Using a blended approach to support calculation skills of pharmacy students

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Abstract

Background: Pharmacy students are expected to demonstrate proficiency in pharmaceutical calculations and must achieve 70% in calculations in the General Pharmaceutical Council registration exam. Students value the flexibility, convenience and usability of technology enhanced learning.

Aims: To develop and evaluate a flexible resource to aid teaching and improve confidence and competence in performing pharmaceutical calculations

Method: A calculations e-package was designed. Evaluation of the e-package was completed via questionnaires and quizzes pre and post e-package release.

Results: The majority of students were very positive about the design aspects 74% (n=338) and impact of the e-package on future calculation competency (79% n=352). Results from 189 eligible students show significant improvement in scores after release of the e-package (*p*-value <0.001).

Conclusion: Significant improvement in students' performance along with positive feedback regarding confidence and design of the package indicate the effectiveness of the e-package as an additional supporting strategy for calculation training.

Keywords: *E-learning, Pharmaceutical Calculation, Pharmacy Education, Students*

Introduction

Pharmacists are generally acknowledged as medicine experts whose main role is to ensure the safety and effective use of medicines in order to safeguard the health and wellbeing of the public. Errors made with regard to drug therapy often lead to adverse drug events which may have serious impact not only on patients and their families but can also have an impact on financial costs and the reputation of the NHS as a whole. Medication errors may occur at any stage during the use of medicines and miscalculation has been shown to be a common causative factor that is preventable. Calculation errors are more likely to occur in paediatric treatment and in those adult medications requiring the calculation of dose, volume or rate of administration (Department of Health, 2004).

Basic calculation skills are an integral part of any science degree and are generally recognised as one area that students struggle with (Barry *et al.*, 2007). Universities in the United Kingdom (UK) with MPharm or other healthcare degrees must ensure calculation skills are embedded within their courses as calculation competency is ultimately critical to patient safety. The Schools of Pharmacy are required to provide a high quality of education and training to all pharmacy students in order to ensure their fitness to practice and fulfil the requirements set by the pharmacy regulator, the General Pharmaceutical Council (GPhC). Currently, MPharm and OSPAP (Overseas Pharmacist Accreditation Programme) graduates, in order to register with the GPhC, are required to achieve a pass mark in the registration exam of 70% overall, which must include at least a 70% mark in the calculations section (which ranges from simple conversion of units to complicated dilutions). Therefore calculation training is very important throughout the MPharm/OSPAP course and during practice.

There are various teaching and learning methods which can be used to teach calculations. Learning styles vary due to many factors such as: age, gender, previous learning experience and therefore various studies have explored the effectiveness of different interventions to improve students pharmaceutical calculation skills (Batchelor, 2007; Powers *et al.*, 2010; Rutter & Watts 2010; Bergen *et al.*, 2011; McMullan *et al.*, 2011 Hegener *et al.*, 2013). The majority of the research has been conducted in the nursing profession (Wright, 2007; Sheriff *et al.*, 2012) but the findings can equally be applied to the pharmacy profession. Students appreciated the flexibility of online materials in addition to face-to-face tutorials and lectures. Improvement in calculations skills was shown as a result of integrating different approaches to calculations training.

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E-learning is becoming more popular and has been used extensively in teaching. Positive outcomes and a high level of acceptance in studies provide support for their future development (Powers *et al*., 2010; Bergen *et al.,* 2011; McMullan *et al*., 2011; Sheriff *et al*., 2012).

In 2011/2012 the authors looked at calculations competency and confidence (Wadghiri, [unpublished]). Percentage scores in a calculations quiz completed by 251 students highlighted that ratio concentration, molecular weight, dilution of solutions, displacement value and infusion rates scored lowest with only 40-56% (n=100-140) getting the correct answers. A questionnaire answered by 134 students from across the years highlighted that 67% (n=90) of students would like to receive more basic calculation skills and training. When establishing interest in an e-learning package for training 64 % (n=86) indicated that they would definitely use one to improve their pharmaceutical calculation skills.

The purpose of this study was to develop and evaluate a calculations e-learning package to aid teaching and improve confidence and competence in performing pharmaceutical calculations.

Methods

An e-learning package was designed in-house over two stages to support pharmacy students' calculation teaching.

