ISSUES ON SCHOOL E-LABORATORIES IN SCIENCE TEACHING

Virtuality, reality and gender

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Abstract: Gender issues and severe related problems have been discussed in the context of using modern technologies over a long period of time. Similar discussions have concerned science teaching, especially the problems of physics education and female students. Finland has been one of the most advanced countries in the implementation of modern technologies, but even here there are several open problems. We have collected data on the use of different pedagogical approaches in modern learning environments in the context of science teaching. We have national survey data from Finland (3,626 lower secondary school students and 184 teachers, and 2,661 upper secondary school students and 81 teachers). These data show that both teachers and students have rather similar ideas about the need to develop versatile pedagogical approaches including the more active use of e-learning tools and tools available for modern science classrooms like Microcomputer Based Laboratory. This means also that a balance is needed in the roles of virtual and real components of learning environments. Male students were dissatisfied with the present situation of e-learning in science. Both genders wished for more frequent e-learning with more variety. We even performed a case study actively engaging in developing science teaching in a modern learning environment yielding more detailed and qualitative data in the context of a virtual school project. We discuss the benefits of such a research-and-development project even for in-service training of teachers.

Key words: ICT use, self-evaluation, science teaching, gender

1. INTRODUCTION

The quality of education is considered in all industrialised countries to be of high political priority. ICT attainment and the use of ICT in schools are generally considered to be appropriate indicators of the quality of education (cf. Directorate-General for Education and Culture, 2001). Other indicators we are especially interested in include science and teacher education. The challenges of the information society and the struggle to achieve high-quality education have led several countries to publish strategies to be implemented also in educational institutions (e.g. SETRIS, 2000). Finland can be considered here as an interesting case among countries with a well-developed infrastructure of an information society. Sinko and Lehtinen (1999) reported the outcomes of a large national evaluation project in Finland. This survey of the status of the use of ICT in schools gave a general view of the problems, but we need more in-depth information about ICT use in science education to evaluate current research-and-development projects and establish new ones. Ilomäki and Rahikainen (2001) studied even secondary school teachers' and students' use of and skills in ICT by gender.

Our focus is on the challenges of designing modern learning environments for school science laboratories and the related needs for teacher education. A science teacher is the main facilitator for active, collaborative and goal-oriented science teaching and learning. Teachers' roles and their beliefs about ICT have been found to have a critical influence on the students' use of ICT. It is crucial that modern technologies are utilised extensively and in a goal-oriented way if the benefits of technology-enhanced learning can be expected to materialise. These issues may be far more important than problems regarding the access to hardware or software. There have been many studies indicating that modern technologies are not used in schools even when available. Also gender issues and gender-related severe problems have been discussed in the context of using modern technologies over a long period of time. It has been supposed that the low percentage of female computer science students reflects a severe problem, as well as an opportunity to recruit a substantial pool of professionals in this field. Similar discussions have concerned science education, especially the problems of physics education and female students.

The effectiveness of ICT use in science education depends, for example, on the teacher's understanding of how to use ICT. It also depends on the teacher's personal knowledge of the concepts involved, and on their ability to help students link their experiences to related concepts. We can refer here even to the use of the Vygotskian idea of the zone of proximal development and scaffolding (e.g. Jonassen, Mayes, & McAleese, 1992) and to the ideas of creative problem solving. Furthermore, it depends on their ability to encourage interaction among students to talk about information available from different sources, and on their ability to develop teaching and learning approaches suitable for ICT uses (Lorsbach and Tobin, 1995; Maor and Taylor, 1995).

It is known that students will learn better if they are interested in the topic to be learnt. The motivation to study science depends on several factors and attributes like students' interest and attitude (Fairbrother, 2000, 16–17). Typically, answers to what might motivate students are sought by investigating their interest in, or attitude towards, science (i) in general (or domains of science or content), (ii) in context (e.g., science in society or technology) where a certain science domain is met, and (iii) in the type of activity (including ICT use) or method of studying the subject or in the teaching methods used (Osborne, 2003). One important medium that affects student interest and learning is ICT use in science education. Therefore, it is important to clarify what kinds of ICT use interest students. According to modern psychological theories (Hoffmann, 2002), interest in science can be seen as a psychological construct that emerges from the student's interaction with (physical) objects and phenomena and explanations of them and, moreover, with science as a school subject. Interest can be seen as a medium supporting learning processes and the quality of learning. In this study, we register student interests through their wishes concerning ICT use.

