learning →	PBL
Content Delivery & Assimilation	Lecture, reflective journals, project-based learning	Group discussions, Reflective journals, case-based learning	Problem-based learning
Research & Writing	Literature Review	Policy Memo	Research Paper
Teamwork	2 presentations	2 presentations	Panel discussion

An Example: PBL in the Health Law class

In the last class of the series, Health Law, we started with Fink's initial phase and determined the situational factors for the course; the learning goals, the appropriate learning and teaching activities; to properly situate the course in the field, and to determine the activities and structure for the course. We outlined the situational factors that were important, including the state of the field, employer expectations, and student and teacher characteristics (Fink, 2013). In discussions with employers and a review of the field, we determined which problem-solving skills and team work skills were particularly important. In some cases, team work skills were more important than subject-matter knowledge. With this information, we were able to work backwards in the sequence of courses to ensure that students had opportunities to practice and master these skills.

In the Health Law class, each student worked on a research topic and spent the quarter answering the problem given within the context of health law and ethics. In class, the instructor answered questions posed by students and walked students through other cases to demonstrate and reinforce the approach to problem-solving. One research project example was the following, "Laura is 16 years old. She comes to your office to have her wisdom teeth removed. This procedure requires anesthesia. Laura's mother completes the intake forms and informed consent documents for Laura. She marks "Not pregnant" on the form. Once Laura is in the chair and you are preparing to administer the anesthesia, she says to you "I think I am pregnant." What are the legal and ethical implications here? What do you do?" The student given this problem identified the key issues to formulate a response. What are the medical implications for performing oral surgery on a pregnant patient? To whom does the physician owe a duty? Who can consent? What are the state laws around medical decision-making for minors? What are the state laws for reproductive decision-making? As the student worked to develop an answer to this question, the instructor reviewed different laws and ethical theories in health care and explored their application. The student also concomitantly worked with the team in the application of issues to problems. See Table 3 to compare assignments and approaches.

Specification Grading for Assessment

We made a significant change in our approach to grading in the 3 classes by replacing the traditional system of points-based grading with specification grading. Specification grading is an approach to assessment that emphasizes students "getting it right" rather than points and grades themselves. The goal of specification grading is to successfully meet the objectives of a course and it grades course performance based on a student's ability to complete these objectives (Nilson & Stanny, 2015). In this approach the instructor does not award points for how well or poorly an assignment is completed. Instead, the focus is on whether students complete a set of specifications. These specifications detail to students what they must accomplish to earn an A, B, C or D in the course. Only when a student meets all the specifications does the student get credit for the assignment. The student gets multiple attempts to complete the assignment, meet the specifications and improve the deliverable in each step.

In setting the specifications for the Health Sciences courses, we ensured that the specifications for the lowest passing grade (i.e. C) demonstrated that students have learned the fundamentals of the course. Nilson and Stanny (2015) mention that this is especially critical, when a course is part of a sequence of courses, where, it is important to demonstrate understanding of a set of baseline skills successfully before moving to the next course. Likewise, students earning an A in the course have demonstrated competency in course objectives.

Results

Since grades are a widely accepted measure of the student's academic performance, we chose to use grades as the metric to evaluate the initial success of our redesign. Since we used specification grading, we also had greater confidence in the use of grades as a measure of assessment. While there are still issues with the use of grades for assessment, in this case, we believe that the use was appropriate. Here we present quantitative and descriptive data on student grades. As mentioned earlier, the data presented here was obtained from CSUEB's Institutional Data Center. Student grades for each of the 3 courses: Health Systems, Health Policy and Health Law were compiled for each quarter, Fall-2012 though Summer-2016. The course redesign and transformation were piloted in Summer-2015 and fully implemented from Fall-2015 onward.

Table 4. Grade distribution of students, post-redesign (Summer 2015- Summer 2016)

	Health Systems	Health Policy	Health Law	All 3 courses combined)
N	519	528	408	1454
% Passing Grade (A-C)	86%	90%	87%	87%
% Failures (C- and below)	6%	7%	9%	7%
% Other (Withdrawal/Withdrawal Unauthorized)	8%	3%	4%	5%

As seen in Table 4, the percentage of students failing any of the 3 classes under consideration dropped from 11 percent to 7 percent. When examined separately, we find that for the introductory Health Systems course, the percent of students failing course decreased by 4 percentage points. Similarly, in the next course in the series, Health Policy, failure rates decreased 4 percent post-redesign. These numbers are encouraging and suggest that students are receptive to the course redesign, which further correlate with better student learning outcomes. In contrast, for the course Health Law, the failure rates have increased by 1 percent in comparison to the failure rates prior to course redesign. Closer examination revealed that the higher failure rate was due to one section of the class. While the overall percent of withdrawals from the 3 courses combined has seen a slight increase, Health Systems course in particular has shown a large increase in the percent of withdrawals from 3 percent pre-redesign to 8 percent post-redesign. We believe that this is primarily due to the timing when students take this course in the curriculum. The Health Systems class is one of the first classes in the Health Science curriculum to introduce health care content through case-based learning and requires that students complete a writing assignment and work in teams. It is likely that students find it difficult to adjust to the new framework of this classes, or it is indicative of challenges faced by students are they juggle work, family, and other personal problems along with course work. Nevertheless, our approach in modifying the select classes using an overarching PBL framework, through varied written assignments and team work helped in decreasing failure rates and bottlenecks in enrollment one year post-redesign.

Limitations

There are several limitations to this study. One of the foremost is that it uses student grades to determine success/failure in a course. A better way to capture success or failure in a course would be to measure the critical thinking of students via qualitative methods or by a combination of grade distribution and qualitative methods. This study also relies on descriptive measures rather than statistical significance of the data presented. We have also not stratified student data by demographics to determine associations with failure rates. It is likely that students' grades were influenced by challenges that students face outside the classroom settings.

