Computer – aided training as an effective tool for prevention of chemical risks

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Abstract:
In this paper is presented how computer aided training in the Course of Science of Risk and Safety encourages students to find information, solve the problems and prevent chemical risks through the new knowledge. The author shares own experience of teaching this course for the students of Chemical Engineering and Gene Technology. This paper shows how computer aided training of Occupational Health and Ergonomics changes students` thinking and attitudes to chemical risks in the working environment.

Introduction:
Technology promises increasing access to more and better information. To help students turn information into knowledge, teachers need to know the new teaching strategies. Psychosocial issues, ergonomics and chemical risks are among the priority areas for future occupational health and safety research, according to a new report published by the European Agency for Safety and Health at Work.
The report *Future Occupational Safety and Health Research Needs and Priorities in the Member States of the European Union* presents the findings of a survey of EU Member States and reveals broad agreement across Europe as to what are the key emerging risks and research needs.
The development of accurate models to describe the dynamic behavior of processes will continue to be a challenge. Such models are needed to analyze process response to disturbances and to predict operating hazards, to test new control strategies, for use in operating training, etc. Processes of present interest include: energy distribution systems, energy conservation strategies, processes involving very high purity separations, hazardous waste treatment and disposal processes, and processes involving newly developed biotechnology. (Howard).
Chemical Engineers now have a dazzling array of computing resources available to them. Fortran and other high level languages, spread sheets, mathematical packages such as Polymath and Mathematica, graphics packages, CAD packages such as CADKEY, special purpose simulators such as Chemsep and PICLES, and full scale process simulators such as PRO/II, Aspen, Hysim, and Chemcad are all tools that are used at some stage in the curriculum. The pedagogical question is how best to integrate them into a unified educational experience that takes advantage of this enhanced computational capability without distracting from developing the fundamentals of problem solving skills and engineering judgement. The evaluation of learning strategies and experiences is a constant challenge.(Howard).

Computer aided training experience in Tallinn Technical University

In September 1999 a new ergonomics laboratory with computers was installed in Tallinn Technical University. These facilities help to inspire to search Health and Safety information in Cyberspace for their studies (Siirak, 2000).
The course Sciences of Risk and Safety to the students of the Faculty of Chemical Engineering and Gene Technology (Bachelor level) was provided autumn 2001. During practices students were inspired to use the internet and find the modern Occupational Health and Safety information from internet databases and to use the databases of the European Agency for Safety and Health at Work,

U.S. National Institute of Occupational Safety and Health (NIOSH) etc. The special web-site for the students was prepared.

Aim of the study

The aim of the study was to find out how effective is computer aided training for prevention of chemical risks.

Material and method

After the course questionnaires were given to the 20 students The questions were how they appreciate the computer-aided training for learning and understanding chemical risks and how they appreciate the availability of information about chemical risks on the web site of the European Agency for Safety and Health at Work..

Results

Most of students (19) answered that the computer-aided training is the most effective method for learning. The new information from Cyberspace has changed their thinking and attitude for reducing chemical health risks and inspired students to prepare the research papers for the examination. They appreciated high the information from the web site of the European Agency for Safety and Health at Work and the availabilility of European directives and standards.

Example of the students research paper

Students **Kristel Hälvin**, **Maarja-Liis Puust**, **Signe Reinsalu, Katrin Sell, Janne Tambek, Eneli Tombak** (Faculty of Chemical Engineering) wrote in their research paper *Lab Risks for Chemists*:
“People who work in biopolymer facilities are exposed to a great variety of hazards. They range from hazards common to most workplaces, like those of ordinary fire and tripping, to hazards that require extensive precautions to adequately control, like the use of hydrogen fluoride (HF) for cleaving synthetic peptides from resins. There are numerous sources of information that can aid in the recognition of hazards. Most institutions are required to maintain an OSHA Log 200 of work-related injuries and illnesses. This source may have useful information regarding the injuries and illnesses of laboratory workers doing similar tasks.
A knowledgeable person from an institution's environmental health and safety office who is familiar with laboratory practice can be a helpful resource. Such a person can best help the laboratory recognize hazards by accompanying staff in a systematic walk through the laboratory area. Information obtained from this collaborative approach is better received than inspection reports that may be sent to the laboratory several weeks after an on-site review. Hazard identification should never be a punitive exercise but should be performed in the spirit of reinforcing good work habits.
There are several important authoritative references for researching the hazardous properties of chemicals and assessing health risks associated with occupational exposures (4-6). Although Material Safety Data Sheets (MSDS) provide information on the hazardous properties of chemicals, they do not provide relevant precautionary information. A valuable, new reference is the National Research Council's comprehensive revision of its 1981 report, "Prudent Practices in the Laboratory: Handling and Disposal of Chemicals" (7). The report includes concise technical summaries of important safety information for 88 chemicals that are commonly used in laboratories, including acetonitrile, cyanogen bromide, dichloromethane, dimethyl-formamide, ethyl acetate, HF, methanol, tetrahydrofuran, and trifluoroacetic acid (TFA). These summaries, called Laboratory Chemical Safety Summaries, are similar in format to MSDS but are written to provide information relevant to the laboratory use of chemicals”.

