Virtual Learning Approach in Practical Education of Cutting Technology

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1. Preliminaries

The theoretical curriculum of the subject titled Cutting Engineering Practice was processed for multimedia support in the late 1990s. During curriculum development, we endeavoured to exploit a wide range of multimedia opportunities, therefore the educational aid contains animations, figures and videos. The electronic curriculum enhanced by multimedia components helps students understand basic concepts; knowledge is better mastered by repeating the material of the lesson. Students are absolutely motivated to review the learning materials enhanced by electronic content since opportunities are rarely provided for playing the entire videos during lessons. So for example, the course of manufacturing cars in individual, series, and mass production cannot be squeezed into practical training when presenting the size of manufacturing series; in their free time, however, students are happy to watch the presentation again together with the associated videos.

Animations are to present simple motions, machine-tool functions, or even the use of instruments. Professors' explanations become simpler by integrating animated teaching material parts in a swf format. An example is the presentation of the coulisse drive of a transversal plane. By the animation displayed, the principle of operation of the machine tool can be understood in a moment without having to disassemble the plane machine to present the mechanism.

Fig. 1. Interesting and useful videos in the traditional curriculum

In addition to animations, the figures in the curriculum also assist in comprehension; the oral information heard can be reviewed after the lesson. In regular practical training, the multi-purpose turner's lathe is presented beside the machine tool; from the electronic teaching material made available, however, students can retrieve the structure, function, and principle of operation of subassemblies at any time. The figures help students consolidate the new information heard during the lesson. The images integrated into the teaching

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material were edited by the Adobe Photoshop software, highlighting substantial parts, since a drawing or a figure is often worth more than a thousand words.

The teaching material contains many videos as well; their full presentation would take valuable time from practice lessons, therefore we concentrate only on the important scenes in the videos and comment on what we have seen. On the one hand, videos include the presentations and machine operations referred to; on the other hand, they present phenomena and special machining methods which we cannot present in the industrial unit of the Institute. As for the chapter on special turner's lathes, let us mention the in-situ adjustment of railway wheels, which is a special turning operation; the video thereon is closely related to the topic, but in cannot be presented live. The process of edge heap generation, imperceptible to the eye, is illustrated by a high-resolution slow-motion recording; this way the phenomenon will be better retained by the student's memory. (Figure 1)

2. THE STRUCTURE OF THE VIRTUAL LEARNING ENVIRONMENT

At the end of 1990s years the application of Virtual Learning Environment (VLE) spread in higher education in Hungary rapidly. Centre for Teacher Training and Engineering Education was the first in Budapest Polytechnic which created the first virtual course. Firstly we had to plan the structure of VLE system, so examined the results of some international researches.

Romiszowski arranges the two basic forms of cognitive activities, that is the mode of learning and the form of communication, along two parameters in VLE. The former may be of an individual, social or group kind while the latter may be of an online, real-time and synchronous kind or of offline, non-real time and asynchronous kind. [1]

Combinations of these may manifest themselves in the most varied forms of electronic training: Web Based Learning, Computer Based Training, E-learning, and VLE. [2]

In the case of Web Based Learning access to the syllabus is by the web browser either via intranet or extranet. Syllabus reachable this way often contains access to other such training resources as for example reference tasks, e-mail addresses, notice boards and discussion board.

Computer Based Training (e-Learning) is a form of electronic learning which aims at the acquisition of learner knowledge or qualifications. According to its form, the electronic syllabus may be of an optional storage-run and multimedia based kind and/or of a hypermedia based kind accessible via web server. [3]

VLE is a form of electronic learning which takes place in an integrated syllabus-transmitting, communicative and student-registry system. Frame systems (Blackboard, WebCT, Moodle) contain standardized elements (LMS, SCORM) and may be run on web servers.

These forms of electronic learning may be interpreted within the framework of traditional and distance learning alike. In the former case the so-called face to face forms of education are combined with the Internet-based learning environment. In the course of processing our modules, we too realized the form of learning referred to as "blended learning" in the technical literature. Virtual classroom is defined as the entity that associates a course with one or more students and one or more tutors/mentors/facilitators with the purpose of reaching some common educational goals (realization of course). Virtual classrooms use the services of the system to reach these goals.