Implications

The results have implications for our program and for students. First, we were previously unaware of the level of variability of grade distributions in course sections. We considered this grade variability unfair and following this study, have received another grant to standardize syllabi across sections and are investigating grade variability in other program courses. This variability suggests the need for additional and on-going training and collaboration among the faculty; particularly lecturers and other part-time faculty. Second, this approach to the classes is resource-intensive. Course caps were reduced and significant resources were expended to train part-time faculty and lecturers in this approach. Many contingent faculty found the training and implementation demands for the course daunting. Finally, while the changes were effective overall and resulted in improved student outcomes, a modified PBL approach may be difficult to implement and maintain in such a few number of courses. Overall, the experience has influenced our approach to the upcoming transition to a semester schedule as our entire program is being transformed to a case-based and problem-based approach.

Conclusion

PBL prepares students for their future careers by introducing them to problem-solving skills. Instructors though must expend time and effort to ensure that their undergraduate students are, at the very least, gradually introduced to this method of learning. Being suddenly faced with PBL has been proven to cause apprehension, unnecessary anxieties and ultimately, failure. Different researchers have found that the level of self-confidence, social-skills, students' individual buy-in, an inviting group atmosphere, advanced study skills, social class and first-generation university students, all affect the success of students achieving flexible, critical thinking skills (Chesser-Smyth & Long, 2012; Dolmans et al., 2005; Hemlo-Silver, 2004; Jury et al., 2014). Our approach relies on a three-part series of courses that slowly move students from more passive learning to more active learning styles that transition into more individual problem-solving. This approach allows student to slowly improve and to build the confidence to solve problems on their own in a supportive setting.

Students should leave their campuses with more than just a diploma. Exposing them to PBL experiences prepares them for the demands of the real world and will help them to succeed in their future fields. The health care field is evolving and the subject matter that students learn rapidly becomes outdated. For example, the health care system in the United States has radically changed with the passage of the Patient Protection and Affordable Care Act. ("ACA"). The ACA rendered the subject matter in many of our courses outdated almost "overnight". Graduates from our program in 2006 working in health care are now faced with health and policy issues unimagined in 2006. For example, the growing debate about outcome-based reimbursement is now a critical policy issue that we would not have imagined ten years ago and hence would not have covered it in classes at that time. When student learning is focused only on subject-matter content, they would not have the opportunity to prepare for a highly-changing field. By shifting the focus to problem-solving, critical thinking, and team work, we give our students the skills to learn on their own and the confidence to face currently undefined challenges in the health care system.

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Looping and Attachment in Early Childhood Education: How the Applications of Epigenetics Demand a Change

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Abstract: Increasing focus on the quality of childcare and Pre-K is calling attention to the circumstances of childcare and impact on the child's social and emotional health, specifically in terms of attachment. The early childhood profession recognizes that consistency in caregiving is essential for the child's attachment. Looping, the practice of keeping a group of children with the same teacher for more than year, has the potential to provide that consistency that is critical for attachment. The field of epigenetics and its compelling findings concerning attachment demand a second look at looping and how it can be implemented to maintain attachment, which is critical to the child's physical, cognitive, and emotional health now and in the future. This case study, conducted at a preschool that practices looping, examines the benefits and challenges of looping through the lens of applied epigenetics.

Keywords: Case Study; Early Childhood Education; Looping; Attachment

The education of our youngest children, ages 0-5, has come to the forefront. The consistently high number of children in childcare and the current expansion of preschool programs through the Universal Pre-Kindergarten movement only focuses more attention on the importance of early education. As preschool and childcare are being recognized as the first stage in the formal educational system in this country, it is imperative to examine the circumstances of childcare and impact on the child's social and emotional health, specifically in terms of attachment. Institutions of higher education are involved in research around these topics and preparing future educators, but there exists little emphasis on the impact of attachment or how the traditional early childhood classroom can be re-conceptualized.

A child's experience in childcare or preschool represents the first experience away from home with an alternate caregiver. Some children experience this transition as young as 6 weeks old, before attachment is fully developed. Consistency in caregiving is essential for the child's attachment (Bowlby, 1988; Goldberg, Muir & Kerr 2013; NAEYC, 2015). Looping, the practice of keeping a group of children with the same teacher for more than a year, has the potential to provide a consistent caregiver during the young child's critical period of attachment and emotional development. Looping, the classroom practice that builds on attachment and continuity of care, has been examined in the literature, but not practiced in a widespread fashion in the United States, nor given adequate attention in teacher preparation programs in colleges and universities (Lab at Brown University, 1997). The field of epigenetics and its compelling findings in regard to attachment demand a second look at looping and how it can be implemented to maintain attachment, which is critical to the child's physical, cognitive, and emotional health now and in the future. This case study examines the benefits and challenges of looping through the lens of the

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burgeoning field of epigenetics, which deserves attention from practitioners in the field, as well as those in higher education who are responsible for training the next generation of teachers.

Looping in Early Childhood Education

Looping, also known as "continuous learning," "continuity of care," "continuous progress," or "persisting groups," is the practice of keeping the same caregiver or teacher with a group of children for two to three years (Grant, Johnson and Richardson, 1996; Lab at Brown University, 1997). This practice originated in Waldorf schools in Europe over a century ago and is still quite common in Europe. There have been scattered applications in the United States, most notably Deborah Meier in New York City during the 1970s and in private Waldorf and Reggio Emilia Schools. In the 1990s, there was a rediscovery and interest in looping in American schools, but overall, has it has been practiced sparingly in the United States (Lab at Brown University, 1997). Looping usually groups children of the same age, but has been used in multi-age classrooms, especially in Montessori schools. The practice of looping stresses long-term relationships, so students of the same age group remain with the same teacher for more than one school year, while multi-age classrooms may have a different teacher year after year (Hanson, 1995; Hegde & Cassidy, 2004). Many schools considering a multi-age program view looping as a first step. This study will focus on a school that practices both looping and multi-age grouping, both intentionally and as a consequence of the circumstances. Overall, looping has been underutilized in the United States, despite the compelling evidence of its benefits.

