Suitability of a Virtual Learning Environment for Higher Education

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Abstract: The number of virtual learning environments (VLEs) is increasing. Already a few case studies claim that VLEs are more effective as a learning method than traditional lecturing. Many of these case studies are in the area of information and communication technology (ICT). Therefore, the good learning results are not surprising.

The aim of this paper is to examine the suitability of a VLE for higher education by comparing learning with a VLE and learning in a traditional lecture on an occupational safety engineering course. We will compare the learning results and the students' opinions of their learning process

The results show that the VLE students outperformed the lecture students. On the basis of these results and previous case studies, the VLE is suitable for higher education. Nevertheless VLEs should be used with caution in higher education. They should add extra value to a course. One possible value would be to use the VLE self-study method to evaluate one's learning before a final exam.

Keywords: virtual learning environment, occupational safety engineering, higher education, comparison of learning

1. Introduction

The number of new virtual learning environments (VLEs) is increasing and they have been advertised as being a solution for remote and cross-border education. Students can perform a wide range of exercises with a computer-based learning environment. This is extremely important when the tasks cannot be practised in real life, for example due to their hazardous nature. For this reason, simulators have been used for years (Wickens 1992) to train pilots and operators in nuclear power plants. Virtual Reality (VR) is also a good tool for practising safety skills. Kizil & Joy (2001) and Filigenzi et al. (2000) have assessed VR for improving miners' safety. Walker and Harrington (2004) have found in their studies that computer-based training is an effective safety training tool.

Many studies report the virtual learning environment as more effective, efficient and satisfying than the traditional learning situation. In recent years, several case studies (Piccoli et al. 2001, Kekkonen-Moneta and Moneta 2001, Marandi and Luik 2003, Zhang et al. 2004, McDonald et al. 2004) have dealt with the use of VLEs in teaching information and communication technology (ICT). The case studies have most commonly been related to the learning of basic types of IT skills, for example word processing, which everyone should master in order to study or teach full-time. This fact has probably increased the motivation to learn and explains the good learning results. Our case study is different since our students are not studying how to use computers. Also, the students in our case are obliged to study the subject in order to obtain their Master's degree.

The aim of this article is to determine the suitability of a VLE for higher education. We will first look at some previous case studies concerning VLEs in higher education. Also, we will present briefly the case studies concerning safety education and VLEs. Then we will introduce our own case study. Our case study is a comparison of a traditional lecture and a VLE for occupational safety, called Virtu. At the end of our paper we discuss the suitability of VLEs in higher education and suggest further research ideas.

2. Previous case studies of virtual learning environments

Comparisons of traditional classroom learning and studying with a VLE have been carried out for example by Piccoli et

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al. (2001), Kekkonen-Moneta and Moneta (2001), Marandi and Luik (2003), Zhang et al. (2004) and McDonald et al. (2004). Both Piccoli et al. and Kekkonen-Moneta et al. used a VLE to teach basic IT skills, Marandi and Luik used a VLE to show teachers how to implement ICT in teaching, Zhang et al. used a VLE to synchronize video presentation with PowerPoint slides and lecture notes and McDonald et al. reported experiences of using a VLE at university.

Piccoli et al. (2001) arranged an experiment that lasted one semester. The test conditions were accurate in order to enable the use of statistical methods. A total of 146 undergraduate students participated in the experiment, which concerned a course in basic IT skills. The hypothesis stating that students in the VLE would score higher points in the exam than the students in the traditional classroom was not supported by the findings. The VLE students outperformed the traditional classroom students, but the difference was not statistically significant. The hypothesis regarding a difference in satisfaction between the VLE group and the control group was correct. Surprisingly, the students in the VLE group were less satisfied.

Kekkonen-Moneta and Moneta (2001) compared the learning experience and the learning results of college students. The students were studying course *Computing Fundamentals*. One group (105 students) studied through lectures and the other (180 students) by an online course. Both groups had weekly laboratory sessions with a teaching assistant. The assessment was based on a midterm examination. The examination included multiple-choice questions for testing students' learning and questions for estimating the students' IT skills. Overall, 261 students participated in this study. This study showed no differences in learning or satisfaction between these two groups. The students in the lecture course performed in the conceptual questions better than students in the online course. However, the online course students perceived the course as less difficult than students in the lecture course.