In the present research, the first research question focuses on the students' and teachers' self-evaluation, how often different types of ICT are used in science education in the present-day situation, and how often students and teachers would like to use them in Finnish lower and upper secondary schools. The second research question concerns the possibility to enhance versatile ICT use in schools by a project with open teacher-researcher collaboration: How students evaluate ICT use after a three-year research and development project.

2. EMPIRICAL APPROACH

2.1 A national survey in Finland

For the survey, 75 schools were randomly selected, weighted by the number of students in grade 9, from the list of all secondary schools in Finland. In each selected school about 65 students were asked to answer the survey. In most cases this means three classes in the school. In one school there were only 20 students, in two about 30 students and in two about 40 students. Our stratified sampling approach means that the students were selected essentially in random from the whole age cohort. Altogether, there were about 60,000 students in grade 9 in spring 2003 and we selected 4,954 pupils for the survey and 3,626 pupils answered. The questionnaire included many items concerning students' ideas about science and science education. Here, we analysed the seven items concerning ICT use in science education. A similar procedure and the same questionnaire was used in upper secondary schools, where the number of schools was 477 and the number of second graders by the end of the spring term was 38,900 and 2,661 of these students answered the survey. Moreover, their teachers answered the same questionnaire, that is 184 lower secondary and 81 upper secondary school teachers.

As the basis of the questionnaire, and as the basis of our research and development efforts, the ICT use was categorised into *(A) tool applications or tool software* and *(B) ICT use in learning (learning through ICT)* (Moursund & Bielefeldt, 1999; Webb, 2002). In the *tool category (A)*, ICT is treated as a set of available software enabling people to accomplish their tasks in a more efficient way. Therefore, we developed the use of general office software, word processors and spreadsheets in science education. The main uses of *ICT in learning (B)* can be divided into three different uses for directly supported learning: (i) Computer-assisted learning (CAL) is any interaction between a student and a computer system designed to help the student learn. CAL includes, for example, simulations (applets in the Internet) and virtual-reality environments. (ii) Computer-assisted research is the use of ICT as an aid in collecting information and data from various information sources with the emphasis on the use of ICT in supporting scientific reasoning (McFarlane & Sakellariou, 2002). Typically, these investigative activities are conducted in small collaborative groups (Wiesenmayer & Koul, 1998) where ICT is used as an agent for interaction with information source, like Internet or nature or in schools, often in Microcomputer-Based Laboratories (MBL). (iii) Distance learning in a natural way has evolved from using only regular mail to using all available IT services adjusted to fully facilitate the students' learning. Thus, modern distance learning solutions are based on a wide range of communication technologies, such as course management systems (e.g. WebCT), and two-way audio/video teleconferencing (Davies, 1998).

The aim of the questionnaire designed for the present survey was to clarify how ICT is used in teaching now and how students would like to use them in studying in lower and upper secondary schools. A general description of a preliminary study has been reported by Lavonen, Juuti, Byman, Meisalo, Koponen & Saloranta (2003) and the questionnaire was refined on the basis of this pre-review.

The questionnaire was sent to the selected schools on 27 March 2003 and the headmasters were asked to organise the survey. They were also asked to send the completed questionnaires back by 20 April 2003. In the covering letter, the national and international purposes of the survey were carefully explained. For example, it was explained how a new kind of in-service training can be organised by the National Board of Education based on the information acquired by the survey. The letter was signed by the Head of the Department of Teacher Education and the Chief Director of the National Board of Education.

Altogether, 26 reminders (37 % of selected schools) were sent on 10 May 2003 to those headmasters who had not organised the survey on time. The purpose of the survey was again explained to them and they were asked to return the filled questionnaires by 25 May 2003. The survey was answered by 3,626 students in 61 schools, which corresponds to 73% of pupils in 81% of the selected schools. A similar procedure was used in the upper secondary schools. The questionnaire was sent to 49 schools, 44 of them answered yielding data on 2,661 students and 81 teachers.

