Use of an interactive CD-ROM as a learning resource and its effect on student outcome in first year human biology

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Abstract: The large classes found in many first year university units present the challenge of maintaining student access to valuable material in the face of increasing student diversity. The development of a self-paced, interactive, computer-based learning resource was designed to provide the flexible delivery necessary to address these challenges of the large class environment. The Primate Biology program, an interactive CD-ROM, was fully implemented into a first year human biology unit in 2001. A student survey was designed to evaluate the Primate Biology CD as a learning resource. The aim was to evaluate student usage of the Primate Biology CD, to gain an understanding of their subjective attitudes towards the program and to find out whether use of the CD influenced student outcome. Of the 479 first year students enrolled in Human Biology 100, 345 (72%) participated in the study. The Primate Biology CD was used at least once by 218 (63%) of these students. Generally students expressed a favourable attitude towards the CD. Students used a wide range of features on the Primate Biology CD, which varied according to where the CD was accessed. The results showed that use of the Primate Biology CD was related to student outcome on the primate biology assessment. This effect was found to be independent of the student’s general ability in the area of human biology, which suggests the CD has a real effect on student outcome. The active learning environment generated by the Primate Biology CD’s interactive features may be an essential element in its positive influence on student performance.

Keywords: interactive CD-ROM, evaluation, student outcomes

Introduction

The ever-increasing diversity of student populations (Exley & Gibbs, 1994) and limited access to resources (French & Rodgerson, 1998) are common challenges in the large classes of first year university units. To meet these challenges a self-paced, interactive, computer-based learning resource titled Primate Biology has been developed (Hill & Tunstill, 2000). The Primate Biology CD-ROM was designed as an additional learning resource in an area of human biology that is traditionally difficult for students to understand and is ideally suited to The Primate Biology CD is an interactive CD-ROM that can be accessed by students during their laboratory times or in their own time. It provides students with the opportunity to learn about many aspects of primate biology including anatomical terms, behavioural characteristics, geographical distribution and how these features are used to classify non-human primates into taxonomic groups. It is hoped that the Primate Biology CD will provide the informative and flexible delivery required by this large class learning environment.
The Primate Biology CD was fully implemented into the first year unit, Human Biology 100, in 2001. Like any new teaching resource this computer-based learning (CBL) program must be assessed to establish whether students are using it, their attitudes towards it and whether it has any impact on students’ outcomes. Implementing a program like this does not mean it will necessarily be used by students and it must be assessed just as any other instructional material should be assessed (Ediger, 2001).

The aim of developing this CD-ROM was to provide all students with access to the high quality primate images in their own time and to establish an enjoyable, interactive and motivating learning environment. Whether use of CBL improves student learning and outcomes directly is currently under debate (Peat, 1996). However, there is no doubt that motivation (McKeachie, 1999), active learning (Nguyen, Newmarch, & Baird, 1997), interactivity (Herrington & Oliver, 1995) and self-paced and flexible delivery (Tait, 1998), which the Primate Biology CD aims to provide, are all positive aspects of a student’s learning environment.

This paper details the results from an initial student assessment of the Primate Biology CD. Student usage of the CD, their subjective experience of it and whether using the CD influenced students’ marks in the primate biology section of this first year human biology unit will be examined.

**The Primate Biology CD**

The Primate Biology CD can be run on a Windows (Intel Pentium 166 processor running Windows 95 or later) or Macintosh (Power PC 120 Macintosh running OS 8.1 or later) system with 32 MB of installed RAM and a colour monitor. Once the Primate Biology CD is running all navigation is conducted via mouse click making it accessible to students with a wide range of computer skill levels.

The Primate Biology CD begins with three brief introductory pages followed by a classification page. From this classification screen (see Figure 1), students can access any primate group by clicking on the primate hyperlink images. A series of screens containing interactive features about that primate group is then available (see Figure 2). Users have the option of accessing pages on the skull or external features of each primate group. The skulls can be accessed via two views of quick time virtual reality (QTVR) images that enable the student to rotate the skull through 360 degrees. The external features link provides students with the option of viewing four introductory video clips of zoo primates. These clips are briefly annotated and highlight identifying features specific to that primate group. Characteristic features of each primate group are also demonstrated through still photographs that can be actively labelled by students. From each primate page there are links to a glossary and quiz.