The literature on looping, which is largely qualitative, supports the process and identifies several advantages for students, parents, and teachers. The most obvious and powerful benefit is the existence of consistent and long-term relationships between students, teachers, and parents (Brebner et. al, 2015; Chirichillo, 2001; Lab at Brown University, 1997; Thomas, 2014). Hegde and Cassidy (2004) examined parent and teacher perspectives on looping, finding that the advantages were clear: stability and continuity of care, ease in transition year to year, anticipating children's needs, and increased parent friendships and networking. Looping provides children with additional time to build the trust and relationships on which much of children's learning depends (Haslinger, Kelly, & O'Lare, 1996; Lincoln, 1997). Children develop stronger social bonds with their peers, are better able to resolve conflicts and are more skillful in working as team members to solve problems (Hanson, 1995). Looping can turn parents into supporters and promotes stronger bonding between parents and teachers (Hegde & Cassidy, 2004). In short, the practice of looping "exemplifies the importance of bonding, attachment and security between a child and a teacher and increased communication and trust between parents and teachers" (Hegde & Cassidy, 2004, p.133).

In addition to relationships, looping has academic benefits. The practice essentially adds an extra month of teaching and learning time during the second year when the typical transitional period at the beginning of the year is virtually unnecessary (Hanson, 1995; Burke, 1996). There is less time spent learning names, becoming familiar with rules and procedures, and assessing the child academically and developmentally. In addition, teacher knowledge about a child's strengths and weaknesses increases in a way that is impossible to achieve in a single year (Lab at Brown 1997). This deeper knowledge about students allows teachers to anticipate behavior, resulting in fewer behavioral challenges (Minkel, 2015). With looping, a teacher can implement a more coherent instructional plan appropriate to the child's development (Grant, et al., 1996). Teachers report that moving a level ahead with their students promotes teacher innovation and keeps

teachers motivated (Hegde & Cassidy, 2004). A teacher who practices looping describes the transformation (Minkel, 2015, para. 41-42):

> Every time I loop, I see boys who were angry and mean become calm and gentle. I see once-timid girls become confident and assertive. I also see a community of 25 students become more than the sum of its parts. I witness that annual alchemy of personalities, interests, and talents working its gradual magic. The children become better readers, writers, thinkers, artists, scientists, and mathematicians, and I become a better teacher.

The case against looping, and perhaps the reasons why the practice has not become widespread in the United States, has few points, but they are compelling (Hegde & Cassidy, 2004; Thomas, 2014). The persistence of negative relationships over the course of two or three years is a major impediment. If any of the relationships between teacher, parents, and students are strained, it could just become worse with time. Teachers also report that adapting to range of grade levels can be challenging, especially when they prefer a certain age group (Hegde & Cassidy, 2004). These challenges are dependent upon individual preferences and personalities and perhaps can be dealt with as exceptions to the general rule. The logistical challenge to looping, especially in early childhood education, is the high rate of turnover among teachers, which is more than 30% for all teaching staff in early childhood setting (Porter, 2012). Administrators considering the use of looping must be certain that the teacher will be at the school for at least two years, which is not always a given. As a result, looping exists in the shadows of the educational system, both in schools and in college programs that prepare teachers. In fact, a recent study found that teachers report an overall lack of knowledge and information regarding the practice of looping in early childhood public education (Thomas, 2014).

This study focuses on the relational benefits of looping, specifically in terms of attachment for young children, ages 0-5. Looping is especially important for young children, whose social emotional foundation is being built through attachments with parents and caregivers. Looping is consistent with the NAEYC philosophy, specifically, that children's healthy brain development is improved by attachment and a sense of belonging, and fostering positive relationships with children is a goal (Jacobs, 2012). A secure attachment between the caregiver and relates to other areas of development, areas such as social- emotional development, cognitive development and language development (Bowlby, 1988; Goldberg, Muir & Kerr, 2013; Hegde and Cassidy, 2004; Murgatroyd & Spengler, 2011). Previous studies, such as Bowlby's landmark attachment theory (1953, 1988) and Hegde & Cassidy's study (2004), alluded to the relationship between attachment, which is promoted through looping, and healthy development, but we now know this as a certainty, thanks to the recent discoveries in epigenetics. These recent scientific findings (Dube, et. al, 2003; Lieberman & Knorr, 2007; Murgatroyd & Spengler, 2011; Scaer, 2005; Thomson, 2007) provide evidence linking early experiences and stressors to physical and emotional problems and cite a solid base of attachment as a preventative measure. Even with these compelling findings, "current childcare center policies and practices for transitioning children in and out of classrooms seem to be at odds with current research on attachment, continuity, and the development of peer relationships" (Groot, 2010, p. 153). The future does not look any different, since teacher preparation programs in institutions of higher education do little to bring these findings to the forefront of their curriculum.

How the Field of Epigenetics Has Magnified the Importance of Attachment

It is commonly accepted that a major benefit of looping is the opportunity for continuous relationships between teachers, children, and families. This is especially important for young children, ages 0-5, whose attachments are still forming. In fact, early attachment theory (Bowlby 1953, 1988) defined the critical attachment period as the first two years of life. Many young children are in childcare centers well before two years old. Not only is the attachment with the parent disrupted, but the possibility for forming an alternate attachment with a teacher is not likely in childcare centers with a high staff turnover rate and thus, no continuity of caregiver (Porter, 2012). Recent findings in the field of epigenetics call attention to the importance of attachment and demand a change in how childcare is managed for our youngest children.

Epigenetics is the "newly emerging branch of biology that deals with the effects of external influences on gene expression…at the biological level, this is where nature and nurture become indistinguishable" (Karr-Morse and Wiley, 2012, p. 152). To non-scientists, this means that environmental forces can alter DNA, as well as current and future health. Karr-Morse and Wiley (2012) examine the explosion of epigenetic literature in recent years, focusing on "the role of early emotions in shaping the organization of the central nervous, endocrine, and immune systems and the physical mechanisms that render children particularly vulnerable to the effects of fear and trauma" (p. xvi). Persistent patterns of negative emotions, like fear, in young children, particularly under 5 years old, renders the developing nervous system more vulnerable to trauma and disease now and even later in life. The effects of this trauma has been linked to physical diseases like cancer, diabetes, heart disease, and asthma, as well as psychological issues such as addiction, emotional health, depression, schizophrenia, Alzheimer's, and autism (Karr-Morse & Wiley, 2012).

