Students’ Skills and Practices of Using ICT: Results of A National Assessment in Finland

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Abstract

The purpose of the study was to analyze Finnish elementary and high school students' skills and practices of using the new information and communication technologies (ICT). As well, their beliefs about the importance of ICT were assessed. The data of the study were responses from 515 students to a specially developed self-report questionnaire. The students attended 25 schools that use ICT intensively and represent all provinces of Finland. From the analysis, there emerged three factors that represent these students' relation to ICT. Characteristic of the first factor was a belief that computer supported learning makes learning more meaningful and encourages one to make more efforts to study. Self-reported competence in using ICT was strongly loaded on the second factor together with intensive reported use of ICT at home as well as networking with expert cultures and coaching of other people to improve their ICT skills. The third factor represented intensity of using ICT at school and appears to be determined more by available, school, computer equipment and the extent to which ICT is used in the school than by a student's expertise in ICT.

INTRODUCTION

One of the basic requirements of education for the future is to prepare learners for participation in an information society in which knowledge is the most critical resource for social and economic development and where distributed expertise and networked activities more and more characterize the emerging types of work. Educational institutions are required to find appropriate pedagogical methods to cope with these new challenges. In this development, the new information and communication technologies (ICT), properly taught and learned, could play an important role as tools for the general restructuring of learning-instruction processes in a way that facilitates the overall development of the students' skills of collaborating and working productively with knowledge, even outside of technical, subject areas. Skills of using ICT necessary in our emerging, knowledge society involve the ability to solve increasingly complex problems in a variety of knowledge-rich domains, participate in knowledge work as well as engage in various networked activities.

The ICT, however, may help promote educational change only if the students and teachers have an access to the new technology and it is intensively
used as a tool for learning in various subject domains. The students and teachers need to have sufficient skills in using and working productively with the new technology. Further, an intensive use of ICT fosters the students' sociocognitive development only insofar as the design and pedagogical usage of applications of ICT are based on well-grounded cognitive principles and sound -- in this case, innovative -- pedagogy [1]. An assessment of the pedagogical value of ICT requires a careful examination of the current practices of using ICT in schools.

The purpose of the present study is to analyze Finnish elementary (11-15-year old students) and high school (16-18-year old) students' skills and practices of using ICT. Finland is one of the most advanced countries in terms of computer usage, internet access as well as information technology. The present study focuses on analyzing what students actually know about ICT, how they are using ICT and what they think about ICT. These questions are likely of general interest because all developed countries are facing similar challenges. Finland, however, is a small enough country that one can more easily carry out a large-scale assessment concerning how information and communication technologies are used in learning and instruction [xx, Sinko & Erno]. Given the decision to employ self-report measures from students more active in use of ICT, the purpose of the study is a) to analyze these elementary and high school students' ICT skills, b) to examine how they are using ICT for recreational and educational purposes, c) to identify their attitudes towards ICT, d) to determine to what extent students actively using ICT have adopted the role of ICT expert.
METHOD

Participants

Investigators designed a self-report questionnaire to measure students' skills and practices of using ICT. The questionnaire was also intended to examine the students' beliefs about ICT's significance in learning and their own future lives. The self-report questionnaire was sent to 10 lower elementary, 10 upper elementary and 10 high schools that were known to use ICT somewhat more intensively than other schools. Principals from 25 of the schools agreed to participate, representing 7 lower elementary, 10 upper elementary, and 8 high schools; the principals who decided not to participate, did so for practical reasons unrelated to the objectives of the study. They designated, within each school, a class of students who use ICT more intensively than other classes of students. The questionnaire was administered to the students at school and returned by the teachers. Altogether 515 students answered the questionnaire. The mean number of students per school that answered the questionnaire was 20 (SD = 8); this corresponds an average size of classrooms in Finnish schools. The percentage of students answering the questionnaire was about 86% of the intended student population. Table 1 presents age and gender distribution of the participating students. However, there were 10 students who left an anonymous questionnaire and their age or gender could not be determined.

Assessment instrument

The self-report questionnaire consisted of Likert-type questions. The students were asked to rate, on a five-point scale, 68 statements concerning their skills, usage and opinions of information technology. For evaluating the students' conceptions, we used a five-step scale from "I fully agree" to "I fully disagree". For assessing how frequently the students use applications of ICT, we employed a five-step scale from (1) "Daily" to (5) "Never".

A limitation of the study was that the students' practices and skills of using ICT were measured by using their self-assessments. As a consequence, the results of the study do not necessarily represent their actual competence or practices of using ICT. In order to control for the possibility that some of the students overestimated their competence, investigators included a multiple-choice test in the questionnaire, designed to measure the students' knowledge of some basic concepts of ICT (e.g., operating systems, computer memory, file formats, WWW publishing).

