

## **Health Sciences and Practice Mini Project**

**Final report on Reusable Learning objects in a post-registration, nurse  
prescribing course (ROWEN)**

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# **Final report on Reusable Learning objects in a post-registration, nurse prescribing course\* (ROWEN)**

**LTSN/HEA mini project Phase 6**

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## **Abstract**

Evaluations from students on a non-medical prescribing course and concerns from tutors about the students' level of understanding of pharmacology concepts were addressed by developing a series of web based reusable learning objects (RLOs). These are small chunks of highly visual, multimedia elearning. RLOs were gradually introduced to successive cohorts to reinforce the face to face sessions. For these students many of whom had not studied biology for many years, the value of the RLOs was in their highly visual explanations and being able to go over the material time and again until it was understood. Student feedback about each RLO and learners' perceptions of their understanding of the pharmacology concepts in successive cohorts were measured using questionnaires. Students were also asked to give an example of how the learning about pharmacology had impacted on their practice in the clinical setting in the questionnaire and in follow up telephone interviews. Learning effectiveness was measured by comparing examination scores between the cohorts.

When RLOs were available on a pharmacology concept no learners rated their understanding as bad or very bad and the distributions describing how well the students understood the concepts shifted to the right (towards well/verywell) in successive cohorts as more RLOs were introduced to the course. Results reported in this study show that the RLOs have been reused at number of levels.

Telephone interviews (n=10) one year after students had completed the course revealed that 50% had used the RLOs again having returned to nursing practice and 50% had recommended the RLOs to other colleagues. There is evidence from online feedback forms that the RLOs are being used by many institutions.

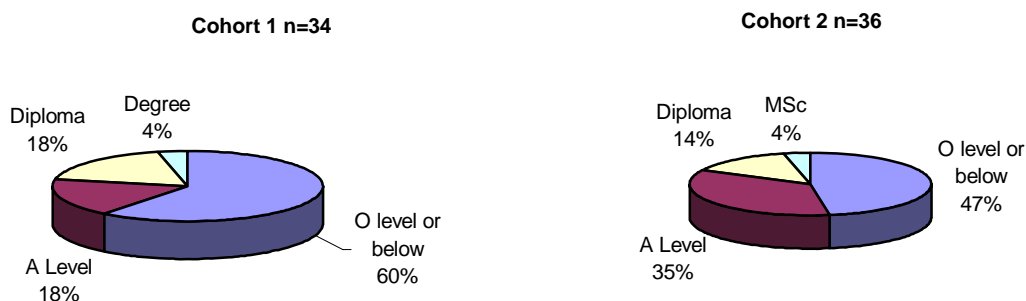
## 1.0 Introduction

The School of Nursing at the University of Nottingham is running an accredited programme of education to prepare non-medical health professionals\* to prescribe. There are three intakes per year (approximately 40 students per cohort). This has implications for resourcing in terms of staffing and accommodation especially as the current structure and delivery of the course requires students to attend the university for 26 days over a 5 month period. The module attracts 20 credits, this is also under review because of the high contact hours. The course covers areas including pharmacology, prescribing, clinical examination and law and ethics.

The students come from a range of clinical settings and bring with them specific expertise/skills from primary, secondary and tertiary care. These are mature students who have been outside mainstream education for a number of years and some have expressed difficulty understanding the pharmacology component of the course. Nurses have always needed a sound biological knowledge to carry out their work safely and effectively (Clarke, 1995), but the advent of extended roles for nurses makes this all the more crucial. There is evidence that nursing students find the learning of biological sciences difficult for a variety of reasons (Trnobranski, 1993; Chapple et al, 1993; Wharrad, 1994) and this leads to potential problems when they come to apply their knowledge in a clinical setting.

Biological sciences (including pharmacology) is covered in nurse training courses but the level and amount was shown to be highly variable (Wharrad et al, 1994). Many of this post-registration group started the module with only an O level standard biological science qualification.

Figure 1 Biological sciences qualifications in students on a nurse prescribing course during 2004-2005 academic year.



\*At the time of the study the course was for nurses, the course now running is for non-medical prescribers

### 1.1 Computer access & Use

30%-40% of the students in the nurse prescribing groups expressed a level of anxiety about using computers. Around 70% had the use of a computer at home and 46% had use of the web at home. 90% regularly used the web for their studies.

### 2.0 Student perceptions of difficulties and needs

Evaluations have indicated that students find the pharmacology component of the course difficult. The following quotes illustrate the difficulties experienced.

*"We needed more time on each aspect [of Pharmacology] until factors were absorbed and understood!!" (cohort 1)*

*"This course is aimed at nurses experienced in their field by definition these nurses will be SRN/RGN trained – pharmacology was not studied and if it was it was some considerable time ago" (cohort 1)*

*"I have always struggled with 'biology' etc so its not the lecturers' fault that I do not understand the sessions. I will revise at my own pace." (cohort 1)*

Students in an early cohort of the course were asked to rate their understanding of some of the core concepts of pharmacology at the end of the course. A summary of their perceptions are shown in Table 1.

Table 1 Students' self reporting of understanding of pharmacology concepts (n=34)

	Very well/well	Neither well not badly	Badly/Very badly
Bioavailability	38%	50%	12%
Drug excretion	18%	61%	21%
Drug metabolism	27%	55%	18%
First pass metabolism	29%	44%	27%

Although up to 38% of the cohort reported that they understood some of the concepts well or very well, the course leaders were concerned that some of the students were clearly struggling with the material. This raises concerns about whether the students will be competent in their prescribing role in practice. Concerns about whether nurses and other nonmedical prescribers need more comparable amounts of pharmacology knowledge and training as their medical colleagues have been reported (Duffin & Yu, 2002; Larson, 2004).