In VLE, where students mainly had to perform a self-directed and self-regulated learning activity, the efficiency of learning was determined by the maturity of the abilities of independent communication, knowledge acquisition and thought.

The learning process in VLE can be best described by the Jarvis model. (Figure 2)

He sets out to show that there are a number of responses to the potential learning situation. Jarvis used Kolb's model (quoted in [2] and in [3]) with a number of different adult groups and asked them to explore it based on their own experience of learning. Jarvis was then able to develop a model, which allowed different routes: non-learning, non-reflective learning, reflective learning (see below). To see these we need to trace out the trajectories in the figure he produced. [6]

a) Non-learning cognitive activities

- Presumption (1→2→3→4). This is where people interact through patterned behavior.
- Non-consideration (1→2→3→4). Here the students do not respond to a potential learning situation.

b) Non-reflective learning

- Pre-conscious (1→2→3→6→4 or 9). This form occurs to learners as a result of having experiences in daily life of which they are unaware. Skimming across the surface.

- Practice (1→2→3→5→8→6→4 or 9). Traditionally this has been restricted to things like training for a manual occupation or acquiring particular physical skills. It may also refer to the acquisition of language itself.

- Memorization (1→2→3→6[→8→6]→4 or 9).

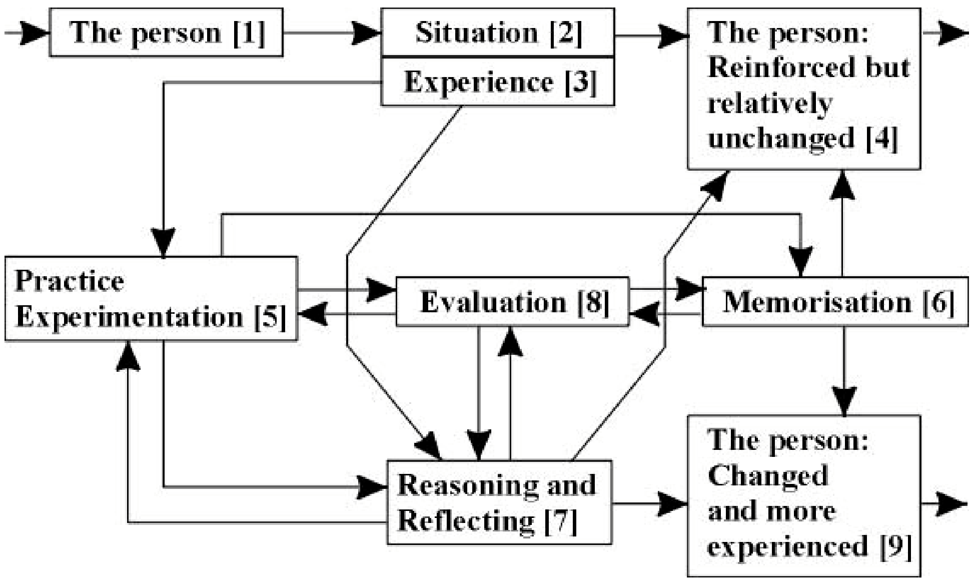


Fig. 2. Experimental learning model

c) Reflective learning

- Contemplation (1→2→3→7→8→6→9). Here the learners consider something and make an intellectual decision about it.

- Reflective practice (1→2→3[→5]→7→5→6→9). This is close to what Schön, D. [quoted in 6] described as reflection on and in action.

- Experiential learning (1→2→3→7→5→7→8→6→9). The way in which pragmatic knowledge may be acquired.

According to Kirschner and Paas [7] the e-learning is learning (and thus the creation of learning and learning arrangements) where the Internet plays an important role in the delivery, support, administration and assessment of learning. We use this term for virtual learning as well to indicate that we need a variety of coherent measures at the pedagogical, organizational and technical levels for the successful implementation of virtual learning in combination with more conventional methods. Integrated or blended learning therefore typically tries to combine elements from face-to-face teaching, distance learning and training on the job.

As an integration of the results of previous projects in the autumn of 2006 Centre for Teacher Training and Engineering Education made an endeavour to create a virtual learning environment of our own (Moodle). We launched our first electronic courses, based on content developments supported by ”Apertus” Public Foundation (the project leader was Dr. Peter Toth) and Tempus Public Foundation (the project leader was Dr. Pal Pentelenyi). The first virtual course processes educational technology and multimedia. Besides electronic syllabus development we considered it important to reflect upon the design aspects of the VLE system. Therefore we formed a team responsible for the creation and operation of the system to test the quality of the completed electronic course [6].

