RESEARCH

Integration of an Online Simulated Prescription Analysis into Undergraduate Pharmacy Teaching Using Supplemental and Replacement Models

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Objective. To describe student use and perceptions of online simulated prescription analysis following integration of supplemental and replacement models into pharmacy practice teaching.
Method. Strathclyde Computerised Randomised Interactive Prescription Tutor (SCRIPT) is a simulated prescription analysis tool designed to support a pharmacy practice competency class. In 2008-2009, SCRIPT scenarios were released to coincide with timetabled teaching as the supplemental model. In 2009-2010, SCRIPT also replaced one-sixth of the taught component of the class as the replacement model. Student use and performance were compared, and their perceptions were documented.
Results. In both cohorts, the majority of use (over 70%) occurred immediately before assessments. Remote access decreased from 6409 (supplemental) to 3782 (replacement) attempts per 100 students. There was no difference in student performance between the cohorts, Students reported group and individual use as well as 4 targeted approaches to their use of SCRIPT.
Conclusions. E-learning can reduce the staff time in pharmacy practice teaching without affecting student performance. SCRIPT permits flexible learning that suits student preferences.
Keywords: competency-based teaching, e-learning, pharmacy education, simulation, web-based learning.

INTRODUCTION

Using online resources to support learning has expanded in line with advances in technology and a growing body of evidence that well designed, online resources can be an effective alternative to traditional educational formats in general and specifically to health professions education.[1-4] The integration of e-learning into existing curricula is essential to the success of such resources.[5-9] Planning and coordination can ensure that e-learning is appropriately aligned to the intended learning outcomes.[10] The mandatory or voluntary nature of a resource, alignment to assessment, and availability are important considerations in the planning stage of integration.[6,8,11]

Mandating the use of a resource can increase student usage but can also lead to increased staffing time compared to using voluntary resources. Aligning the relevance of e-learning to assessments can increase student motivation to use the resource and can lead to them spending more time on the task.[6] Spacing and sequencing of resource availability in relation to other curriculum items may also impact student use. Khogali et al indentified that students who accessed e-learning after lectures and problem-based discussions saw less benefit and were less systematic in their use of e-learning compared to students who had used e-learning in preparation for either the lectures or problem-based discussion.[8] Maier et al investigated the effect of spacing the release of e-learning cases over an academic year, concluding that well-spaced resources can lead to more balanced usage when compared to releasing all the cases at the same time.[11]

While these studies demonstrate impact of an integration strategy, there are no clear guidelines for the integration of e-learning into established pharmacy curricula. As such, educators

may look to other disciplines for ideas and advice to inform their integration strategies. Outside health professions education, Twigg defined 5 models for integrating e-learning into established curricula: supplemental, replacement, fully online, emporium, and buffet (Table 1) and suggested that these models may help formulate a strategy when redesigning a curriculum.[5]

At the University of Strathclyde (UoS), the 4-year pharmacy degree (MPharm) is structured around learning outcomes specified by the regulatory body in Great Britain called the General Pharmaceutical Council (GPhC) (Table 2). The GPhC has used Miller's triangle, a model that uses four stages of development – knows, knows how, shows and does – to define the level of each learning outcome to be achieved at graduation.[12] Competency-based outcomes were assessed through observation of performance in a competency-based class that ran simultaneously with an underpinning knowledge class. The competency-based class was taught in a laboratory setting that mimicked a real life pharmacy dispensary. Students assessed prescriptions for clinical and legal appropriateness, then labeled, dispensed, and checked them. Staff members, who were all registered pharmacists, role-played as prescribers, patients, or patient representatives, and students had to issue prescriptions during role-play in class and at assessment.

Several factors supported the need for an e-learning integration strategy including increased numbers of students entering the degree program, restrictions on laboratory space, and availability of suitably qualified teaching staff. As a response to this need, Strathclyde Computerised Randomised Interactive Prescription Tutor (SCRIPT), an e-learning simulated prescription analysis program, was designed as a revision tool for the competency-based class. This e-learning tool helps students achieve the competencies required for safe and accurate dispensing, which are core in any pharmacy program. In the 2007-2008 session, SCRIPT was available to all students enrolled in the class as an outside-of-class tool on a voluntary basis. Student use and perceptions were evaluated and in response to these evaluations, SCRIPT was refined to include the following: more scenarios, a simpler method of error selection (a dropdown menu and filtering), scenarios grouped by topic, enhanced feedback on each scenario, and a reporting function to help staff identify problem areas based on class use and performance.[13] The e-learning program was aligned to the class following the supplemental model as a result of increased student numbers and desire among staff and students for better integration of SCRIPT into the MPharm degree. After review, the replacement model was adopted to better integrate SCRIPT.