When asked 'How could the pharmacology component of the course be strengthened?' students offered the following suggestions.

*"videos of material eg synapse, metabolism etc"*

*"To be explained in a more basic way to help us digest the knowledge at a slower pace"*

### **3.0 Intervention**

Reusable learning objects (RLOs) are discrete units of learning that can be integrated into a formal lecture or used individually to aid revision or background knowledge (Leeder, Wharrad & Davies, 2002; Wiley, 2000; Gilbert, 2000). There are many definitions of RLOs and discussions about the benefits and limitations of size. Our working definition of an RLO is:

*"an interactive WWW-based resource based on a single learning objective which can be used in multiple contexts"*

(School of Nursing Educational Technology Group  
[www.nottingham.ac.uk/nursing/sonet/rlos](http://www.nottingham.ac.uk/nursing/sonet/rlos))

RLOs may be presented in different formats to suit individual learning styles, to maintain interest and optimise learning, and to address disability issues and technological constraints. This will enhance learning as students can work on difficult aspects at their own pace and revise materials prior to main lectures. RLOs are therefore useful for personalised learning and to address differentiation (which was a problem in this course). High quality graphics and audio are used in the RLOs to help engagement with the material and to facilitate learning. Up-dating material is always an issue: it's much easier and more cost effective to update a single RLO than large CAL packages or whole modules.

By making some core components of the course accessible to the students from their workplace or home via the web (only 46% of the students in this study had access to the web from home but it is anticipated this will rise in future groups) also had a number of advantages:

- reduce the number of trips into the university
- saving on space and staffing
- opportunities for revision
- providing a good foundation for future lectures
- working at own pace
- fitting into the structure of their clinical work

### 3.1 Support

Funding was obtained from the University of Nottingham Staff & Education Development Unit to produce the first three of 20 RLOs needed to support the Nurse Prescribing course (£9750). A second funding stream of £35000 to complete the development was reduced to £5000 this delayed the production of the full set of RLOs however 9 were produced. The HEA/LTSN miniproject grant was used to evaluate the embedding of the RLOs into the prescribing course and was used to employ a research assistant to carry out the telephone interviews. The RLOs can be viewed at <http://www.nottingham.ac.uk/nursing/sonet/rlos> under the pharmacology theme. Our involvement in the Universities Collaboration in Elearning (UCeL) meant that we also had access to a media hub at Cambridge; some of the RLOs produced therefore have the UCeL badge.

### 3.2 RLO Development framework

The development process was based on the UCeL framework; details can be found at [www.uce.ac.uk](http://www.uce.ac.uk). The process involved peer expert review at 2 stages and formative student evaluation prior to use with student groups. The general format and designs of the RLOs are shown in the screenshots below.

### Screen shots of Pharmacology RLOS

The screenshot shows a web browser window with the following content:

- Browser Title:** Pharmacology: Half-life of Drugs - Microsoft Internet Explorer
- Address Bar:** D:\pharmacology\bioproc\halflife\index.html
- Page Header:** UCeL Reusable Learning Object
- Section Title:** Pharmacology: Half-life of Drugs
- Introduction Text:**

The duration of action of a drug is known as its half life. This is the period of time required for the concentration or amount of drug in the body to be reduced by one-half. We usually consider the half life of a drug in relation to the amount of the drug in plasma. A drug's plasma half-life depends on how quickly the drug is eliminated from the plasma. A drug molecule that leaves plasma may have any of several fates. It can be eliminated from the body, or it can be translocated to another body fluid compartment such as the intracellular fluid or it can be destroyed in the blood. The removal of a drug from the plasma is known as **clearance** and the distribution of the drug in the various body tissues is known as the **volume of distribution**. Both of these pharmacokinetic parameters are important in determining the half life of a drug.

Here is the symbol to represent the half-life:  $t_{1/2}$
- Video Player:** A video player showing a clock face with the text 'UCeL Paracetamol' overlaid.
- Page Footer:** © 2004 School of Nursing & Midwifery, University of Nottingham. Developer: Fred Riley. Content author: Heather Wharrad.

RLO - Pharmacology: Bioavailability (Activity) - Microsoft Internet Explorer

Address: D:\pharmacology\bioproc\bioavailability\05b.htm

**UCeL**  
Reusable Learning Object

**Pharmacology: Bioavailability**

Introduction Drug Properties Physiology Medicine Properties Bioavailability **Activity** Assessment Resources

**Activity**

Look at the two dose curves again. Estimate the bioavailability of the oral drug by comparing the areas beneath the two curves.

You have a choice of four values. Once you have made your judgement click on your choice to discover if you have estimated correctly.

25%  
50%  
75%  
100%

pre next

Page created: 16 January, 2004  
Last updated: 28 April, 2004 6:01 PM  
By: [Gareth Peever](#), [Mark Foss](#)

Done

start LTSN\_ROWEN r... Rowen bioavailability nurseprescrib\_3... Nurse Prescchar... RLO - Pharmacol... 16:28

### **3.3 RLOs developed**

The RLOs listed below have been completed as part of this project.

- Exploring the synapse
- First pass metabolism
- Understanding half life
- Understanding bioavailability
- The lock & key hypothesis
- Excretion of drugs in the kidney
- Drug metabolism in the liver
- Drug receptor interaction
- Plasma proteins in drug binding

## **4. Evaluation Study**

### **4.1 Aims and Objectives**

Aim: to determine the educational value of RLOs introduced into a classroom based nurse prescribing course.

Objectives:

1. To determine student evaluations of RLO content, design and usability
2. To monitor learner satisfaction with the pharmacology component of the course in successive cohorts following the phased introduction of RLOs.
3. To identify any application of RLO learning to nursing practice during or after the programme
4. To obtain views from the nurses on the impact of RLO learning on practice one year after the programme.

