Clinical Anatomy 18:613–617 (2005)

MEDICAL EDUCATION

Development of Instructional, Interactive, Multimedia Anatomy Dissection Software: A Student-Led Initiative

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Although dissection provides an unparalleled means of teaching gross anatomy, it constitutes a significant logistical and financial investment for educational institutions. The increasing availability and waning cost of computer equipment has enabled many institutions to supplement their anatomy curriculum with Computer Aided Learning (CAL) software. At the Royal College of Surgeons in Ireland, two undergraduate medical students designed and produced instructional anatomy dissection software for use by first and second year medical students. The software consists of full-motion, narrated, QuickTime MPG movies presented in a Macromedia environment. Forty-four movies, between 1–11 min in duration, were produced. Each movie corresponds to a dissection class and precisely demonstrates the dissection and educational objectives for that class. The software is distributed to students free of charge and they are encouraged to install it on their Apple iBook computers. Results of a student evaluation indicated that the software was useful, easy to use, and improved the students' experience in the dissection classes. The evaluation also indicated that only a minority of students regularly used the software or had it installed on their laptop computers. Accordingly, effort should also be directed toward making the software more accessible and increasing students' comfort and familiarity with novel instructional media. The successful design and implementation of this software demonstrates that CAL software can be employed to augment, enhance and improve anatomy instruction. In addition, effective, high quality, instructional multimedia software can be tailored to an educational institution's requirements and produced by novice programmers at minimal cost. Clin. Anat. 18:613–617, 2005.

Key words: anatomy instruction; computer assisted learning; dissection

INTRODUCTION

Since the Renaissance, dissection of the human body has been central to medical education (Parker, 2002). Dissection is necessary for: 1) establishing the primacy of the patient, 2) conceptualization of the multidimensional human body, 3) touch-mediated perception of the cadaver/patient, 4) appreciation of anatomical variability, 5) learning the basic language of medicine, 6) competence in diagnostic imaging, and 7) training for medical specialties (Aziz et al., 2002). Today, dissection remains the primary approach to teaching gross anatomy (Fitzharris, 1998).

Anatomical dissection presents a formidable challenge to undergraduate medical students. In a limited amount of time, students must be able to gather, process, and store a substantial amount of information, while following a specified dissection method and learning tissue manipulation techniques that will help them to acquire this information (Cottam, 1999). To further compound this experience, cadaveric dissection is an important preceptor for issues relating to death and dying and many students experience considerable anxiety or stress during dissection (Jones, 1997; Aziz et al., 2002). Accordingly, a medical student's initial experience in the anatomy dissecting lab can be overwhelming.

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Received 14 September 2003; Revised 2 January 2005; Accepted 21 January 2005

Published online 26 September 2005 in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/ca.20140

For centuries, dissection has been taught through lecture, demonstration, and dissectors containing written instructions and diagrams (Gregory and Cole, 2002). Due to increasing class size, demonstration has become less feasible and the dissector is now the primary source of guidance. Lately, video (Clemente et al., 1971; Acland, 2000), still photography (Slizova et al., 2001), and closed-circuit live televised projection (Reidenberg and Laitman, 2002) have been used for instruction. Also, the shrinking cost and increasing availability of computer technology has facilitated the implementation of digital image databases of cadaveric structures (Spitzer and Whitlock, 1998; Ackerman, 1999), web-based surface anatomy RealPlayer video clips (Bacro et al., 2000), and other computer aided learning (CAL) modalities (Gatti, 1993; Nieder et al., 2000; Reidenberg and Laitman, 2002).

Many medical education programs have recently integrated CAL into their anatomy curriculum (Fitzharris, 1998). The benefits of CAL for the educator include further possibilities for presentation of visual anatomic information in a more interesting manner and easier dissemination of knowledge within a more user-interactive environment (Paalman, 2000). The student benefits by having novel opportunities for learning the fundamental principles needed to succeed in the practice of modern medicine and biomedical research (Paalman, 2000). Some institutions have reduced dissection lab time and supplemented their curriculum with CAL programs, due to financial or logistical considerations (Paalman, 2000). Computers provide a cost-effective means of delivering high quality content within the teaching laboratory or by remote access (Fitzharris, 1998).