Stage 1: The package included an introductory page explaining how to use the package and a table of contents. Students were free to move between sections in any order they chose. Calculation questions were designed based on those encountered in pharmacy practice. The package included 14 types of pharmacy related calculations: Body Mass Index, molarity, infusion rate, dose calculation, extemporaneous formula, displacement volume, equivalent doses, multiple dilutions, serial dilutions, quantity to dispense, chloroform dilution, half-life, suppositories – displacement values, ideal body weight and clearance. For each calculation type there was a worked example and three - four practice questions. The worked examples were presented in the form of a video with audio narration. The package design involved the use of a digital recording pen and pad to record tutor voice to explain each calculation step in the worked examples as shown in Figure 1.

The practice questions incorporated feedback responses to help students reach the correct answer as shown in Figure 2. Hints were given after each incorrect response, after the fourth incorrect response the answer was given. Congratulations were offered for a correct response.

Stage 2: A total of 50 new practice questions were designed and added to the package, based on student feedback and performance in the quizzes in Stage 1, along with step-by-step solutions and hints. Two new sections were formed 'basic pharmaceutical calculations' and 'alligation'. Questions were added to: molarity, infusion rates, dose calculation, extemporaneous

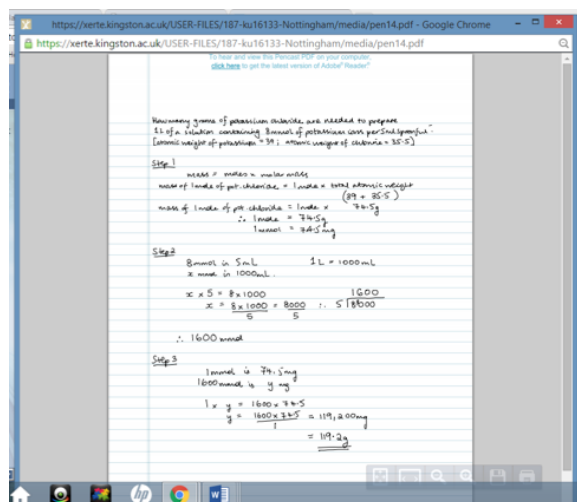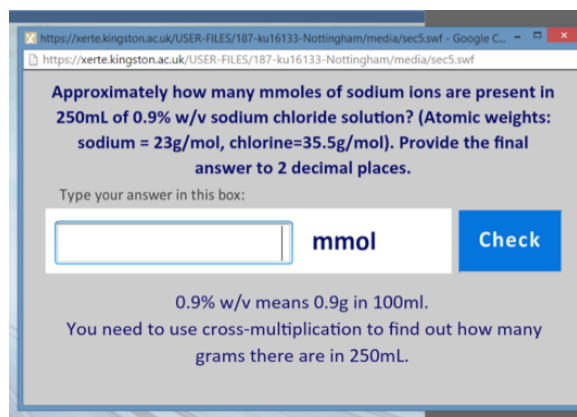**Figure 1: Worked example viewed at end of audio-visual recording**

Figure 2: Practice example showing first attempt feedback

formulae, displacement volume, multiple dilutions, serial dilutions and ideal body weight & clearance. A detailed page of instructions of how to use the package was also built in to help overcome any technical difficulties. The package was being used on campus and students' own computers so there was a wide variety of browsers of varying versions.

An evaluation was carried out over two years of the impact and usefulness of the e-learning package.

Stage 1: Two short calculation quizzes, each containing five open ended questions, were developed covering: dose conversion, body mass index, dilution, infusion rate and quantity dispensed. Use of the British National Formulary (BNF) was permitted but no calculators were allowed so as to simulate the same conditions as the GPhC registration exam at the time. One quiz was delivered before the e-package was released and one after the e-package became available. In November 2012, 3rd

year MPharm and OSPAP students (n=170) were administered the pre-package quiz (Appendix A). The e-learning package was launched to all year groups of pharmacy students. The post package quiz (Appendix A) was administered to 3rd year MPharm students after two weeks and to OSPAP students after four weeks

Stage 2: Three quizzes were developed each consisting of five non-multiple choice questions considered to have the same level of difficulty (two marks given for each). These included; infusion rate, multiple dilution, serial dilution, quantity dispensed, dose conversion and molecular weight (Appendix B). The questions were based on the topics students seem to find most challenging. Again no calculators were allowed. The quizzes were administered to 4th year and OSPAP students only (n=136). Quiz 1 was administered in a workshop before release of the e-package online and Quizzes 2 and 3 were administered in workshops three weeks and six weeks after the release.