### **4.2 Methods**

All students (n=110) entering the course between January 2004 and September 2005 were included in the study. The study protocol was explained to all students. The students were given the opportunity not to be included in the study; this did not influence in any way their progress on the course. The first cohort followed the standard course module that the previous cohorts had followed ie students were provided with book lists, weblinks and some general CAL materials, but no RLOs were provided to supplement the pharmacology learning. The second (treatment cohort) received the same course but with the introduction of 4 RLOs ('Exploring the Synapse'; 'Bioavailability', 'Half life' and 'First Pass Metabolism') that could be accessed by the student at any time during the course. They were introduced to the students during the pharmacology element of the course in a computer lab session, this ensured that students were aware of all the learning objects available to them and that they could find them on their internet browser. Any technical or navigation

problems were dealt with in this session. No students contacted us with any problems accessing the RLOs after the session when using them at home or unsupervised in the university or in the workplace although some did come to light in the questionnaires (see 5.1.1).

The second series of RLOs completed for cohort 3 were 'Lock and Key hypothesis', 'Plasma proteins', 'Drug excretion in the kidney' and 'Drug metabolism in the liver'. The writer of the excretion and metabolism RLOs decided that 4 introductory RLOs on the anatomy and physiology of the liver and kidney were required. These were available to students but were not included in the evaluation study.

### **4.3 Data collection and tools**

Data were collected from 3 successive cohorts at the same time points in the course. Participants who did not attend the class on that occasion were asked to complete the questionnaire at the following session. The questionnaires were distributed by the pharmacology lecturer (who was not one of the investigators). The following methods were used to address objectives 1-4 (section 4.1).

#### **4.3.1 Student evaluations of RLOs**

Students views were obtained using standard RLO evaluation questionnaires (see [www.ucel.ac.uk](http://www.ucel.ac.uk)) comprising 29 fixed response questions and 3 open response text boxes asking 'What did you like about this RLO?', 'How could the RLO be improved?' and 'Any further comments?'. The fixed response questions used a 6 point scale using the descriptors 'Not applicable', 'Strongly Agree', 'Agree', 'Neutral', 'Disagree' and 'Strongly Disagree'. These questions were arranged into 5 sections: access to computers, usability, look and feel, content and reuse. Students were also asked to record the time taken to work through the RLO.

#### **4.3.2 Learners' perceptions of their understanding of the pharmacology concepts**

Learners' perceptions of their understanding of the pharmacology concepts were measured in successive cohorts using a questionnaire. The questionnaires were distributed at exactly the same time point at the end of the course for each cohort. The questionnaire asked students to rate their understanding of the core concepts in pharmacology. Students who received the RLOs were asked to rate the value of the RLOs for pharmacology learning against other resources (Table 5 section 5.3.1).

#### **4.3.3 The application of pharmacology RLO learning**

Students were asked to give an example of how the learning about pharmacology had impacted on their practice in the clinical setting

in the questionnaire given above. This was also one of the questions asked in the follow up interviews (see 4.3.4).

#### **4.3.4 The student's perceptions of the impact on their practice of RLO learning in pharmacology.**

This was explored in the telephone interviews one year after completion of the course. The questions asked in the interview were:

*(i) Do you recall/Did you use the RLOs that supported the course/Did you have any problems accessing them?*

*(ii) What properties of the RLOs helped your learning? (prompt media components. Verbal, visual, diagrams, animations ...)*

*(iii) Have you used the RLOs again? (when, how often..?)*

*(iv) Have they had any impact on your practice?*

*(v) Do you see any value in this method of teaching pharmacology?*

*(vi) Have you used other RLOs?*

*(vii) Have you recommended the RLOs to others?*

*(viii) Would you like to see more developed? What topics would you like to see developed as RLOs?*

*(ix) Do you have any suggestions for improvement of the RLOs?*

*(x) Do you feel confident in your understanding of the pharmacology of the drugs you prescribe?*

*(xi) What is your highest biological science qualification?*

#### **4.3.5 Learning Effectiveness**

This was measured by comparing examination scores between the cohorts.

## 5.0 Results

### 5.1 Student evaluations of RLO content, design and usability

Students spent on average 8-15 minutes working through the RLOs. Table 2 shows the time spent on each of 4 RLOs. Other RLOs in the pharmacology series were of similar length (Table 2).

Table 2 Length of time taken for students to complete RLOs

RLO	Mean time (mins)	SD	N
Half life	15	6	17
Bioavailability	14	6	17
Synapse	9	4	20
First Pass	8	3	19

Student ratings of the usability, design, content and structural aspects are shown in Table 3. Questions also referred to the perceived educational value of the RLOs. The results have been pooled for the first four RLOs developed in the pharmacology series. The pattern of results looked the same for the other RLOs and for the questions 'I enjoyed being able to work at my own pace' and 'I like the idea that I can access this RLO whenever I need to'.