During our preparation of the assessment instrument, 60 students were asked to fill an early version of the self-report questionnaire, and an item analysis was carried out. Items that appeared to be unclear or that did not discriminate between the students were eliminated.

The purpose of the study was to assess students' skills and practices of using ICT and their general beliefs about the importance of ICT at school and
in human life. The contents of statements presented in the questionnaire were derived from cognitive research on computer-supported learning and cognitive theory. On the basis of these measures, we designed scales for assessing certain important phenomena connected with ICT skills, practices of using ICT, and the nature of students' expertise in ICT.

In Table 2 is presented a summary of scales related to development of the self-report questionnaire. The scale of technical ICT skills consisted of items that were designed to measure the subjects' general assessment of their mastery of the ICT as well as their competence in different domains of ICT such as textprocessing, spreadsheet, desktop publishing, authoring tools, and WWW. Another scale consisted of items that focused on examining how intensively students use different applications of ICT for recreational purposes. This scale was labeled intensity of recreational use. Further, we analyzed how intensively students use of ICT and applications as a tool of their own learning. This scale was labeled as intensity of educational use.

A further group of scales consisted of items that focused on determining what students think about ICT and its significance. The students were asked to assess a set of items related to heir beliefs about the significance of ICT in answering the challenges of the future ("Computers have a great future", "I do not care of computers at all"). This scale was labeled as attitude towards ICT. Another group of items was intended to assess whether the students think that they are allowed to use ICT sufficiently in their schoolwork or whether they would like to use ICT more intensively ("I would like to use ICT more in my schoolwork"). This scale was labeled as inclination towards learning with ICT.

In addition, the present investigators assessed what the students think about ICT as a tool ("I would prefer writing by hand rather than use textprocessing", "I am interested in processing graphics with a computer"). This scale was labeled as attitude towards using ICT tools. Finally, we assessed the students' beliefs about the effects of ICT on their own learning and motivation ("I think that use of information technology makes learning much more meaningful" "I am much more hardworking when I am allowed to use information technology"). This scale was labeled as ICT support for learning.

Psychological and educational research examines learning as a process of developing expertise [2,3,4]. A child may be regarded as "expert" insofar he or she has a rich body of accessible and usable domain knowledge [5,5]. The metaphor of student-as-expert assumes that an ordinary student can, to a significant extent, adopt some essential features of an expert role, specifically, taking on challenging knowledge-building goals and adopting practices that facilitate high educational achievement and cognitive development [5,6,7,6,7]. Several scales were designed to assess the nature of students' expertise in ICT. We analyzed students' expertise in ICT in detail by examining whether they reported they are ready to take challenging problems to solve in order to learn ICT ("I think that learning information technology is fun because it
Students’ ICT skills

continuously provides challenges”; “I am ready to put a lot of effort for
learning something related to information technology on my own”). Following
Bereiter and Scardamalia [7], this scale was labeled as progressive problem
solving. Further, we aimed to assess to what extent the students using ICT
intensively had, according to their report, adopted the role of an ICT expert. (“I
have done work related to information technology outside school”; “I guide my
fellow students in issues related to ICT”). This scale was labeled as adopting
the expert's role. An essential aspect of the development of expertise is to
function as a part of an expert culture and in support of a network that
promotes development of expertise [xx, Ericsson & Lehman]. Therefore, the
questionnaire contained a scale for assessing the students’ degree of ICT-
related networking (“I am in contact with ICT amateurs also from other
countries through Internet”); (“I am participating regularly in ICT events”).
This scale was labeled as networking. Finally, in order to assess to what extent
ICT was interpreted as a tool of collaborative activity (instead of a socially
isolating technology), we asked them to think about the following kinds of
items (“Students who use computers have less friends than other students”; "I
have learned a lot from students' joint information technology projects"; " It is
much more fun to use ICT together with someone than alone"). This scale was
labeled as collaborative use of ICT.

Prior to analysis, the data were examined for missing values. A small
number of participants (5-10%) left some parts of the questionnaire empty,
presumably, interpreting that those parts as not relating to them. Because the
percentage of missing values was rather low and those values appeared to be
randomly distributed throughout the data, the missing values were ignored.

The Reliabilities of Individual Scales

Means and Cronbach Alphas for different scales are presented in Table
3. The table contains, also, numbers of items for each scale as well as their
means and minimum and maximum values.

The internal consistency of the scales varied from .57 to .93. The
reliability analysis revealed that the scales were satisfactory and provided a
good basis for further analyses. To analyze relationships between the
measures, we calculated a sum variable for each scale (a sum of all individual
items in a scale). Examination of the reliabilities of the scales indicated that
the sum variable represents the phenomenon being investigated in a rather
reliable way. Result analysis was based on these sum scores as well as
principal component scores in addition to distributions of individual variables.