Figure 3 shows the screen design of our first electronic teaching materials. In the top left hand corner of the screen, we can see the current unit, in the top right hand corner, navigation links to the chapters, the glossary and to help, while in the bottom right hand corner we can see sequential navigation links within the unit itself. In addition to the time-dependent parts of the subject matter (text and images), time-dependent media (narratives, animations and videos) may be started in the bottom left hand corner. In order to avoid packed screens, in justified cases there are floating windows to present further textual information.

Fig. 3. The graphic surface of the electronic teaching material

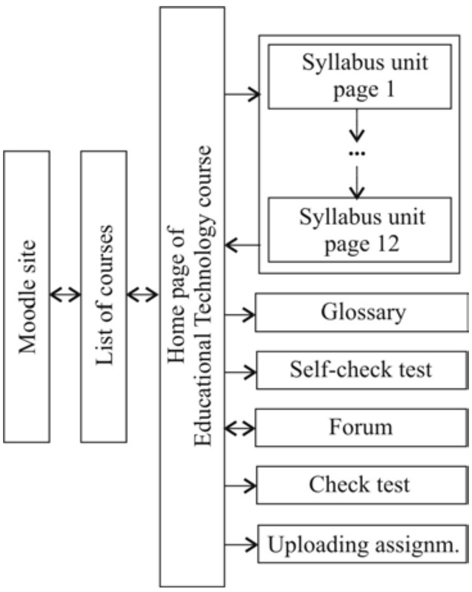


Fig. 4. The structure of the syllabus content

This quality testing must cover the content and structure of the syllabus as well as such elements of the user interface as for example the ergonomic, psychological and pedagogical examination of the graphical layout of the screen or the evaluation of interactive and navigational possibilities offered by the system.

Figure 4 shows the structure of the course under scrutiny. Having entered Moodle, the learner selects first the course to be studied then the most appropriate ones to his needs of the particular units of the syllabus, of the learning aids and of the communicative forms on the home page. Six such objects have been incorporated in the virtual course under scrutiny, namely an electronic syllabus, a glossary, a self-check test, a forum, a check test and an uploading assignment.

3. Establishing a virtual learning environment in the Moodle system

We are aware of the fact that a virtual learning environment cannot fully substitute for traditional practical training: machine-tools will still have to be acquainted with and used in reality in order to master the basics of cutting engineering. However, a virtual learning environment and the electronic content included provide opportunities for processing the theoretical background material of cutting. We aim to apply the two methods together, to establish a most efficient educational environment by selecting proper proportions.

In our opinion, the subject of Cutting Technology embedded in the Moodle educational system may improve practical training for cutting; we see novel opportunities in teaching this vocational subject. The virtual course was developed in cooperation by two organisational units of the Budapest Polytechnic, the Centre for Teacher Training and Engineering Pedagogy and Bánki Donát Faculty of Mechanical Engineering. The Centre was responsible for the pedagogical issues of establishing an electronic learning environment, while the Faculty was responsible for the content issues thereof. Cutting Engineering is included in the vocational subjects of BSc mechanical engineering training; it is of utmost importance to all students, especially to those specialized in CAD/CAM. Future mechanical engineers and engineering assistants can be expected to be skilled in this subject; however, knowledge of various levels is required for mastering the science of cutting. Courses embedded in the Moodle system have been developed for the following levels:

- Level 1: for students not involved in specialist training
- Level 2: for engineering assistant students
- Level 3: for students in regular BSc training
- Level 4: for students specialized in CAD/CAM
- Level 5: for students opting for special elective subjects.

Each level assumes to have mastered different levels of knowledge, therefore students are allowed to step one level up after completing the modules designated for them. Work performed in this virtual learning environment links up with the educational process of the regular training course, progressing in parallel with it (blended learning). The fact that levels are built on each other is ensured in traditional BSc training as well; this way students unskilled in Cutting Engineering can be prevented from first mastering more vocation-specific elective curricula. The Moodle system provides an opportunity for this, among other things.

