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Research Article

The Effectiveness of Lecture-Integrated, Web-Supported Case Studies in Large Group Teaching

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Abstract

The effectiveness of lecture-integrated and web-supported case studies in supporting a large and academically diverse group of undergraduate students was evaluated in the present study. Case studies and resource (web)-based learning were incorporated as two complementary interactive learning strategies into the traditional curriculum. A truncated version of a case study, with links to websites containing background/further information was uploaded on the university's virtual learning environment (WebCT), to prompt students to answer questions. The overall aim was to support all students by encouraging self-directed learning. Our results show that most students who participated in the present study, irrespective of academic background, found both strategies useful in supporting the lecture and in providing them with the necessary background knowledge. Students who accessed web-links achieved significantly higher test scores in Immunology and in the module as a whole, than those who did not, irrespective of their course of study. This did not relate to A level grade in Biology and/or Chemistry. Findings from this study encourage the wider implementation of such complementary strategies to support large student groups with divergent prior knowledge.

Keywords: Case study, web-link, immunology, widening participation, pedagogy

Introduction

The requirement to teach large numbers of students, set against constraints on staff time, leads many higher education institutions to favour a traditional didactic style of knowledge delivery. The limitations of this approach are well known and become of great relevance when the variety of backgrounds and routes students may have taken to reach a given module means that they may have highly divergent prior knowledge.

In the School of Biology, Chemistry and Health Science (BCHS) at Manchester Metropolitan University (MMU), Immunology lectures at Level 1 are delivered within a Physiological Systems module on a number of degree and HNC[1] level programmes. Five lectures in Immunology provide the basis for extended study at levels II and III. The mode of entry into both degree and HNC courses is varied and includes direct entry from secondary schools and colleges, Access, Foundation and BTEC courses[2] . As a result, students have a highly divergent prior knowledge of Biology and/or Chemistry, ranging from advanced to GCSE levels[3] . In addition, the score

[1] HNC: Higher National Certificate.

[2] Access and Foundation courses are one year courses, equivalent to advanced level qualifications from secondary schools in the UK. BTEC is a vocational qualification conferred by the Business and Technology Education Council, UK.

[3] GCSE: General Certificate of Secondary Education, taken by secondary school students in the UK, normally at age 14-16. Advanced Level: A General Certificate of Education at Advanced level, taken by students in the final two years of secondary education, after completion of GCSE.

for recruitment of mature full-time undergraduates at the Manchester Metropolitan University is well above average (Higher education statistics agency, 2004). All these students are taught the same material, by the same tutor, in one of two groups constituting degree (Biomedical Science; BMS) or degree (Biological Science and Clinical Physiology: BS and CP respectively) plus HNC students.

Evidence suggests that the incorporation of active learning into the traditional large group lecture enhances the learning experience (Klein, 2001; Huang and Carroll, 2005; Hoag, 2005). One such method is to use case study scenarios that are incorporated into a single traditional style lecture (here called a lecture-integrated case study). Case studies can increase student attention and motivation (Davis and Wilcock, 2005) and have been shown to promote 'higher order thinking' such as analysis, problem solving and decision making (reviewed in Steinert and Snell, 1999). Since the use of metaphors/scenarios can *'..bring together conceptual understanding and reasoning with real-life, relevant issues'* (Exley and Dennick, 2004) case studies also encourage a more insightful and humanist, self-directed approach to learning (Klein, 2001; Hoag, 2005; Walters, 1999).

Within Bioscience disciplines, case studies have been implemented in a number of formats, either interspersed between lectures, as a group (5-6) activity within a clinical immunology course (Hoag, 2005), or used as a truncated case-stimulated session within Endocrine Physiology lectures (Walters, 1999). In the latter study, single or multiple case studies were sometimes 'carried over' to the next lecture to provide continuity of information. In the present study, we integrated one case study into a single lecture and investigated whether such a strategy was useful in supporting the lecture. As problem solving and critical thinking require time to allow for 'reflection' and 'knowledge construction' (Race, 2001), we attempted to promote this through placing the case study on the university's virtual learning environment (VLE), WebCT (www.Webct.com) prior to the assigned lecture.

