Title page

An e-learning package to support interprofessional education (IPE): A pilot feasibility and efficacy randomized controlled trial in a medical education setting

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Abstract

Background

Inter-professional education (IPE) is one component of the medical education curriculum and there is a growing interest in the use of e-learning to support this area of the curriculum. The aims of this research were to undertake a pilot feasibility and efficacy trial to test the feasibility of undertaking experimental research in a medical education setting and the efficacy of an e-learning intervention (on-line simulation) to support IPE.

Design and methods

The design of the study was a pragmatic pilot trial with a waiting list. The participants were 3rd year medical undergraduate students. The trial involved random allocation to either access or no access to on-line simulations in two strata. The outcome assessments were embedded items in the end-of-year summative exam.

Results

From the year 3 cohort of 407 students, 253 were eligible to participate in the trial and 152 were excluded. For stratum 1, of 162 eligible students, 88 consented, 25 declined and 49 did not respond. For stratum 2, of 91 eligible students, 37 consented, 17 declined and 37 did not respond. For stratum 1, there was no significant difference in performance on the embedded questions between intervention and control groups. The effect size was -0.10, 95% confidence interval -0.52 to 0.33. Similarly, for stratum 2, no significant differences between intervention and control groups were apparent. The effect size was 0.22, confidence interval -0.46 to 0.90. When the results for strata 1 and 2 were combined in a meta-analysis the pooled effect size was -0.01 95% CI -0.36 to 0.35 p =0.98. This indicates no statistically significant difference between the simulation and no-simulation groups.

Discussion

Recruitment to the trial fell short of what was expected. Similarly, student retention in the trial was lower than anticipated, with just under half of the students who consented to take part actually engaging with the intervention. The trial found no statistically significant difference in efficacy between the intervention and non-intervention groups. However, this finding must be interpreted with caution due to the small sample size.

Conclusions

This study tested the recruitment and retention of year 3 medical students to a pilot feasibility trial of a web-based learning package. The promise of the intervention was also investigated using questions embedded in a summative assessment. Whilst such trials are feasible and acceptable, conducting a study to CONSORT standards requires measures to encourage student engagement.

Background

Interprofessional Education (IPE)

Interprofessional Education (IPE) occurs when *'two or more professions learn with, from and about each other in order to improve collaboration and the quality of care'* (Centre for the Advancement of IPE, 2002). IPE is increasingly seen as an important contributor to improved health outcomes (World Health Organisation, 2010); and regulatory bodies such as the General Medical Council now require education providers to include such learning in their curricula (GMC, 2009). IPE interventions vary widely in their nature and duration, the participants involved and the learning outcomes sought (Thistlethwaite 2012; Thistlethwaite and Moran 2010).

IPE and e-learning

Arranging for different professional groups to learn together often involves substantial logistical challenges that can make implementation of IPE programmes problematic (Abu-Rish et al 2012). Interest in the use of technology to overcome these barriers is growing, and the development of e-learning pedagogies which are appropriate for IPE is being considered (Casimiro, McDonald, Thompson and Stodel 2009).

The Joint Information Systems Committee (JISC) in the UK defines e-learning as 'learning facilitated and supported through the use of information and communications technology' (JISC 2007). In recent years, e-learning, facilitated by the development of the internet and the World Wide Web, has become a significant component of health professions education (Cook et al 2008).

In the context of IPE, e-learning can allow students to '*learn with'* other professional groups when face-to-face learning is logistically difficult. Universities in Canada and the UK, for example, have developed on-line IPE modules in which students consider interprofessional issues with the support of a facilitator (Solomon et al 2010; Clouder, 2008). Alternatively, e-learning can provide preparatory or supplementary resources to support IPE, allowing students to *'learn about'* each other prior to clinical placement. Tutors at Monash University, Australia, have reported that realistic interdisciplinary clinical DVD simulations can be a useful adjunct to clinical learning for allied health students (Williams 2010). Furthermore, interactive e-learning packages can foster an understanding of how different professional groups contribute to the patient pathway, forming a useful basis for face-to-face interprofessional clinical attachments (Buckley et al 2008).

Evidence for the educational effectiveness of IPE and e-learning

Several wide ranging reviews have considered the available evidence for the educational effectiveness of IPE in different educational contexts.