In both stages a survey questionnaire (Appendix C and D) was developed and made available to all year groups. The questionnaires (mostly closed ended questions and Likert scales) were developed and the study was approved by the University Ethics Committee. Face validity was obtained via academic staff and content validity was determined via a pilot study with ten MPharm students. Hard copies of the questionnaires were distributed and completed in workshops after the post package quizzes. The questionnaire was also made available online via emails and the university's virtual learning environment. The questionnaires were designed to evaluate: usefulness of the package, its influence on confidence and competency in calculations and the future use of the package as part of the MPharm degree. Completion of the questionnaires was anonymous and voluntary.

All data was analysed using Microsoft™ Excel. Paired and unpaired t-tests and ANOVA analysis were conducted to establish any statistical significance of the data.

Results

Stage 1: Of a total 170 pharmacy students (OSPAP and 3rd year), 112 (66%) attended both workshops where the pre and post package quizzes were administered, hence were eligible for analysis.

The percentage of correct scores for each question pre and post use of the package respectively was as follows; dosage calculation 46% vs 29%, body mass index 26% vs 41%, dilution 10% vs 48%, infusion rate 5% vs 46% and quantity dispensed 32% vs 48%. A paired *t*-test gave a *p*-value of $\ll 0.0001$ indicating a significant change between pre- and post- package results as shown in Table I.

With respect to the overall quiz scores, the percentage of students who obtained less than 40% decreased from 69% (n=77) to 38% (n=43) post package, whilst the number of students who achieved 40-69% increased from 30% (n=34) to 43% (n=48) and the number who achieved 70% or more increased from 1% (n=1) to 19% (n=21)

Table I: *t*-test of combined Year 3 and OSPAP quiz results (n= 112) (Stage 1)

Difference between pre and post package results	
Mean	18.48
Standard Deviation	23.60
Standard Error	2.23
Calculated T value	8.29
Tabulated *t*-value at 95% CI	1.98 ($p<0.0001$)

Stage 2: The attendance rates between the three quizzes were varied hence only 77 out of a total 136 students (68 in 4th year MPharm & 9 in OSPAP) were eligible.

In the 4th year group, there was a 60% increase in the mean score (out of 10), from 2.8 +/-2.1 (Quiz 1) to 4.5 +/-2.6 (Quiz 3) but a wider range was noticed.

In the OSPAP group, the scores in both Quiz 1 and 2 ranged from zero to six while the range was from two to eight in Quiz 3. The number of students who scored zero had significantly reduced, from 25% in Quiz 1 to 8% in Quiz 2 and ultimately 0% in Quiz 3. There was an 87% increase in the mean score, from 2.67 +/-2.15 in Quiz 1 to 5.00 +/- 1.95 in Quiz 3, with a narrower range of scores.

Table II shows the number of students who had improved scores between quizzes. Although there was no statistical significance difference between the scores in Quiz 1 and 2, the calculated *p*-values for the last two sets of data are less than 0.001 which indicate a statistically significant difference between both Quiz results (Quiz 2 vs 3 and Quiz 1 vs 3).

Table II: The comparison of individual performance between quizzes with *p*-values (n=77) (Stage 2)

4th Year MPharm and OSPAP	Improved Number of students (%)	No Change Number of students (%)	Worse Number of students (%)	*P*-Values
Quiz 1 vs. Quiz 2	26%	45%	29%	0.26
Quiz 2 vs. Quiz 3	62%	21%	17%	8.19×10^{-9}
Quiz 1 vs. Quiz 3	61%	21%	18%	6.88×10^{-9}

A paired sample *t*-test was conducted for the combined results (4th year MPharm and OSPAP) testing the statistical significance of the difference between the quizzes. A one-way analysis of variance (ANOVA) was carried out to find the difference between the three sets of data. The resulted *p*-value of <0.0001 indicates that the mean scores between the pre and post-quizzes differ significantly.

Questionnaire results

In Stage 1, 62% (n=368) of pharmacy students filled in a questionnaire and in Stage 2, 41% (n=229). In Stage 1, 62% (n=228) of students who filled in the questionnaire said they used the e-package. In Stage 2 only 3 students said they had not used the package.

Reasons for not using the package

At Stage 1, reasons for not using the package were given by 132 of the non-user students as: already confident in calculations 11% (n=5), did not have enough time 60% (n=79), lack of access to a computer 9% (n=12), prefer to learn from books 22% (n=29), do not find e-package learning helpful 2% (n=3), found it difficult to use 1% (n=1), prefer to use paper to annotate my work 1% (n=1). In Stage 2, only 7% (n=15) who had used the package said they wouldn't use the package again in future as: already confident with calculations (n=3), don't find it useful (n=6), adequate training already provided in workshops (n=4), do not prefer e-learning (n=3),

Factors that would encourage use of the package

After Stage 1 factors highlighted were: make available as a mobile phone application 26% (n=36), a tutor led session to introduce the e-package 5% (n=7), will be used nearer to the final exams 3% (n=4), more reminder and promotion from lecturers 6% (n=9). Similarly in Stage 2, upcoming exams were stated by a majority (62%, n=139) as a factor that would encourage use of the package.