How, exactly, do negative emotions as a young child result in these serious disorders? When a child feels fear, ephemeral sensations we call 'feelings,' our emotions, fuel the stress response in our brains, causing changes in the autonomic nervous system and physical changes (Karr-Morse & Wiley, 2012, p.19). Sometimes, this fear is so extreme or persistent and is accompanied by a state of perceived helplessness it becomes traumatic. Often times, diseases result from chronic perceptions of helplessness and hopelessness added to toxic stress, leading to the overstimulation of the autonomic nervous system (Murgatroyd & Spengler, 2011). All children experience a series of "little traumas" – not cataclysmic events – but they have the same effect, setting up a lifelong course of systemic dysregulation (Scaer, 2005). These "little traumas" begin before birth, including stress in utero related to the mother's undernutrition, malnutrition, and toxins in the womb (Karr-Morse & Wiley, 2012, p. 66). Even a mother's stress during pregnancy results in "maternal cortisol directly transported across placenta and enters fetal system through the exchange of blood" (p. 65). It is clear that prenatal stressors have implications in terms of early brain development.

Upon birth, there are more possibilities for these "little traumas," including prematurity and the resulting physical strain on the infant's body, difficult or traumatic births, and intrusive medical intervention, like forceps and induction. "From the last trimester of gestation to age two, we experience the most rapid brain growth of our lifetime. This growth is not entirely symmetrical. The emotional right brain undergoes a growth spurt in the first two years of life…and dominated development through the end of the child's third year, when spoken language begins to flourish and stimulate growth on the left side" (Karr-Morse & Wiley, 2012, p. 209). Thus, these newborns are especially sensitive to effects on their social and emotional development. Thomson (2007)

notes that much of what we consider as problems resulting from neonatal experience is actually a reflection of life in the womb.

During infancy, toddlerhood, and leading up to age five, there is an "emotional vulnerability of the immature system that is so overlooked in our culture" (Karr-Morse & Wiley, 2012, p. 97). The widely held opinion about young children is that trauma experienced at a young age is "erased over time, lost in the fog of early experience" (p. 92). This is simply not true. The brains of young children are particularly tuned to both positive and negative emotions in surroundings. Lieberman notes that "one of the most important findings over the last 30 years is that there is no such thing as a baby not noticing what is happening" (cited in Karr-Morse & Wiley, 2012, p. 103).

It follows that to prevent the negative effects of stress on the child's developing and fragile system, there should be a solid, consistent, base of attachment. The importance of attachment is not new, going back to foundational studies conducted by Bowlby (1953, 1988). However, recent findings based on the implications of epigenetics amplify the call to prioritize the child's need for attachment, especially in settings outside of the home. The main caregivers are responsible for the "blueprint for baby's own emotional regulations and future expectations of relationships" (Karr-Morse & Wiley, 2012, p. 98). In fact, inconsistent caregiving or early separation from a caregiver (in most cases the mother) is in fact a traumatic event, and has had negative effects (Karr-Morse & Wiley, 2012). Lieberman (2007) defines trauma as anything that results in the disruption of the 'secure base' – essentially any experience that seriously disrupts the physical and emotional balance and security provided by the child's primary relationship with an adult, typically the mother."

The traumas that disrupt the secure base are numerous – ranging from abusive parents, depressed or emotionally distant parents, repeated medical intervention, adoption, foster care, divorce, death of a parent, absent parents, stress in the home, and yes, even child care. This is a controversial topic, but through this lens, leaving the consistent attachment of a parent to attend a center outside of the home is a "little trauma." As Karr-Morse and Wiley (2012) explain:

> A securely attached baby who has been well attended by a sensitive and responsive caregiver may continue to cry and exhibit distress at separation from the mother, but by around six months of age will have about the same baseline cortisol levels in the alternative care setting as those at home. For insecurely attached children, by contrast, even minor emotional challenges raise cortisol levels (p. 112).

Certainly, childcare is not the villain. Out of home childcare is a crucial support for families – and one that is only increasing in need and use. It is a necessity, with ¾ mothers with children under six working 30+ hours a week (Karr-Morse & Wiley, 2012, p. 121). The problem is how it is practiced and implemented has not caught up to what we know about what children need for optimal development. Childcare, what should be the foundation of our nation's educational system, still lacks the standards and public support it deserves and the education, training, and salaries of the childcare workers remain subpar (Porter, 2012). As a result, many children are being traumatized and re-traumatized by the gap between what we know and what we do (Karr-Morse & Wiley, 2012). There are some troubling findings regarding how child care, particularly longer hours at a younger age, affects quality of attunement and attachment. More hours in child care

correlate to higher rates of aggression among kindergarteners, more aggressive and disobedient behavior through grade 6 (Karr-Morse and Wiley, 2012). Although high quality care has some cognitive benefits at 54 months of age, quality - not quantity - produces constructive results (p. 116).

The main contribution of applied epigenetics to the discussion on childcare and early education is that attachment really matters, as Bowlby (1953) first recognized over a half-century ago. Early childhood trauma can lead to an array of negative health outcomes and behaviors, the effects of which can last a lifetime (Dube, et al., 2003; Murgatroyd & Spengler, 2011). Of course, we cannot control the trauma, some horrific, that young children experience in their own homes, but secure attachment and positive relationships are critical to offset some of these negative influences. We have all had little traumas in our childhoods, but a strong remedy is "just one key relationship – just one person who is available to the child over time, who sees the [child] as valuable, and who communicates that feeling – can make all the difference in how later stress or trauma affect's the child's future" (Karr-Morse & Wiley, 2012, p. 189). These key relationships are often found with teachers, the adults with whom children spend the most time outside of the home.