In the post registration setting, Reeves and colleagues (2010) considered the outcomes of four randomised controlled trials (RCTs) and two controlled before and after (CBA) studies that investigated the effects of IPE. Of these, two reported positive effects on professional practice and patient care, two reported mixed effects and two reported no effect.

Two recent reviews have considered IPE across pre and post registration settings, both of which found some evidence for the effectiveness of this type of learning. A review of simulation-based interprofessional education (Zhang, Thompson and Miller 2011) included 25 studies and noted that included studies reported high student engagement and satisfaction. A second review by

Lapkin, Levett-Jones and Gilligan (2011) included three RCTs, five CBA studies and one controlled longitudinal study. These authors concluded that IPE can enhance students' perceptions and attitudes towards collaborative working and clinical decision-making, but that its potential contribution to the development of communication and clinical skills requires further investigation.

Most recently, a review of pre-registration IPE encompassing quantitative, qualitative and mixed methods designs (Abu-Rish et al 2012) included 83 studies, 8 of which involved randomisation of students to educational interventions. These authors reported that included studies offered some evidence for improvements in knowledge of IPE competencies, student satisfaction with their IPE course and team skills.

Whilst three of these reviews included examples of IPE involving e-learning, experimental or quasi-experimental evaluations of such interventions were rare. Abu-Rish and colleagues (2012) found that 13 studies (out of 83) included an e-learning component, none of which involved a true experimental design. Zhang et al (2011) reported 3 studies with an e-learning component, two of which were evaluated by a pre/post test design and one by description and repeated measures techniques. In the Lapkin (2011), review, which considered only RCTs or quasi-experimental studies involving two or more professional groups, one study (out of 15) involved e-learning. This CBA study, by Becker and Godwin (2005), reported that orientation to the virtual 'classroom', together with faculty training enhanced delivery of a six week, web-based IPE module for undergraduate students.

In 2008, a wide ranging systematic review of internet-based learning in the health professions reported that differences between this type of learning and more traditional methods were small (Cook et al). More recently, a realist review of 'what works, for whom and in what circumstances' found that learners will engage with internet-based learning if they perceive it to be advantageous compared with other methods, is technically easy to use and is 'compatible with their values and norms' (Wong, Greenhalgh and Pawson 2010).

Each of these reviews recognise significant limitations in the existing evidence base. Lapkin (2012) stressed the need for rigorously designed and conducted RCTs; Reeves (2011) noted the need for studies using a wide range of methodological designs, including well-conducted randomised controlled trials, as appropriate to answer different types of research question; Zhang et al (2011) stressed the need for validated evaluation strategies; and Abu-Rish and colleagues (2012) called for greater consistency in reporting both IPE models and research studies. It is clear that, whilst there is a substantial and growing body of literature relating to IPE and e-learning, evidence for their educational effectiveness remains limited and many questions remain to be answered.

Experimental studies in medical education

The appropriateness of experiments, particularly randomised controlled trials (RCTs), to establish the efficacy and effectiveness of interventions in medical education has been debated in the literature (Torgerson, 2002; Norman, 2008; Gruppen, 2008, Cook 2012). In their systematic review of the quality of reporting of experimental studies in medical education, Cook and colleagues assessed the quality of reporting of 105 studies against a range of quality indicators. They concluded that the quality of reporting was generally poor and therefore proposed criteria as a starting point for establishing reporting standards for medical education research (Cook *et al*, 2007).

In their review of e-learning practices in undergraduate medical education, Lau and colleagues reported that only 12% of identified studies used designs able to demonstrate causality: randomised controlled trial (RCT) or quasi-experimental designs (Lau and Bates 2004). More recently, Cook and colleagues (Cook, Levinson and Garside, 2011) noted that items such as sample size calculations were frequently absent from reports of experimental studies of the efficacy of e-learning. In these two respects, the limitations of e-learning studies reflect the limitations of the wider medical education literature (Baernstein, Liss, Carney and Elmore, 2007).

Several authors have commented on the complexity of undertaking experimental studies in educational environments (Ringsted, Hodges and Scherpbier, 2011; Gruppen, 2008). Such studies must effectively manage issues of design, recruitment and retention; and use outcome measures that are both informative and acceptable to the trial population.