Overall design of the package

In Stage 1 the modal response for each design feature was 'Good' as shown in Table III.

Similarly in Stage 2 when asked about overall design, the modal response was good 50% (n = 113) with 26% (n= 58) of respondents choosing "very good" and no students choosing "poor" or "very poor".

Table III: E-package design rated by the students (Stage 1)

	Very Good	Good	Average	Poor	Very Poor
Layout (N=233)	24%	56%	17%	3%	0%
Imagery (N=229)	18%	49%	27%	6%	0%
Navigation (N=229)	24%	44%	25%	7%	0%
Interactiveness (N=229)	19%	52%	24%	4%	1%
User Friendly (N= 230)	22%	52%	20%	5%	1%

Worked examples

In Stage 1, the majority (91%, n=213) of students made use of the worked examples and 94% (n= 201) found the worked examples helpful or very helpful. 72% (n=152) said they would prefer more worked examples per topic.

The majority of students, 64% (n=137) used the worked examples before attempting the practice questions for each topic, 23% (n=48) used them when they got stuck on a question and 13% (n=28) after attempting the calculations for each topic. 44% (n=101) found the hints provided to solve each question to be helpful all of the time, while others 43% (n=97) found the hints to be helpful some of the time.

The majority (over 50%) (n=100) of students found all five attributes of the worked examples; sound, video, speed, legibility and explanation to be at a "Good" level.

Practice Questions

Across both stages, 93% (n=421) of students found the topics to be relevant to their course. At Stage 1, 46 % (n=103) found the questions hard or very hard, whilst 52% (n=117) found the difficulty level average with the rest finding them easy. At Stage 2, 81% (n=176) stated that the questions were suitable to their levels of study.

Future use of the package

In Stage 1, 92% (n=206) of students said they would use the e-package again for the purpose of revision, 51% (n=115) to clarify questions that they did not understand in class. 34% (n=77) of students said they would use the package in future years of study, while 49% (n=110) of students said they would use the package to prepare for the GPhC registration exam.   Similarly in Stage 2, 93% (n=211) said they would use the package again.

Potential for improvements to the package

In Stage 1, 118 students made suggestions for improvements. 28% (n=33) suggested increasing the number of practice questions available for each topic, 24% (n=28) wanted more examples, 27% (n=32) wanted fully explained answers with the solutions. Similarly in Stage 2, 55% (n=123) wanted more practice questions, 46% (n=101) wanted more worked examples. Other suggestions included adding a timer facility (49%, n=109), adding a quiz 46%, n=102) and making the e-package available on smart-phones (52%, n=116)

Confidence in pharmaceutical calculations

Prior to release of the package in Stage 1, 43% (n=155) of students described themselves as either very confident or confident with pharmaceutical calculations, while 40% (n= 145) were neither confident nor unconfident and the remaining 17% (n=61) were either unconfident or very unconfident. Following release of the package no student declared themselves unconfident or very unconfident. Figure 3 illustrates the difference in students' confidence level regarding their ability to perform pharmaceutical calculations before and after using the e-package.

Figure 3: Students' level of confidence pre and post release of the e-package in Stage 1

■ Pre-package confidence level N=361

■ Post-package confidence level N=222
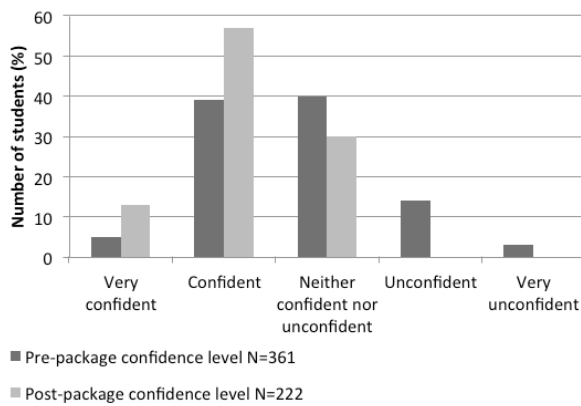
Similarly in Stage 2, when asked to rate the impact of the e-package on students' confidence with respect to their pharmaceutical calculations, 87% (n=197) felt their confidence had improved as shown in Figure 4.