Perhaps, even if infants and toddlers did not have a positive attachment period, there is hope if there were a long-term relationship with a teacher in a childcare center or school that practices looping. Within the context of a safe, familiar environment with a steady caregiver, attachment can form, which leads to self-regulation, and ultimately maintaining physical, cognitive, and emotional health. "Because self-regulation begins with the physiological regulation of the infant by an adult and because the process is built into the baby's brain, and because it shapes behavior and health for a lifetime, attunement and secure attachment are among the most crucial skills to protect within our families" (Karr-Morse & Wiley, 2012, p. 212). This process of gradually learned emotional connectedness to other people – or the failure of that process – begins with the family. However, with more families relying on childcare and some families with too many distractions and stressors, this responsibility falls on the childcare and early education institutions. It is time for us to recognize the important role that early educators play in facilitating and maintaining secure attachments, which generate stunning physical consequences that affect not only individual well-being but also familial, community, national and world health" (Karr-Morse & Wiley, 2012, p. 194). Looping is a first step in meeting this critical need for healthy attachment of our youngest children and should be part of the conversation in schools, private child care centers, preschools, colleges, and universities.

A Case Study in Looping: Millcreek School

Millcreek School (Note: the school and all personal names used are pseudonyms) is a private preschool located in the northeastern United States. Millcreek has a history of being family-oriented. A small group of friends who were trained abroad in Montessori methods founded the school eight years ago. Although there have been setbacks - namely, the untimely death of one of the founders, some contention between the remaining owners, and declining enrollment - the school has survived. Millcreek is private and financially supported through tuition. Although the tuition at Millcreek is among the lowest for Montessori schools in the region and comparable to other private preschools in the area, it is out of reach for many of the families in the county. Similar Montessori schools in the city have tuition three times the rate at Millcreek. Millcreek has not raised the tuition in four years and has a program in place to assist presently enrolled families under financial strain. Even so, enrollment has dropped from an all-time high of 38 children to a

current low of 13 students. As a result, two teachers and an assistant have been laid off, and the school is operating with a restricted budget.

At the time of this study, the student body was composed of four females and nine males, ranging in age from 2.5 to 6 years old. Consistent with the Montessori model of multi-age grouping and the practice of looping, the children are grouped together with the same teachers in this two-room school for the entire duration of their schooling, typically 2-3 years, even when the school had more enrollment and staff. The director manages the administrative aspects of the school on a part-time basis but is rarely on-site. There are three female teachers: one head teacher, Ms. Beth, who is Montessori-certified, and two part-time assistants, Ms. Sue (a parent) and Ms. Ann (a parent of a Millcreek graduate), both of whom have backgrounds in the field of Education and share the position as volunteer assistant.

Since Millcreek adheres to a specific curricular model, it is important to understand the classroom setting, which is quite distinct from other preschool curricula. The Montessori model is known for its emphasis on independent learning and a supportive community. The Montessori model is highly individualized and encourages independence, so children work at their own pace, which is a major benefit of multi-age grouping. Children choose their own "work," so they feel a sense of ownership and control over their learning. The materials are designed for a developmental progression in five areas of Montessori education: language, practical life, mathematics, sensorial, and geography/cultural studies (American Montessori Society, 2015). During the long "work" period (2-3 hours), the teacher interacts individually with children on their progress in various areas. The day also consists of group "circle time" and social time at recess and lunch. The Montessori program at Millcreek has impressive results. Last year, 90% of the graduating preschoolers (4-5 year-olds) at Millcreek were already at a Kindergarten reading level or higher. Traditional academic skills are not the only focus of learning. Teachers emphasize the development of social and emotional skills and integrate themes of sustainability, active lifestyles, and healthy eating throughout the year. The well-rounded approach to learning considers the development of the whole child.

Most relevant to this study, the Montessori philosophy encourages social and emotional development and values relationships. Children begin at Millcreek at age 2.5 to 3 years old and stay with the same teacher and peers until leaving at age five or six. Because Millcreek exemplifies the practices of both looping and multi-age grouping, it is an interesting case study, especially in light of applied epigenetics research.

Methodology

The case study employs an inductive participatory action research approach to examine the implementation, benefits, and challenges associated with looping in a preschool setting. The case study as a qualitative method is appropriate for inductive, exploratory research that can then be used to formulate more specific questions or identify trends (Creswell, 2013; Yin, 2013). The case study is inductive since it begins with two general research questions: "How does this preschool program use looping? What are the benefits and challenges associated with looping, as viewed through the lens of applied epigenetics?"

During eight months of data collection, institutional background information and data were collected first. Then, interviews of the 3 teachers and 18 parents (at least one parent of each child) were conducted at the school, before and after school hours at the parents' convenience. (Interview Protocol is located in Appendix A). The focus of the interview was the parents' perceptions of their experiences at Millcreek, specifically their role as partners in their child's education and their

observations of their own child's progress. Classroom observation occurred 48 times. In addition, observation included 12 family events and meetings outside of school hours. Observations were general at first, then focused more specifically, as coding themes emerged from the data. A memorandum of understanding between the school and researcher was approved, and IRB approval was obtained.

The particular qualitative approach utilized was participant observation, in which the researcher collected data on naturally occurring behaviors in their usual contexts, in this case, the daily interactions in the Millcreek school. Three forms of data were triangulated to establish themes: observations at the school, interviews with teachers and parents, and documents from the school and surrounding community, including demographic data and institutional records. The discussions from the interviews were audio recorded and transcribed. Observations were documented with the observer's notes. All data collection and analysis was personally conducted by the principal investigator. To assure consistency and trustworthiness, observation criteria was stipulated and a thoughtful set of questions was used with at least one parent of every child at Millcreek, ensuring diversity of perspectives and information-rich sampling. The qualitative data was then systematically coded and analyzed to find similar themes from all three sources: the institutional documentation, the interviews, and the observations. During the course of exploring this data, open coding was used to identify three general themes: how looping was implemented; the benefits; the challenges. Once these themes were established, axial coding was used to investigate the connections between the evidence and provide many sub-categories of these three themes. At the conclusion of data analysis, member checks were conducted with the teacher, the director, and most of the parents to ensure that the findings were sound and credible. The methodology of qualitative participant observation over eight months, as well as the interviews, allowed for a nuanced and detailed examination of the research question.