Aims

The aims of this research were to undertake a pilot feasibility and efficacy trial to test the feasibility of undertaking experimental research in a medical education setting and the efficacy of an e-learning intervention (on-line simulation) to support inter-professional education (IPE). The primary objective of the trial was to test the feasibility of recruiting and retaining undergraduate medical students to a randomised controlled trial evaluating the efficacy of an e-learning software package. We also wanted to investigate the acceptability of including additional questions embedded in the end of the third year summative assessment to use as outcome measurements in the efficacy trial. The secondary objective of the trial was to pilot the promise of the intervention by estimating its effect on academic outcomes (knowledge and understanding).

We designed, conducted and reported a robust pilot RCT using the CONSORT statement for reporting of randomised clinical trials (Schulz *et al*, 2010; Altman *et al*, 2001) adapted for use with a trial in medical education to ensure rigour of design and minimisation of bias.

Design and methods

The design of the study was a pragmatic pilot trial with a waiting list. The participants were 3rd year medical undergraduate students. The trial involved random allocation to either access or no access to on-line simulations to support IPE independent of their clinical attachment. Some students had been allocated to clinical attachments with simulation (including access to the on-line simulations) for the period of the study, and they were excluded from the study (see Figure 1) as they could not be randomised to not having access to the simulations.

INSERT FIGURE 1 ABOUT HERE

The intervention was self-study access over a 3-month period to an on-line software package that supported IPE by illustrating the contributions of different health professions to the patient pathway. As an independent learning package, each simulation took between one and two hours to complete. For the purposes of the trial the treatment period was 3 months (January to March 2011).

Interventions

The fully developed intervention consisted of a series of interactive e-learning packages, each of which described the patient pathway for a common condition. Each package simulates the

relevant patient pathway using video clips that show a virtual patient interacting with the various professionals involved in their care. Students view the video clips, answer questions, undertake activities and are encouraged to engage in reflection. Feedback on the accuracy or otherwise of their answers is provided. Pathways include: chest pain, peri-operative care, rheumatoid arthritis, falls, fractures, haematuria, transient ischaemic attack, antenatal diabetes and breast cancer. The aims of each package are to raise students' awareness of the roles of the different professional groups in the patient pathway; encourage students to view the patient pathway in a holistic way rather than as a series of discrete, disjointed steps; encourage students to develop an understanding of the patient perspective on their care; and increase students' understanding of the clinical condition, its diagnosis and/or treatment.

Recruitment and consent

All eligible year 3 undergraduate students received an information sheet and oral briefing about the trial in mid-December, 2010. This was followed up immediately by an email directing students to a URL at which they were able to complete an on-line consent form. Take-up was monitored in the weeks before Christmas and reminders were sent to students at periodic intervals.

Students were randomly allocated to access the on-line simulations in January 2011 or to be put on a waiting list to have access after the end of the trial in April 2011. Randomisation was stratified according to whether or not the students had used the online simulations in previous clinical attachments before the trial (see Figure 1). Stratum 1 comprised students who had no previous experience of the on line simulation; stratum 2 comprised students who *may have had* previous access to the simulations.

Concealed randomisation was undertaken by an independent statistician using the random number function in Microsoft Excel. In keeping with trends in clinical trials (Paul, Seib and Prescott 2005), after an initial briefing, trial recruitment was managed electronically, with an online consent form and email communication.

Methods for protecting against sources of bias

Protocols were developed for limiting access to the on-line simulations before and during the trial in order that a) no student accessed the simulations before the start of the trial and b) no student in a control group accessed the simulations during the trial.

Sample size calculation

Using assumptions of 90% recruitment and 90% retention and the significance level (alpha) set at 0.05, the sample size calculation indicated that about 62 students would be required in each group to observe an effect size of about 0.5 with 80% power. However, given that the intervention is supplemental, an anticipated effect size of 0.5 is rather over-ambitions. Therefore, although the trial was powered to find an effect size of 0.5, we acknowledge that the trial is underpowered to observe a more realistic effect size of 0.2 or 0.3.

INSERT TABLE 1 ABOUT HERE

Stratum 1 was at the margin of being adequately powered. Stratum 2 had slightly less power due to smaller numbers. In addition, as above, participants in stratum 2 may have had previous access to the simulations, making it is less likely that a significant effect between intervention and control groups would be detected.