**Table 3 Student ratings of attributes of RLOs (n=137)**

**a. Usability**

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A missing
The RLO was easy to use	54 39%	73 53%	6 4%	2 4%	0	2 2%
The RLO was easy to navigate. I felt in control	58 42%	70 51%	5 4%	2 2%	0	2 2%
The RLO was well structured and easy to follow	65 47%	64 47%	6 4%	1 7%	0	
I liked the look and feel of the RLO	46 34%	64 47%	19 14%	4 3%	1 7%	

**b Media attributes and size**

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A missing
The images and animations were valuable components of the RLO	66 48%	62 45%	7 5%	1 7%	0	0
The on screen text was useful and helped me assess the amount of information each section contained	38 28%	74 54%	12 9%	1 1%	0	12 9%
The RLO took longer than I expected to complete	8 6%	26 19%	31 23%	50 37%	20 15%	
The narration made the RLO more engaging. I preferred this to text alone	44 32%	60 44%	10 7%	9 7%	0	1

**c. Educational value & learning support**

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A missing
I needed the help of a lecturer to understand the content	7 5%	30 22%	20 15%	38 28%	35 26%	0
The RLO was interesting and engaging	52 38%	72 53%	7 5%	3 2%	0	
The RLO was pitched at the right level for me	36 26%	69 50%	19 14%	7 4%	5 4%	1 1%
I needed more support when using the RLO	5 4%	33 24%	21 15%	42 31%	31 23%	2 2%
The content was appropriate and fitted my learning needs	36 26%	87 64%	10 7%	3 2%	0	
The activity was appropriate and aided my understanding	41 30%	83 61%	8 6%	4 3%	0	
The RLO encouraged me to reflect on the material	31 23%	85 62%	13 10%	3 2%	1 1%	
I am confident that I will be able to use the knowledge gained from this RLO in future practice	46 34%	79 58%	9 7%	2 2%	0	
The self-assessment helped me gauge how well I'd understood the material	51 37%	65 47%	9 7%	6 4%	1 1%	
The RLO has aided my understanding and I feel I have achieved the learning objective	48 35%	75 55%	9 7%	4 3%	0	
The RLO will help me retain the information	53 39%	62 45%	15 11%	2 2%	1 1%	4
I think it's useful to supplement lectures with RLOs like this one	65 47%	52 38%	5 4%	3 2%	0	12
I will use this RLO again	50 37%	62 45%	6 4%	3 2%	2 2%	14
The RLO integrated well with the module and other teaching sessions	39 29%	77 56%	5 4%	2 2%	0	14

Some students made further comments in response to the open questions, for example:

- Exploring the synapse:

*"This one was good to go over and over again until I got it right and for revision"*

*"Diagrams really useful"*

- First Pass metabolism:

*"Liked the visual analogues, fantastic way of learning and remembering"*

- Half life of drugs:

*"Very practical in terms of use/understanding in practice"*

*"Excellent learning tool"*

- Bioavailability:

*"It is a useful tool for revision, particularly being able to pace it and return to material to verify understanding"*

*"Excellent way to learn"*

### **5.1.1 Negative Comments**

Some negative comments were expressed relating to quality assurance and access to the RLOs and the content.

*"Would like to use the computer assisted, thought session was informative – but didn't know how to access from home computer" (cohort 2)*

*"Feedback from RLO as to quality and how correct the content was" (Cohort 3)*

*"Print out of the material displayed – to view later at leisure would have been helpful" (Cohort 3)*

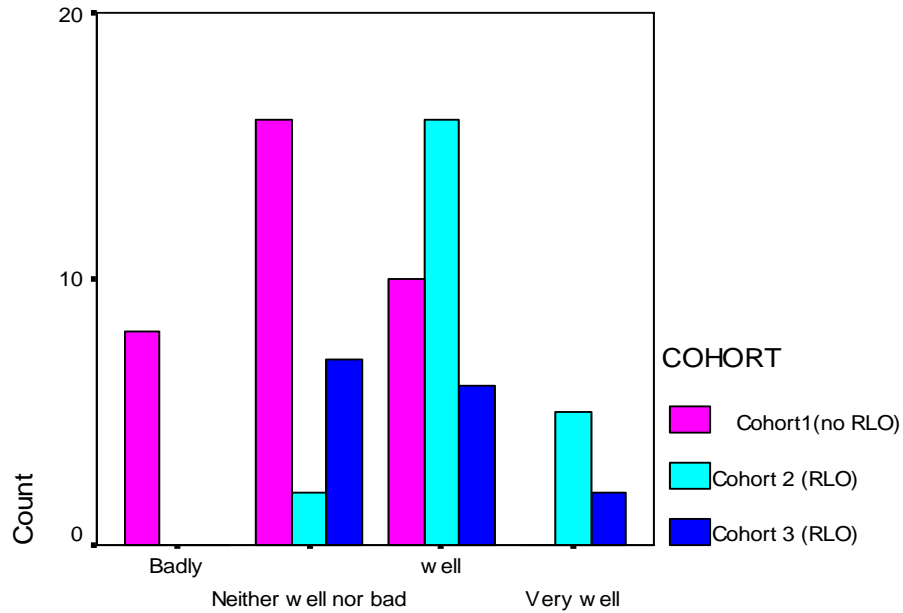
## **5.2. Learners' perceptions of understanding of pharmacology concepts**

Learners' perceptions of understanding of pharmacology concepts were measured in successive cohorts using a questionnaire at the same point at the end of the course. The overall distribution describing how well the students understood the concepts shifted to the right (towards the well/verywell pole) for the cohorts where RLOs were available for learners. When RLOs supported the concept no learners rated their understanding as bad or very bad (Figures 3a-3d).