RESULTS

Relationships Between the Scales

Principal factors extraction with Varimax rotation was performed
through SPSSWIN on 11 sum scores representing students' skills and practices
with respect to ICT, as measured by the self-report questionnaire. Orthogonal
trotation was selected because of conceptual simplicity and ease of description.
This solution also appeared adequate because correlations between factors
were low. A scree plot was used to estimate the number of factors. In the
analysis, we arrived at a three-factor Varimax-solution that explains 71.4% of
variance of the variables. In Table 4 are presented results of a principal-
component analysis based on sum scores derived from the above-described
scales.

Insert table 4 about here

The first factor (F1) has high loadings on positive attitude towards ICT
and inclination to learn and use ICT as a tool of learning. The factor is
characterized by a belief according to which the use of information technology
both improves motivation and learning achievements. In addition, on the factor
were loaded positive attitudes towards ICT and using of ICT tools, progressive
problem solving, as well as using ICT collaboratively. This factor that
appeared to represent a belief that ICT helps students to learn is called ICT
Facilitation for Learning.

The second factor (F2) is characterized by high loadings on technical
ICT skills and intensive use of multiple applications of ICT for recreational
purposes. On the same factor was loaded, also, functioning in an expert's role;
i.e., participation in coaching one's fellow students and other people in ICT
skills. Further, networking with expert cultures of ICT characterizes this factor.
The factor is called Expertise in ICT.

Characteristic of the third factor (F3) were high loadings on intensity of
self-reported use of ICT at school. This factor was somewhat associated also
with skills of using ICT indicating, on one hand, that intensive use of ICT at
school may support development of ICT skills and, on other hand, that students
interested in ICT are actively searching for opportunities to use ICT in their
schoolwork. Existence of the third factor indicates that the students' opportunity
to use ICT at school depends on available and accessible technical
resources as well as a curricular support for ICT usage, more than their
expertise in ICT. The factor is called Intensity of Using ICT at School.

How Students Representing Different Age and Gender Groups Used ICT?

Relationships between students' age and gender and the principal
component scores obtained through the factor analysis are now examined. In
Table 5 we present mean principal component scores for students representing
different age- and gender groups.

Insert table 5 about here

The analysis revealed that the male students emphasized ICT
Facilitation for Learning (F1) more than the females. However, in comparison
to the huge gender difference in ICT skills (see below), the difference between
male and female students' enthusiasm about ICT is not very big. Sheffé group
comparisons revealed that the principal-component score of **ICT Facilitation for Learning** (F1) of all groups of male students was higher than that of 11-12-year or 16-18-year old female students. Further, the analysis indicated that both 13-15-year old male and female students emphasized stronger than other age groups of students that ICT facilitates learning. The data, as earlier stated, do not permit the assessment of a connection between the pattern of enthusiasm and the self-selection of respondents from among students actively involved in ICT.

The analysis indicated that the female students scored significantly lower on scales associated with **Expertise in ICT** (F2) than male students. Male students' F2 scores were higher in all age groups than female students' corresponding scores; self-reported expertise in and intensive use of ICT is currently typical for the young males. The results may be affected by the male students' tendency to overestimate their own competence in ICT (see below). Further, the results indicate that 11-12-year old male students' ICT skills appeared to be at a lower level than those of the other age groups. A corresponding phenomenon was not present for the female students.

An analysis concerning the third factor (F3) indicated that the intensity of using ICT at school was lower in the case of the 16-18-year old female (high-school) students; they appeared to use ICT significantly less than the other age groups in their school work. A corresponding statistically significant phenomenon was observed also for 16-18-year old male students who are using ICT at school less than younger males. To conclude, in our cross-sectional perspective, and based on our sample of more actively involved schools, the intensity of reported use of ICT at school appeared to monotonically decrease over educational levels from elementary to high school.

**Intensity of Use of ICT at School**

The analysis revealed that 82.9% (n=411) of the students have a computer at home and all the students have, in principle access to computers at school. Further, the analysis indicated that more than a half of the students have access to the internet both from home and from school. Many of students who do not have internet access from home have it at school. These findings are to be understood in the context of the selection of the schools as more actively involved in ICT.