Marandi and Luik (2003) compared the use of the WebCT learning environment with traditional face-to-face teaching from the point of view of effectiveness and of improving students' IT skills, knowledge and attitude. The study was conducted in order to help Estonian teachers utilize their computer software and Internet connections. A group of 39 teachers was divided into two groups; one group used the WebCT (27 teachers) and the other group studied in the traditional way (12 teachers). Both groups studied subjects related to computers and teaching or learning. After the course, a questionnaire was sent to the participants to be completed and returned voluntarily and anonymously. In this study the learners with the WebCT were more satisfied and self-confident with their computer skills.

Zhang et al. (2004) conducted two experiments in which they compared a prototype of a Virtual Mentor (VM) system called "Learning By Asking" (LBA) with traditional classroom teaching. Altogether 52 students participated in the e-learning group and 51 students in the traditional classroom group. All participants were undergraduate students. The same instructors taught both groups and ensured that the material was the same for both groups. The effectiveness of learning was measured by test grades (objective approach) and questionnaires (subjective approach). In this experiment, the students in the e-learning environment got significantly higher grades than those in the traditional classroom situation. However, in this case the satisfaction level between the groups did not differ significantly.

McDonald et al. (2004) compared students' performance in the traditional classroom and in an online course. The data was collected over a period of two years. The data included students' final grades from this course and information on students' overall performance at the university. In the traditional classroom group there were 134 students and in the online group 63 students. The results showed that students who studied in the traditional classroom outperformed the online students. The authors discussed whether one reason for this could be the long history of using traditional lecturing at the university. Also, the development of a good online course takes time. However, they also concluded that further research is needed to determine the real reasons for these results.

Both VLE and VR are used in safety training. For example Filigenzi et al. 2000, Harrington & Walker 2004 and Walker & Harrington 2004 have concluded that VLE is an effective safety training tool. Filigenzi et al. (2000) and Kizil & Joy (2001) have used VR for miners' safety training. After the training, students' ability to identify hazards had improved. They also concluded that VR technology improves miners' safety. (Filigenzi et al. 2000, Kizil & Joy 2001) Walker and Harrington (2004) compared the effects of computer-based learning and instructor-led training in fire safety. They found that the computer-based group used less time than the traditional lecture group for the training, so the computer-based learning might be more effective than traditional lecturing. Nevertheless, they were not able to change attitudes towards occupational safety using computer-based learning (Harrington & Walker 2004).

VLEs have advantages compared with traditional teaching. When different teachers lecture on the same topic, no two lectures are ever exactly the same. Furthermore, the same teacher hardly ever repeats the same lecture in exactly the same form or with exactly the same content (Walker & Harrington 2004). Lecturers can demotivate students with their routines. On the other hand, VLEs are a flexible way of teaching (Walker & Harrington 2004) because they can be used at the most convenient moment (Clarke 2001). Students do not have to follow a specific timetable, as they would have to do with traditional lectures, and therefore they cannot miss a lecture (Walker & Harrington 2004). Lee et al. (2002) found in their study that positive attitudes towards using computers were the key factor in the VLE's success. Students' positive relationship to computers helps also the learning process (Lee et al. 2002, Crosier et al. 2000).

3. Methods

3.1 The course

The comparison presented in this article is based on two comparisons related to the course *Introduction to Safety Engineering*. The course is offered by the Institute of Occupational Safety Engineering at Tampere University of Technology (TUT). TUT had altogether 10120 students at the time of the study, of which 1997 (19.7 %) were female students (Fagerström 2004).

The course *Introduction to Safety Engineering* is usually the first one students take at the Institute. The course consists of lectures, all covering different areas of occupational safety engineering, such as ergonomics, risk management, occupational hygiene and accident prevention. The course is held three times per year: once in the autumn semester, once in the spring semester and once in summer. Over 600 students complete the course annually. The students are divided into small groups (approximately 30 students per group). In autumn and spring, teaching consists of two lecture hours per week for seven weeks. In the summer course, the lectures are given during one week, three hours per day. Also, twice a year the students have the opportunity to complete the course in a virtual classroom. Once a year the course is offered to the international students.

3.2 Empirical setup of comparison

The comparisons presented in this article were conducted in summer 2004 and autumn 2004. All the students taking part in the comparison had Finnish as their native language. In the summer course the students were divided into two groups (24 and about 40 students). Of the two groups, one was chosen for learning by VLE. The other group (the control group) studied the whole course via traditional lecturing. The first group also received all teaching in the normal traditional way, except in the case of occupational hygiene, which they studied by VLE. In the autumn course the students were divided into 10 groups (altogether approximately 300 students). Of these groups two were selected for the study: one group studied by VLE and the other studied through traditional lectures. This study did not affect the other eight groups at all; they studied the whole course through traditional lectures. The empirical setup of the comparison is presented in Figure 1. All the stages are described in detail below.