In order to address the issue of diverse student academic backgrounds we utilised the world-wide web, with its plethora of information, as a resource for specialist websites that contain relevant background information. Our aim was to provide further support in information retrieval, since computer and internet-based key skills are recognised nationally as important areas for development in the undergraduate curriculum (Scott, 2005; Tariq and Cocrane, 2003). Hence, we adopted complementary teaching strategies that allowed the incorporation of interactive learning into the traditional teaching curriculum. This involved the use of case study scenarios linked to web-based resources via the VLE. By placing a truncated version of a case study on the VLE forum, students were prompted to answer questions using supporting web-links to websites containing background/further information. The overall aim of the study was to support all students, irrespective of academic background, by encouraging self-directed learning.

Materials and Methods

Students who participated in the study came from one of four different programmes: three BSc degree level courses: BMS, BS, and CP, and one HNC course (Applied Biological Science) . CP and HNC are taken by students in full-time work who attend MMU on a day release basis. As such, students attending these two courses were grouped together for the purpose of analysis. The BMS students were taught as one group, whilst the BS, HNC and CP students were taught together as another separate group. Each group of students was diverse in terms of academic background. Each group received the same information, delivered by the same individual. Overall student number for both degree and HNC entry was 264. An initial needs analysis defined the students' perceptions of their levels of confidence in information retrieval and IT skills. Most students were unfamiliar with the use of academic search engines such as Boxmind, subject gateways such as INTUTE (formerly BIOME) and databases such as

Medline and Science direct, while over half the students lacked confidence in carrying out searches on the web.

The strategies were implemented between January and March 2006 as follows:

1) Lectures 1, 2, were taught in traditional face-to-face sessions.
2) During lecture 3, students were also referred to a list of useful websites (posted on WebCT) covering background information relating to the subject matter.
3) A mini case study was included in the second half of lecture 4, in order to familiarise the students with the style of the lecture-integrated case studies. At the end of the lecture, students were instructed to access the first part of the case study to be implemented in lecture 5 (Table 1). Additional web-links were also provided on the VLE to help answer the questions in the case study (Table 2).
4) Lecture 5 was divided into three parts: part 1 gave an introduction to the lecture, and was followed by a description of the case study scenario; part 2 gave further detailed information on subject matter and was followed by questions relating to the case study attempted by students in buzz groups (2-3minutes); part 3 provided laboratory results and resolved the case study and was followed by an explanation linking it to subject matter

Table 1 *Case study for lecture 5*

Case Part No.	**Topic: The structure and function of antibodies**
1 **The Case**	The case: Susan was celebrating her graduation with her friends. They went to a restaurant and Susan ordered the Chef's Special: '***Chicken Gourmet****: cooked with lemon, chopped nuts and herbs'.* Ten minutes after eating her food, Susan felt sick. She soon left the table. She had a bout of diarrhoea. Susan's friends were alerted to her condition when 15 minutes later, she didn't return to the table. Susan had fainted. An ambulance was called in and Susan was taken into hospital.
	What was the Doctor's diagnosis of Susan's condition?
2 **Questions**	*Questions*: Was the chicken not cooked well? - *Salmonella poisoning?* How does our immune system protect us against gut microbes?

5) To evaluate the strategies, the following were assessed: (a) Student perception of the usefulness of the implemented strategies. (b) Student access to the web-supported material (by tracking the number of "hits" on the WebCT area). (c) Student performance in the summative assessment in relation to web-link access: for this purpose, students were subdivided into those with A-level and those with other qualifications (GCSE and other) hereafter called the A-level and GCSE groups respectively. The rationale for this division was that the students in the A-level group were more likely to have covered the relevant background information.

6) Additionally, the performance of those students with A-level in summative assessment was also analysed in relation to A level grade (Pearson's Correlation coefficients).