**Methods**

Students enrolled in Human Biology 100, a first year human biology unit, participated in this study. The students were encouraged to use the Primate Biology CD as an alternative resource to lectures and tutorials throughout first semester of 2001. It was designed to provide additional support for students as they examined and identified features on real skulls. The Primate Biology CD could be purchased or accessed during laboratory times (4 computers) and via another 58 computers located in the Anatomy and Human Biology School. Prior to the recruitment of participants ethical approval was obtained from the University’s Human Research Ethics Committee.
Early in the second semester of 2001 students were invited to complete a brief questionnaire on their use of the Primate Biology CD. 345 (72%) students returned completed questionnaires and consent forms. Two participants’ exam and semester results could not be
linked to their questionnaire and they were excluded from the analysis of student outcomes. The questionnaire asked for details on student use of the Primate Biology CD, their attitudes towards it and whether they felt it helped their learning and understanding of the material.

To establish whether the Primate Biology CD influenced student performance the questionnaire was linked via the student’s student number to their primate biology short answer exam question mark. The question assessed the student’s ability to provide a taxonomic classification of a non-human primate. This particular question was used as an accessible marker of student performance and made up 3% of the semester mark, however, the CD actually covered 10% of the semester’s assessable material. As a student’s performance on any one question would be associated with their general competency in the area, the questionnaire was also linked to the student’s total first semester assessment for Human Biology 100. This enabled the general ability of a student to be statistically controlled for in the assessment of the Primate Biology CD’s influence on student outcome.

Results

Student usage of the Primate Biology CD
A total of 345 (72%) Human Biology 100 students participated in this study. Of those 218 (63%) used the Primate Biology CD at least once, either in or out of their lab times. Considering only those students who used the CD, 162 (74%) used the Primate Biology CD during lab times and 144 (66%) used it outside of their lab times. When asked for reasons why students did not use the CD in their lab 49 (27%) students thought they would get access to it later, 41 (23%) were absent that week and significantly 38 (21%) students said they did not know about it. Students who did not use the CD outside of their lab times responded in a similar vein, with 81 (41%) saying they planned to, however, they did not have enough time, again 37 (19%) were unaware of the program and 26 (13%) did not think it would help their understanding of primate biology. Of those students who used the CD outside of their lab times the majority used it only once and for 30 minutes or less (65 = 45%), however, it is worth noting that 33 (23%) returned to use it three or more times and 39 (27%) used it for 60 minutes or more. In support of this, 89 (41%) students said it was very valuable that they could use the CD in their own time.

A wide range of the Primate Biology CD’s features were accessed by students. The most commonly used feature was the classification page and the views of the skulls feature, while the least accessed features were the external features and quiz features. Figure 3 shows that students who used the CD in and out of their lab times had, as a group, the highest percentage of students accessing each feature, except the external features feature, compared to any other group. This may be due to the time available as students who only used the CD in their lab time had the lowest rates of usage for every feature except the spinning skulls feature.

Students’ subjective experiences of the Primate Biology CD
The students surveyed expressed a predominantly favourable attitude towards the Primate Biology CD. 66% of students who used the CD rated it as enjoyable/very enjoyable; 94% of students found the program easy/very easy to navigate around; 75% of students said it was valuable/very valuable that the CD could be used in their own time and 95% of students who used the CD felt at least one feature of the Primate Biology CD helped their learning and understanding of the material. 96% of students who used the Primate Biology CD recommended it be used by future first year students and interestingly 30% of students who did not use the CD recommended it to future students.
Figure 3: Student use of the Primate Biology CD features according to where it was used

**Use of the Primate Biology CD and student outcome**

Figure 4 shows mean student marks on the primate biology short answer exam question for the 345 participants.

