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Research Article

Use of PharmaCALogy Software in a PBL Programme to Teach Nurse Prescribing

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Abstract

Pharmacology is taught on a dedicated module for nurse prescribers who have a limited physical science background. To facilitate learning a problem-based approach was adopted. However, to enhance students' knowledge of drug action a PharmaCALogy software package from the British Pharmacological Society was used. Students were alternately given a lecture or encountered the software as a prelude to a short test a week later. The process was repeated with their roles reversed, followed by use of a questionnaire to evaluate user experience. Generally students receiving the lecture first performed better on the test but after experiencing both forms of learning there was little difference in performance. Response was positive with regard to the software especially the aspect of visualising drug interactions. However, lack of prior knowledge and paucity of time on task were seen as negative features. The responses indicate measures that may improve the student experience by taking greater note of learning styles and existing IT skills.

Keywords: computer-based learning, constructivism, problem-based learning

Introduction

"Advanced Pharmacology for Supplementary and Extended Prescribing Practice" is a dedicated module provided for post-registration nurses in part fulfilment of a course that enables these nurse practitioners to operate as extended and supplementary nurse prescribers. The addition of even more drugs for Supplementary Prescribing has added to the burden of content of the module, as virtually every drug group may be encountered by a supplementary prescriber (Department of Health, 2003). As a discipline, classical pharmacology is vested in the physical sciences. Traditionally, undergraduates of the discipline would have an extensive understanding of chemistry, physics, biology and maths and a pharmacologist could anticipate a study of the impact of drug molecules from a holistic interaction though to a molecular interaction. This underpinning knowledge base is not present in the majority of post-registration nurses whose training encompasses a very different range of skills, yet it is essential that they have a knowledge and understanding of the mode of action of drugs. However, they have a distinct knowledge advantage, rarely enjoyed by the traditional undergraduate studying pharmacology, and that advantage is the experience of seeing the drugs used in the clinic to treat a considerable number of pathologies (Coleman, 2000).

A problem-based learning approach has been used on this module, whereby the students approach a knowledge and understanding of drug action from the perspective of their immediate life/work experience and use this as a springboard to a deeper understanding of drug action. Problem-based learning is used as in the Department of Medicine at McMaster University, Canada and critically described by Perrenet, Bouhuijs and Smits (2000). The methodology has proved effective over the past decade in terms of student evaluation, module assessment data and external examiner commentary. To aid the process, one lecture to emphasise the nature of drug targets is given which includes selected images and animations from a suite of PharmaCALogy computer assisted learning packages produced during project TLTP76. The material serves to provide students with a generic, molecular, end focus for drug action and signposts to some extent the direction of their research in support of problem-based learning. Though appreciated by students, this practice was at odds with the philosophy of the module; on the basis that problem-based learning is constructivist in its approach, allowing students to participate in their own learning process (Neo and Neo, 2001). Although research in computer assisted learning is criticised for being overly product oriented (Karasavvidis, Pieters and Plomp, 2003) this study sought to review the effectiveness of learning via the computer assisted medium set against the learning achieved by the more traditional lecture, an approach advocated by other authors (Spellman, 2000; Crook, 2002) and at the same time explore the students' reactions to the software offered.

Methodology

A cohort of post-registration nurses from a variety of professional backgrounds studying the module were divided into two groups, A and B. With one exception all were female and aged between 30 and 55. In the first week Group A undertook a study of the topic "Drug Targets". The students were supported by two members of the module team and provided with instruction sheets, which also contained questions to provide a focus for working through the software. Students were encouraged to work in pairs rather than encounter the software experience on their own. At the end of the session, the students were provided with model answers to the questions. Group B students were given a conventional lecture on the same topic; the structure of the lecture was assembled to match the content of the computer software as closely as possible. One week later, both groups were assessed by means of a 10-question short answer test. The test comprised predominantly recall type questions, with the remaining third of the questions requiring a brief explanation to be provided. Then, Group A received the conventional lecture whilst Group B experienced the software presentation. One further week later, both groups completed the same 10-question test and also answered a 20 point questionnaire to evaluate their experience of the use of dedicated software. Students were asked to respond on a five point Likert scale (1=strongly agree to 5=strongly disagree). Data analysis was carried out using Statistical Package for the Social Sciences (SPSS v12). The between-group comparisons were evaluated using independent t-tests and within-group comparisons made with a paired t-test. Effects of experience (lecture or software) and sequence (lecture first, software second, or software first, leacture second) were analysed using a general factorial ANOVA.