Table 2 *List of sample web-links for lecture 5 (placed on WebCT)*

Lecture Topic/title	**Relevant background topic for Web-link**	**Web-link address**	**Summary information**
Structure and function of antibodies	Antibody structure and function (provides ***supporting information*** for students)	http://www.accessexcellence.org/RC/VL/GG/antibodies.html	These are posters containing illustrations of the antibody molecule, antibody specificity and its function in defence against infection. *Alberts et al (1998).*
	Protein structure (provides ***background*** information for students)	http://www.biologymad.com/ (Click on AS Biology → click on the topic 'Biochemistry' → 'Proteins').	This is a good site if you would like to cover the basics in protein structure and understand how proteins (like antibodies and MHC molecules) fold to form functional proteins. (You can start by scrolling down and looking at the summary structures first). *Gilbert (2003).*
	Protein structure (provides ***background*** information for students)	http://bmbiris.bmb.uga.edu/wampler/tutorial/prot0.html	This site offers a tutorial on peptide and protein structure, filling any gaps in basic understanding and also offering extended information. It contains some colourful illustrations. *Wampler (1996).*

To assess student perception of the usefulness of the strategies (5a, above) all students were given an evaluation questionnaire. This was delivered by an independent member of staff. In addition, twelve students were interviewed individually or in small groups (2-3 students per group). Questionnaires were based on a Likert scale that included the following: very useful (in supporting the lecture), useful, no difference, not useful, did not access (Figure 1: Evaluation questionnaire).

STUDENT EVALUATION QUESTIONNAIRE **February 2006**

Please circle the most appropriate answer:

What course are you attending?
BSc…… HNC……. Other…….
What is your highest Biology qualification?
A Level AS level GCSE Access course other None

Web-links (on WebCT's 'Immunology Resources' area)

1. *Did you find the weblinks for lecture 3 useful?*

Very useful useful no difference Not useful Did not access them

2. *Did you find the weblinks for lecture 5 useful?*

Very useful useful no difference Not useful Did not access them

3. *Any comments on the weblinks? Which weblink did you find most useful?*
……
……

List of definitions ((on WebCT's 'Immunology Resources' area)

1. *Did you find the list of definitions useful in helping you understand Immunology?*

Very useful useful no difference Not useful Did not access it

Case studies

1. Did you find the case study for lecture 4 (Mark's Heart transplant) helpful in understanding the lecture?

Very helpful helpful no difference Not helpful Did not attend lecture

2. Did you find the case study for lecture 5 (Susan's allergy) helpful in understanding the lecture?

Very helpful helpful no difference Not helpful Did not attend lecture

3. Did you try solving Case study 5, before the lecture? YES / NO
If you did, were the weblinks helpful? YES / NO

4. Did the case studies encourage you to want to find out more about the topic/s?…
……
……
……..

The Immunology lectures

1. *Which lecture was your most enjoyable lecture? why?*

……..

2. *Which lecture did you find most difficult to understand? Why?*

……..

Any other comments:
……..
……
…… ***Thank you &***
Best wishes for the exam

Figure 1 *Evaluation Questionnaire*

Results

a. Student's perception of the usefulness of the strategies

1. Evaluation questionnaire

The total questionnaire return was 29 (out of 117) for the Biomedical Science degree (BMS) group, and 46 (out of 147) for the Biological Science degree (BS) and HNC/CP group. Although this represents a low percent return, the evaluation questionnaire revealed that for those students who competed the questionnaire, the majority found the case study useful (or very useful) in supporting the lectures. Indeed, those students who had good background knowledge of Biology (A level) found the case study as useful as those without A-level (GCSE or other): 96% vs 100% and 100% vs 89% for the BMS and BS groups respectively. Overall usefulness was similar for both the BMS and BS groups (97% vs 96% of students). Despite this, few students (13%) said that they had attempted to solve the case study prior to the lecture.