Literature searches of Medline, Embase, Eric, and Google Scholar indicated that there were no other published descriptions of online prescription assessment tools, nor was there literature to describe the stepwise implementation of online simulation into established curricula. This study aimed to describe the sequential introduction of 2 models of integration. Quantitative data were used to describe student use and qualitative methods were used to determine student perceptions. Student performance in two cohorts of the class was compared.

METHODS

This study adopted a mixed-methods approach consisting of quantitative analysis of student use and class performance with qualitative interviews to determine student perceptions of SCRIPT. Two sequential cohorts of students, from the third year of a GPhC-accredited MPharm degree course, were used.

The version of SCRIPT used in this study comprised approximately 500 scenarios covering the most commonly encountered prescription types in the United Kingdom. Fourteen tests were aligned to the competency-based class teaching, each containing a minimum of 20 scenarios. In the 2008-2009 academic year, the supplemental model was adopted; tests were released for remote access to coincide with teaching in the practical sessions but the existing class content and structure remained unaltered.. In the 2009-2010academic year,, the replacement model was adopted; in addition to remote access, SCRIPT was used in self-directed group learning, replacing one-sixth of the taught component of the class. During the 30-minute, self-directed learning period in the practical sessions, students had access to the tests aligned to the themed teaching. Using SCRIPT on students' own time was encouraged but not required.

All third year students who were registered for the class in the 2008-2009 and 2009-2010 sessions were included in the supplemental and replacement cohorts, respectively. Students from other years who may have been retaking the class and all staff were excluded from the study.

Students in both cohorts received an introductory online demonstration of SCRIPT in lecture format and a practical introduction in a timetabled practical class. For the online portion, students were split into small groups of 2 or 3 to allow shared use of a computer.

The Virtual Learning Environment automatically recorded student access to a test, and 3 randomly chosen scenarios from that test were exported to Excel for analysis. Data collected included the number of SCRIPT attempts made, date and time of each attempt, an anonymous, unique user ID, test ID, test results, test score, and whether the test was completed. These data were exported for analysis 8 days after the final class assessment. Data were cleaned according to the inclusion/exclusion criteria, removing records of staff or students not registered for the class, tests accessed before or after the study period, and tests that were opened but not completed. Partially completed tests were included in the analysis. Data were analyzed to identify total use of SCRIPT for each cohort, patterns of use relating to the time of day, week of the academic year, and prescription type chosen. All data were corrected to use per 100 students to account for differences in cohort size. Analysis of total, remote, and in-class use was conducted for the replacement cohort. The number of attempts made on each test was counted to determine how students had targeted each test in each cohort.

The competency-based class had 2 summative assessments, on which students began with 100% and had points deducted for each error made. Points deducted equated to the severity of the error. Students could gain exemption from the degree assessment if they achieved 70% on the exemption assessment (the first summative assessment). The pass mark from the degree assessment (the second summative assessment) was 50%. The pass/fail rates of the cohorts on the 2 assessments were compared.

Statistical analysis was completed using PASW (SPSS) version 18 for Windows: SPSS inc, Chicago. A Mann-Whitney test was used to determine differences between each cohort in the number of attempts made. Pearson's chi-square was used to establish if the number of students achieving success in the class was significantly different between the cohorts. A p value less than 0.05 was considered significant.

Twenty students from the replacement session were selected at random, using a computerised number generator, and were invited to participate in a semi-structured interview. The interview guide contained open questions exploring 4 key topics: student use of SCRIPT during taught classes, student use outside of taught classes, student perceptions of the e-learning tool, and student perceptions of the support structures available (including other students, staff, and technical support). The interview guide was pilot-tested on 2 final-year pharmacy students. Interviews were conducted by 2 independent research students, and all interviews were recorded and transcribed. A thematic analysis was conducted, during which data were analyzed horizontally by reviewing student responses for each of the questions, then vertically by reviewing each student interview as a whole transcript.[14] Data were coded independently, then themes were reviewed and agreed for validity. As this was an in-course evaluation, the departmental ethics committee stated that ethics approval was not required.