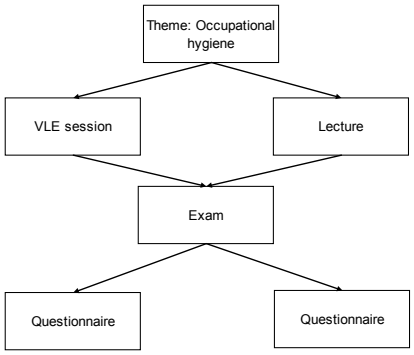

Figure 1: Empirical setup of comparison

3.2.1 The virtual learning environment

In this study we used a VLE in occupational safety called Virtu. Virtu was developed in a co-operational project between the Institute of Occupational Safety Engineering and the Institute of Software Systems at TUT. Virtu has traditional VLE content (see Fig. 2), such as theory and exercises (the so-called textbook), but it also contains a virtual enterprise by means of which a visit to a real company is simulated (also reported by Ihamäki & Vilpola 2003, Kiltti & Koskela 2003). All the texts in Virtu are in Finnish. The textbook has several occupational safety related topics. Virtu was developed according to a user-centred design process (Ihamäki & Vilpola 2003).

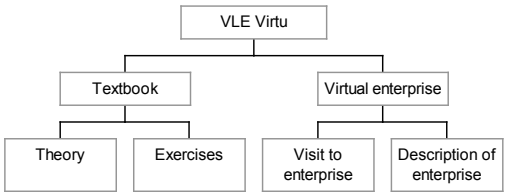

Figure 2: Structure of VLE Virtu

3.2.2 The students

In the VLE learning sessions there were 54 students; 47 males and 7 females (13.0 %). The proportion of female students is a bit lower than the overall proportion of female students at TUT. The students enrolled in the course without knowing about the experiment. Most of the students (70.4 %) have chosen the course because they were obliged to study the subject. Only two of the students had completed other courses at the Institute of Occupational Safety Engineering. However, 26 (48.1 %) students had some kind of safety training, for example from their summer job (fire safety, electrical safety, etc). Among these 54 students, the grade expectations were high; only six students just wanted to pass the course. Most of the students (33) wanted to get good grades, i.e. 3-5 (the scale is from 1 to 5, with 1 as lowest and 5 as highest grade).

About 74 students were taught by the traditional lectures. In the summer, due to the lack of space in the classroom, not all of the lecture students were able to take part in this study. Fifteen students voluntarily answered the exam and the questionnaire. From the autumn course 34 students took part in this study. To sum up, the control group consists of 49 students, 37 male and 12 female students (24.5 %). The proportion of female students is larger in the control group than among the overall students at TUT. Most of the students (65.3 %) have chosen the course because they were obliged to study the subject. Two students had completed other courses at the Institute. Also, 23 (46.9 %) students had some background knowledge of safety issues. For example, many students had had safety training from their summer jobs according to a specific job description or in personal protective equipment (PPE). Eleven students wanted just to past the course. Over half (26) of the students wanted to pass the course with the grade 3 or higher.

3.2.3 The learning sessions

The Virtu learning sessions were organized in one of the computer suites at TUT. Each student had his or her own computer to work with. The students were told that they were expected to study occupational hygiene, to work independently and to study as they saw fit. They were given a maximum of 1.5 hours to study occupational hygiene with Virtu and complete the exam. The time of using Virtu and of completing the exam was measured. The students were allowed to make notes while studying. Finally, after the exam, the participants were asked to fill in a questionnaire.

In the summer, the students taking part in purely traditional lectures did not get any material before the lectures, but the material (slides) was available on the Internet after the lectures. The lecture in occupational hygiene followed a normal structure: during the lecture, several transparencies were shown. The lecturer also related examples regarding occupational hygiene. The students were

able to ask the lecturer questions. The lecture lasted about 45 minutes. After the lecture the lecturer asked about half of the students to remain in the classroom. Then the students were told that there would be an exam on occupational hygiene and a questionnaire.