Results

In the first week, eight students received the lecture and 13 used the software before undertaking a test one week later. Test results showed a significant difference between the groups, the students in receipt of the lecture gaining a significantly higher grade than students who used the software (Table 1, *p*<0.007). However, a week later, following the 'cross over' between the groups the test results showed improved overall performance and virtually similar marks with no significant difference between the groups noted (Table 2, *p*>0.174).

Table 1 *Results of test for students one week after 1st lecture or software presentation (p<0.007)*

	Experience	n	Mean (%)	Standard deviation
Week 1 Group B	Lecture	8	45.13	17.89
Week 1 Group A	Software	13	26.92	13.31

Table 2 *Results of test for students one week after 2nd lecture or software presentation (p>0.174). Note that for Group A n = 11 (two students unable to attend due to covering for illness of colleagues' at their own practices)*

	Experience	n	Mean (%)	Standard deviation
Week 2 Group A	Lecture	11	57.73	13.30
Week 2 Group B	Software	8	58.13	21.03

Tables 3 and 4 compare the results of students for the lectures and software between week 1 and week 2. There is some improvement in test performance in the second week comparing lecture group from week 1 with that in week 2 (*p*<0.05); however, there is a considerable improvement between the two software groups from week 1 to week 2 (*p*<0.001). Pooling the data (software users plus lecture recipients; Table 5) suggests a general improvement in test performance from week 1 to week 2 (*p*<0.02).

Table 3 *Results of test for students one week after receiving lecture presentation (p<0.05)*

	Experience	n	Mean (%)	Standard deviation
Week 1 Group B	Lecture	8	45.13	17.89
Week 2 Group A	Lecture	11	57.73	13.30

Table 4 *Results of test for students one week after receiving software presentation (p<0.001)*

	Experience	n	Mean (%)	Standard deviation
Week 1 Group A	Software	13	26.92	13.31
Week 2 Group B	Software	8	58.13	21.03

Table 5 *Results of test for all students (both Groups combined, p<0.02)*

	Experience	n	Mean (%)	Standard deviation
Week 1 Group A+B	Either	21	33.86	17.33
Week 2 Group A+B	Either	19	57.89	16.44

***Table 6** Results for test for all students who participated in both experiences (Lecture and Sofware)*

	Experience	n	Mean (%)	Standard deviation
Week 1 Group B	Lecture	8	45.13	17.89
Week 2 Group A	Lecture	11	57.73	13.30
Week 1 Group A	Software	11	28.18	13.47
Week 2 Group B	Software	8	58.13	21.03

It should be noted that in Table 6, the standard deviations for Group A are very different, 23% and 48% respectively. This might be explained by the diversity of the cohort: they are a very heterogeneous group. There are a range of professional backgrounds, including A&E specialists, health visitors, practice nurses and physicians assistants and a range of educational qualifications. The general factorial ANOVA reveals no significant main effect of the experience on test score ($F(1,34)=2.417$, $p=0.129$); but a significant effect is noted for the sequence of the experience, i.e. whether the lecture experience preceded the software experience or vice versa ($F(1,34)=15.979$, $p=0.001$). No significant interaction of these independent variables was revealed ($F(1,34)=2.654$, $p=0.112$). The results suggest initially that the lecture may be a more effective medium whereby students acquire knowledge. However, by the second week there was no significant difference between the groups, an outcome that is supported by the ANOVA and consistent with the findings of other studies (Martens *et al.*, 1997; Phipps and Merisotis, 1999). Although when studying with software students achieved a comparable test score to when they study in a conventional lecture, the sequence lecture and software experience appears to have a significant effect, with those who experienced the lecture first and software second performing better in the test. The apparent ‘sequence of experience’ effect may be a consequence of active knowledge construction by engagement with the interactive software, enabling students to better understand the subject material, working in a constructivist way to build up their own meanings with staff acting as a facilitator. To achieve an average score of nearly 60% might be considered successful learning; but it does suggest that a blend of conventional delivery with computer assisted learning is the more effective process, and that on the basis of improved knowledge of subject content it may not be appropriate to use the software on a stand alone facility in its current form of use. Blending problem-based learning with online learning has been shown to impact positively on student performance (Taradi *et al.*, 2005; Riffell and Sibley, 2004; Pearson, 2004).

Further insight into this set of results may be gained from the questionnaire results presented in Table 7 and Box 1, which presents the students’ qualitative responses to the question of the best and worst features of the package. In general the students’ view of the software is positive, commending the organisation and visual advantages of the software package. A fairly consistent series of responses were obtained, only question 4 resulted in an equivocal response where similar sized groups of students either felt that they had sufficient background to follow the programme or didn’t have sufficient background, consonant with Sit *et al’s* (2004) experiences when exploring students’ views of online learning. A number of students felt that they had been disadvantaged in using the software first and several commented on this in the responses in Box 1. The other feature that is criticised (rightly) is the lack of time to complete the software, a situation that was later remedied by staff providing other opportunities to use the software under tutor guidance.