A mixed methods approach was adopted to give more insight than either quantitative or qualitative methods alone.[14]

RESULTS

One hundred twenty-seven students were in the supplemental cohort and included 88 (69.3%) female students. Of the 145 students in the replacement cohort, 89 (61.4%) were female. No students were mature entrants with a previous degree level qualification. Unless stated, comparisons in this study were made of remote access attempts, which we assumed were self-directed by individual students outside of timetabled teaching. Students in the supplemental cohort accessed SCRIPT outside teaching time more often per 100 students than students in the replacement cohort (p=0.002) (Table 3).

A comparison of the total number of attempts made in the supplemental and replacement cohorts showed that student access attempts decreased after integrating SCRIPT into class teaching. One hundred and twenty one of 127 (95.3%) students in the supplemental cohort accessed SCRIPT outside timetabled teaching compared to 114 of 145 (79.6%) students in the replacement cohort. All students in the replacement cohort accessed SCRIPT during class time. In both cohorts, 96% of

remote attempts at accessing SCRIPT were made between 08.00am and 01.00am. The number of remote attempts made in the supplemental cohort was significantly greater than the number of attempts in the replacement cohort at each hour between 9:00 and 22:00 ($p<0.05$). In the supplemental session, remote access by students declined between 17:00 and 19:00 which, although present, was less noticeable in the replacement session. Students' remote use of SCRIPT in relation to the academic week highlighted several peaks in activity during the year (Figure 1). Both cohorts displayed the greatest peaks in activity around class assessments, although the frequency of access in the replacement cohort was less.

Students in both cohorts appeared to target specific prescription types in their revision (Table 4). Both cohorts targeted tests related to general revision and simple controlled drug scenarios more than they accessed other tests. The top 4 most accessed tests were the same in both cohorts. In the supplemental and replacement cohorts, 127 and 145 students sat for the exemption assessment, and 75 and 86 students sat for the degree assessment, respectively. Fewer students sat for the degree assessment because some had gained exemption by passing the exemption assessment. A Chi-square (2-tailed) test revealed no statistical difference between the cohorts for the proportion of students who passed the exemption assessment or the degree assessment (Table 4).

Eighteen of 20 students were interviewed, at which point no new themes were emerging. Analysis identified 4 themes: in-class and remote use of SCRIPT, use alone or in groups, approaches for targeting prescription scenarios, and facilitators and barriers to engagement with e-learning. The majority of students indicated they used SCRIPT alone at home on their own time predominantly for examination preparation

Students reported using SCRIPT in the evening because it was convenient, and they had more time to use it. Some students indicated they used SCRIPT before the practical class for preparation and afterwards, in the evening, for consolidation of learning.. A few students did not use SCRIPT in their own time because they did not agree with the answers.

Students held mixed views on the length of time available to use SCRIPT during class, but they suggested this time requirement be reduced as students became familiar with SCRIPT. The majority of students thought that their SCRIPT use would have been less if it was only available remotely, as a Supplemental format because they might not have invested the time required for familiarisation and thus might not have valued it as a revision tool.

Students reported using SCRIPT both individually and in groups. During class time, the majority of students accessed SCRIPT in pairs because discussing scenarios was helpful. Some students indicated that they had logged out of their account so that their partner could log in for their turn.However, some students did not like working in groups because students worked at different speeds and group work reduced time for individual use.

Students used SCRIPT alone outside class because it was faster for them and because it was easily accessible: group use required students to "*co-ordinate diaries*". Where group use had happened this was around a big screen in the library and it was particularly helpful for clarifying challenging scenarios.

Students described 4 approaches to targeting prescription scenarios, targeting weaknesses, random, linear and targeting topics (Table 5): targeting perceived weaknesses being the most common. While approaches differed from student to student, some suggested they may adopt more than one approach depending on whether they were in class, consolidating their learning, or revising for an assessment. During class time, participants predominantly targeted scenarios aligned with the class being taught that week, suggesting that staff had instructed them to do this. Some students chose this approach because they found it easier to learn one topic at a time.