During the autumn course, students were able to print the slides for the lesson before hand. A different lecturer taught the course than in the summer. Otherwise the lecture followed the same structure and had the same content as the summer course had. The lecture lasted 50 minutes, covering also a short group work session on the different agents of occupational hygiene. After the lecture the students competed the exam and the questionnaire.

3.2.4 The exam

After the learning session the students had a closed-book exam. The exam questions concerned the issues learned in the learning session. It was the same for both groups. The exam was fairly short, covering only one A4 sheet. The students had to enter their names on the exam paper. The exam started with two multiple-choice questions about the basic definitions in the subject area. The remaining three questions were open-ended: the students were asked to write freely about what they remembered on the subject. The maximum obtainable score was 14 points.

3.2.5 The questionnaires

After the exam each student filled in a questionnaire. The purpose of the questionnaires was to gather subjective information about the VLE and the lecture. The two questionnaires were constructed as similarly as possible, in order to be able to compare the answers of these two groups. The questionnaire included questions concerning earlier education in safety engineering and students' grade expectations from the course. To enable comparison of this background information with the learning results, students had to enter their names on the questionnaire.

In the VLE questionnaire students were asked to mark all parts of Virtu that they used during the session. In this way versatility in using Virtu could be examined. The Likert scale from 1 to 5 was used to measure the ease of use, suitability, comfortableness and quality of the content in the VLE. If students chose one (1), it meant that they strongly disagreed. In contrast, if they chose five (5), it meant that they strongly agreed. A questionnaire incorporating positive and negative statements about the same subject was used in order to ensure that students properly understood what was intended by the statements. The questionnaire included also open-ended questions about good and poor features, and the use potentials of Virtu.

In the lecture questionnaire, the students were asked to rate the lecture according to their own learning and the usefulness of the content. These were evaluated using the Likert scale from 1 to 5. One corresponded to 'very little' and five to 'very much'. Also, the students estimated the efficiency of time use. This was evaluated with the Likert scale from 1 to 3, where the numbers 1 and 3 corresponded to 'too much' and 'too little', respectively.

4. Results

4.1 Time used

The VLE students studied independently and quietly. Most of the students studied only the theory of occupational hygiene and did not visit the other areas of Virtu. After 19 minutes of studying, the first student returned the CD to the supervisors and started the exam (see Table 1). Over half of the students (53.7 %) returned the CDs during the next 5 minutes. After the first rush, students ended the studying at quite steady intervals. The last student returned the CD after 44 minutes of use.

In the summer, the lecture lasted about 45 minutes and in the autumn 50 minutes.

Table 1: Time used to study with VLE

Time (min)	Persons (N=54) returning VLE	Persons (N=54) returning VLE (%)
< 20	1	1.9
20-25	22	40.7
25-30	18	33.3
30-35	7	13.0
35-40	2	3.7
>40	4	7.4

4.2 The learning results

In the VLE group, previous knowledge in occupational safety did not affect the results. Students with such knowledge did not score higher points than others. Table

2 presents the points received for both groups. Of the VLE students, 20 were able to score the maximum points in the exam. On average, the VLE students scored 13.0 points (standard deviation 1.3). The points for multiple-choice questions were on average 9.5 (0.8) and for the open-ended questions 3.6 (0.7).

Table 2: Points received among the VLE students and lecture students

Points received	Persons (N=54) in VLE	Persons (N=54) in VLE (%)	Persons (N=49) in the lecture	Persons (N=49) in the lecture (%)
Less than 10	1	1.9	14	28.6
10-11.75	7	13.0	7	14.3
12-13.75	26	48.1	23	46.9
14	20	37.0	5	10.2

Figure 3 describes the effect of studying on the points received. Students who studied longest with the VLE got better results than those who studied the shortest time. The correlation is not very strong.

For the students who attended the traditional lecture, previous knowledge in occupational safety did not affect the results. Only five students were able to score the maximum points in the exam (see Table 2). On average the students scored 11.5 points (standard deviation 2.2). The average score for the multiple-choice questions was 8.2 points (1.7) and for the open questions 3.4 (0.9).