2.2 A case study

We launched a three-year virtual school project, the Finnish Virtual School of Science Education (FVSSE), in autumn 2000. In the beginning of the project there were 31 science teachers. Twenty five science teachers actively participated for most of the project. They had an average of 10 years teaching experience. More than two thirds of the teachers were qualified upper secondary school teachers, while the rest were lower secondary school teachers. About one quarter of the teachers taught chemistry or mathematics and almost half physics as the main subject. The project was active for three years and the responsibility for designing the activities was gradually transferred from the researchers to the participating teachers. The possibilities of ICT use in science education within the FVSSE was discussed in the framework of active teaching and learning. "Active" means that students are guided and involved in collaborative learning processes (Hodson, 1998, 34-43). The students may search for information themselves or collaboratively from library resources or from the Internet and, of course, through investigations in nature and, furthermore, in the man-made environment during field trips and visits. Therefore, students' knowledge was considered a result of their active role in the creation of meanings for new concepts based on information available, their prior knowledge, as well as individual and social experience (Masui & De Corte, 1999). On the other hand, students' learning should be, of course, facilitated through the active intervention of a teacher who knows the structure of science, the nature of cognition as an adaptive process, and what the students already know (Novak, 1998) and, furthermore, a meaningful way of using ICT in education (Cohen, 1997).

In the very beginning of the FVSSE, it was decided that ICT use in science education should be planned and developed on the basis of the school science curriculum and, therefore, it was important to discuss ICT use in investigations and other practical activities (cf. McFarlane and Sakellariou, 2002). Teachers became especially familiar with computer-assisted research. For example, Microcomputer-Based Laboratories were used in measurements, spreadsheet in organising and presenting the data, the Internet as a source for information, and word processing in publishing outcomes of investigations and other tasks. Because ICT has become increasingly important due to the growth of the World Wide Web (e.g., virtual libraries and databases) etc., teachers concentrated on activities where the Internet was the source of information. They considered it important to know how this information can be processed so that students can acquire new knowledge and become familiar with the scientific reasoning, (e.g., learn to distinguish statements that are not true or to control variables or to test hypotheses, cf. Millar, 1996, 15). In the Finnish National Framework Curriculum (NBE, 1994), which had to be followed in these teaching experiments, there is also a description of how *ICT should* be used in physics and chemistry education: "*The teaching in physics and chemistry can be diversified by using ICT in measurements, data analysis, model construction, analysis of knowledge, and in reporting.*"

Different distance learning approaches were both the means and the content within the FVSSE. Electronic mail, newsgroups, chat rooms and videoconferencing were also intensively used for educational purposes. The use of newsgroups was chosen as the main distance working method. Several different course management systems (e.g. WebCT and Humap Kids) were used in teaching experiments. For example, two groups of students in different schools co-operated in the project "*Life cycles of different types of glass*".

The selection and designing of the FVSSE activities and the project evaluation were also based on self-evaluation data on teachers' ICT competencies and the equipment available in their science classrooms. There was a wide spectrum of competencies, as well as areas where all teachers felt unconfident with their skills. Therefore, in the beginning of the FVSSE we concentrated on developing ICT use in science education within those areas where teachers themselves were competent. An important aspect of the function of the FVSSE was that the detailed planning of teaching experiments was the responsibility of the participating teachers. They performed most valuable development work in the practical designing of the pedagogical approaches.

3. RESULTS

3.1 Survey data

The data on ICT use we report in the present paper have been collected using the scale of evaluation: 1 never; 2 rarely (1-4 times a term); 3 sometimes (2-4 times a month); 4 often (2-3 times a week); 5 daily (almost every school day). Even the differences between the current situation and the wishes are shown in the Tables 1 - 4. The frequencies of ICT use in science education – current use and hoped-for use – are compared with the Wilcoxon Signed-Rank (Z-values) Test. It is a non-parametric test used with two related variables to test the hypothesis that the two variables have the same distribution. It makes no assumptions about the shapes of the distributions of the two variables. The test takes into account information about the magnitude of differences within pairs and gives more weight to pairs that show large differences than to pairs that show small differences. This test is used here to compare if there are statistically significant differences in the distributions of two variables: how often a certain ICT category is currently used and how often it should be used. Negative (student like less of a certain ICT use) and positive differences in the opinions of students are calculated. The distributions of male and female students (and students vs. teachers) are compared using a Chi-Square Test, which tests the hypothesis that the row and column variables are independent. The direction of the relationship was analysed from the cross-table so that it was possible to say which group had or wished to have the teaching method concerned more frequently. Table 1 shows lower secondary school students' (n_{male} = 1641, n_{female} = 1794) evaluations of how often different types of ICT use are seen in practice currently in learning physics and chemistry.

The data show that the evaluations of the current situation of the ICT use is rather similar with male and female students. Even their wishes are not very different. Here, we may conclude on the basis of median differences that female students have experienced ICT use less often than male ones. The gender differences in the wishes of male and female students is statistically significant.