Findings: How Looping Works, Benefits, and Challenges

Millcreek teachers made a decision to practice looping when the school was established and had two classrooms. Now, with decreased enrollment, looping is practiced out of necessity. This is a small school with few teachers. Ms. Beth and her two assistants taught the one and only class in the school. Children started the program at about 3 years old and stayed with the same class and teachers until they were 5 or 6 years old. Of the 13 children involved in the study, 11 began at Millcreek between 2.5 and 3.5 years old and stayed for two or more years. Two students from this group stayed 3 years, as they completed the Kindergarten year at Millcreek. The other two students started later, only staying for one year before entering public school kindergarten. On average, this class of students stayed in a consistent setting with the same teachers for 2.4 years.

This is not to imply that over the course of these years the experience was the same for the students. The roles of the children changed over time. Younger children (2.5 to 4 years old) are welcomed and oriented into the program. There is a lot of observing older children and exploring. The older children (4 -6 years old) become the teachers and role models for the younger students. They have more responsibility and do more advanced "work" that builds upon the work of the first year.

A typical day at Millcreek began with parents bringing the children at 9:00a.m. The assistants took the children to find "work" while Ms. Beth talked with every parent. This drop-off time was a valuable opportunity for parent communication and did much to build the relationships between teacher and parents. Ms. Beth described this as "a necessary part of what we do in Montessori education. It also makes it much easier to bring up issues when you feel comfortable

with the parents." Indeed, problems could be handled immediately, instead of waiting for a phone call or conference. The observations revealed many topics covered during these daily chats. Parents asked questions, updated the teacher on situations at home, and just chatted socially. Many conversations extended to topics beyond the classroom. Then, the class would join for morning circle between 9:30-9:45a.m. This was a time to welcome the children, do the calendar, and introduce new concepts or work for the day. Often, the older children would dominate the conversations, while the younger children watched or squirmed. From 9:45-12:00, the children were engaged in an extended work period. During this time, consistent with Montessori methods, the children were expected to choose their own work and initiate learning. Teachers would engage in individual "lessons" appropriate for their developmental level and in sequence with the Montessori planes of development. The younger children focused on basic lessons like practical life, pouring, sweeping, basic motoric skills, and fundamental numeric and phonetic concepts. The older children had more advanced lessons involving reading, operations, complex problem-solving, and exploration of new concepts. Often, an older child was observed approaching a struggling young child to model the work that s/he had already mastered. This type of peer learning reinforced what the teachers were doing. The remainder of the day consisted of lunch, another circle time with story read aloud, and outdoor exploration time until parents returned at 2:00p.m. Throughout the days, the growing level of comfort between the children and the teacher was obvious.

Benefits of Building Relationships, Extended Learning, and Family Support

Although the general category of "benefits," was a starting point in the research questions and initial data gathering, it soon became apparent that the benefits were complex and intertwined. One of the most notable benefits of looping is the consistent relationships with students and families over time. Hegde & Cassidy (2004) found that "teachers felt that being with the children over time as their primary caregivers was essentially advantageous and beneficial to these young children. The continuity allowed these children to feel more secure and stable. Further, in many ways this led to building a more secure and a trustworthy relationship between the teacher and the children" (p. 134). There were many instances observed in which Ms. Beth's knowledge of the children and a trustworthy relationship was apparent. She explained that "getting to know the children during the first few months is important, but it doesn't end there. I watch how they grow and change over time. It helps to know the history of the child when we tackle new things." Indeed, the teachers spent a lot of time during the first few months of school simply observing the younger students to gain a sense of where they were developmentally. They built these relationships by taking the time to speak individually with every child about his/her work or interests. The relationships were visible with the older children. Ms. Beth often made references to the progress of the older children, like 5-year-old Esther when she completed the entire Hundred Board: "I remember when you were three and we counted to 10 together. Now look – you can go to 100 all by yourself!" This level of personal knowledge builds trust and consistency, which is essential for social and emotional development. Looping provides children with additional time to build the relationships on which much of children's learning depends (Haslinger, Kelly, & O'Lare, 1996; Lincoln, 1997).

These relationships were especially important for children who were experiencing significant stress at home, as in one notable case. Leon was a 4-year-old boy who just started the school and had a severe speech delay. He was impulsive, and many children did not understand him, which often led to frustration. One day during his third month of school, he was particularly disruptive, and when redirected, he threw his work across the room and stomped away, refusing

to rejoin the class activities. Ms. Beth told Leon's mother about the behavior and explained that she asked Leon to rejoin the class when he was ready and had a discussion with him about appropriate ways to "use his words" and handle his frustration. When Ms. Beth asked the mother if she ever saw this behavior at home, Leon's mother began sobbing, explaining that her husband was deployed to Iraq again and that she was "on her own" with Leon and her 7-year-old daughter, all while trying to work nights as a nurse. She was mentally and physically exhausted and had no energy to deal with Leon's behavior. This conversation, while emotional and painful, built much rapport and allowed Ms. Beth some valuable insight as to the cause of Leon's behavior. Leon's father, the disciplinarian of the family, was now absent, which negatively affected Leon, a significant stressor. Ms. Beth offered empathy and support to the family. She gave Leon's mother an idea of how she and the assistants handled Leon's behavior and encouraged her to try the same at home. Ms. Beth also connected Leon's mother with a babysitter who could help out so she could get some rest! The relationship between Leon's mother and Ms. Beth was strengthened considerably after this event and they could communicate openly about his behavior. In addition, the extra support lent by Ms. Beth went a long way to help Leon through the stress he was experiencing at home. Leon's behavior improved over the course of the next few months, despite the stress at home. This was an example of how the strong relationships built through with a consistent caregiver supported a child and family experiencing stress.