- The course titled Cutting Engineering 1 provides assistance to students coming from grammar school or a vocational secondary school of other specialty. Here, the focus is on understanding basic concepts and the presentation of fundamental technical correlations. The main pedagogical objective of the course is to raise interest and to direct students' attention to the importance of cutting, since our everyday objects are inconceivable without it. Even if indirectly, cutting appears in all our articles of use because during the product manufacturing process, components produced by cutting must have been used, and they were produced by machines and production lines also consisting of cut components. The course titled Cutting Engineering 1 is intended to include a curriculum to absolutely comply with the requirements mentioned above, and is abundantly supported by videos and animations. This course can be made good use of in correspondence training as well, especially for students who do not work in this special area, and/or are not skilled in this subject.

- The course titled Cutting Engineering 2 is intended to support the curriculum of engineering assistant training, which much more involves the practical application of basic concepts. The pedagogical objective of the course is to apply the correlations learned and to present the tools and equipment of state-of-the-art cutting. Engineering assistant training is characterized by the fact that it goes on in several cities in the country like Budapest, Győr, Kecskemét, and Békéscsaba. Transferability between institutions is ensured by standardized curricula and examination systems, contributed to by the course titled Cutting Engineering 2 embedded in the Moodle system.

- For the course titled Cutting Enginering 3, it is assumed that students are interested in cutting; it is hoped that students are sufficiently motivated to take in new knowledge. During this course, students get acquainted with the theoretical correlations of cutting; the practical utility of calculation formula is intended to be highlighted. All students of regular mechanical engineering training are to take up the course titled The Basics of Cutting Engineering, therefore the material learned at lectures and practice courses can be replayed. The chapters of the electronic curriculum consisting of modular components are intended to be compiled in a way that students could also make use of them later on in their studies as well, both in regular and correspondence training courses. Due to large student numbers, the test function of the Moodle system can be made good use of in this course.

- The level 4 course of Cutting Engineering is developed for students of mechanical engineering specialized in CAD/CAM. CAD/CAM means computer-aided production design; this specialty is a successor of the former production technology. A deeper understanding of Cutting Engineering is a basic requirement at this level, as the topic of CAD in Cutting Engineering – based on this subject – is included in the graduation examination as well. Students specialized in Automotive Engineering or Machine Design are not concerned by this course any longer, therefore the conditions of education are more favourable. In practice, this means that the annual average number of regular students specialized in CAD/CAM is 50 to 60. Students' higher-level professional knowledge enables them to complete workshop assignments and projects in a Moodle environment. Ideal conditions for this are provided by the communication tools of the system (Forum, Chat).

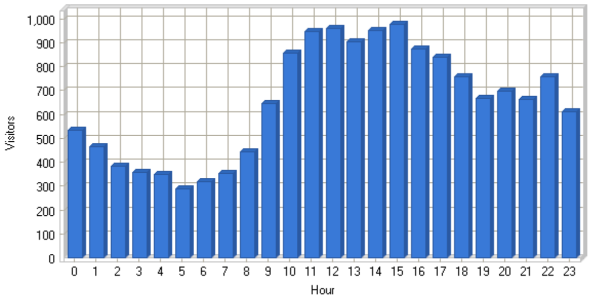
- Level 5 of Cutting Engineering awaits those students specialized in CAD/CAM who are willing to participate in scientific experiments of Cutting Engineering, and would produce a thesis on such research. This course is an elective course to be opted for within the regular training course. In completing the course, students' research work and expertise activities are supported by Moodle. Effective means in this respect include Wiki, Workshop and Forum.

Courses of Cutting Engineering at any level are based on modules in a Moodle virtual environment, produced by applying, supplementing and revising earlier electronic curricula. Although the contents associated with some of the levels are still awaiting development, the architecture and structure of the course has already been realized. The curriculum of each module has been embedded separately, thus students' activity in each module can be traced. The Moodle system can produce statistical reports; the data will tell which chapters we will have to revise. Students use the curriculum of Cutting Engineering 1 regularly and in great numbers, as evidenced by the statistics function of the Moodle system. Figure 5 shows the time spent in the curriculum of module 1; it can be inferred therefrom that students watch the enclosed videos as well.