Table 7 *Student questionnaire responses. Values are means ± SD of 20 responses. Scoring is based on an agreement rating detailed at the foot of the Table where 1 is strongly agree and 5 is strongly disagree*

Q No.	Question	Mean	SD	Mode
1	The menu and objectives of each software package are clearly stated	2.55	1.23	2
2	I enjoyed the learning process	2.35	1.14	2
3	I can go at my own pace	2.90	1.48	1
4	I did not have sufficient background knowledge to follow the software package	2.90	1.37	2
5	I interacted well with the simulation	2.60	0.99	3
6	Misunderstanding or lack of knowledge could be easily detected	3.00	0.97	3
7	Presentation of animations, simulations and graphics is very good	1.85	1.09	1
8	Instructions on the simulation are consistent	2.00	1.12	1
9	The pace of the interaction is adequate	2.45	1.28	3
10	The simulation was a better way to understand than private reading	2.55	1.32	1
11	The simulation was a better way to understand than a lecture	3.35	1.31	3
12	The simulation was more useful than a tutorial on the subject	3.35	1.23	3
13	The simulation was difficult to use	3.15	0.93	4
14	I disliked this method of learning	3.40	1.05	4
15	The simulation could readily replace lectures on the same topics	3.40	1.10	4
16	The simulation gave me a better visualisation of the subject	2.10	1.17	1
17	The simulation presented material in an organised way.	2.00	1.17	1
18	I would recommend that the simulation be used again in the course	2.30	1.30	3
19	I would recommend the simulation to friends interested in the subject	2.25	1.37	1
20	The simulation motivated me to further study in some of the areas covered	2.55	1.36	1

1 = strongly agree, 2 = agree, 3 = neither agree or disagree, 4 = disagree 5 = strongly disagree

Some students commented on their lack of IT skills, which had made engagement with software more difficult than it might have been. More positively, they commended the highly visual nature and stated that their understanding of the molecular events of drug action had been enhanced. Sadly students, despite a lack of aversion to this method of learning still preferred lectures and tutorials, which was rather a disappointing response in a problem-based learning module.

***Box 1** Qualitative responses*

Best features

Able to visualise chemistry

I enjoyed the software because of the visualisation

Stimulating accessible, good visual aid

It enabled a clearer understanding by visualising the interactions that took place

The visual impact – however I am sure it would have been more useful if I could have had the lecture first

Diagrams/images help and consolidate theory – visualisation helps understanding.

The animation and interaction

When I worked out what was wanted I was pleased when I got the correct answer

If background preparation had been done first, the software would have been good revision, cheerful and interactive

Logical process increased my ability to absorb the information

It made understanding of a difficult subject more clear

Work at my own pace

Good for private study

Worst features

Time was very limited in order to absorb and enjoy the process. Would have benefited from having three hours or several more lectures in this way

Not enough time and explanation to get the full benefit from the package

Needed more time to work on it

The time constraint to use the software was a limitation

Needed verbal backup

Not all aspects fully explained – needed to ask for help from tutors

I needed tutorial support alongside as I could not always make sense of it

Needed initial formal teaching or planned pre-lecture reading to prepare for the use of software.

Being computer literate was very important and could slow the process of learning if not educated in this area

My IT skills are extremely poor and found it difficult to follow without help

Also not being too computer literate the whole experience was quite alien and in some ways blocked my learning

Discussion

A computer assisted learning package was used in the context of a problem-based learning module to enhance student understanding of the mode of drug action at a molecular level. Whilst the impact of drugs at a whole body systems level is readily understood by these students, the mechanisms by which the impact is achieved is more complex and difficult to visual. The process is also dynamic and usually explained in textbooks, review articles and journals by complex and static graphic presentations. The software package in contrast presents drug targets in a more dynamic way by using animations of processes and static graphics are presented in an interactive manner (Coleman *et al.,* 1995). This was perceived as strength of the programme. Andrewartha and Wilmot (2001) suggest that individuals find it easier to learn and remember knowledge visually and that knowledge will remain in a person's memory if the learner actively reaches for it and manipulates it rather than acquiring the information passively. The advantage of visualisation is also recognised by Lim (2001) who asserts that the animations can provide conceptual anchors that help generate dialogue and build towards a more holistic approach. This should be of value in a problem-based learning approach. One advantage of this software was that it had a relatively linear structure without too many levels of screens. In this way "choice fatigue" was avoided as it is recognised that the freedom to select pathways through the software can generate insecurity (Andrewartha and Wilmot, 2001). The same authors offer the following desiderata for computer assisted learning:-