At the Royal College of Surgeons in Ireland (RCSI), undergraduate medical students attend two 3-hr dissection classes per week, during their first 15 months of undergraduate study. In addition to written and multiple choice exams, academic progress is assessed through practical exams at which students are required to demonstrate their knowledge of anatomy on a cadaver.

Between March 2001 and September 2002, instructional, interactive, multimedia dissection software was conceptualized and produced entirely by two RCSI undergraduate medical students. The software comprises both web-based and CD-ROM-based narrated videos, illustrations, text, and still photographs to accompany each of the 72 undergraduate dissection classes. The software was produced at minimal expense, using applications that came bundled with an Apple iBook provided by the RCSI as part of the tuition fee package. A complete cadaveric dissection was filmed using a digital video (DV) camera. The DV was edited and converted to QuickTime MPEG movies using Apple's iMovie. Macromedia Director 7.0 (educational edition) was employed to create CD-ROMs with stand-alone interactive presentation platforms for each movie and its associated text, illustrations, and still photographs. The software runs directly from the CD-ROM and does not require any application or hardware addition to be installed on the student's computer.

The aim of the software is to introduce students to what they are expected to accomplish in a forthcoming class and to increase their proficiency, comfort and efficiency in both the dissection lab and the examinations. This is achieved through providing students with interactive, narrated, instructional MPEG movies that precisely illustrate and explain the RCSI specific dissection instructions for each class. The quality of dissection is not a professional preparation as one would view in an anatomy atlas. Rather, it takes into consideration students' time constraints and skills, and presents the dissection in a manner commensurate with the student experience.

The software is provided to students free of charge. It may be viewed on computers in the college library or CAL laboratory. Moreover, students may obtain the software from the library or college web-site and download it to their laptops. Students may use the software before each dissection class, or they may bring their laptops into the dissection lab and use the software for guidance.

In addition to its original intended use, the development and implementation of the software suite has provided the RCSI with the opportunity to further familiarize medical students with computer use, identify a means of encouraging the development of user-defined instructional software and assess the value and potential of educational software that can be produced by novice programmers at minimal cost.

MATERIALS AND METHODS

Cadaveric Material

Cadaveric material was obtained from the RCSI through the cadaver donation program. One male cadaver and three prosections (one sagittal section of a female pelvis, one sagittal section of a male pelvis, one coronal section of a male head and neck) were used.

Dissection and Filming

A complete head to toe dissection was conducted. The dissection strictly adhered to the undergraduate

anatomy dissection instructions written by the RCSI Professor of Anatomy. One student dissected the cadaver while another filmed the entire procedure with a tripod-mounted, Cannon DV camera and maintained adequate lighting with a photographic flood light. In addition to filming the dissection process, numerous other sequences were recorded for subsequent incorporation into the edited movie to help students comprehend the orientation of the cadaver and relations of anatomical structures. The specific position of the camera in relation to the cadaver was carefully chosen to maximize visibility of anatomical structures and illustrate dissection technique. In numerous cases, this necessitated the dissection being conducted off camera, and then staged on film.

Film Editing and Production of Software

Approximately 72 hr of DV footage was recorded during the entire dissection process. DV was transferred from the DV camera, via a fire-wire cable, to an Apple iBook. Apple's iMovie software was used to edit the DV footage, record narrations, insert illustrations and add text or titles. Once a movie was compiled, iMovie was used to convert it to QuickTime MPEG format. All movies were compressed with the Sorensen Video compression engine. Early in the development process, a decision was made to limit the length of the movies to 5 min or less, due to considerations for file size and students' attention spans. Accordingly, not all footage is presented in real-time. Macromedia Director 7.0 (educational edition) was used to produce an interactive platform for presenting each movie, its associated text, illustrations, and still pictures.

Implementation and Accessibility

The software suite was made available to 240 first-year medical students in the autumn of 2001, free of charge. Students could view the software on computers in the anatomy dissection lab, the CAL laboratory or the library. Furthermore, students could obtain the software for download from the RCSI intranet site or in the library.