Stratum 1
Stratum 1 assessed the efficacy of access to on-line simulations (access versus no access) with no additional experience of the intervention (Table 1). Students were randomly allocated to an intervention group which had access to the six on-line simulations or to a control group which did not have access to the simulations, but which was given access to the simulations once the trial had finished and the intervention and control students had undertaken the outcome assessments.

Stratum 2
Stratum 2 assessed the efficacy of access to on-line simulations (access versus no access) where there was the possibility of previous additional experience of the simulations within a clinical attachment. Students were randomly allocated to an intervention group which had access to the same six on-line simulations or to a control group which did not have access to the simulations but was given access once the trial had finished and the intervention and control students had undertaken the outcome assessments.

Outcome measures
The primary feasibility outcome measure was the percentage of students recruited, consented and retained in the study (including actual performance of the simulations and completion of assessment). The secondary efficacy outcome measures was the difference between groups in awareness of different professions to the patient pathway assessed using embedded questions in a written assessment (10 multiple choice or extended matching set questions out of a total of 120). All students in the year answered all questions which were based on core learning outcomes for the whole year group. The questions, however, focussed on interprofessional issues which although should be knowledge covered by all students were further supported by scenarios presented in the online simulation. Embedded questions relating to the trial were marked but not included in the final assessment mark for any student. These marks were used for trial analysis only. The different groups were compared with respect to engagement with the research process and the effect of the simulations on their interprofessional awareness. Electronic data captured from the patient pathways web portal indicated for each student the number of simulations completed and the time taken to complete each one.

Analyses
An intention-to-treat analysis was undertaken. The effect size (with confidence intervals) between the intervention and control groups at outcome on the secondary outcome measure was calculated. These analyses were undertaken separately for stratum 1 and stratum 2 and then combined in a meta-analysis.

Results

Recruitment
From the year 3 cohort of 407 students, 253 were eligible to participate in the trial and 152 were excluded. For stratum 1, of 162 eligible students, 88 consented, 25 declined and 49 did not respond. For stratum 2, of 91 eligible students, 37 consented, 17 declined and 37 did not respond. Figure 1 shows the CONSORT flow-diagram of participants through the trial to test the efficacy of on-line simulations.

INSERT FIGURE 1 ABOUT HERE

Retention/compliance

Table 2 illustrates student engagement with the intervention as measured by the number of web pages accessed by each individual. During the trial period, 43% of the intervention students in stratum 1 accessed the materials, visiting a median number of 9 web pages. For intervention students in stratum 2, 44% of students accessed the materials, visiting a median number of 14 pages. Combining data from the two strata, the Pearson correlation between the number of pages accessed during the trial and subsequent exam score was 0.18, p=0.38, n=27.

INSERT TABLE 2

Outcome measures
Out of 405 students in the entire cohort, 402 completed the summative assessment with embedded questions. Table 3 illustrates comparative data for all groups.

INSERT TABLE 3

For stratum 1, there was no significant difference in performance on the embedded questions between intervention and control groups, as shown by an independent measures t-test: t (86) = -0.45, p=0.65, 95% confidence interval of the difference -6.2 to +3.9. The effect size (Cohen's d with pooled standard deviation) was -0.10, 95% confidence interval -0.52 to 0.33. Similarly, for stratum 2, no significant differences between intervention and control groups were apparent: t (34) = 0.65, p=0.52, 95% confidence interval of the difference -5.2 to 10.1. The effect size was 0.22, confidence interval -0.46 to 0.90.

Meta-analysis
When the results for strata 1 and 2 were combined in a meta-analysis the pooled effect size was -0.01 95% CI -0.36 to 0.35 p =0.98. This indicates no statistically significant difference between the simulation and no-simulation groups.

Discussion

In reporting the design and results of these trials this paper has demonstrated it is possible to undertake such a study in a complex educational system. The sample size calculations indicated that, with sufficient recruitment and retention, the study would be sufficiently powered to observe a medium effect size. Based on an estimate of students' likely willingness to participate, substantial recruitment to the trial was anticipated. However, recruitment fell short of what was expected. Similarly, student retention in the trial was lower than anticipated, with just under half of the students who consented to take part actually engaging with the intervention. Given that the trial period preceded the end of year assessment, it is reasonable to infer that the pressure of exam preparation was an important factor in students' decisions to disengage.