The majority of students thought that SCRIPT was a good resource, because it had lots of scenarios, did not require staff support, it simulated assessments and it was easy to use. . However, some students thought that SCRIPT was confusing and/or ambiguous and that scenarios were not true to life. Some students requested more scenarios to be developed. The most common suggestion for development was to reduce the ambiguity in error selection and to make it easier for students to report errors. One student said that they would like to know the marking scheme to help rationalize the score obtained after completing a scenario.

DISCUSSION

For both cohorts, patterns of remotely accessing SCRIPT emerged, included time of day and time in the academic year. Students also targeted prescription types similarly, and the majority of attempts were made on students' own time and immediately before assessments, which is consistent with other published work.[6,16-19] This pattern of use was likewise observed when SCRIPT was not aligned to class teaching.[13]

The replacement cohort accessed SCRIPT less often per 100 students than the supplemental cohort in terms of remote attempts and total access. However, comparison of total access between the cohorts may not be a true reflection of access because students did not have a dedicated computer during the teaching sessions. Sharing computers in class could account for up to 3 students accessing SCRIPT as a small group in the replacement cohort. For this reason, only access outside of teaching sessions was used to compare how students accessed SCRIPT in the cohorts. We assumed students accessed SCRIPT individually outside of class, but students suggested that this was not always the case. The use of SCRIPT in small groups complicated the quantitative analysis of log files. Also, it is not clear which students in a group were in decision making or observational roles. However, working with computers in groups may lead to a reduced need for staff support, greater task achievement, and improved student satisfaction, so should be encouraged[20] Garrison and Kunaka found that, in a blended learning environment, "the emphasis must shift from assimilating information to constructing meaning and confirming understanding" through dialogue and debate.[21] Working with SCRIPT in groups outside class time was reported as helpful for difficult scenarios, a scenario also reported by Lou and by Garrison and Kanuka.[20,21]

The reasons behind fewer remote attempts in the replacement cohort were not fully explored in this study, though we speculate that additional use during class time reduced the need for remote use, or frustrations with perceived ambiguities in the scenarios reduced desire to access it. A continuation of out-of-class work by groups formed during class may also have contributed to less remote usage.

When perceived ambiguities were highlighted, we reviewed these in detail to ensure accuracy of the answers and feedback. Perceived ambiguities often related to misinterpretation of the answer options, suggesting that students had not read the instructions. To minimize this, developers should ensure that programs are intuitive so students do not have to learn the program before focusing on the subject matter.

The perceived usefulness of an e-learning resource is a key driver for learner usage,[22,23] and fewer remote attempts in the replacement cohort may have been a result of students perceiving they had exhausted relevant scenarios during class time, having decided they did not like the program, or having achieved individual goals earlier than students in the supplemental cohort. Moreover, students in the replacement cohort suggested they had become familiar with SCRIPT earlier than those in the supplemental cohort, who had to use their own time for this purpose. Thus, the use of technology in class may help familiarize students with the program.

Students appeared to use SCRIPT for different purposes, such as identifying learning needs, targeting learning needs, consolidating in-line learning with taught material, and systematically revising. Students may also have adopted different approaches at different times of the year, highlighting the flexibility of online tools and suggesting that students can reflect on their learning needs and prioritize their learning according to principles of adult learning.[24] Khogali et al reported that some medical students adopted a systematic approach to accessing the resources compared to others who "preferred to browse".[8] Staff and developers should acknowledge that students may use e-learning differently from its intended purpose.

Positive findings of this study were that the replacement model of integration reduced staffing requirements by one member at each teaching event, allowed students flexibility to address their learning needs in the preferred approach, and allowed students to explore individual and group use of SCRIPT in a supportive laboratory environment. In addition, neither the replacement nor the supplemental model affected the students' ability to pass the competency-based class. This is consistent with Cook et al's systematic review and meta-analysis, which found that e-learning can offer alternative educational formats without negatively impacting learning outcomes when compared to traditional teaching models.[25]

Although this study demonstrated benefits associated with the replacement model, there were limitations. A number of confounding factors limited the ability to draw conclusions on the effect of

an individual's use of SCRIPT on the achievement of learning outcomes. In particular, part-time employment in a community pharmacy or participation in study groups may have also influenced achievement of learning outcomes. Although analysis of log files provided a quantitative indication of self-motivated use of e-learning outside of class, the student-reported use of SCRIPT highlighted a risk of relying on quantitative methods of evaluation alone. The context in which each log file was recorded was not clear, and a mixed-methods approach should be used for future evaluations.