RESULTS

The completed process resulted in a series of CD-ROMs containing all programs for every dissection class for each region of the body (i.e., thorax, upper limb, abdomen, etc.). A description of the software suite is given in Table 1. The software did not require any further applications or hardware to be added to the computers issued to students as part of their tuition fee package. Once a CD-ROM had been inserted into the disc drive, all the student had to do was click on the icon representing the dissection they wished to view. When the program launched, they would view the written dissection instructions for that class. After they read and comprehended the instructions, they could click on an icon to start the movie. Once the movie was playing, they could rewind, fast-forward or pause playback by controlling the QuickTime scroll bar.

TABLE 1. Description of Software Suite

Total number of CD-ROMs	5
Total number of files	44
Total file size	3426.4 MB
Total running time	2:58:50 hr
Average file size	77.9 MB
Range of file sizes	37.2 to 215.7 MB
Average movie running time	4:04 min
Range of movie running times	1:32–10:56 min

DISCUSSION

The production of this software suite was accomplished with the use of readily available, entry-level computer and video equipment. Production of the movies was a simple and quick process. Any problems with poor quality film or lighting could easily be corrected with Apple's iMovie software during the editing process. The cost to the educational institution was minimal and considerably less than a site license for many commercially available software applications. Moreover, the software was designed and produced by students who had previous experience with the RCSI anatomy curriculum. Accordingly, the software is tailored to the RCSI educational objectives and provides students with an effective, straightforward resource for instruction and review.

Students' response to the instructional dissection software has been very positive (Table 2). The majority of students who used the software found that it alone was a sufficient instructional resource for dissection class. Most of the students felt that the dissection software offered a good depiction of the dissection process they were expected to perform. Likewise, they deemed the software content to be consistent with other course references and materials. In addition to its original intended use, students used the software to review and study for anatomy examinations; the software allows students to review anatomical structures seen in earlier lessons which may not have been preserved during

TABLE 2. Evaluation of RCSI Dissection Software by First Year Medical Students[a]

Evaluation item	Strongly agree[b]	Agree	Neutral	Disagree	Strongly disagree	Mean[c]
I use the software to prepare prior to practical sessions	17 (15)	42 (37)	14 (12)	21 (18)	20 (18)	3.13
The software adequately prepared me for dissection practicals	23 (20)	51 (45)	12 (11)	4 (4)	24 (21)	3.39
The software adequately represented the anatomical structures I dissected/viewed in the anatomy lab	47 (41)	52 (46)	3 (3)	6 (5)	6 (5)	4.12
The content of the software is sufficient for learning	33 (29)	65 (57)	10 (9)	4 (4)	2 (2)	4.08
The content of the software was consistent with other course references and materials	73 (64)	10 (9)	3 (3)	5 (4)	23 (20)	3.92
I used the software to prepare for examinations	19 (17)	58 (51)	3 (3)	15 (13)	19 (17)	3.38
The software made my experience in the anatomy lab less intimidating	31 (27)	57 (50)	2 (2)	2 (2)	22 (19)	3.64
The software is easy to use	76 (67)	28 (25)	0 (0)	2 (2)	8 (7)	4.42

[a]Based on 114 returned questionnaires from a class of 240.
[b]Students responded to a questionnaire using a 5-point scale. Values indicate the number of responses with % in parentheses.
[c]Values are the mean response with Strongly Agree = 5 and Strongly Disagree = 1.

subsequent dissection classes. Importantly, students reported that the software made their experience in the anatomy lab less intimidating. In comparison to traditional media (i.e., written instructions, still diagrams), using the instructional, interactive, anatomy dissection software to convey dissection instructions increases the students' confidence in the dissection classes. The movies contained in the software provide instruction that is easier to understand because they give the user a better visual and spatial representation of the dissection and allow the user to review any part of the dissection before actually carrying out the dissection on a cadaver. The movies also show a depiction of the dissection that is commensurate with what the students will experience and allows them to set realistic goals for the dissection to be carried out.