Using a routine assessment as a vehicle for outcome measurement had several advantages. It reduced the additional burden of assessment on trial participants; it increased the objectivity of the evaluation by reducing student awareness of the specific assessment items; and it allowed outcome measures to be undertaken by large numbers of participants in an efficient manner using routine administrative and quality assurance arrangements. On the other hand, given the need to evaluate interventions in a timely way (Ringsted, Hodges and Scherpbier, 2011), embedding

questions in an assessment required conducting the trial when students were focused on exam preparation.

The trial found no statistically significant difference in efficacy between the intervention and non-intervention groups. However, this finding must be interpreted with caution due to the small sample size.

The trial has a number of strengths, one of which was the use of the CONSORT statement to guide its design, conduct and reporting to maximise rigour: randomisation was independent and concealed and outcome ascertainment was undertaken blind to group allocation. A further strength was the demonstration of the possibility of using the RCT design in the medical education field, although this was challenging, particularly in terms of recruitment and retention.

However, there are a number of limitations in the trial. In addition to the issues of recruitment and retention mentioned above, measuring student engagement using the number of web pages accessed may not have reflected fully the level of student engagement with the intervention. The issues observed with poor student engagement may reflect the fact that participation in educational trials is, currently, not the norm for students. The correlation between exposure and outcome measures was weak and this is a limitation of the study.

A systematic approach to raising students' awareness of the importance of educational research and increasing familiarity with educational research methods could reduce anxiety about participation, encouraging greater engagement and commitment. The involvement of medical education departments is associated with the use of more objective outcome measures and can support academics and clinicians in undertaking rigorous educational research (Baernstein, Liss, Carney and Elmore 2007). An important role for such departments could be to develop systematic approaches that involve students in research regularly, so that participation becomes a normal, accepted aspect of student life. Finally, although the embedded questions were reviewed for face and content validity, these questions need further validation.

The trial compared standard clinical teaching with clinical teaching plus e-learning and found no statistically significant difference. Cook (2006) previously highlighted the educational value of studies that directly compare two web-based interventions. Such studies may also serve to reduce perceived, if unfounded, perceptions of disadvantage in written assessments by offering all students an equivalent experience.

Given the complexity of educational settings, theoretical sample populations may be difficult to realise in practice. If trials are to be reported routinely to CONSORT standards, with sample size calculations and effect sizes as the norm, using objective outcome measures such as embedded questions, and particular measures to maximize student engagement may be required.

Conclusions

Recent reviews of the IPE and e-learning literature have called for further research into the effectiveness of these types of intervention, including the design, conduct and reporting of high quality RCTs. This study tested the recruitment and retention of year 3 medical students to a

pilot feasibility trial of a web-based learning package designed to prepare students for IPE through greater awareness of the contribution of different professions to the patient pathway. The promise of the intervention was also investigated using questions embedded in a summative assessment. Whilst such trials are feasible and acceptable, conducting a study to CONSORT standards requires measures to encourage student engagement. Increasing students' familiarity with educational research methods and ensuring equity of experience between participant groups may assist in increasing student engagement. Development of systems in which participation in educational research becomes an expected part of student life may be an appropriate development.

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Figure 1: CONSORT flow-diagram of participants through the trials