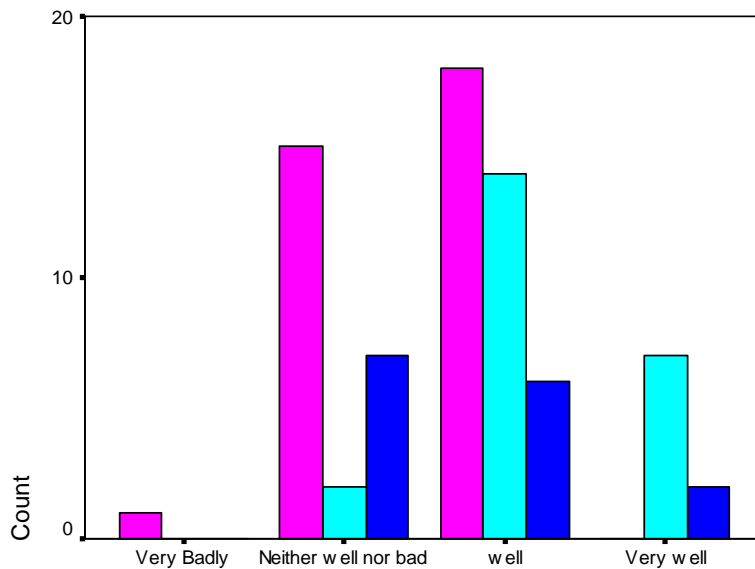
**Figure 3**

**Students perceived understanding of pharmacology concepts on a nurse prescribing course. In 3a. an RLO was available to cohorts 2 and 3. In 3b an RLO was available only to cohort 3**

a.

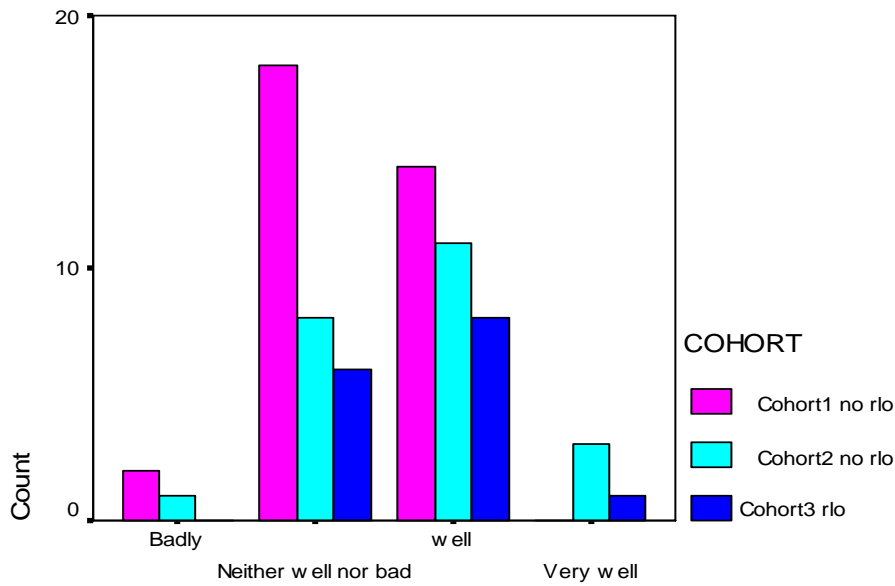


Understanding First pass metabolism

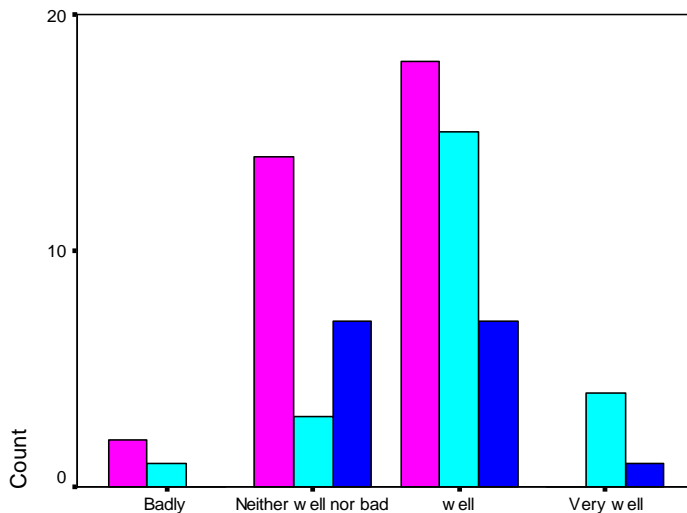


Understanding Half life

b.



Understanding Binding to plasma proteins



Drug receptor interaction

A Kruskal Wallis test was carried out to compare the responses of the 3 cohorts (Table 4). RLOs are listed in the table in order of the biggest differences between the mean ranks. There was a significant difference between the mean ranks of the 3 cohorts in all but 2 RLOs (Lock and Key and Plasma proteins). The biggest difference in mean rank was seen for 3 of the 4 RLOs accessed by 2 cohorts representing the shift in the distribution from left ('Badly' scale) to right ('Well' scale) as demonstrated in Figure 3a for First Pass Metabolism. Questionnaires were returned by 14 students in Cohort 3 so the sample size in this group was smaller than for cohorts 1 (n=35) and 2 (n=25).

**Table 4 Kruskal Wallis test to compare the ratings of perceived understanding of each pharmacology concept between 3 cohorts (2 degrees of freedom)**

RLO	Chi square	p value
First pass metabolism	24.2	0.001
Understanding bioavailability	16.5	0.001
Understanding half life	15.1	0.001
Excretion of drugs in the kidney	13.7	0.001
Drug metabolism in the liver	10.1	0.007
Exploring the synapse	8.6	0.014
Drug receptor interaction	7.7	0.022
Lock and Key hypothesis	5.9	0.053
Plasma proteins in drug binding	3.9	0.142

### 5.3 The application of pharmacology learning

Students were asked in the questionnaires to give example of how they used the RLOs for learning about pharmacology and whether this had impacted on their practice in the clinical setting. Some of their responses are listed below:

*“Reinforced need to take drugs regularly due to my understanding of half lives eg paracetamol” (Cohort 2)*

*“I feel the increase in RLOs (referring to production of more to support the course) will be very useful, I have used these a lot as part of my revision programme – as they help to visualise and interpret different concepts” (Cohort 2)*

*“I have been less impulsive in prescribing decisions, I am more likely to try alternative measures first, rather than just advising medication as I would have done in the past, particularly in the elderly” (Cohort 3)*

#### 5.3.1 Resources used to support learning

Students in cohorts 2 were asked to put in order of priority 6 types of resources they felt best supported them throughout the course (1=best 6=worst). The ‘web resources’ refer to more general weblinks other than the RLOs; and students were also made aware

of larger (than RLOs) CAL packages produced in the School some years ago. Responses were obtained from 11 students (Table 5).