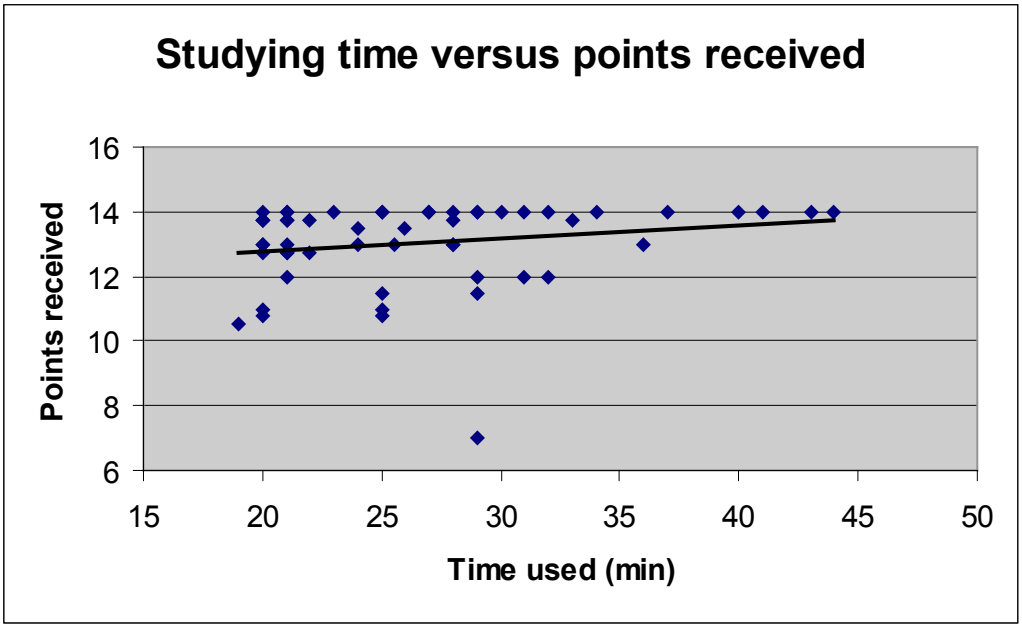

Figure 3: VLE studying time versus points received

4.3 Subjective experiences

The students' opinions of using Virtu are presented in Table 3. Overall, the students found Virtu relatively easy to use. Almost all of the students (94.4 %) thought that one could easily learn to use Virtu. None of the students though it was hard to study with Virtu. However, every fifth student (22.2 %) did not have an opinion on this matter. Also, none of the students thought that Virtu could not also be used in other Occupational Safety Engineering courses. Since most of the students had not taken other courses at the Institute, it is not easy to estimate the suitability of Virtu for such courses. However, half of the students did not have an opinion on this matter. Since occupational hygiene was dealt with in the second-last lecture, the students had some idea of the suitability of Virtu for the whole course. Many students (84.7 %) thought that Virtu was suitable for studying the subjects on the course. Also, most of the students would use Virtu at home, if they had it.

Table 3: Students' opinions on using Virtu (the statements are translated from Finnish)

	No opinion (%)	Strongly disagree (%)	Disagree (%)	Agree (%)	Strongly agree (%)
I learnt quickly to use Virtu	0.0	1.9	3.7	33.3	61.1
It was easy to study the subject with Virtu	22.2	0	0	61.1	16.7
The content of Virtu was versatile enough	22.2	3.7	13.0	40.7	18.5
I would learn better in face-to-face education	48.1	5.6	27.8	11.1	7.4
I would use Virtu at home if I had it□9.3□0.0□9.3□53.7□27.8□□Virtu was not suitable for the Introduction to Safety Engineering 9.3	0.0	9.3	53.7	27.8	□Virtu was not suitable for the Introduction to Safety Engineering Virtu was not suitable for the Introduction to Safety Engineering
I think Virtu could be used in other Occupational Safety Engineering courses also	50.0	0.0	0.0	37.0	13.0

The students mentioned three good features (clarity, exercises and own space) of Virtu in the open-ended questions. The students (19 mentions) found Virtu to be very clear to use. For example, the students said that Virtu did not include too much information. Also, the exercises were liked: 15 students mentioned them in the open-ended questions. Many students (19) appreciated that they were able to control the speed of studying themselves. Almost half of the students (48.1 %) said that Virtu could be used as a self-study method. Eleven students thought it could be used during the lecture (by the lecturer). One student wanted to connect the self-study method and the lecture. The student liked the experiment with Virtu ("You had to do something yourself, you were not able to fall asleep during the lecture"). Another student mentioned that he would prefer the VLE to the slides when revising for the final exam. Although the clarity was liked, 44.4 % of the students thought that the content of Virtu was a bit limited. For instance, they considered the exercises were too easy or too few.