Table 1. Lower secondary school students' (n_{male} = 1641, n_{female} = 1794) evaluations of how often different types of ICT use are currently activated in learning physics and chemistry and how often they should be used.

Different types of ICT use		Current (A)		Wish (B)		Differences between B and A		Z[1)]
	2)	Md	Mo	Md	Mo	Neg	Pos.[3)]	
ICT tools (Word, Excel)	M	2	1	3	3	246	756	15.1***
	F	1	1	2	3	132	808	20.5***
Internet (information retrieval)	M	2	1	3	3	224	860	19.0***
	F	2	1	3	3	103	1004	25.1***
Videos, films,	M	2	2	3	3	238	802	16.8***
	F	2	2	3	3	134	858	21.4***
Computer assisted learning,	M	2	1	3	3	229	829	17.8***
	F	1	1	2	2	126	853	21.3***
E-mail or newsgroups	M	1	1	3	3	207	759	16.6***
	F	1	1	2	1	89	912	23.6***
Learning management systems	M	2	1	3	3	217	699	15.1***
	F	1	1	2	1	79	808	22.1***
MBL	M	2	1	3	3	230	602	11.4***
	F	1	1	2	1	116	573	15.6***

1) ^{ns} $p > 0.05$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
2) M = male, F = female
3) Md = median, Mo = mode, Neg. = Negative ranks, Pos. = Positive ranks

Table 2 shows students' and teachers' ($n_{Student}$ = 3626, $n_{Teacher}$ = 184) evaluations of how often different types of ICT use are currently activated in learning physics and chemistry and how often they should be used, evaluated using the same scale as above. It seems that the evaluations of the current situation of the ICT use are similar for students and teachers. Even their wishes are not much different. However, the students wish for somewhat more use of CAL, simulations and learning management systems. Teachers put more importance on MBL applications, but see no need for learning management systems.

Table 2. Lower secondary school students and teachers' ($n_{Student}$ = 3626, $n_{Teacher}$ = 184) evaluations of how often different types of ICT use are currently activated in learning physics and chemistry and how often they should be used.

Different types of ICT use	3)	Current (A) Md	Current (A) Mo	Wish (B) Md	Wish (B) Mo	Differences between B and A Neg. (%)	Differences between B and A Pos.(%)[2]	Z[1]
ICT tools (Word, Excel)	S	2	1	3	3	381 (11)	1573 (43)	25.0***
	T	2	2	3	2	0 (0)	108 (59)	9.7***
Internet (information retrieval)	S	2	1	3	3	328 (9)	1875 (52)	31.2***
	T	2	2	3	3	0 (0)	87 (47)	9.7***
Videos, films	S	2	2	3	3	373 (10)	1673 (46)	27.0***
	T	3	3	3	3	1 (1)	42 (23)	6.0***
Computer assisted learning	S	2	1	3	3	358 (10)	1690 (47)	27.4***
	T	2	1	2	2	1 (1)	93 (51)	8.9***
E-mail or newsgroups	S	1	1	2	1	296 (8)	1685 (46)	28.5***
	T	1	1	2	1	0 (0)	76 (41)	8.0***
Learning management systems	S	1	1	2	1	298 (8)	1518 (42)	26.2***
	T	1	1	1	1	0 (0)	67 (36)	7.7***
MBL	S	2	1	2	1	351 (10)	1185 (33)	18.9***
	T	1	1	2	2	0 (0)	101 (55)	9.0***

1) ^{ns} $p > 0.05$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
2) Md = median, Mo = mode, Neg. = Negative ranks, Positive = Pos. ranks
3) S = student, T = teacher

The data in Table 3 illustrate upper secondary school students' (n_{male} = 1174, n_{female} = 1487) evaluations of how often different types of ICT use are seen in practice currently in learning physics and chemistry. The scale of evaluation is the same as above. It seems that the evaluations of the current situation of the ICT use are similar for male and female students. In addition, the differences are even smaller than in the lower secondary schools. However, there were statistically significant gender differences in the wishes with female students not wishing to use e-learning, learning management systems or MBL as much as males. The important feature seems to be both genders wishing to use ICT more often than they have experienced in the present situation.

Table 3. Upper secondary school students' (n_{male} = 1174, n_{female} = 1487) evaluations of how often different types of ICT use are currently activated in learning physics and chemistry and how often they should be used.