Resource type	Average rank
Lecture notes	1.4
Text Books	1.8
RLOs	2.9
Journals	4.1
Web resources	4.6
CAL	5.2

**Table 5 Ranking of RLOs against other resources to support pharmacology learning**

#### **5.4 The student's perceptions of the impact of RLO learning after the course and on practice.**

7 female and 3 male practitioners who had completed the prescribing course more than one year previously agreed to be telephone interviewed about the RLOs in the prescribing course. Table 6 provides a summary of the results and lists some of the specific student comments.

**Table 6 Summary of responses from previous students one year after the course.**

Sex	Science education not including nurse training	Percieved impact on practice?	Used RLOs after course?	Value of RLO approach to teaching pharmacology?	Would you like to see more developed?	Do you feel confident about your understanding of the pharmacology of the drugs you prescribe?
F	Biology O level	Yes	Yes	Yes	Yes	Yes
F	Human Biology, Chemistry, Physics O level	No	Yes	Yes	Yes	Yes
F	None	Not just RLOs	Yes	Yes	Yes	Yes
F	Human Biology A level; Chemistry, Physics O level	No	No	Yes	Yes	Yes
M	A level human Biology and Chemistry	No	No	Yes	Yes	Yes to a certain extent
F	O level Biology and Physics; some chemistry after leaving school	Yes	No	Yes	Yes	7/10 feel safe enough
F	O level biology, chemistry and physics	No	No	Yes	Yes	Yes
M	Biology O level	N/A	Yes	Yes	Yes	It's a learning curve
M	Biology and Chemistry CSE/O level	N/A	Yes	Yes	Yes	N/A
F	Biology O level	No	No	Yes	Yes	Yes

### 5.4.1 Long term follow up evaluation

Comments from students about RLO learning during a telephone interview 1 year (October 2005) after completion of the nurse prescribing module. The questions can be seen in section 4.3.4.

#### Q(ii) Properties of RLOs that helped

- Participant 81 (female)

*'Quite useful for myself because I need a mental picture of what is going on to be able to understand it.'*

- Participant 82 (male)

*'For me it was the visual aspect, actually seeing the concept visually was a huge bonus for me because it just made things click. We'd had key lectures and I'd read about things, but I think for me just to see how things worked visually was what I needed to put the whole picture together.'*

- Participant 83 (male)

*'Sometimes I found that the application of the pharmacology in understanding I found quite difficult. The rlos when I used them several times, it clarified a **great** deal of information for me.'*

*'The one that immediately comes to mind is the picture of a boiler in a room and opening the window and the heating going up and down, thermostat system. That clarified Because of the visual with the aural it really worked for me.'* NB This RLO on Homeostasis had been developed as part of another project but was available to this group of students.

#### Q(v) Value in RLO method of teaching pharmacology?

- Participant 41 (female)

*'In our group we found the pharmacology lectures pretty intense and that (the rlos) did actually simplify it a lot yes it was definitely really useful'.*

- Participant 43 (male)

*'It probably helped with my exam. To pass the exam yes. It kind of changes the slant, sometimes reading a book is difficult and listening to a person is sometimes difficult, it kind of gives a third opportunity to take information in in a slightly different way.'*

*'Used since – no. but discussed the people on the course with people on the course My colleague XXX who I work with as well– we both found them very useful. I don't know if that is coming from a male perspective though, because I know a lot of women didn't find them as useful. Made men slight pv more than women.'*

### **Q(v) See value in the method of teaching pharmacology?**

- Participant Q4 (female)

*'The rlos put in picture form what I would have thought' especially for those who struggled with the concepts they would have helped to ground those things, would have made them clearer'*

- Participant 44 (female)

*'Because you are able to go at your own pace because pharmacology is the toughest part of the course from what I found and talking to other people. Studying it in that sort of fashion enables you to go at your own pace and go over again and again if you need to which I certainly did.'*

- Participant 82 Q4 (male)

*'Invaluable. For me as a MH nurse practitioner the whole concept of pharmacology, pharmacodynamics, pharmacokinetics was a new concept so I would have really liked some rlos for each each area.'*

### **Q(viii) Other RLO topics**

- Participant 4 (Pilot)

*'It would be a helpful addition to learning and the learner can go and access as and when. To clarify points that you haven't picked up in the lecture and that you can go over it time and time again.'*

- Participant 43 (male)

*'Any means of learning which, kind of, it's not spoon fed it makes you think but it's interesting. Then any other method of teaching is going to be a bonus, especially for those people who perhaps find reading from textbooks kind of arduous and sort of very difficult or kind of like listening to lectures may not be able to undersand what they're doing. It's just a third port of information I think.'*

- Participant 43 (male)

*'If you could do something clinically, how to give an injection how to take blood, how to suture. Things that are practical based but do require a little bit of theoretical knowledge behind With the animation that you can have you could do that with suture I think that would be brilliant for it. You can do that with the proper technique of as opposed to the stylised technique for instance of myself yeh I can do it and my suturing isn't bad but if you had an rlo everyone is following the right technique.'*

### **5.5 Learning effectiveness**

There were no differences in mean exam scores between the cohorts.