Students who used the Primate Biology CD outside of their lab times, that is the group of students who used the CD in and out of the lab and the group who only used the CD outside of the lab, had a significantly higher mark than students who did not use the CD at all (t(340) = 3.421, p = 0.001, 2-tailed). Students who only used the CD in their lab time did not score
significantly higher marks than those who did not use the CD at all. Further analysis showed that students who used the Primate Biology CD in and out of the lab were the only group to have significantly higher marks than those students who only used the CD in their lab time ($t(160) = 2.227, p = 0.027, 2$-tailed). The average primate biology mark did increase with higher levels of student usage, however, this association did not reach statistical significance. Alternatively the extent of features used by the student rather than the amount of time spent using the Primate Biology CD could be the significant factor. To investigate whether use of the interactive features contributed to student outcome the total number of features used by each student was analysed (see Figure 5). A significant correlation was found between the number of features used on the Primate Biology CD and the student’s mark for the short answer primate biology exam question ($r = 0.188, p = 0.006, 2$-tailed). ANOVAs were conducted on each of the seven Primate Biology CD features to establish whether students who used the feature received significantly different marks from students who used the CD and did not use the specific feature and those who did not use the CD at all. All ANOVAs were significant at the 1% level, suggesting use of the CD’s features impacted positively on student outcomes.

![Figure 5: Mean primate biology short answer mark according to the number of Primate Biology CD features used](image)

Post hoc analyses (tukey honestly significant difference) were conducted on each feature to establish which groups were significantly different within the ANOVA. Post hoc analyses showed that most significant differences were between students who used the feature and those who did not use the CD at all. For two specific features, the spinning skulls feature and the quiz feature, post hoc analysis showed that the significant differences were between students who used the feature and those who did not use the feature and between students who used the feature and students who did not use the CD at all (see Figure 6). It is now necessary to isolate the effect of the Primate Biology CD on student outcome from the student’s general ability. The measure of student ability used in this study is the student’s total first semester assessment for Human Biology 100. As there was a high correlation between student’s primate biology short answer exam mark and their total first semester mark ($r = 0.562, p < 0.001$) it was necessary to statistically control for student ability in these analyses.
The mean student mark for the primate biology short answer exam question according to usage of the spinning skulls and quiz features (“Yes” = used the feature; “No” = used the CD but did not use the feature; “not applicable” = did not use the CD). Different letters indicate significant mean difference (ANOVA, p < 0.001).

**Student ability, student outcome and the Primate Biology CD**

As mentioned previously students who used the Primate Biology CD had significantly higher primate biology results than those who did not, however, they also had higher total semester marks (t(290) = 3.674, p < 0.001). When use of the Primate Biology CD and students’ total first semester mark were entered into a linear regression model only total semester mark remained a significant predictor of the student’s score on the primate biology exam question (β = 0.546; p < 0.001). Therefore, controlling for the variance in students’ primate biology mark accounted for by their overall first semester assessment removes the Primate Biology CD as a significant predictor of students’ marks. Here it appears that more competent students are more likely to use the Primate Biology CD and have higher marks for the primate biology questions.

The students’ total first semester mark was also associated with the number of features used (r = 0.14, p = 0.039). When the number of features used and the student’s total semester mark were simultaneously entered into a regression analysis a significant model was produced explaining 33.3% of the variance in student short answer marks (F(2,214) = 53.507, p < 0.0005). The regression analysis shows that the use of more Primate Biology CD features remained a significant independent predictor of students’ primate biology marks, even after removing the variance accounted for by the students’ semester mark (β = 0.011, p = 0.05).

To establish whether specific features were independent predictors of student outcome a univariate general linear model was conducted on each feature including the student’s total first semester mark for Human Biology 100 as a covariate. After removing the variance accounted for by the student’s semester assessment; use of the quiz feature (F(2,339) = 5.020, p = 0.007) and use of the views of the skull feature (F(2,339) = 3.1, p = 0.046) remained significant independent predictors of student primate biology short answer marks.