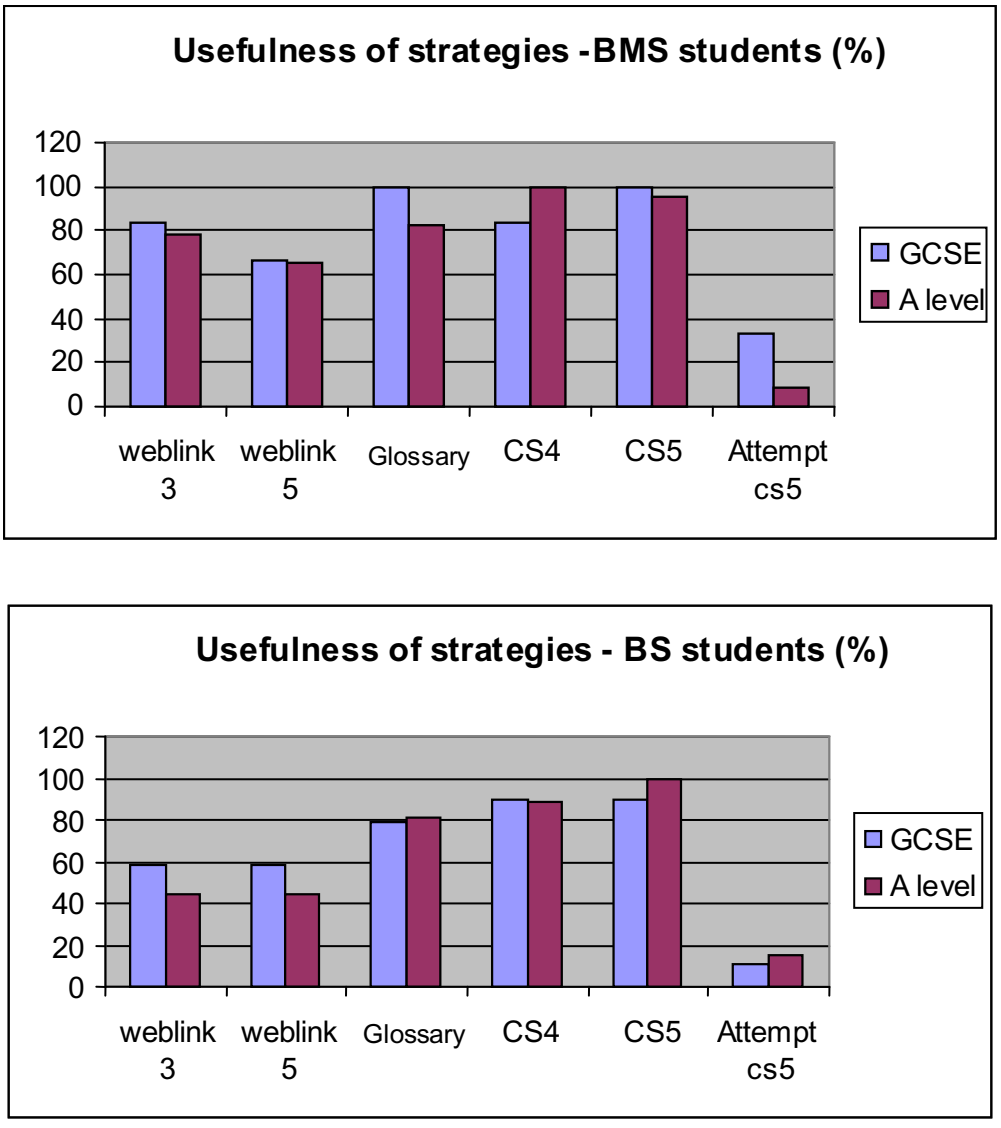

FIGURE 2 *Percentage number of students who identified the individual strategies to be useful or very useful. A) BMS students. B) BS students.*

Most BMS students who replied to the questionnaire, found web-links for the third lecture useful or very useful, while only half of the BS students did so (79% vs 50%).

As these web-links were intended to support students with basic (GCSE or other) knowledge in Biology, we were interested in their usefulness for this group. Indeed, they were more useful for the GCSE (or other) than the A level group (83% vs 78% and 58% vs 44% for the BMS and BS students). Similarly, web-links for lecture 5 were more useful for the BMS than the BS group, although within each group, both the GCSE and A level groups found them just as useful. The number of students accessing web-links was 65% and 50%, respectively (Figure 2). None of the students who completed the questionnaire found any of the strategies 'not useful'. A minority of students found that they made 'no difference' to helping them understand the subject matter, while the rest had not accessed them at the time the questionnaire was distributed.

