Paper to be presented at ESERA2007, Malmö, August 21-25, 2007.

Perspectives on the use of Computer Technology in College Physics Education in China

Zhu Xia[a, b], Liao Boqin[a], and Jonte Bernhard[b]

[a]Physics Department, Southwest University, 400715, Chongqing, P. R. China
[b]Eng. Ed. Res. Group, ITN, Linköping University, SE-601 74 Norrköping, Sweden

Introduction

In China, traditionally, teachers present lectures on a blackboard. After class, students have a chance to watch some videos on the application of physics and physics experiments. In 1998, multimedia lectures appeared for the first time. Recently, this type of multimedia lecture, combined with whiteboard and real demonstrations, has become popular. According to the *Essential Requirements of College Physics,* the use of multimedia and the Internet is required for college physics teaching. It is thus necessary to discuss what new possibilities are provided by computer technology to improve college physics education.

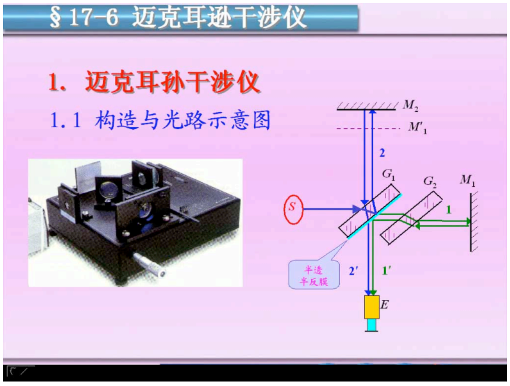

Figure 1. Example from multimedia courseware developed in P. R. China.

Argumentation

In physics education, computer technology can be used to visualise phenomena. Multimedia lectures can make physics visual: clarifying physics concepts, making physics vivid, deepening student understanding and making the knowledge more impressive. Some complex physics phenomena, concepts and principles are difficult for students to imagine. For instance, how can the components of rotational vector in uniform, circular motion demonstrate simple harmonic motion (Halliday, Resnick, & Walker, 2005)? With multimedia this is easy to illustrate because of the visual process.

Multimedia courseware enhances the power of class presentations. After listening, humans can memorize 15% of the material presented, whereas after seeing, humans can memorize 25%. After both listening and seeing, humans can memorize 65% of the facts presented. Therefore, integrating sound and image in courseware will improve student learning in college physics education.

In physics education, computer technology can be used to expand reality, beyond the limits of the classroom, in time and space. The experience can be made broader by the use of videos. Experiments that are time-consuming to set up, can be shown in a shorter time and those that require expensive equipment, or are difficult to carry out, can be demonstrated. An example of this is a video, made by Professor Yun, showing the real process, at a factory, of induction heating.

In physics education, computer technology can be used to open new windows to the world. Although the underlying, fundamental physical principles, typically presented in a

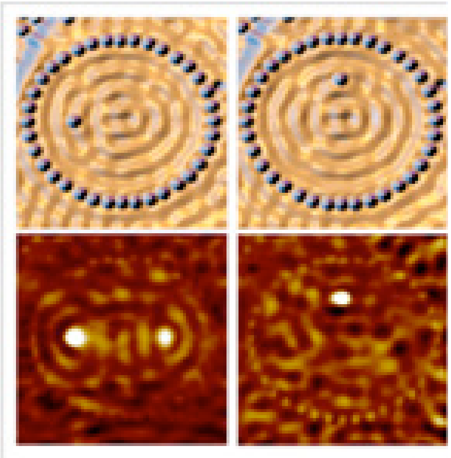

Figure 2. Quantum mirage effect.

physics course, are stable, the developments and applications are continuously changing and evolving. At the same time, the realisation that scientists want to acquire or enhance their own knowledge, may motivate students to study physics. After studying quantum effects, some students expressed a strong interest in this topic. An example of the results of an internet search, made by these students into the "quantum mirage effect, is shown in figure 2. When a magnetic cobalt atom is placed at a focus point of an elliptical corral (upper left), some of its properties also appear at the other focus (lower left), where no atoms exists (appears as a bright spot at each focus). When the cobalt atom is placed elsewhere within the ellipse, but not at a focus point (upper right), the mirage disappears (lower right). This shows that, because of the wave nature of electrons, information could potentially be transferred without wires. The quantum mirage could enable the miniaturization of electronic circuits far beyond that envisioned today (Manoharan, Lutz, & Eigler, 2000).