**Discussion**

This study provides valuable information on student use of the primate Biology CD and its impact on student outcomes. The finding that 63% percent of students surveyed used the
Primate Biology CD at least once in its inaugural year is encouraging. However, this level of usage is slightly lower than the first year CBL programs at The University of Wollongong (80%, French & Rogerson, 1998) and The University of Sydney (70%, Franklin & Peat, 1998). Students’ comments indicate that some students were not aware of the program’s availability. This highlights the need for a wider distribution of information regarding access to the Primate Biology CD, even though it was presented and discussed in lectures and labs. One aim of developing this program was to make resources more accessible and more enjoyable for the students. This has been achieved with the majority of students favourably evaluated the Primate Biology CD, which is consistent with other research into the use of CBL in tertiary education (see Peat, 1996; Tait, 1998; Sly & Stace, 1999; Sultana, Levy, & Rogers, 2001).

The majority of students used the Primate Biology CD during their lab time and although this group had a lower mean score on the primate biology short answer question, it was only significantly lower than those students who used the CD in and out of their lab times. However, the majority of this association between use of the CD and student outcome is due to more competent students, who generally have higher marks, accessing the CD. There are some aspects of the CD that do have important independent effects. The number of features used within the Primate Biology CD was independently associated with student outcome on the primate biology question. Therefore, it seems important to encourage a more in depth use of the CD, independent of whether it is accessed in or outside of lab times. The interactive nature of the Primate Biology CD is ideally suited to provide an active learning environment (Nguyen, Newmarch & Baird, 1997). The engagement and interactivity associated with high quality CD-ROMs (Barker & King, 1993) are also some essential features that promote active learning environments (see Meyers & Jones, 1993; Goody, 1998), which may be one reason why CBL, is rated so highly and seems to be associated with positive student outcomes.

The most striking finding of this investigation was the positive impact the use of the views of the skulls feature and quiz feature had on student outcome independent of the effect of student ability. This is especially interesting when it is recognised that the quiz feature had the strongest effect yet was the least accessed feature of the Primate Biology CD. The views of the skulls feature of the Primate Biology CD provides the students with four views of high quality primate skulls and the quiz provides a random sample of multiple-choice questions examining the whole CD’s content. It is plausible that the views of the skulls feature provides the engaging and motivating element of multimedia (Barker & King, 1993; Peat, 1996) that promote an active learning environment. This perspective is supported by Wilss (1997) who found that graphics in multimedia programs improved student comprehension and understanding.

The quiz feature’s positive influence on student outcome may be in part due to its graphics component. However, the feedback provided during the quiz could be the most valuable aspect for students. Figure 7 shows the quiz format with a multiple-choice question about an associated image. Many of the quiz questions relate to features of the skull, which may partially explain the influence the views of the skull and spinning skulls features had on student outcome. As Figure 7 demonstrates, whether students get the initial question right or wrong, they are provided with an explanation that can help direct their future exploration of the program. This immediate feedback is extremely valuable and may be a key factor in student progress (Ramsden, 1992). Peat (1996) showed that 72% of students preferred to have a computer quiz with immediate feedback rather than wait for feedback on a paper and pencil assessment. These quizzes are not assessed, rather they are used for student self—direction.
This highlights the *quiz* feature as a type of formative assessment, which “is where the purpose is to get an estimate of achievement which is used to help in the learning process” (Brown & Knight, 1994, p15). It is clear the *quiz* feature’s influence may work via other pathways such as the motivation provided by asking students questions (McKeachie, 1999), however, the positive effect of formative assessment receives support from the literature. Students who utilised formative assessment in the form of practice tests (Sly & Stace, 1999) and practice quizzes (Cassady, Budenz-Anders, Pavlechko & Mock, 2001) had significantly higher marks in subsequent summative assessment.

![Quiz](image)

**Figure 7:** An example of the quiz feature and immediate feedback

**Conclusion**

This paper proposes that features of the Primate Biology CD do improve student outcome on primate biology short answer questions independent of student ability. The total number of features accessed was an independent predictor of student outcome, suggesting the extent to which a student explores the various features of the program is important. Further analysis limited the effect to the *views of the skull feature* and the *quiz* feature. It is difficult to specify the essential elements of these two features, however, an active learning environment and the provision of formative feedback appear to be contributing factors.

**References**


Acknowledgements
The author would like to acknowledge the support and encouragement of Jan Meyer and Allan Goody throughout this research; Julie Hill and Jassie Tunstill who have provided assistance with the questionnaire construction and access to the Primate Biology CD and all of the students who took the time to be a part of this research.

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