The 'Glossary' was found to be useful or very useful for both the BMS and BS students (86% and 80% respectively). The remaining students did not access the list. For the BMS group, more of the GCSE students found the list useful than did the A level students (100% vs 83% respectively), but was similar for the BS group (79% vs 81%). (Figure 2)

2. Interviews with students

Students interviewed (*n*=12) reported finding the case studies very useful. One student commented: 'It's a real life concept. People enjoy problem solving. You feel like a doctor – it gives you a sense of accomplishment'. In terms of the dynamics of integrating the case study during the lecture, students appreciated working through the case study and the fact that it was presented as a 'cliff-hanger' in three parts (Steinert and Snell, 1999), facilitated, and interspersed between factual information. Although some students did not access the web-links, those students who did, found them very useful, not least because it saved them having to search for the information themselves. As some students put it: '..you couldn't do it any better, reaching out to all the people. You direct students to where they should be looking'; 'it can save hours of work'; '..you can spend a lot of time looking for stuff and it might be all wrong'. In terms of student preferences for the different strategies, some students seemed to prefer the integrated case study approach because it was 'analytical'. Others preferred accessing web-links because they were more generally useful for a number of other modules, whereas the case study was specific to that particular lecture.

In terms of classroom mechanics, lectures 4 and 5 were more interactive than lectures 1-3. This was most obvious for lecture 5. Students were less inhibited about answering questions when prompted. Some students quickly arrived at the answers when facilitated to do so.

b. Student access of the information:

Web-link usage was evaluated by identifying the number of times the file containing the link was 'hit' by students on the WebCT (Table 3). The lecture handouts were 'hit' at least once by nearly all students. This was either before or after the relevant lecture, and often shortly before the final examination. In addition, interviews with students indicated that these web-links were indeed accessed and used. Students interviewed stated that they had retained the links for future use.

Table 3 Total number of WebCT hits for students from all four courses (n=264)

Support Material	Number of 'Hits' (% of group)
Web-links for lecture 3	108 (44%)
Web-links for lecture 5	62 (25%)
Glossary	73 (30%)
Solved Case study (Lecture 4)	61 (25%)
Solved Case study (Lecture 5)	28 (11%)

c. Student performance (summative assessment):

Summative test scores for students were analysed to see if they were associated with web-link access. A brief summary is shown below:

1) Overall performance in summative assessment – comparison between groups: The HNC/CP students achieved highest mean test scores, while the BMS degree students achieved similar mean test score to HNC and CP students. The BS degree students were the poorest performers.

2) Relating overall performance to Web-link access. Do the web-links support student learning? Our results showed the following (Table 4, Figure 3): The group of students who accessed web-links achieved consistently higher test scores (both in the Immunology questions and the module as a whole), than those who did not, irrespective of their course of study. For BMS degree students, web-link access seemed to be of most benefit to students with good background in Biology (A level). For BS students, web-link access seemed to be of most benefit to degree students with limited background in Biology (GCSE/other), as well as HNC/CP students.

Table 4 *Mean percentage summative test score in the Immunology section (mean +/- SD). Numbers in parentheses indicate total score for the whole module.*

Course	BMS		BS Degree		HNC/CP
Background	**A level**	**GCSE/other**	**A level**	**GCSE/other**	
Overall group	**51.58 ± 5.01** (55.16±14.05) *n*=67	**40.35± 3.73** (45.44±13.14) *n*=34	**46.75 ± 4.95** (52.93±13.11) *n*=74	**37.65 ±4.56** (41.31±15.48) *n*=29	**52.16 ±5.83** (53.77±17.49) *n*=26
Accessed web-links	**66.35±5.30** (63.35±14.31) *n*=17	**46.80±3.16** (52.40±13.49) *n*=10	**49.14±4.07** (56.85±10.69) *n*=7	**50 ± 4.38** (49.80±17.96) *n*=10	**60.8 ±5.74** (59.91±18.86) *n*=11
Did NOT access links	**46.56 ± 4.28** (52.38±12.95) *n*=50	**37.67±3.79** (42.54±12.11) *n*=24	**46.50 ± 5.06** (52.5±13.34) *n*=67	**31.16±3.82** (36.84±12.27) *n*=15	**46.13±5.41** (49.27±15.51) *n*=15
Difference in mark*	**19.5%** (10%)	**9%** (10%)	**2.5%** (4%)	**19%** (13%)	**15%** (11%)