Different types of ICT use	2)	Current (A) Md	Current (A) Mo	Wish (B) Md	Wish (B) Mo	Differences between B and A Neg.	Differences between B and A Pos. 3)	Z 1)
ICT tools (Word, Excel)	M	2	1	3	3	91	541	16.8***
	F	2	1	2	3	166	586	15.3***
Internet (information retrieval)	M	2	1	3	3	94	565	17.7***
	F	2	1	3	3	107	709	20.2***
Videos, films	M	2	2	3	3	86	616	19.0***
	F	2	2	3	3	103	800	22.2***
Computer assisted learning	M	2	1	3	3	93	550	17.1***
	F	1	1	3	3	68	747	21.7***
E-mail or newsgroups	M	1	1	2	1	70	392	14.2***
	F	1	1	1	1	44	519	18.2***
Learning management system	M	1	1	2	1	75	418	14.7***
	F	1	1	2	1	44	568	19.4***
MBL	M	2	1	3	3	123	362	10.7***
	F	2	1	2	3	114	408	12.8***

1) ^{ns} $p > 0.05$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
2) M = male, F = female
3) Md = median, Mo = mode, Negative = Negative ranks, Positive = Positive ranks

Table 4 shows upper secondary school students' and teachers' ($n_{Student}$ = 2661, $n_{Teacher}$ = 81) evaluations of how often different types of ICT use are currently activated in learning physics and chemistry and how often they should be used, evaluated using the same scale as above. Again, the evaluations of the current situation of the ICT use are similar for students and teachers, few modes in the student data being lower. Even their wishes are not much different. The important feature seems to be the wish of both teachers and students to use ICT more often than they have experienced in the present situation. However, somewhat problematic may be that neither teachers nor students wish to use learning management systems much (even if somewhat more than presently used).

Table 4. Table 4. Upper secondary school students and teachers' ($n_{Student} = 2661$, $n_{Teacher} = 81$) evaluations of how often different types of ICT use are currently activated in learning physics and chemistry and how often they should be used.

Different types of ICT use		Current (A)		Wish (B)		Differences between B and A		Z[1]
	[3]	Md	Mo	Md	Mo	Neg. (%)	Pos.(%)[2]	
ICT tools (Word, Excel)	S	2	1	3	3	257 (10)	1127 (42)	22.0***
	T	2	2	3	3	0 (0)	44 (54)	6.1***
Internet (information retrieval)	S	2	1	3	3	201 (9)	1274 (48)	26.7***
	T	2	2	3	3	0 (0)	38 (47)	5.8***
Videos, films	S	2	2	3	3	189 (7)	1416 (53)	29.2***
	T	2	2	3	3	1 (1)	29 (36)	4.8***
Computer assisted learning	S	1	1	3	3	161 (6)	1297 (49)	27.5***
	T	1	1	2	2	0 (0)	51 (63)	6.5***
E-mail or newsgroups	S	1	1	2	1	114 (4)	911 (34)	23.0***
	T	1	1	2	2	1 (1)	38 (47)	5.4***
Learning management system	S	1	1	2	1	119 (4)	989 (37)	24.2***
	T	1	1	2	1	0 (0)	36 (44)	5.3***
MBL	S	2	1	3	3	237 (9)	770 (29)	16.6***
	T	2	2	3	3	1 (1)	47 (58)	6.0***

1) ^{ns} $p > 0.05$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
2) Md = median, Mo = mode, Negative = Negative ranks, Positive = Positive ranks
3) S = student, T = teacher

3.2 Comparison with the case study

Table 5 shows a comparison of the lower secondary school students' in our national survey (NS, $n_{NS} = 3626$) and the FVSSE case study students' ($n_{FVSSE} = 85$) evaluations of how often different types of ICT use are currently activated in learning physics. In almost all categories, the case study students have experienced much more use of different types of ICT. The use of MBL is the only difference where both student population data have exactly the same medians and modes.

Table 5. Average lower secondary school students' (national survey, ASNS) and FVSSE students' (n_{ASNS} = 3626, n_{FVSSE} = 85) evaluations of how often different types of ICT use are currently activated in learning physics and chemistry.

Different types of ICT use	Group	Md	Mo
ICT tools (Word, Excel, ...)	*ASNS*	2	1
	FVSSE	3	3
Internet (information retrieval)	*ASNS*	2	1
	FVSSE	4	3
Computer assisted learning,	*ASNS*	2	1
	FVSSE	2	2
E-mail or newsgroups	*ASNS*	1	1
	FVSSE	3	3
Learning management systems	*ASNS*	1	1
	FVSSE	2	2
MBL	*ASNS*	2	1
	FVSSE	2	1

The comparison of the survey data and data of the case study is problematic. However, it seems natural that in the experimental project group essentially all ICT uses are more often activated than in average schools. It is interesting to note that MBL gets a low-frequency evaluation in both groups.