Despite the fact that students found the software readily accessible, useful and easy to use, only a minority installed the software on their laptop computers or used it regularly to prepare for dissection class. Accordingly, further effort is being directed towards making the software even more accessible and increasing students' comfort and familiarity with novel instructional media. An attempt to increase students' use of the software has been made by giving a DVD containing the software to each first year medical student when they start the anatomy course. In addition, the RCSI Department of Anatomy further promotes the students' use of the software by referring to it during dissection classes and in other teaching materials it produces (i.e., dissection laboratory manuals). The Department has also integrated additional CAL software into its curriculum (i.e., online histology course), which will help to increase students' familiarity with novel instructional media. Early feedback from these initiatives shows increasing use of the software by students.

The increasing availability and waning cost of computer equipment has enabled many institutions to supplement their anatomy curriculum with CAL software (Gatti, 1993; Spitzer and Whitlock, 1998; Ackerman, 1999; Bacro et al., 2000; Nieder et al., 2000; Reidenberg and Laitman, 2002). Some institutions have used CAL software to replace time spent in the dissection lab, due to financial or logistical considerations (Paalman, 2000). At our institution, we believe that an integral part of the anatomy curriculum is to provide anatomy dissection classes in which students have the opportunity for 'hands-on' dissection experience. Although we feel that, currently, CAL software cannot fully replicate this experience, we believe that incorporation of CAL software into the curriculum leads to more effective use of the resources allocated to maintaining an anatomy dissection lab and more efficient use of the students' time spent in dissection classes.

The successful design and implementation of this dissection software demonstrates that CAL software can be employed to augment, enhance and improve anatomy instruction. Effective, high-quality, instructional multimedia software can be tailored to an educational institution's requirements and produced by novice programmers at minimal cost. Furthermore, with several simple initiatives, novel instructional media can be readily incorporated into the undergraduate medical curriculum.

ACKNOWLEDGMENTS

Thanks to Mr. Eric Clarke and Prof. W. Stanley Monkhouse of the Department of Medical Informatics, RCSI, and Prof. T. Clive Lee of the Department of Anatomy, RCSI.

REFERENCES

Ackerman MJ. 1999. The visible human project: a resource for education. Acad Med 74:667–670.

Acland RD. 2000. Acland's Video Atlas of Human Anatomy, 1st Ed (Video). Baltimore: Lippincott Williams & Wilkins.

Aziz MA, McKenzie JC, Wilson JS, Cowie RJ, Ayeni SA, Dunn BK. 2002. The human cadaver in the age of biomedical informatics. Anat Rec 269:20–32.

Bacro T, Gilbertson B, Coultas J. 2000. Web-delivery of anatomy video clips using a CD-ROM. Anat Rec 261:78–82.

Clemente CD, Harwick HJ, Mahoney LE. 1971. Guides to Dissection, Volume 1–42 (Video). Houston: Teaching Films, Inc.

Cottam WW. 1999. Adequacy of medical school gross anatomy education as perceived by certain postgraduate residency programs and anatomy course directors. Clin Anat 12:55–65.

Fitzharris TP. 1998. Survey of gross anatomy courses in the United States and Canada. Anat Rec 253:162–166.

Gatti AJ. 1993. The use of ADAM software in Podiatry. Clin Podiatr Med Surg 10:563–576.

Gregory SR, Cole TR. 2002. The changing role of dissection in medical education. JAMA 287:1180–1181.

Jones DG. 1997. Reassessing the importance of dissection: A critique and elaboration. Clin Anat 10:123–127.

Nieder GL, Scott JN, Anderson MD. 2000. Using QuickTime virtual reality objects in computer-assisted instruction of gross anatomy: Yorick-the VR skull. Clin Anat 13: 287–293.

Paalman MH. 2000. New frontiers in anatomy education. Anat Rec 261:47.

Parker LM. 2002. What's wrong with the dead body? Med J Aust 176:74–76.

Reidenberg JS, Laitman JT. 2002. The new face of gross anatomy. Anat Rec 269:81–88.

Slizova D, Krs O, Pospisilova B. 2001. Increasing quality of anatomical education by introduction of digital imaging into documentation of topographic dissection. Acta Medica (Hradec Kralove) 44:145–147.

Spitzer VM, Whitlock DG. 1998. The visible human dataset: the anatomical platform for human simulation. Anat Rec 253:49–57.