Overall the lecture was liked. The students thought the best part of the lecture was the group work. It brought the subject closer to real life. The students were also asked to rate the lecture according to their own learning and the usefulness of the content. Most of the students (93.9 %) estimated that their learning was at least 'moderate'. The students considered the content to be quite useful for them: 25 students rated it 'moderate', 16 'good' and 3 'very good'. When the students were asked to evaluate the time used, almost all of them (93.9 %) were satisfied. Only three students would have liked to have studied longer.

5. Discussion

Based on our case study and the presented previous case studies, we can conclude that the VLE is suitable for higher education. Piccoli et al. (2001), Marandi and Luik (2003) and Zhang et al. (2004) proved VLE to be more effective than traditional lecturing. Kekkonen-Moneta and Moneta (2001) were not able to determine any difference. McDonald et al. (2004) concluded that their VLE should be improved, because the learning with the VLE was not effective. In the following, the limitations of our research and our conclusions are discussed.

First, two different lecturers taught the students. As mentioned on page 5, when different teachers lecture on the same topic, no two lectures are ever exactly the same. Due to the vast number of students completing the course annually, it is impossible for just one lecturer to lecture to all of the students every year. However, since it is an introduction course, the content of the lectures do not vary that much between the lecturers.

Second, we compared only short-term learning. The results of long-term learning could be different. To measure long-term learning among university students is very difficult. Many things can affect the results. The students are able to take more courses in the area of occupational safety engineering. Also, more and more companies train employees (also summer trainees) in occupational safety issues. It is easier to examine the quality of long-term learning in corporate safety training than among students studying at university. Consequently, it would be

advisable to carry out comparative testing also in companies.

Third, our case study was not a true comparison of VLE with a lecture. The students had to stay in the computer class and study the subject using VLE. The VLE session was not truly independent of time and space, as it should be.

The two groups did not differ significantly in terms of background variables (e.g. learning results, earlier safety knowledge and sex ratio). Therefore, the results for the two groups are comparable. The VLE students used less time to study the subject than the students receiving the traditional lecturing. The computer class is an open environment, which might have some effect on the learning experience due to social pressure. Obviously, no one wanted to be the first student to return the CD-ROM and start the exam. However, after the first rush, the VLE students ended studying at quite steady intervals. This suggests that the time record is accurate.

All of the VLE students returned the CD-ROM to the supervisors by the time the summer lecture ended. However, noteworthy is that the students receiving the traditional lecturing did not feel they had been studying very long. In fact, three students wanted to study even longer. On the other hand, learning via lecturing is somewhat different. Often the exercises follow the lectures and so students have more time to process the information. In real life the learning process lasts longer than a mere lecture. Virtu combines the lectures and the exercises and therefore gives a better estimate of the time used to study. The time used to study suggests that the VLE is an effective learning method. The effectiveness is further supported by the learning results. The VLE group scored systematically higher points than the traditional lecturing group.

As already found by Lee et al. (2002) and Crosier et al. (2000), a positive attitude towards computers increases learning. In our case study the students were studying at a university of technology and therefore they might have a more positive attitude towards computers than average people. This could be one reason why the VLE students outperformed the lecture students. This is a second reason why the testing in corporate safety training is needed.

A good feature of VLEs is that students can themselves control the speed of studying. The VLE students appreciated this feature. They are able to return to some area if they do not feel confident about their knowledge of it. In principle, students have the same opportunity during traditional lectures: students can ask the lecturer questions. Sometimes students are embarrassed about asking questions and admitting lack of knowledge. When using a VLE, others do not know what you are doing. This works also the other way around. When studying with a VLE, one can skip the area that is familiar for oneself. The normal lectures do not provide this opportunity and this may frustrate some of the students.

Many lecturers are trying to find ways to change their lectures because students are “sleeping” during lectures or are concentrating on something other than the subject of the lectures. Lectures which active students could be an answer. One student in our study welcomed the change Virtu offered to lectures. Generally, TUT has relatively few virtual courses and therefore they are still considered mainly a means of providing variety in addition to normal lecturing. However, VLEs must be used with caution. VLEs must add something special to the course or the subject. VLEs have indisputable advantages in safety training. When we are dealing with humans (occupational safety), we do not have the possibility of learning by trial and error. An additional value of VLE could be the possibility to use VLE also at home as a self-study method. Students would be able to study when convenient. The exercises in the VLE would help the students to evaluate their own learning.