4. DISCUSSION AND CONCLUSIONS

We defined the focus of this research to be how ICT is used in science education from the students' and teachers' perspectives now, and how students and teachers would like it to be used in lower and upper secondary schools in Finland. In general, the evaluations of the current situation of the ICT use, as well as the wishes, appear rather similar with male and female students. However, female students have experienced ICT use significantly less often than male ones. Also the gender differences in the wishes of students are statistically significant. Further, the evaluations of the current situation of the ICT use are similar also with students and teachers. Even their wishes are not much different. However, the students wish somewhat more use of CAL, simulations and learning management systems. Teachers put more importance on MBL applications.

We find, however, that it is important in interpreting the above differences to note that such a survey with large group sizes may yield statistically significant differences even when these are relatively small and perhaps not so important. Altogether, this study gives indications of where the optimal balance of using different types of ICT uses in schools might be, if teachers' and students' wishes are observed.

The second research question concerned the possibility to enhance versatile ICT use in schools by a project with open teacher-researcher collaboration. This problem was approached by the comparison of the survey data and data of the case study. The qualities of these data are substantially different and any comparisons should be made with caution. However, it seems natural that in the experimental project group essentially all ICT uses are more often activated than in average schools. It is most interesting that according to the median and mode data the situation in the FVSSE schools (Table 5) seems to be rather close to the situation outlined by the wishes of the survey schools (Table 1).

It is to be noted that MBL gets low frequency evaluation in both groups. However, the current framework curriculum in Finland emphasises the experimental nature of modern sciences and there is a huge potential in enhancing learning in school science laboratories by the active use of MBL. There are some problems with the accessibility of modern MBL software and hardware in schools, but there are indications that this is not the critical bottleneck (cf. Sinko & Lehtinen, 1999). It means that this is perhaps the most important challenge to our future research and development projects. We have actually started work on attaining these goals several years ago (e.g. Meisalo & Lavonen, 1997; 1999). It seems that teachers, as well as learners, need quite a lot of scaffolding at least occasionally, and this can be organised even over the Internet (Juuti, Lavonen, & Meisalo, 2003). The other conclusion of our study is that the innovative development of new pedagogical ICT uses by teachers helps in the activation of e-learning. This kind of effort may be recommended for further research and development activities.

Our study did not extend to lower grades of the comprehensive school. However, it seems that one of the problems is the lack of motivation to use, and negative attitudes towards, ICT. It is obvious that pupils should have ample opportunities to enjoy e-learning in science already during their first school years. The on-going curricular reform the National Framework Curriculum in Finland will open doors for teaching chemistry and physics on grades five and six. There is currently a huge need for in-service training of teachers and we have produced a versatile learning environment with both a virtual and a real component available for schools (Juuti, Lavonen, Kallunki, & Meisalo, 2003; Juuti, Lavonen & Meisalo, 2004). In further research within this project, the emphasis will be on the dissemination of the idea of using the environment in a versatile way for studying and enjoying learning. This seems to give more benefits to girls as well as boys so that both genders have equal opportunities for further studies in science.

To reach gender equality in science education, it is not enough to focus on uses of ICT (as in this research) or teaching methods (Lavonen, Juuti, Meisalo, Uitto, & Byman, 2004), it is important as well to focus on pupils interests in different contexts. Students', especially female students' interest to study physics is very sensitive to changes of contexts where physics topics are met. In another paper (Juuti, Lavonen, Uitto, Byman, & Meisalo, 2004) reporting a national survey, we showed that female and male students are equally interested to study physics in the context of human being. Therefore, suggested approach could be to integrate ICT in studying physics in human being context. There were more gender differences in wishes in ICT use for lower secondary than upper secondary school students. It is obvious that ICT use should be planned with care. Female and male students wished equally more information retrieval to be used in schools (Table 1). Thus, an interesting teaching experiment could be based on the idea that pupils search in the Internet examples on how studied phenomena, physical concepts and laws appear in human beings. An example could be a study of perspiration as thermal control of human body.

The gender equality challenge remains quite important, but there are in our present study some indications of how the gender differences in interests in science learning or ICT use may be diagnosed and utilised for providing equal opportunities for both male and female students for gaining understanding in relevant problems and participating in science and technology studies as well as entering related professions.

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