## **6.0 Discussion**

The reporting of nurses' difficulties in understanding and applying biological science based knowledge has a long history (Chapple, Allcock & Wharrad (1993); Clarke (1995); Trnobranski (1993); Wharrad, Allcock & Chapple (1994)) and recent studies support this earlier evidence (Kyriacos, Jordan & van den Heever (2005); Dorthe (2004) & King (2004)). In these studies, understanding pharmacology is often singled out as a particular learning problem ((Kyriacos, Jordan & van den Heever (2005); Dorthe (2004) & King (2004)). The relatively recent prescribing role now undertaken by nurses and other non-medical professionals has also heightened awareness of the need for a good understanding of pharmacology principles. This study arose because our own student evaluations identified difficulties with the pharmacology component of the (then) nurse prescribing course (Bath-Hextall, Wharrad, Lymn & Foss (2004)). The empirical evidence presented in section 5.0 of this report suggests that the intervention of RLOs on core concepts of pharmacology had an impact on all the students during the course and for two students, when they returned to nursing practice; for some the educational value of the RLOs was still recognised a year after completing the course. The results also suggest that RLOs may help the weaker or less confident students with understanding of pharmacology since when RLOs were available no students rated their understanding of the specific concept as 'Bad' or 'Very Bad' (Figure 3 and Table 4). This shift in the distribution was not significant for 2 of the RLOs ( $p > 0.05$ ). The 'Lock and Key' and 'Plasma proteins' RLOs were in the second batch of development and hence were only available to cohort 3. The sample size for cohort 3 was small ( $n = 14$ ) hence the statistical power was reduced this may have resulted in a type 2 error. Further evidence is required to establish whether RLOs are effective in levelling students within mixed ability groups. The following sections will discuss some specific aspects of the evaluations.

### **6.1 Design and media attributes**

The RLOs were based on some standard design principles. Each RLO was a discrete self contained learning unit. As suggested by Boyle & Cook (2003) to optimise reuse there should be no unnecessary dependencies ie links to other websites or RLOs within the RLO content sections – our RLOs had a separate resources page at the end of the RLO. Educationally this makes sense because students remain engaged with the topic and don't get led off track before completing the RLO by being drawn to other resources. The RLO addressed a single learning objective and each had a self assessment suitably aligned to the learning objective according to the principles of Biggs (2003). The visual components of the RLOs were always highly rated by the students because of their value in describing processes that were difficult to understand in the printed form. Although not specifically mentioned in this study, we have also found reference to everyday examples to explain concepts is also important – for example in the RLO about Half life a bucket with a hole in it is used to explain why, to

be therapeutically effective, drug levels need to be retained by giving regular doses. Earlier work in developing CAL materials for students showed that students did not like to be staring at a computer screen for long periods of time – CAL packages were typically 1-2 hours of learning and although students could return to the package, they seemed to prefer shorter self contained units (Wharrad, Kent, Allcock & Wood, 2001). There is much debate about the optimum granularity (size) of RLOs for reuse and learning effectiveness (Palmer & Richardson, 2004). In this study students were satisfied with the size of the RLOs (average time students spent on the pharmacology RLOs was 8-15 minutes (Table 2)).

## **6.2 Use, reuse and reuse again**

The principle of reuse needs to be considered at the design stage of an RLO. Which groups are going to be using the RLOs? Are they to be used by students from different disciplines? There are debates about making an RLO small and generic so wide reuse can be achieved against ensuring contextual pedagogically meaningful learning which may limit reusability (Boyle & Cook, 2003; Duval et al, 2003). This has led to the idea of generative learning objects (GLOs) where the learning design is retained but the content and examples within the shell can be adapted to suit use of the GLO in different contexts (Boyle et al, 2005). Development of GLOs is part of other strands of our work.

In this study there are 3 levels of use/reuse to consider:

- The RLO is used by a student on the module that the RLO was originally designed for then the same student reuses it on another occasion
- Students on another nursing course at the same educational level uses the RLO (horizontal reuse)
- Students on a non nursing course in the same or another university uses the RLO (vertical reuse)

There is evidence from this study that the pharmacology RLOs have been reused at all 3 levels. Table 6 participant 83 states clearly he has revisited the RLOs many times in order to consolidate the principles. 50% of the students had (re) used the RLOs after they had completed the course. The prescribing course has 3 intakes a year – the RLOs will be available to 120 students per year.

The pharmacology RLOs are being used by a range of pre and post registration courses in the School of Nursing within biological sciences and branch modules. They are also used by Graduate Entry Medicine students at Nottingham.

An optional online feedback form offered at the end of each RLO has been completed by staff and students who have used the RLOs, a summary up to November 2005 shows numbers of users for each RLO who returned online feedback forms (Figure 4). The percentage ratings for the total numbers of students (n=228) and staff (n=31) are shown on the right of the figure.