Discussion:

Educational technology is one of the most frequent topics of discussion--and debate--in higher education today. While proponents predict that computers will radically and irrevocably transform education, skeptics compare computers to other technological innovations that have come and gone over the last century. The truth most likely lies somewhere in between. Computers probably will never totally replace teachers, any more than books replaced them centuries ago. But neither will computers ever entirely disappear from the educational scene. (Enerson, 1997)).

In all academic environments there are nowadays increasing opportunities for interactivity in research, documentation and learning. Networks between universities are built and growing in number. What we call "knowledge transfer" is an important phenomenon in present society. The technology that is now used to transfer knowledge was earlier confined to experts. This is no longer true, learning in itself is changing: we can now be co-workers and colleagues when shaping new knowledge. Education on distance is becoming more and more common. The teacher`s role and the student`s role have changed, it is more a two way instead of a one-way process… ICT (Information and Communication Technology) involves a transfer of power connected with knowledge. A breakdown of the traditional hierarchical structure is occurring. Long-distance work, tuition from a distance and long-distance services already provide new prerequisites for the roles of regions. Information Management is now Knowledge Management – due the more sophisticated technology mix. We will probably reach Creativity Management; Fantasy Management and Trust Management in the future (Bradley, 2001).

ICT may change the competencies and skills needed in companies in several ways, depending on the industry and occupational category. New competence requirements in the ICT sector and in information and knowledge work mean new challenges for national educational systems. In particular, traditional technical and higher engineering education needs critical evaluation and a broadening of curricula with knowledge traditionally included in social sciences (Järvenpää, 2001).

Numerous attributes of computer simulations have been identified from the recent literature. Computer simulations can: replace experiments that use hazardous materials ; reduce cost ; replace experiments that occur too quickly or too slowly to be done in a regular laboratory period ; reduce cognitive noise, so that students can concentrate on the concepts involved in the experiments ; provide feedback to enhance conceptual understanding ; provide dynamic animations to emphasize the molecular level of chemical reactions ; permit students to collect a multitude of data quickly, so as to discern trends ; permit students to generate and test hypotheses ; engage students with high level of interactivity ; present a simplified version of reality by distilling abstract concepts into their most important elements , making abstract concepts more concrete ; provide a complex, contextualized, dynamic environment ; standardize instructional pedagogy, teaching, and content across multiple lab sections ; actively engage students in scientific inquiry ; reduce ambiguity and help identify cause and effect relationships in complex systems ; serve as pre-laboratory preparation to aid understanding of the lab ; foster problem-solving skills ; promote critical thinking skills ; foster deeper understanding of physical phenomenon and chemical reactivity; help students learn about the natural world through seeing and interacting with underlying scientific models that would not be readily inferred through first-hand observation ; enhance concept formation and promote conceptual change . From this literature, computer simulations clearly have the potential of improving conceptual understanding of chemical principles and theories and teaching laboratory skills . In addition to the cognitive benefits mentioned here, the virtual organic laboratory simulations offer another practical benefit: Students can do the lab any time of the day, from anywhere in the world with internet access. Computer laboratory simulations may be the answer to the increasing need to deliver a pedagogically sound laboratory experience in distance science courses. Simulations can enhance learning, particularly if students are allowed to collaborate, either at the computer or in cyberspace (Gaddis, B., Anderson, D. 2000).

Conclusions:

Computer aided training is very effective tool for prevention of chemical risks. It requires more financial resources for developing all possibilities and capabilities of computer aid training for prevention of chemical risks.

References

Bradley, G. (2001) Information and communication technology (ICT) and humans- how we will live, learn and work. In: G. Bradley (ED.) *Humans on the Net* (pp.22-44). Stockholm, Sweden: Prevent, 2001

Enerson, D. (1997) Using computers as an Aid to Teaching and Learning: Learning from Existing Practice http://www.psu.edu/celt/computer.html

Gaddis, B, Anderson, D. (2000), Conceptual Change in Chemistry Through Collaboration at the Computer http://web.uccs.edu/bgaddis/leadership/collab_project.htm

Järvenpää, E., Eloranta, E., Information and communication technologies and quality of working life:implications for competencies and well-being. In: Bradley, G. Editor. Humas on the Net. Stockholm:Sweden, Prevent, 2001.

Howard, G. M. http://www.engr.uconn.edu/cheg/profiles/gmh.html

Siirak, V. (2000) Experience with problem-based learning in ergonomics and safety education in Estonia. In: D. de Waard, C. Weikert, J. Hoonhout and J. Ramaekers (Eds.) *Human-System Interaction: Education, Research and Application in the 21st Century* (pp. 99-106), Maastricht, The Netherlands, Shaker Publishing.