Figure 4: Ratings of the impact of the e-package on students' confidence regarding pharmaceutical calculations
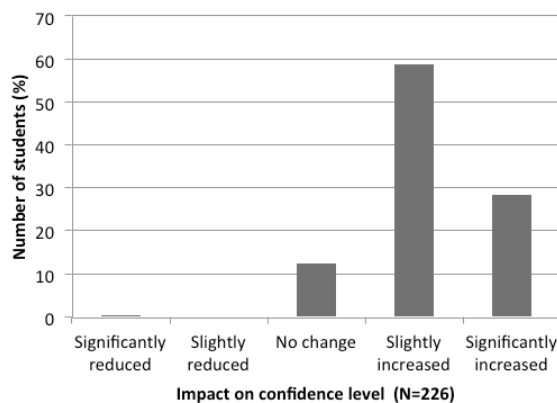
Overall 91% (n=413) of students felt the e-package was either helpful or very helpful and after Stage 2, over 80% (n= 181) students agreed that the e-package is a good learning tool.

Discussion

There are variations between individuals in learning styles and preferences and e-learning has a place. Various studies have highlighted the advantages of using blended learning over the traditional approaches used to teach calculations in nursing and pharmacy students (Wright 2008; McQueen *et al.,* 2010; Powers *et al.,* 2010; Rutter & Watts, 2010; Bergen *et al.,* 2011; McMullan *et al.,* 2011; Nutan & Demps, 2014).

This study has shown evidence for the e-calculations package to have a positive impact and agrees with the literature. The quizzes at both Stages clearly showed significant improvement in scores after release of the e-package. The surprising decrease in scores for the dose conversion question in Stage 1 might possibly be due to students' ability to locate the dose conversion information in the BNF rather than the calculation itself. In Stage 2, there was lack of use of the package between Quiz 1 and Quiz 2 due to the limited time period and overlap with other assessments the students had. The initial time period was also not close to university exams and Objective Structured Clinical Examinations (OSCEs) which are still the main driver of use.

The tight timescale and key assignment deadlines meant not all students who would want to use the e-package got a chance, however those that did were very positive about the structure, design, ease of use and impact on their calculation competency.

This study has shown the pharmaceutical e-calculations package to be a useful support material to assist students learning. It cultivates and re-enforces most students' level of competency with increases in numbers scoring 40-69% and 70+% of 14% and 16% respectively at Stage 1 and 61% (n=47) improved scores at Stage 2 .It also enhances student confidence in performing pharmaceutical calculations (70% (n=155 out of 222) post package vs 43% (n=155 out of 361) pre-package at Stage 1 and 87% (n=197) post package at Stage 2 were confident or very confident).

The study has some important limitations. First, there was no control group as it was considered inappropriate in this subject area related to patient safety to deny access to the e-package by random allocation. It is not known therefore how the same cohort of students would have performed in the quizzes without access to the package. Another pathway of additional calculations assistance was not developed so different methods of support were not compared. Second, it is difficult to know whether the improved performance is entirely due to use of the e-package as students may well have used other calculations resources already accessible to them for practice such as module workbooks and published calculations books. Thirdly, self-reporting and non-response bias may have had some impact on the positive response however all responses were anonymous.

To our knowledge this is the first structured e-package developed in a school of pharmacy using the pen and pad technology (IP distribution and transfer are currently restricted).

This technology aids audio and visual support for working through calculations and self-assessment. The e-package was designed to support basic and specific pharmaceutical calculations. Crucially it is not module specific. It is expected that this tool will increase confidence with essential mathematical concepts of both students and recent graduates preparing for registration exams. The structure of the questions in the package is similar to the new GPhC registration exam which came into force for the first time in June 2016. All current

pharmacy undergraduates will sit this new exam which will no longer be using multiple choice questions for the main calculations paper.

Wright (2007) concluded that healthcare students make mistakes in carrying out basic arithmetical calculations and lack understanding of the mathematical or clinical concepts to be applied. Whilst the use of calculators assisted in speeding up basic calculation processes and helped when a lack of basic mathematical skills was an issue they did not help when the problem was an inability to conceptualise the calculation. Currently the e-package is structured by calculation type, it will thus be important in ongoing development to add to or modify the package so that examples require the students to conceptualise the calculation and then apply their knowledge to find an answer. This will be done with the addition of mixed topic quizzes and currently questions are being added which combine calculation types within a given question and include use of Summary of Product Characteristics (SPC) extracts.