As VLEs have been proved to be suitable for higher education, we cannot form conclusions regarding their superiority over traditional lectures in every situation outside higher education. VLEs have been proved to be particularly successful in so-called introduction courses. VLEs can be used to standardize the teaching of a large number of students in their early step of studies. Usually a vast number of students complete these introduction courses, so it would be profitable to target the VLEs for

these courses. Lee et al. (2002) emphasized the positive attitude as a success of VLE. So, in order to get good learning results with a VLE they need to be designed well and the needs of the user group must to be considered thoroughly. Bad design quickly demotivates the students.

The VLE Virtu will be next tested in corporate safety training in order to determine its suitability for older people. Corporate safety training gives a better estimate of long-term learning, because we can better control the safety-related training received by the employees than that received by students who can complete safety courses at the university or have safety training in their summer jobs.

References

Clarke, A. (2001) *Designing Computer-Based Learning Materials*, England, Aldershot Gower Company, 196 p.

Crosier, J. K., Cobb, S. V., Wilson, J. R. (2000), "*Experimental Comparison of Virtual Reality with Traditional Teaching Methods for Teaching Radioactivity*", Education and Information Technologies, Vol 5, No. 4, pp. 329-343.

Fagerström, M. (2004) *Statistics,* Tampere University of Technology, Tampere, 72 p.

Filigenzi, M. T., Orr, T. R. & Ruff. T. M. (2000) "*Virtual Reality for Mine Safety Training",* Occupational and Environmental Hygiene, Vol. 15, No. 6, pp. 465-469.

Harrington, S. S. & Walker, B. L. (2004) "*The effects of ergonomics training on the knowledge, attitudes, and practices of teleworkers",* Journal of Safety Research, Vol. 35, pp. 13-22.

Ihamäki, H. & Vilpola, I. (2003) "*Designing an Adjustable Learning Environment Concerning Safety at Work"*, in *Proceedings of the 2nd European Conference on e-Learning*, Roy Williams (Ed), Academic Conferences International Reading, UK, pp. 217-226.

Kiltti, P. & Koskela M. (2003) "*Development of a Computer-Based Learning Environment for Instruction in Occupational Safety and Health Issues",* in *Proceedings of the Seventh International Symposium on Human Factors in Organizational Design and Management*. Luczak, H. & Zink, K.J. (Eds.) Germany, pp. 715-719.

Kekkonen-Moneta, S. & Moneta, G. (2001) "*Online Learning in Hong Kong: A Preliminary Comparison of the Lecture and Online Versions of a Computing Fundamentals Course,* in Proceedings International WWW Conference (10), Hong-Kong.

Kizil, MS. & Joy, J. (2001) "What can Virtual Reality do for Safety?", University of Queensland, St Lucia QLD, 10 p. [online] http://www.mishc.uq.edu.au/index.html?id=623

Lee, J., Hong, N. L., Ling, N. L. (2002). "*An analysis of students' preparation for the virtual learning environment*", The Internet and Higher Education, No. 4, pp. 231-242.

Marandi, T. & Luik, P. (2003) "*Teacher Training – With or Without Computers?"* in *Proceedings of the 2nd European Conference on e-Learning*, Roy Williams (Ed), Academic Conferences International Reading, UK, pp. 303-310.

McDonald, M., Dorn, B. & McDonald, G. (2004) "*A Statistical Analysis of Student Performance in Online Computer Science Courses",* in Proceedings of the 35th SIGCSE technical symposium on Computer science education, ACM Press , New York, NY, USA, pp. 71 – 74.

Piccoli, G., Ahmad, R. & Ives, B. (2001) "*Web-Based Virtual Learning Environments: A Research Framework and a Preliminary Assessment of Effectiveness in Basic IT Skills Training",* MIS Quarterly, Vol. 25, No. 4, pp. 401-426.

Walker, B.L. & Harrington. S.S. (2004) "*Can nursing facility staff with minimal education be successfully trained with computer-based training?"* Nurse Education Today, Vol. 24, pp. 301-309.

Wickens, C. D. (1992) 2nd Ed. *Engineering Psychology and*

Human Performance, Harper Collins Publishers, 551 p.

Zhang, D., Zhao, J. L., Zhou. L. & Nunamaker, J. F. Jr. (2004) "*Can e-Learning Replace Classroom Learning?"* Communications of the ACM, Vol. 47, No. 5, pp. 75-79.