- Intuitive controls
- Encouraging feedback
- Provide remediation
- Tactile experience by manipulating on-screen elements
- Let students discover outcomes rather than being too didactic
- Create situations that require problem solving
- Takes the form of a simulation of a real event

Whilst the pharmaCALogy package was designed with these issues in mind; the current users' responses did not always reflect recognition of these attributes. Whilst the visual element and structure was acknowledged and applauded there were misgivings with regard to the learning environment in terms of knowledge and time on task. Familiarity with the environment does impact on the success of the student encounter with such a resource and whilst the software may have clear pedagogical integrity this may be compromised at the learner computer interface through difficulties with the software itself (Peat *et al,* 2002). Student commentaries presented in this study are echoed in part by the same authors:-

> *"…allows visual reinforcement. Visual aids/animation helps clarify and understanding…"*

and conversely

> *"the information is much more successfully provided elsewhere – as it is more organised and direct. These are only useful once everything else has been memorised to ensure everything has been covered."*

The phrase *"once everything else has been memorised*" matches current students comments that the use of the software would have been better after an introductory lecture. This issue is recognised by ChanLin (2001) who suggests that discrepancy in prior knowledge might influence the way given visual information is processed and the degree to which related concepts and information are triggered and connected. It is considered that a greater impact may be achieved if students possess specific prior knowledge, with Kirschner *et al.* (2006) suggesting that the advantage of guidance begins to recede only when learners have sufficiently high prior knowledge to provide 'internal' guidance. Certainly this view was reinforced in the current study. In addition, the test results support the notion that a blend of both lecture and software is a more effective approach to learning. It is recognised that there is an element of reinforcement and time for internalisation that would make interpretation of this result somewhat ambiguous. However, the comment is disappointing, as students had encountered the information on drug action during the early part of the module and each drug target encountered in the software presentation had been presented through the medium of the problem-based learning experience and students had already articulated the pharmacological actions concerned. It is difficult to state unequivocally that a given methodology is superior to any other, particularly in view of the complex social issues that create and contribute to the environment of learning. A salutatory note is sounded in Spencer’s (1999) review of educational technology, that reveals in many studies no real difference is actually observed between technologies used and traditional forms of delivery.

Such views may reflect the nature of the environment, which is different from the usual group based approach used on the module. One student described the environment as “alien” and the use of the software as a one-off may have compromised learning. The group is almost all female and comprised entirely of mature students. Several researchers have indicated that these groups can be disadvantaged in such learning environments (Spellman, 2000; Lee, 2003). An IT self-assessment audit would have been a useful adjunct before commencing this study. Similarly, although tutor support was provided, there is no doubt that a less intensive approach would have yielded more satisfactory experiences. The pressure of content volume, driven by increasing professional demand has perhaps compromised some aspects of the learning experience and the general environment of the module needs re-consideration to allow development of IT skills in this context. It reinforces Gibbs’ assertion that course design and process can be more important than teaching and content (Gibbs, 1992).

The issue of “time on task” raised by students is important, something that is acknowledged by van Den Hurk (2006) who reported that student who are better at planning their time and who have better self-monitoring skills are more efficient in allocating their individual study time and prepared more appropriately for tutorial group meetings. An acknowledged benefit of computer assisted learning is that students can work at their pace (Vogel and Klassen, 2001; Andrewartha and Wilmot, 2001). As a consequence of the volume of material to be encountered on the module, contact time was limited. The software used was licensed only for the University intranet and could only be accessed on the University premises. Whilst this is less of a barrier for full-time students, the present cohort attends on a part-time basis and opportunity to use on-site facilities is limited. Access is a crucial social issue in use of computer assisted learning (ChanLin 2001; McNaught *at al.,* 2003) and it would be better in the future to improve access to allow a less intensive interaction. The software used is now available in web-based format which will markedly improve access.

Conclusions

It is acknowledged that although this study comprises a small sample size, the outcomes should be considered in the context of delivery. Nurse prescribing is a two-module short course approved by the Nursing and Midwifery Council so that the students can act as independent prescribers and as such is stand alone. The cohort is quite heterogeneous in terms of professional background, qualifications and time since the last experience of 'formal' education.

To an extent students found interaction with the software of value, particularly in terms of visualising and understanding drug actions at more fundamental levels. However, prior knowledge and lack of time on task were important issues that required more detailed planning.

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