Acknowledgements

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Appendices

Appendix A: Stage 1 Pre and Post Quiz Questions

Pre-package Quiz

1. A patient has been taking oral morphine 30mg every 4 hours. The patient now needs to be put on a subcutaneous infusion of diamorphine providing an equivalent dose over a 24hr period. What dose of subcutaneous diamorphine given over 24hr should the patient receive?

2. Calculate the BMI for Mr. Jones. He is 165cm tall and weighs 70kg.

3. How much diluent would you need to mix with the alclometasone dipropionate 0.05% cream to make 60g 0.015% alclometasone dipropionate cream?

4. A patient weighing 70kg is to be given an infusion of drug X at a dose of 5micrograms/kg per minute. The drug is available in a 25ml container at a strength of 2.5mg/mL in Sodium Chloride 0.9%. What is the appropriate rate of infusion in mL/h?

5. What is the exact number of prednisolone 5mg tablets you should dispense for this prescription: take 30mg prednisolone tablets daily for 5 days, then reduce by 5mg every 3 days until the course is finished?

Post-package quiz

1. Dr Jones has a patient taking dexamethasone 6mg daily. He wants to convert the patient onto methylprednisolone to give an equivalent anti-inflammatory dose. What would be the total daily dose of methylprednisolone required to the nearest mg?

2. Calculate the BMI for Mr. Singh. He is 180cm tall and weighs 85kg.

3. How much potassium permanganate 1 in 1000 solution would you need to prepare 500mL of a 0.01% w/v solution?

4. You are required to administer 0.6 litres of Normal Saline over 5 hours at a rate of 20 drops/ml. How many drops per minute are required to start the flow rate off at the correct rate?

5. What is the exact number of tablets you should supply for this prescription: Take 40mg prednisolone daily for 7 days, then reduce by 5mg every 5 days until the course is finished?

Appendix B: Stage 2 Quiz questions

Quiz 1 – Pre-Package

1. You receive a prescription with the following;
   Dexamethasone   8 mg bd-5days then, 8 mg od for 5 days then 6 mg od for 5 days then, 4 mg od for 5 days then mg od for 10 days then stop

2. What weight of a substance is required to make 250ml of a solution such that 10ml diluted to 1L will give a 1 in 10,000 solution?

3. You receive a prescription for Betamethasone Ointment 0.05 % and you only have 0.1 % ointment in stock. How much of the stock product do you need to use to make 40 g Betamethasone Ointment 0.05%?

4. A patient weighing 70kg is to be given an infusion of drug X at a dose of 5 micrograms/kg per minute. The drug is available in a 25ml container at a strength of 2.5mg/mL in Sodium Chloride 0.9%. What is the appropriate rate of infusion in mL/h?

5. How many grams of potassium chloride are needed to prepare 500 mL of a solution containing 6 mmol of potassium ions per 5 mL spoonful? [atomic weight of potassium = 39; atomic weight of chlorine = 35.5]

Quiz 2 – Post Package

1. What is the exact number of tablets you should supply for this prescription: Take 40mg prednisolone daily for 7 days, then reduce by 5mg every 5 days until the course is finished?

2. What weight of a substance is required to make 500ml of a solution such that 5ml diluted to 1L will give a 1 in 5,000 solution?

3. How much diluent would you need to mix with the alclometasone dipropionate 0.05% cream to make 60g 0.015% alclometasone dipropionate cream?

4. A patient weighing 80kg is to be given an infusion of drug C at a dose of 6micrograms/kg per minute. The drug is available in a 50ml container at a strength of 2.4mg/ml in glucose 5%. What is the appropriate infusion rate in mL/hr?

5. How many grams of potassium chloride are needed to prepare 500 mL of a solution containing 5 mmol of potassium ions per 5 mL spoonful? [atomic weight of potassium = 39; atomic weight of chlorine = 35.5]

Quiz 3 – Post Package

1. A patient has been taking oral morphine 30mg every 4 hours. The patient now needs to be put on a subcutaneous infusion of diamorphine providing an equivalent dose over a 24hr period. What dose of subcutaneous diamorphine given over 24hr should the patient receive?

2. What weight of a substance(g) is required to make 650ml of a solution such that 3.25ml diluted to 500ml will give a 1 in 2,000 solution?

3. What volume of water (mL) should be mixed with 80% ethanol to prepare to prepare 400mL 30% ethanol?

4. A patient weighing 60kg is to be given an infusion of drug X at a dose of 7micrograms/kg per minute. The drug is available in a 30ml container at a strength of 3.5mg/mL in Sodium Chloride 0.9%. What is the appropriate rate of infusion in mL/h?