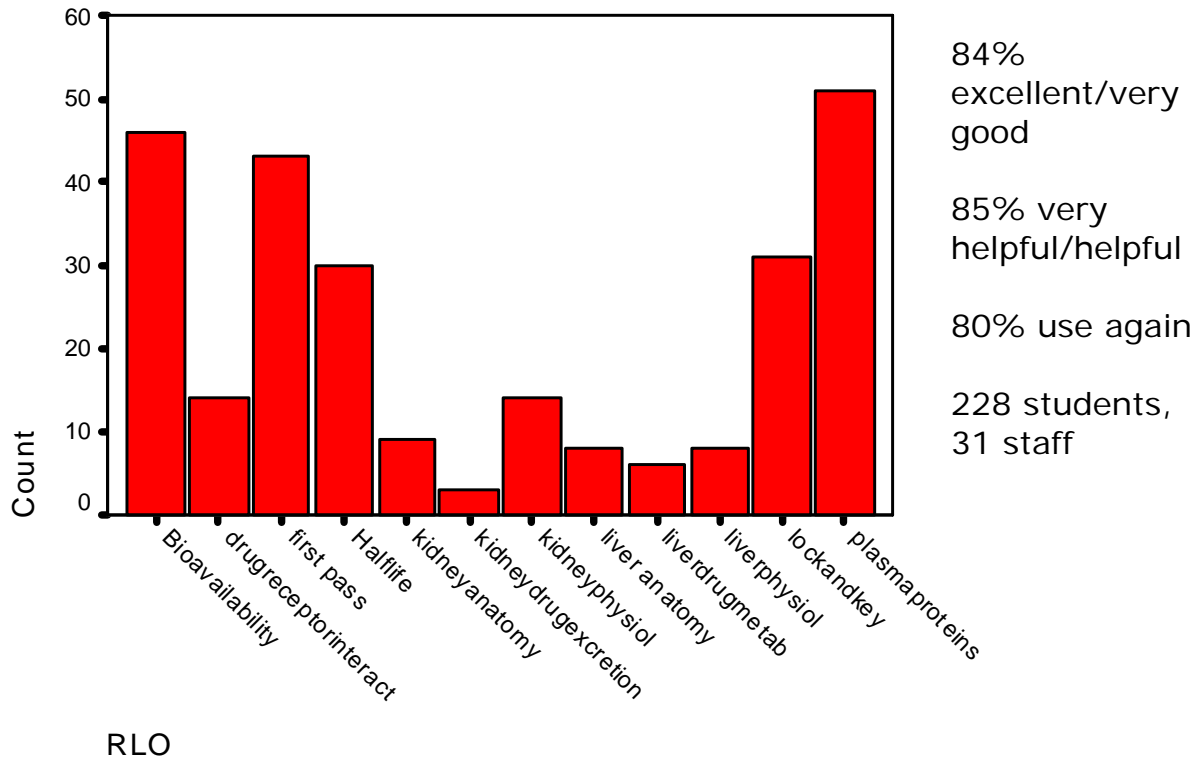


Figure 4 Online feedback on pharmacology RLOs (up to November 2005)

Apart from the positive comments about the RLOs from a range of student groups ranging from A level students to degree students, it is also clear that the RLOs are being accessed from nursing and other courses in the UK and around the world.

*"This web site is excellent and I have recommended to other nursing students of Brighton University. Thank you for such a good web site and it was very helpful!"*

*"I'm a student at a community college in New York, and had to do research on osmosis and diffusion. Your site was terrific! Thank you."*

*"This is a very simple aid, but very clear. Every student can understand it. Since I teach in a Spanish speaking country, I would like to see it Spanish. It may not be possible, I know."*

*"Thank you for this excellent website! I am currently coming to the end of my second year in Nursing (mental health) at the University of Surrey."*

*"I wish there were more of these. A great way to bring pharmacology to LIFE"*

*"Liked the crossword helped to remember names"*

*"The easiest way to learn and to teach others this i learnt from this site."*

Although occasionally expectation of availability of further RLOs is raised:

*"I will be glad if u provide me other tutorials regarding pharmacology (MPhilPharmacol)"*

We have received specific requests from a prescribing course in New Zealand and from a Health Trust in Wales to embed the RLOs into their courses.

### **6.3 Lecturer involvement**

There has been a steady rise in the number of lecturers who have become involved in authoring RLOs for this project and others in the School of Nursing. There are a number of reasons for this. After seeing RLO exemplars, lecturers realise the potential for their own courses. The size and standardised development framework assures would be participants that the task of developing an RLO is less daunting than a large CAL package or whole online module or course. This approach is advocated in a report by MacDonald et al (2005) who state:

*"Developing technology based resources needs to be made easier, quicker and more efficient....."*

The support of a full time learning technologist in the School is also undoubtedly a positive factor.

### **6.4 Further RLOs**

Student evaluations showed that more RLOs should be developed to support the non-medical prescribing course.

*"Yes . Pain gate theory, lots of other aspects of the course...Absolutely, absolutely... Theories regarding analgesia and antibiotics.."*

Areas identified as potentially beneficial were higher level pharmacology, pain theory and management and clinical skills techniques.

Since this project started the team were successful in obtaining HEFCE funding to become a partner in a Centre for Excellence in Teaching & Learning in Reusable Learning Objects. There are many other projects underway involving development and research into the design and use of RLOs.

### **6.5 Reflections on the research**

The original amount of funding for RLO development was substantially reduced (£35000 to £5000), this slowed up the work considerably and the number of RLOs produced was reduced from 20 to 9. It was difficult to find adequate funding to carry out the extensive evaluation we had planned, again this has meant the project has taken a year longer than envisaged.

The RLOs were undoubtedly valued by the students; however as with all practice based education studies it is not possible to attribute changes in perceived or actual understanding or attainment to any one factor. There are too many uncontrollable variables particularly in between cohort studies. The RLOs were used within a blended learning environment involving a number of lecturers so there were inevitably changes in course delivery between cohorts. Triangulation of a range of evaluation methods to build a picture of effectiveness was our approach to overcome problems with confounding factors.

As the number of RLOs being produced simultaneously builds up in projects of this nature, production (as well as project) management needs to be carefully coordinated to ensure that specification writing, peer review processes, formative student evaluations etc are timely. The time taken to chase up documentation as the writing and production team gets bigger shouldn't be underestimated.

### **6.6 Dissemination**

This work has been disseminated widely at UCeL and more recently Centre for Excellence in Teaching & Learning in RLOs workshops. A presentation was also given at AMME in 2004 (Bath-Hextall, Wharrad & Lymn, 2004).

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