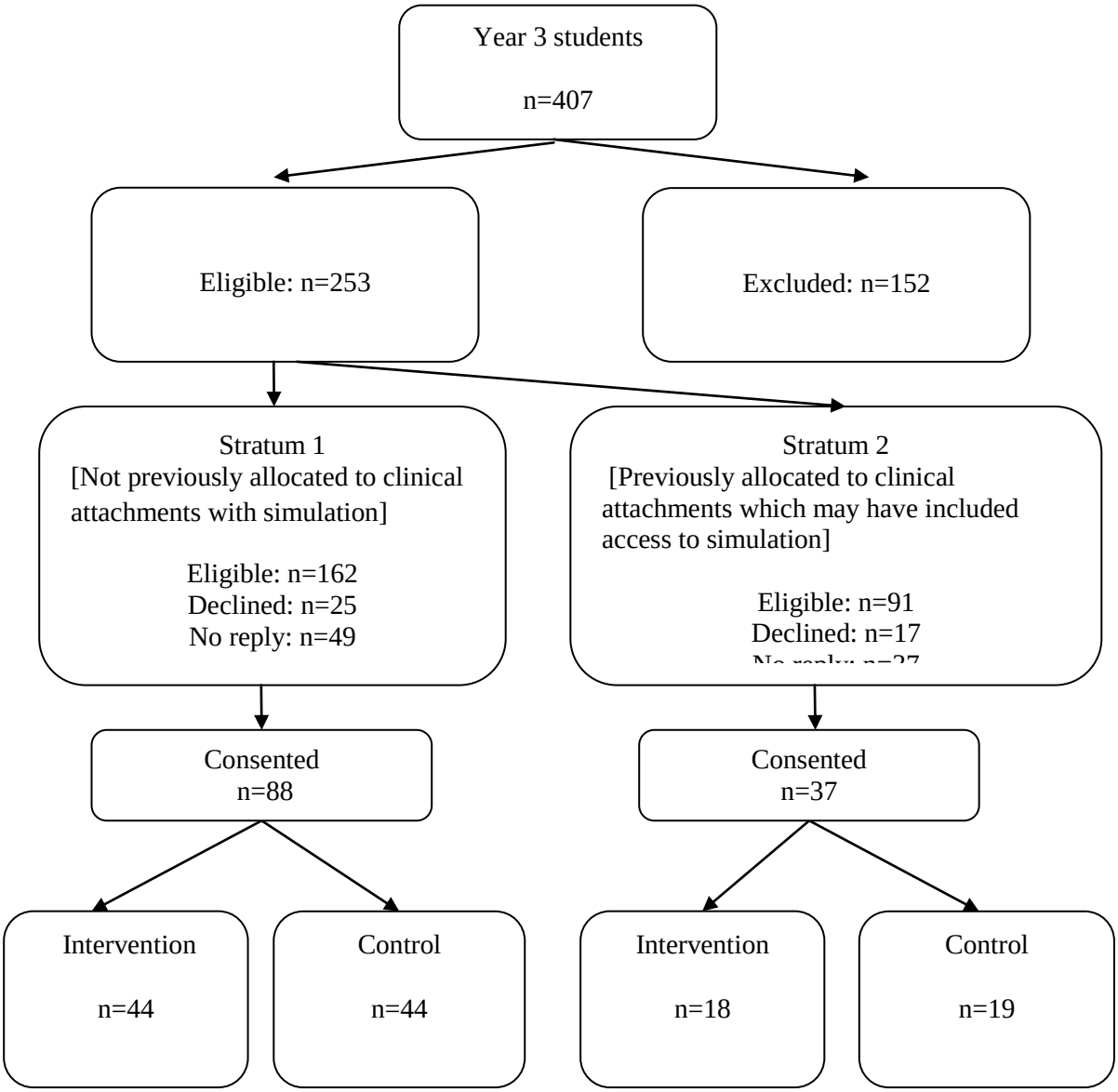

Table 1 Sample size calculations

	Stratum 1		Stratum 2	
Number in each group	**100%(n= 81)**	**81% (n = 66)**	**100% (n=47)**	**81% (n=38)**
Power	**Effect size**			
0.9	0.51	0.58	0.68	0.75
0.8	0.44	0.49	0.58	0.65
0.7	0.39	0.44	0.52	0.58
0.6	0.35	0.39	0.46	0.51
0.5	0.31	0.34	0.41	0.46

Table 2 Trial retention and compliance. *The number and percentage of students who accessed at least one page of a case study are shown, together with the mean, median, minimum and maximum number of pages accessed.*

Group	Number in group	Individuals accessing the intervention n (%)	Pages accessed			
			Mean	Median	Minimum	Maximum
Stratum 1 intervention	44	19(43)	10	9	1	34
Stratum 1 control	44	0(0)				
Stratum 2 intervention	18	8(44)	20	14	3	61
Stratum 2 control	19	0(0)				

Table 3 Student performance on embedded questions. The number of students (n) who completed the summative assessment in each group is shown, together with their mean score on the embedded questions (%), standard deviation (SD) and 95% confidence intervals are also shown.

Group	Students in group (n)	Students completing assessment (n)	Mean score (%)	SD	95% CI	
Stratum 1 intervention	44	44	77.3	11.9	73.7	80.9
Stratum 1 control	44	44	78.4	11.8	74.8	82.0
Stratum 2 intervention	18	17	78.2	11.3	72.4	84.1
Stratum 2 control	19	19	75.8	11.2	70.4	81.2