5. What is the exact number of prednisolone 5mg tablets you should dispense for this prescription: take 30mg prednisolone tablets daily for 5 days, then reduce by 5mg every 3 days until the course is finished.

Appendix C: Stage 1 questionnaire

1. How would you rate your confidence with respect to pharmaceutical calculations?

Very Confident	Confident	Not very confident	Not confident
☐	☐	☐	☐

2. How satisfied are you with the pharmaceutical calculation training you receive within the professional practice modules?

Very Satisfied	Satisfied	Neither Satisfied or Dissatisfied
☐	☐	☐

Dissatisfied	Very Dissatisfied
☐	☐

3. Did you use the pharmaceutical calculation e-package?
   Yes ☐   No ☐ If not please move to section 6

Section 1: E-package design

4. How would you rate the design of the e-calculation package?

	Very good	Good	Average	Poor	Very poor
Layout	☐	☐	☐	☐	☐
Imagery	☐	☐	☐	☐	☐
Navigation	☐	☐	☐	☐	☐
Interactiveness	☐	☐	☐	☐	☐
User friendly	☐	☐	☐	☐	☐

5. Did you make use of the facility to customise your screen? E.g. screen size, front size etc.
   Yes ☐   No ☐

6. Were the instructions and information at the beginning of the package easy to understand?
   Yes ☐   No ☐

7. Did you experience any technical issue with the package? E.g. unable to navigate through screens
   Yes ☐   No ☐

If you answered yes, please tell us what problems you encountered:

[ ]

Section 2: Worked examples

8. Did you use the worked examples?
   Yes ☐   No ☐ Please move to section 4

9. How helpful were the worked examples?
   Very helpful   Slightly Helpful   Neither helpful or unhelpful   Unhelpful
   ☐   ☐   ☐   ☐
   Very Unhelpful
   ☐

10. Was one worked example sufficient for each topic?
    Yes ☐   No, more examples should be provided ☐

11. At which point did you go through the worked examples?
    Before attempting the calculations for each topic ☐ When I got stuck on a question ☐
    After attempting the calculations for each topic   ☐

Section 3: Voice over

12. Please rate the following:

	Very Good	Good	Average	Poor	Very poor
Quality of the voice over	☐	☐	☐	☐	☐
Quality of the video	☐	☐	☐	☐	☐
Speed of the narration	☐	☐	☐	☐	☐
Eligibility of the handwriting	☐	☐	☐	☐	☐
Explanation of the solution	☐	☐	☐	☐	☐

Section 4: Pharmaceutical Calculations

13. Do you feel the topics in the e-package are similar and relevant to those you encounter in the MPharm course?
    Yes ☐   No ☐

14. How would you rate the difficulty of the questions within the package?
    Very hard ☐   Hard ☐   Average ☐   Easy ☐   Very easy ☐

15. Did the hints help you get to the correct answer?
    Yes ☐   No ☐

16. Are there enough practice questions for each topic?
    Yes ☐   No, should be more ☐   No, should be less ☐

17. Are there any other pharmaceutical calculation topics you would specifically like this package to include? If any please state:

[ ]

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18. How would you like to improve the e-package in the future? E.g. more basic calculations questions, written solution of the questions, specific hints

[ ]

Section 5: Overall view of the e-package

19. How helpful did you find this e-package?
    Very helpful   Slightly Helpful   Neither helpful or unhelpful   Unhelpful
    ☐   ☐   ☐   ☐
    Very Unhelpful
    ☐

20. What were your expectations before using this package?
    This will really help my pharmaceutical calculations   ☐
    No expectations, I've been told to look at it, so I will   ☐
    I am already confident with my pharmaceutical calculations   ☐

21. After using the package, how were your expectations met?
    Exceeded my expectations ☐   Met my expectations ☐   Did not meet my expectations ☐

22. How would you use this package again (More than one option can be selected)
    Clarify questions encountered in class   ☐
    Revision   ☐
    In further years of study   ☐
    For the pre-registration exam   ☐
    Would not use this package again   ☐
    Other please specify:

[ ]

If you wouldn't use this package again then please let us know the reasons why:

[ ]

23. How would you rate your confidence with respect to pharmaceutical calculations after using the e-package?
    Very Confident   Confident   Not very Confident   Not confident
    ☐   ☐   ☐   ☐