** Difference in test score between students who did, and those who did not access web-links.*

3) Relating exam performance to A-level grades. Comparison between grades of students within the BMS and BS degree courses revealed that for the A-level entry BMS degree students, most students (*n*=67 of 68) had attained an A-level in biology (grades A-E, average=C-D) and over half (*n*= 44 of 68) had attained an Al-level in Chemistry (grades A-E, average E), while for the A-level entry BS degree students, most students (*n*=73 of 74) had attained an A-level in biology (grades A-E, average=C-D) and few (*n*= 31 of 74) had attained an Al-level in Chemistry (grades B-E). For comparison between exam performance and A-level grades, the results indicated that the BMS students' examination performance in the Immunology section and in the module as a whole, did not relate to either the Biology or Chemistry A-level grade. This is true for the whole group and for those who accessed the web-links. However, for the BS students, there does seem to be a positive relationship between examination performance and the A level Biology grade, for the Immunology section and this is highly significant for the performance in the module as a whole (Table 5). The test scores for the previous year's student cohort-summer 2005 taught in the traditional teaching style revealed that the mean mark for students on BMS Course was improved by 6% (*n*=25 students randomly selected).

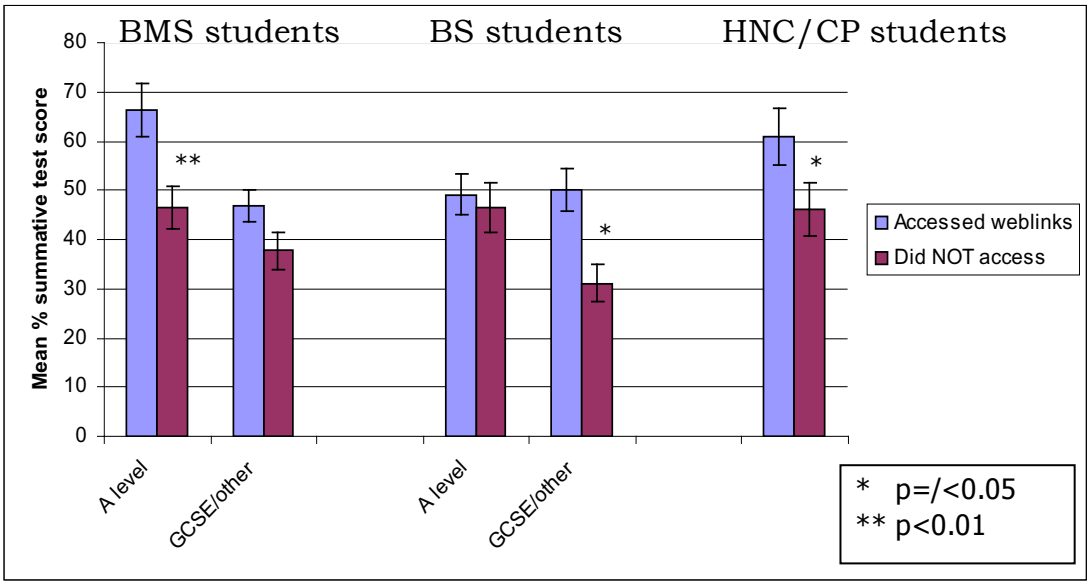

Figure 3 *Mean percent summative test score for students who accessed, and those who did not access the web-links, for each of the groups tested.*

Table 5 *Relationship between test scores and A-level grades (Biology and Chemistry)*

Course	BMS		BS	
A-level subject	**Biology**	**Chemistry**	**Biology**	**Chemistry**
Total group	0.082	0.217	0.307 **	0.112
	(0.185)	*(0.242)*	*(0.469) ** *	*(0.077)*
Accessed web-links	0.014	0.241	0.314	0.885 **
	(0.087)	*(0.304)*	*(0.809) * *	*(0.732)*
Did NOT access links	0.276 *	0.309 *	0.304 **	0.043
	*(0.331)** *	*(0.264)*	*(0.445) ** *	*(0.010)*