CONCLUSION

The integration of the SCRIPT e-learning tool from the revision-only, supplemental model to a taught pharmacy class (replacement model) was accepted by students. Class achievement did not differ between the models of integration. Interviews with students highlighted their diverse approaches to using SCRIPT in class and as a remote tool, including working in groups and targeting specific prescription types. Refinements need to be made to reduce ambiguity and to increase intuitiveness of the program. Other institutions wishing to meet the needs of a diverse student population may consider using a replacement model to reduce staffing time and increase flexibility of learning methods.

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Table 1. Twigg's 2003 Course Redesign Models

Course Redesign Model	Key Features
Supplemental Model	Retains basic course structure. Technology is added to increase revision opportunities and student engagement.
Replacement Model	Replace some in-class activities with online, interactive learning activities that align with remaining in-class activities.
Emporium Model	Students choose the topics, material, and learning methods to suit their learning needs, with guidance from online instructional software.
Fully Online Model	Courses presented entirely by online software. Thus increasing student numbers, flexibility and can allow immediate feedback on submission of assignments.
Buffet Model	Variety of learning opportunities (online, face-to-face, individual, and group) allow students to pick and choose the learning activity or resource that best fits their learning needs and style.

Table 2. General Pharmaceutical Council (GPhC) Outcomes Assessed at Level "Shows How" in the Competency-based Class

GPhC Outcome	Outcome Descriptor
10.2.2.c	Instruct patients in safe and effective use of their medicine
10.2.2.d	Analyze prescriptions for validity and clarity
10.2.2.e	Clinically evaluate the appropriateness of prescribed medicines
10.2.2.f	Provide, monitor, and modify prescribed treatment to maximize outcomes
10.2.2.g	Communicate with patients about their prescribed treatment
10.2.2.h	Optimize treatment for individual patient needs in collaboration with the prescriber
10.2.2.j	Supply medicines safely and efficiently in compliance with legal requirements and best professional practice. To note, this should be demonstrated in relation to both human and veterinary medicines
10.2.4a	Establish and maintain relationship with patients while identifying their desired health outcomes and priorities
10.2.4b	Obtain and record relevant medical, social, and family history of patient
10.2.4d	Communicate information about available options in a way that promotes understanding
10.2.4e	Support patients in choosing an option by listening and responding to their concerns and respecting their decisions
10.2.4f	Conclude consultation to ensure a satisfactory outcome
10.2.4h	Provide accurate written or oral information appropriate to the needs of patients, the public, and other health care professionals

Table 3. Summary of Student Access to SCRIPT for Supplemental and Replacement Cohorts

	Supplemental	Replacement

Remote attempts made by each student (median (Inter Quartile Range))	44 (29-79)	23 (5-48)
Remote access per 100 students	6409	3782
In-class access per 100 students	-	1340
Total attempts per 100 students	6409	5122

Table 4. Number of Students Passing and Failing Exemption and Degree Assessments

Assessment	Supplemental Cohort	Replacement Cohort	Chi-square
Exemption assessment			
Sample size (n =)	127	145	
Passes	52	58	
Fails	75	87	χ^2=0.025 p>0.5
Degree assessment			
Sample size (n)	75	86	
Passes	45	56	
Fails	30	30	χ^2=0.449 p>0.5

Table 5. Approaches for Targeting Prescription Scenarios in SCRIPT

Approach	Description
Targeting weaknesses	Students targeted prescription types based on their perceived weaknesses
Random	Students attempted random prescription types to test knowledge
Linear	Students progressed through the scenarios in a linear fashion based on order of topic release date
Targeting topic	Student accessed prescription types based on the topic they were revising at the time to consolidate learning

Figure 1. Remote SCRIPT attempts in relation to academic week, corrected to rate per 100 students.