24. Would you like to have a similar e-learning package in other modules?
    Yes ☐   No ☐

Section 6

25. Why did you not use the pharmaceutical calculation e-package?
    Already confident in calculation ☐   Prefer to learn from books   ☐
    I didn't have enough time   ☐   I don't find e-package learning helpful ☐
    Lack of access to a computer   ☐   Difficult to use   ☐
    Other please specify:

[ ]

26. What would encourage you to use an e-package? E.g. accessibility on the phone, being able to work the answers on the screen

[ ]

Section 7: Overall

27. How would you like to improve the teaching of calculation skills within the professional practice modules? (More than one option can be selected)

Workshops ☐	Practical's ☐
Online resources- study space ☐	Homework ☐
Tutorials ☐	E-packages ☐
Quizzes ☐	Sample Questions for referral ☐
Calculation based games ☐	

28. Would you have used this package if it was a mobile phone app?

Yes ☐   No ☐

29. Which pharmaceutical calculations do you need more training with? (More than one option can be selected)

Converting units of measurement ☐
Expressing Concentrations ☐
Dilutions ☐
Extemporaneous Formulae ☐
Calculation of Doses ☐
Displacement Values ☐
Molecular Weights ☐

30. What stage of study are you currently in?

Year 1 ☐   Year 2 ☐   Year 3 ☐   Year 4 ☐   OSPAP ☐

31. Are you

Male ☐   Female ☐

32. What is your age range?

18-21	22-25	26-30	31-39	40+
☐	☐	☐	☐	☐

33. Please feel free to give any other comments regarding the e-package: e.g. any improvements or problems encountered what you would change or what you really liked about it.

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Thank you for taking the time to participate in this survey, your feedback is much appreciated

Appendix D: Stage 2 Questionnaire

1. How helpful did you find this e-package?

Very helpful	Helpful	Neither helpful nor unhelpful	Unhelpful
☐	☐	☐	☐

Very unhelpful
☐

2. How did you feel about this e-package? (More than one option can be selected)

A good learning tool ☐	Too complicated to use ☐
Time consuming ☐	User-friendly ☐
No comments ☐	

3. How did you rate the overall design of the e-package? E.g. layout, voice-over etc.

Very good	Good	Average	Poor	Very Poor
☐	☐	☐	☐	☐

4. Why did you use this e-package? (More than one option can be selected)

Exam or test is coming up ☐	I felt unconfident on certain topics ☐
Lecturer's recommendation ☐	I need more calculation practice ☐
I have been told to do so ☐	

Other please specify:

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5. Will you use this e-package again?

Yes (Please move to Q7) ☐   No (Please continue on Q6) ☐

6. Why wouldn't you use this e-package again? (More than one option can be selected)

Already confident with calculations ☐	Do not prefer e-learning ☐
Don't find it useful ☐	No access to computer ☐
Adequate training already provided in workshops ☐	

Other please specify:

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7. How would you rate the improvement of your pharmaceutical calculation skills after using this e-package?

Significantly improved	Slightly improved	No improvement
☐	☐	☐

Slightly unimproved	Significantly unimproved
☐	☐

8. How would you rate the impact of this e-package on your confidence with respect to pharmaceutical calculations?

Significantly increased	Slightly increased	No change	Slightly reduced
☐	☐	☐	☐

Significantly reduced
☐

9. How would you like to improve the e-package in the future? (More than one option can be selected)

Add timer facility ☐	Add a quiz at the end ☐
Make it available on smart-phones ☐	Add more practice questions ☐
Add more worked examples ☐	

Other please specify:

```



```

10. Do you feel the topics in this e-package are similar and relevant to those you encounter in the MPharm course?

Yes ☐   No ☐

11. Do you feel the difficulties of questions in this e-package are suitable to your level of study?

Yes ☐   No, it is more difficult. ☐   No, it is less difficult. ☐

12. How long did you spend on this e-package during your last visit? (If you have visited more than 1 time then please tick the average)

Less than an hour	1-3 hours	4-6 hours	More than 6 hours
☐	☐	☐	☐

13. How many times have you visited the e-package?

1	2	3	4	5 or more
☐	☐	☐	☐	☐

14. What year group are you in?

Year 1	Year 2	Year 3	Year 4	OSPAP
☐	☐	☐	☐	☐

15. What is your gender?

Male ☐   Female ☐

16. What age group are you in?

18-21	22-25	26-30	31-39	40+
☐	☐	☐	☐	☐

17. Please feel free to give us any further comments regards the e-package:

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┌─────────────────────────────────────────────┐
│                                               │
│                                               │
│                                               │
│                                               │
└─────────────────────────────────────────────┘
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Thank you for your time, your feedback is much appreciated.