Numbers in parentheses indicate the correlation coefficient value for the whole unit.
** p<0.05; ** p =/< 0.01*

Discussion

In the present study, we have identified the lecture-integrated case study approach as a useful teaching strategy in supporting students in a large group setting. Furthermore, when supplemented by web-based learning, these strategies also supported students with limited prior knowledge of relevant information. The majority of students *who participated in the present study* perceived the case study to be useful in supporting the lecture, irrespective of their academic background, despite the fact that only a proportion of them had attempted to solve the case study prior to the lecture. Within the class setting, student responses to the implementation of the lecture-integrated case study were very encouraging. Students were more responsive and interactive rather than passive in the learning process (Ramsden, 1999). There was a greater level of interaction between students (through buzz groups) as well as with the instructor, through answering relevant questions or by posing questions themselves. Although many students had found 'Immunology' a difficult topic, with much factual information, they seemed to value the case studies because as a result, they were '*able to put the facts together'*. This supports the importance of contextualisation for an effective learning experience (Willmott, 2005). The influence of the case study on the student's critical thinking was not assessed in the present study, since multiple choice questions were based on factual recall (appropriate for level I students). Previous studies have shown that although case studies did not significantly improve student performance on critical thinking questions, they were nonetheless identified as a valuable tool in improving student attendance and interaction (Hoag, 2005).

Although most students were computer literate, and had all received library induction during the first weeks of their programme, they were not always aware of the range of search engines, subject gateways and databases available, nor any individual websites to support their learning. Hence, most students *who completed the questionnaire* found web-links useful, irrespective of academic background. It is not clear why web-link 3 was accessed more than web-link 5, which was intended to complement the case study strategy. Nonetheless, those who did access the web-links, found that these links did help in solving the case study. In terms of supporting the needs of students with limited background knowledge of Immunology, those students who accessed the web-links achieved higher test scores in Immunology and in the module as a whole. More BMS students found these links useful than did BS students. Our finding that web-link access correlated with overall exam performance is consistent with current literature. For example, use of web supported material has been shown to increase overall student scores in a large class setting (Henly and Reid, 2001). A relevant question to ask here is whether the web-links *per se* helped the students gain better marks in Immunology, or whether these students were more self directed and therefore revised better for the exam? Our results show that the Immunology section mark correlated with the overall module mark, suggesting that the latter may be true. However, we do not believe that such correlation is causal, for two reasons. First, due to the spread in marks, and second, the fact that more motivated students would have looked up information anyway, even in the absence of web-links, but that the latter will have saved them much valued time in searching for the information. Exam performance (test scores) in the Immunology section and in the module as a whole, did not relate to either the biology or chemistry A level grade. The student's 'want/need' and motivation may thus be sufficient to fuel self-direction (Race, 2001) and improve exam performance. As expected, this was true for students attending the more vocational courses with a clear career path and structure (HNC/CP and BMS students).

The execution of the two strategies in the present study was facilitated using WebCT. The use of a VLE has become a valuable tool that enables the execution of a number of teaching and learning strategies within higher education, especially for a large group of students of diverse

educational background (Williams and Quinsee, 2003; Kendall and Prowse, 2005). Students' access of the supporting web resources and attempts to solve the case study, both prior to and during the lecture, may represent necessary first steps towards self-directed learning. Indeed, this is of special importance for first year students who are at a transitional stage in the learning process. A limitation of the present study is the fact that the strategies were implemented over a short window of time *and executed once, though with several subject groups.* Nonetheless, our findings are encouraging. All the students who were interviewed stated a preference of the new lecture format to the old traditional lecture style. Furthermore, the execution of strategies in the present study was a most rewarding experience for the instructor. Indeed, an instructor's enthusiasm, empathy and engagement, represent some of the key Es necessary for successful implementation of any teaching strategy (Willmott, 2005). Interaction within the lecture helped establish dialogue and identify any misconceptions in understanding of subject matter. With wider implementation of our strategies within the module/ course of study, students will be better prepared for their role and participation in an interactive style lecture format.

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