As demonstrated in Leon's case, strong relationships with parents and the children could prevent misbehavior. Ms. Beth and the assistants knew the children so well that they anticipated their behavior. For example, 4-year-old Jay, who was in his second year at Millcreek, was a busy, easily distracted and excitable child. Ms. Beth recognized this pattern and made sure that she did lessons with Jay earlier in the day, when he was more attentive, and made efforts to keep him away from another boy, who had a similar demeanor. In addition, the older children, who knew the rules and expectations, often reminded the younger students what to do. For example, observations revealed two older girls, who the teachers privately referred to as "mother hens," often redirected the younger children, showing them how to sit in circle, how to do their work, or even help with washing hands in the bathroom. This type of peer reinforcement of behavioral expectations reinforced the teacher's message. Indeed, behavioral issues were minimal by the third month of school and those presented were handled quickly and consistently. The level of negativity associated with handling misbehavior was remarkably low because there was a level of attachment and consistency already established between the students and teachers.

Another major benefit is extended learning for both the students and the teachers. In terms of teaching time, looping essentially adds an extra month of teaching/learning time during the second year when the typical transitional period at the beginning of the year is virtually unnecessary (Burke, 1996). The early year observations showed that the teachers started right in with the older children. In fact, one assistant teacher explained it like this: "In September, the focus is always getting the new or young kids on board with the routine and expectations in Montessori. Usually that is less than half of the class. The older kids, who were with us all of last year, just jump right in where they left off in June. It's great – they are so independent." This added academic benefit not only increases learning but builds up the child's confidence in his/her abilities, as learning is viewed as continuous.

It is not only the older children who have extended time to learn, but also the teachers. Teachers recognized another added benefit to looping, a personal benefit that working with a class over time promotes: innovation and professional growth. The teachers could not recycle projects and assignments year after year. Having the same students for two or more years required them to

be creative in planning new work. Ms. Beth explained her system: "For each topic we cover, I have files with many project ideas. Every year, we do something different so the children experience something new each year. Maybe every 4-5 years, I will repeat a project, but this has forced me to stay creative." In addition to innovation, the teachers also benefit by working their skills in handling a range of ages and developmental expectations. One of the assistants new to the school stated, "I think I've become a better teacher this year, definitely better thinking fast on my feet. I've had to deal with 2-year-olds having potty accidents then turn around and help 5-year-olds sort out a sharing conflict. I pretty much feel ready to tackle any problem a toddler or kindergartener can bring." This kind of growth and learning on behalf of the children and the teachers contributed to a sense that everyone was learning together and had extra time to do so, because of foundation of a pre-existing relationship.

Parents also reaped the benefits of looping. Looping can turn parents into supporters and promotes stronger bonding between parents and teachers (Burke 1997; Hegde & Cassidy, 2004). The parent involvement at Millcreek was quite strong, with every family contributing something to the school, whether it was time, supplies, or skills. The eight months of observation, specifically of the new parents at Millcreek, revealed that brief daily updates often evolved into multi-dimensional relationships. In fact, several parents characterized Ms. Beth as not only a teacher, but a friend by the end of the year. The parents overwhelmingly "love" Ms. Beth. As one parent described, "Beth is so special. She has the perfect preschool personality…bubbly and fun, but stern if need be." Ms. Beth made an effort with *every* parent, even those who were not as involved as others. At a summer "painting party," five families (including students and siblings), the director, and the teachers congregated to repaint the bookshelves, furniture, and walls. There was laughing, poking fun, and a real sense that "we were all here to fix up *our* school." This level of commitment is above average, even for preschool, where there is generally a much higher level of volunteering. When asked about this level of commitment, parents cited their relationship with the teachers and the school: "Millcreek is part of our life. [Our son] has been coming here since he was a baby and now he's a big boy." "Ms. Beth is just so much a part of our lives. We know her and trust her and want this school to succeed." Clearly, this level of commitment is rooted in strong relationships, which evolved from the attachment that the consistency that looping provides.

Challenges of Practicality, Good Fit and Adaptation

To be fair, the negative aspects of looping must be acknowledged. The main issues include: practicality, a good fit, and adaptation on the part of the student and the teacher, specifically, the possibility that students would not adapt to change in future grades, and teachers' ability or willingness to adapt to a range of age levels. At Millcreek, there was evidence of a few of these challenges.

The first and most popular complaint about looping is practicality. Millcreek is a small, private school with a dedicated teacher. Circumstances of low enrollment and intentional efforts were made in the decision to practice looping and multi-age grouping. Turnover was not a concern, so the anticipation of having the same teacher for more than a year is practical. This is not the case in every school, especially since the rate of turnover among preschool teachers is quite high (Porter, 2012).

Another challenge is achieving a good fit between teacher and student. If it is not a good match, for whatever reason, looping presents the unintended consequence of the persistence of negative relationships over years. Ms. Beth is well-liked, but there was one notable exception, the mother of 3-year-old Rose. This mother was extremely involved with the school; she started a

parent gardening group and always volunteered. However, about six months into the school year, Rose was having difficulty staying focused and was easily frustrated. Ms. Beth noticed the behavior and asked her mother about routines at home, such as bedtime, eating patterns, and recent changes. Rose's mother asked for Ms. Beth's advice and admitted that she and her husband did not really have a set bedtime for Rose and often, she would stay up until 10:00 or 11:00 p.m. with them. The more Ms. Beth heard about Rose's home life, the more she realized that it was a very disorganized and chaotic environment for a 3-year-old child. Ms. Beth gently suggested ways to institute a routine and why it would benefit Rose. Her mother became very defensive, ended her involvement with the school, and pulled Rose out of school, opting to keep her home until the new school year began. A few weeks before ending her involvement with the school, Rose's mother said in an interview, "I know [Ms. Beth] means well and she is an awesome teacher, but she has no right butting into the way I raise my child." Ms. Beth was saddened by the family's decision and said, "It is not fair to Rose, and I am sorry they made that choice out of anger." Even though Rose's mother sought out Ms. Beth's suggestions on how to handle Rose's behavior, some parents are not open to such advice. In this case, Rose's mother perceived the parenting suggestions negatively, which had an unfortunate effect on Rose and the family's involvement with Millcreek. When asked about the possibility of leaving, Rose's mother said, "I just don't think I can handle this for two more years. Beth overstepped her boundaries and I am the parent." It can be expected that there may be friction between some parents and teachers. In a classroom that utilizes looping, the prospect of staying with the offending teacher for the rest of the year, let alone more than a year, can be troublesome for parents. Perhaps in a school with more than one classroom, there would be an option to move the child.

