Our Experiences with Development of Digitised Video Streams and Their Use in Animal-free Medical Education

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Summary — Alternatives and their teaching are an essential part of the curricula at the Faculty of Medicine. Dynamic screen-based video recordings are the most important type of alternative models employed for teaching purposes. Currently, the majority of teaching materials for this purpose are based on PowerPoint presentations, which are very popular because of their high versatility and visual impact. Furthermore, current developments in the field of image capturing devices and software enable the use of digitised video streams, tailored precisely to the specific situation. Here, we demonstrate that with reasonable financial resources, it is possible to prepare video sequences and to introduce them into the PowerPoint presentation, thereby shaping the teaching process according to individual students' needs and specificities.

Key words: *alternatives to animals, digitised video streams, teaching, time-lapse microscopy, video recording.*

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Introduction

Laboratory animals used to play a traditional role in the curricula at most medical faculties. This was also the case in our faculty until 1989. After the revolution in 1989, society's attitudes in our country changed substantially and the welfare of animals became an important issue. In 1993, a new *Animal Protection Law* (fully harmonised with European Union [EU] *Directive 86/609/EEC*) was implemented. With the help of leading experts from the EU, and with financial support from the EU, we organised the TEMPUS (Trans-European Mobility Programme for University Studies) Joint European Project No. 1485 (1991–1995). Based on these activities, our faculty reduced the number of laboratory animals used for teaching purposes dramatically (for details, see Report of the TEMPUS Evaluation Meeting [1]). Currently, only a limited number of laboratory rats, mice and rabbits are used during practical classes, and in only two departments. Thus, the main outcome of the TEMPUS project was the adoption of a new curriculum. In this curriculum, the emphasis is put on two aspects of alternatives:

1. replacement of laboratory animals in practical classes; and
2. theoretical and "hands-on" teaching of *in vitro* methods.

Furthermore, an essential part of the new curriculum is a special seminar dealing with the theoretical background of alternatives (the Three Rs concept).

To carry out all of the alternative teaching activities, teaching materials must be meticulously prepared. In addition, these materials should be in such a form as to allow their frequent updating based on discussions with students or due to new developments in the field. This is now easily accomplished, because of the almost uniform use of PowerPoint-based presentations during lessons and practical classes. In our departments, we have numerous experiences with the preparation and subsequent use of a whole range of video recordings. These videos are very suitable for teaching, due to their dynamic nature. On the other hand, once prepared, these dynamic screen-based materials are difficult to modify according to the individual requirements of teachers. Moreover, it is not especially convenient to use the video recorder during lessons. Therefore, we tried to develop and introduce a simple system for the inexpensive conversion of video recordings into digitised video streams, which can be easily incorporated into PowerPoint presentations. We hope that these techniques will help us to proceed toward our ultimate goal: animal-free teaching at the Faculty of Medicine in Hradec Králové.

Methods

In the first half of the 20th Century, many scientific films were recorded in 16mm format, successfully documenting various research activities, with some

of them describing experiments on animals. In the second half of the century, video recording became more and more dominant, and a great number of educational videos were produced, either commercially or by teachers themselves. Unlike the 16mm format, the great advantage of video recording is the possibility to inspect the recording immediately. Taking advantage of this feature, we have produced short videotapes dealing with *in vitro* toxicity assessment, recording mainly the toxic effects of some compounds on cells cultured *in vitro* with the help of time-lapse photography (2).

Since the 1990s, it has become possible to record images directly, by means of digital cameras, and to store the resulting files in a digital format. This way of recording offers the advantages of computer-enhanced image analysis, including its presentation. On the other hand, there still exist numerous situations where the use of conventional video format appears to be more convenient, due to technical system requirements and the actual layout of the experiment, financial aspects notwithstanding.

A Hybrid System: Digitisation of Video Sequences

We believe that combining both analog and digital approaches offers a suitable compromise, and this hybrid approach has many advantages. The system is based on recordings acquired by a camcorder or time-lapse video recorder. The recording is subsequently converted into a digital format, while taking advantage of the entire range of editing options. Finished digital files can be freely incorporated into presentation programs, or they can be easily published in electronic Internet-based journals, an important option. Basic advantages of this approach include high image quality, flexible control of image quality, instant availability of all acquired images, and the option of data transfer and building of electronic image databases comprising image descriptions.

The hybrid approach involves the following steps:

1. image capture on magnetic videotapes;
2. digitisation and editing of recordings;
3. presentation; and
4. storage.

Video capture

It is possible to use any camcorder (we use a Panasonic AC-455MB S-VHS movie camera) or video camera connected to the video recorder. The latter approach is preferred for the time-lapse video recording of cells cultured *in vitro*. We have also used a JVC TK-C1481 camera and a Mitsubishi video recorder HS-S8300.

Digitisation and editing of video recordings

In this step, the most important issue is the choice of suitable software. Apart from professionals' needs, where different requirements are applied, amateur video standards are most satisfactorily met by the Adobe Premiere 6.0 program. This software enables relatively rapid digital conversion of analog recordings into a digital format, and their retrieval, editing and storage, including visual and sound effects. Nevertheless, the entire process has high memory demands, because the size of a single digital image at resolution 512 × 384 pixels is 384KB; thus a five-minute video sequence (6000 images) takes about 2.2GB. To solve the problem of size, one has to consider compression. We have several options for choosing a compression format that will be most suitable to our particular needs. Generally, the most common is MPEG (moving picture expert group) compression, which exists in three formats (Table 1).

MPEG-1 offers lower quality, but considerable compatibility; it is not demanding on hardware, but the resulting files are bigger. MPEG-2 offers high quality, in particular for Digital Versatile Disc (DVD) and digital TV, but again, the resulting files are bigger. MPEG-4 offers higher quality and the final files are smaller, but it requires speedier computers.

Table 1: Moving Picture Expert Group (MPEG) compression formats

	MPEG-1	MPEG-2	MPEG-4
Year of introduction	1993	1995	1999
Bit rate	1.0–1.5Mbit/second	up to 100Mbit/second	0.01–1.0Mbit/second
Image quality	Sufficient	Excellent	Excellent
Hardware requirements	150MHz	300MHz	400MHz

Presentation of video sequences

Digitised video sequences can be stored on any transport medium (e.g. IoMega ZIP, CD-ROM, DVD). Sequences can be presented by means of specialised programs; for example, ATI, WinDVD 2000 or PowerDVD. The most convenient form for presentation is PowerPoint. Here again, care must be taken to check the compatibility between this program and the digital video stream.

Discussion

We have examples of three types of digitised video streams:

1. Recordings of experiments with animals (e.g. anaesthesia, endotracheal intubation and artery cannulation in the rat) — eliminating the need for animals during practical classes.

2. Recordings of *in vitro* alternative methods — stimulating the understanding of the *in vitro* approach.

3. Recordings of the dynamics of cell responses to a toxic agent *in vitro* — demonstrating the potential of cell cultures as a main alternative in toxicity testing.

Some of our sequences may be accessed at our departmental homepage (http://www.biologie-lfhk.cz), as well as in the Internet journal, *Frontiers in Biosciences* (http://www.bioscience.org).

Evaluation and Conclusions

Effectiveness and student attitudes to this approach were evaluated in an anonymous survey. The students' responses were very positive. We believe that, with this method, we can significantly reduce the number of animals used in teaching, and in the future, promote animal-free teaching.

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