In physics education, computer technology provides opportunities for both teachers and students to share the courseware material with anyone, anywhere, anytime. At present, in the local area networks of many universities in China, lecture notes and question banks are stored, video lectures are, in some cases, also stored, multimedia courseware and material banks are provided and BBS discussion areas (question and answer) are available. Question banks can provide students with immediate feedback and help them build transferable, problem-solving skills. Presently in China, teachers and students can share course material at three levels; within the university, within China, and with the world. MIT OpenCourseWare[1], since its inception in 2002, has become the world model for educational sharing. China Open Resources for Education promotes open sharing of educational resources within China, and shares Chinese OCW globally[2]. Global OpenCourseware enhances Chinese teachers' ability in class preparation and presentations.

Figure 3. China Open Resources for Education as an example of sharing of courseware.

It is now possible, in China, for teachers to integrate text, graphics, audio, video, animation, and images into the multimedia courseware and implement it in a classroom. An example is *The General Physics Multimedia Courseware* (Zhu et al., 2001). This was developed by Zhu Xia, as the group leader of the developing team. It is interactive and user-friendly. Following the instructions, teachers may easily adapt, customize, and add to the courseware to meet the needs of their course. According to Middendorf and Kalish (1996), the

[1] http://ocw.mit.edu/index.html
[2] http://www.core.org.cn/en/index.htm

average attention span for college students is about 15-20 minutes. The animation and demonstrations can deepen understanding and prevent students from losing their concentration. But it should focus on the critical aspects of learning, rather than just be entertaining. Moreover, developing the critical thinking capabilities (Ellis, 2001) and abstract thinking capabilities are important tasks of physics education. When and where to use them should be analysed carefully.

The use of multimedia courseware is not only changing the style of lecture, but will also improve the conditions for learning physics. Ausubel (1968) once stated that "If I had to reduce all of educational psychology to just one principle, I would say this: the most important single factor influencing learning is what the student already knows." Computer technology provides new possibilities for improving college physics education. But the technology will not determine learning outcomes. Bernhard's (e.g. Bernhard, 2007) research shows that technology only provides the possibility of, but does not guarantee an improvement in physics education. Following Tinker (1996), Bernhard (2003, p. 320) notes the importance of educational design and argues "Computer aided learning, can not be implemented as only a technology. The educational implementation is of crucial importance and hence there is no definite answer to the common question whether computers help to achieve 'better' learning." Therefore, the key to changing the possibilities into reality, is that teachers must design their own class presentation according to different students, and the website resource should be an optional supplement.

Conclusion

Computer technology provides new possibilities for making college physics education more effective and efficient than ever before. In China, through the multimedia courseware and Internet, including local area network, implementation of these possibilities into reality is happening.

Bibliography

Ausubel, D. P. (1968). Educational Psychology: A Cognitive View. New York: Holt, Rinehart and Winston.

Bernhard, J. (2003). Physics learning and microcomputer based laboratory (MBL): Learning effects of using MBL as a technological and as a cognitive tool. In D. Psillos & K. P. & V. Tselfes & E. Hatzikraniotis & G. Fassoulopoulos & M. Kallery (Eds.), Science Education Research in the Knowledge Based Society (pp. 313-321). Dordrecht: Kluwer.

Bernhard, J. (2007). Thinking and learning through technology - Mediating tools in engineering education. Paper presented at the Thinking Conference, Norrköping.

Ellis, T. J. (2001). Multimedia enhanced educational products as a tool to promote critical thinking in adult students. Journal of educational multimedia and hypermedia., 10(2), 107-123.

Halliday, D., Resnick, R., & Walker, J. (2005). Fundamentals of physics (7th ed.). New York: Wiley.

Manoharan, H. C., Lutz, C. P., & Eigler, D. M. (2000). Quantum mirages formed by coherent projection of electronic structure. 403(6769), 512-515.

Middendorf, J., & Kalish, A. (1996). The "change-up" in lectures. National Teaching & Learning Forum, 5(2), 1-5.

Tinker, R. F. (1996). Introduction. In R. F. Tinker (Ed.), Microcomputer-Based Labs: Educational Research and Standards (pp. 1-10). Berlin: Springer.

Zhu, X., Chen, J.-B., Xiao, C.-C., Deng, M.-X., Yan, H., & Liu, L. (2001). Multimedia Courseware of General Physics (CHN). Beijing: Higher Education Press.