A last challenge is the notion of adaptation. The child, who has become accustomed to the same teacher over time, must someday face the adjustment to a new teacher. Within the infant and toddler age range, it has been noted that attachment and bonding are essential (Bowlby 1958, 1988; Burke, 1997; Goldberg, Muir & Kerr, 2013). Children need the stability bonding and then can later adapt to new environments and teachers. By age five or six, children enter the transition into concrete operations and become more social. Most have secure attachments are able to adapt quite easily (Bowlby, 1988). In fact, Ms. Beth often asked parents how older siblings, who were Millcreek alumni, were doing. Parents reported in the interviews and to Ms. Beth that their children who entered Kindergarten or 1st grade after Millcreek "adjusted so well" and "jumped right in with no fear." One parent, whose second child recently started public school reported, "She had a great transition into public school. I think Ms. Beth did such a great job of making her feel confident and smart that she was ready for anything. She needed those two years here to grow up, grow into herself, before facing the big school."

In addition to the child's ability to adapt, the teacher must adapt to teaching children of various age ranges. This was not an issue for Ms. Beth, who had a wide range of abilities with children ages 2.5 to 6 years old. She would often pull aside small groups of children with similar abilities and conduct mini-lessons or show new work appropriate to their level. Teachers in looped classrooms must not only be comfortable with the range in ages and abilities, but have time management skills that allow them to work with each group. The teacher's level of comfort with various age groups seems to be a matter of preference, but Ms. Beth and the assistants welcomed the challenges and opportunities of working within a multi-age classroom. This model is a cornerstone of the Montessori model. As Ms. Ann, one of the assistants, described it, "I love the different ages. It is like having a big family here, with big brothers and sisters teaching the younger ones. We [the teachers] get to watch them grow up over the course of a couple years and it's

amazing. They come in as babies and leave us all grown up – and we can say that we were a part of that growth." This sense of achievement certainly seems to contribute to positive morale among the staff. To summarize, Table 1 outlines the specific benefits and challenges associated with looping at Millcreek.

Table 1

Summary of Benefits and Challenges of Looping, ages 2-5

Specific Benefits	**Specific Challenges**
Teacher develops strong relationships with children over time and development, which has social-emotional and learning implications.	Practicality in schools with high staff turnover.
Consistency of relationships allow for open communication about stress at home	Good fit between teacher and child or persistence of negative relationships over time.
Behavior problems are minimal because teachers know what to expect from the children.	The child's ability to transition and adapt to a new teacher/school after spending so long with a familiar teacher.
Extended learning time for older students who do not need transitional time at the beginning of the year.	The teacher's ability to adapt to new age groups and the challenges each presents.
Teachers have opportunities for extended learning by having to be innovative over the years and adapt to different age groups.	
Parents develop bonds with teacher over time, leading to more investment in the school, volunteering, and support of learning at home.	

Implications

The case study at Millcreek is an excellent example of how looping works for this small school. In light of the recent applications of epigenetics and importance of fostering attachment during the early years, looping should be reconsidered as a way to build a meaningful foundation for young children, many of whom do not have such a foundation at home. Given the physical and mental health implications of stress on the developing brains of young children, we should be doing everything we can to build a foundation of secure attachment. "There is much we can do at any age to heal and reduce the cumulative toll of chronic fear and trauma on our health" (Karr-Morse & Wiley, 2012, p. x.). The malleable early childhood years present a golden opportunity to prevent many problems that come as a result of stressors. This study represents an example of how research can shed light on an important, but neglected topic in the field of early childhood education. Although the case study presents limited empirical evidence to support consideration of children's social-emotional well-being in terms of relationships with the caregiving adults in out-of-home care, it is an attempt to bring attention to an important topic that institutions of higher education should be researching further and certainly including in their teacher preparation curriculum.

Of course there are larger social changes that would help immensely, such as better education for parents about their critical role in the development of their child (Bowlby 1988; Dube, et al., 2003; Karr-Morse & Wiley, 2012) and extending maternity leave so that parents have adequate time to properly bond with their babies (Karr-Morse & Wiley 2012; Thompson, 2007), but let us focus our discussion on implications within the realm of education. The applications of epigenetics should raise awareness about the importance of a consistent caregiver, which is rare in the field of childcare, which has very low pay and high turnover (Porter, 2012). Perhaps efforts to raise the status and compensation in the field of early childhood education would result in more teachers like Ms. Beth, who stick with a school for years, providing a consistent teacher year after year. Only with a consistent teacher can looping be practiced (Laboratory at Brown University, 1997). A teacher with the same students over the course of two or three years can build a meaningful relationship with the students and their families. This is especially critical during the early years, infancy through Pre-K. The looping model would require the field of childcare and preschool to reconsider the teacher assigned to only one age group and demand that teachers extend outside of their comfort zones to adapt to the multi-age classroom. It is an undertaking, but well worth the effort, in terms of a child's overall development - academically, socially and emotionally. Only with attention and further research on this topic, which requires cooperation with institutions of higher education, can meaningful change occur.

As preschool becomes integrated with the standard school system in the United States through the Universal Pre-K movement, teachers, administrators, colleges, and universities should consider the potential of looping, especially in light of the findings in epigenetics, which define the malleable nature of the early brain and the critical role of attachment. Looping is one classroom practice that can do much to provide a consistent base of attachment and mitigate the negative effects of stressors that many young children experience.

Appendix A: Interview Protocol for Families

1. Background Information
    a. How long has your child attended Millcreek?
    b. Why did you choose this school for your child's first educational experience?

2. Perception of Relationships at the School
    a. How would you describe your experience at Millcreek?
    b. How do you perceive your child's experience? What are your observations of your child's progress?
    c. How do you feel about your child being with the same teacher for more than a year?
    d. What are the pros and cons of this approach?
    e. How do you view your role as a partner in your child's education?

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