Introduction to the practice of cutting is approached from the aspect of production; students themselves can decide about the importance of cutting. A separate chapter is devoted to the basics, components and structure of manufacturing processes, as well as to the position and role of cutting in manufacturing processes. Chapter 3 discusses the basic phenomena and ways of cutting. The module involves a collection of basic terms, videos to help understanding, and a collection of electronic aids.

Module 2 discusses the subject of turning; the chapters are built up of the associated practical curricula. The basic phenomena, ways, and tools of turning are discussed together with characteristic workpieces and chips; the structure and operation of a turner's lathe is presented together with its appliances.

In modules 3-7, further cutting procedures are elaborated, such as boring, milling, chiselling, planing, and grinding. Similarly to turning, the chapters consist of the associated practice-oriented parts. The basic phenomena, ways, tools, workpieces and chips of the technology concerned are discussed; the structure and operation of machine-tools and their characteristic appliances are presented.



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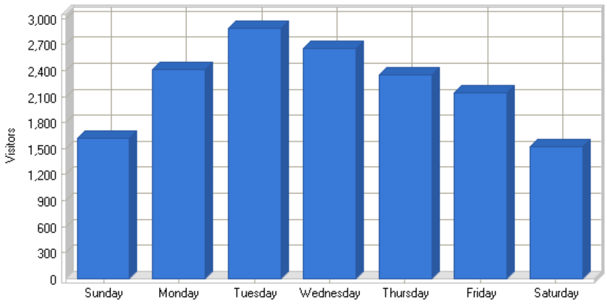

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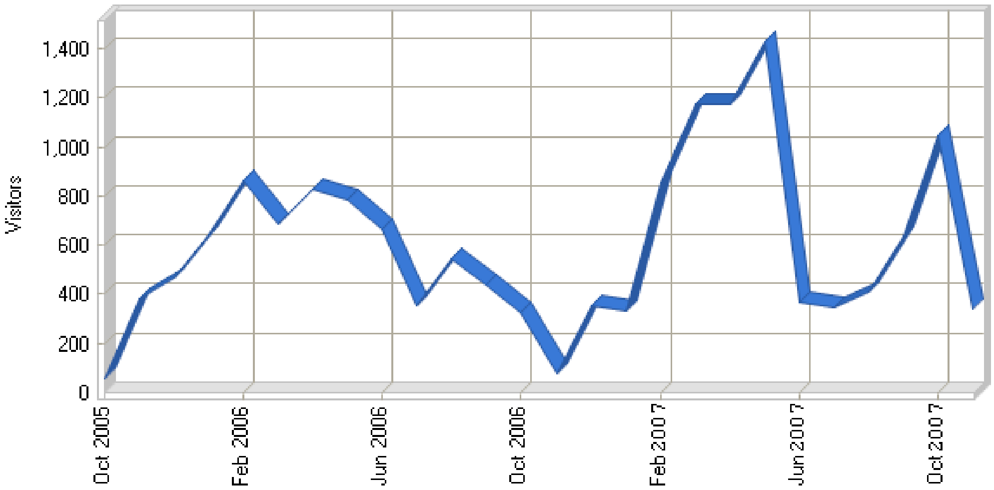

c)

Fig. 5. Student activities in virtual course

Fig. 6. Structure of Cutting Engineering 1

For students taking higher-level courses in Cutting Engineering, this curriculum is supplemented by presenting other procedures, on the one hand, and it is enriched by deeper and deeper professional content on the other hand. Level 3 involves, among other things, the technology of hollowing and cogwheel production procedures; level 4 – intended for students majoring in CAD/CAM – presents the ways of spark cutting. More profession-specific curricula are built into level 5 with the module titled Production Process Informatics, where students can master research activities related to tool certification.

SUMMARY

Virtual Learning Environments are built on a foundation of two key elements: computer technology and education. The technology aspect of virtual learning environments provides facilities for learning management tools, online learning frameworks, collaborative learning environments, web course design tools, etc. The system typically resides on a server and is designed to manage or administer various aspects of learning; delivery of materials; student tracking; assessment and so on. We tried to integrate the virtual learning environment and the traditional face-to-face teaching-learning process in training of cutting technology. We are convinced that the modules of cutting interpolated into a virtual environment contribute to the enrichment of students' knowledge. We know at the same time that they will only be real professionals if they get to know and use machine-tools in their real environment as well.

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