Intensity of using ICT was examined by asking the students to assess how often they use information technology for recreational and educational purposes. Usage of ICT was examined by performing a paired-sample t test; i.e., we compared each student's (n=505) assessment of his or her intensity of recreational and educational use of ICT to that of each other student. As expected, the analysis indicated that the students use ICT significantly more intensively for recreational than educational purposes (t=16.5 (511), p<.0001). Further, the results revealed that the male students use ICT for recreational purposes much more intensively than female students (F(1,502)=38.0, p<.0001) regardless of age group. In addition, we observed a statistically significant interaction effect Age x Gender (F(2,502)=2.9, p<.05). This
Students' ICT skills appeared to reflect the fact that, within our cross-sectional perspective, that intensity of using ICT for recreational purposes decreases as a function of age in the case of female students, but increases in the case of male students. Although there was a significant gender difference when recreational use of ICT was examined, a corresponding difference was not found for educational use of ICT. Intensity of reported use of ICT for learning and studying is apparently determined by variables other than recreational use of ICT; it is, we hypothesize, determined by access to computers and the role of ICT in the curriculum [see xx].

It was encouraging that, regardless of the differences concerning recreational use of ICT, over 20% of these female students reported that they use ICT daily; For the selected schools, 70% of females studying at the elementary and 50% at the high-school level reported that they use ICT at least weekly. Many of the students use computers several hours a week. A small group of students \((n=11)\) use ICT more than 6 hours a day.

Concerning the school subjects in which the students are using ICT, our analysis indicated that these students are employing ICT relatively little as a general-use tool in science or humanities. ICT is used in special courses on information technology as often as all the other school subjects together, considering usage in terms of the "often" responses. In this population, however, 60% of students use ICT "sometimes" in their foreign language studies, Finnish language, and humanities.

The study also examined how the students are using the internet. A little less than 20% of the students use electronic mail (email) daily, 35% weekly. Also "surfing" on the net or searching for information from the internet are relatively frequent activities: Approximately 40% of the students reported engaging in these activities at least once a week.

Attitudes Towards ICT

Results of the principal component factor analysis indicate that gender differences concerning Factor 1 (ICT Facilitation of Learning) were significant but less drastic that differences in skills of using ICT. The analysis of the sum score representing attitudes towards ICT indicated, as expected, that the male students' \((M=3.9, SD=.82)\) attitudes towards ICT were more positive than those of the female students \((M=3.4, SD=.77)\) \((F(1,484) =38.8, p>.0001)\). Regardless of the gender differences, however, only a small proportion of students had very negative attitude towards ICT. For instance, only 22 fully disagreed with a statement that "Computers will be very important in human life". It was also encouraging that only a small proportion of the students had a negative attitude towards using ICT as a tool of learning. In such an assessment of negativity, however, it is important to re-state that the selection of schools using ICT intensively may have had the effect of reducing negative responses.

The students were asked also to assess whether ICT promotes better learning outcomes. The analysis indicates that the male students \((M=3.7, SD=.94)\) believed in ICT facilitation of learning more strongly than did the
female students \((M=3.2, SD=.92)\) \((F(1,493)=34.8, p<.0001)\). For instance, when asked to assess a statement, "I am much more eager to do my schoolwork when I can use information technology", approximately 60\% \((n=156)\) of male and 30\% of female \((n=71)\) students fully or partially agreed with the statement. In accordance with these findings, both male and female students expressed their interest in using ICT more intensively in their studies. There was a gender effect; male students emphasized this idea more strongly than female students. Yet almost half of the female students partially or fully agreed with a statement, "I would like to use ICT more in my school work".

**Expertise in ICT**

As explained above, the students' skills in using ICT were examined by asking them to assess how well they had mastered certain applications of ICT. In Figure 1 is presented a normalized distribution of the sum score for variables representing mastery of ICT as a function of age and gender. Because the students' skills were evaluated using self-report, the questionnaire included a multiple-choice section designed to assess the students' knowledge of some basic concepts related to ICT (see the method section). The responses to the test were scored so that for a correct answer, a student got +1; wrong answer, -1; and "I do not know" answer, 0 points. Figure 1 presents both the students' normalized self-assessment scores and normalized scores obtained from the above-described test.

From Figure 1, it can be inferred that, according to our expectation, the male students self-assessed skills of ICT \((M=.44, SD=1.0)\) are definitely higher than those of the female students \((M=-.51, SD=.71)\) \((F(1,476)=110.1, p<.0001)\). The age of the students did not, however, affect self-assessed ICT skills. Examination of Figure 1 reveals that 11-12-year old boys overestimated their competence in ICT. The self-assessment of the younger females corresponded quite well to their real (i.e., self-reported) performance.

The 16-18-year-old male and female students' self-assessments, in contrast, appeared to be somewhat lower than their actual competence. It should be noticed, however, that the test did not consider all aspects is ICT skills, only familiarity of some basic concepts. Nevertheless, the assessment provides evidence supporting the possibility of a very rough estimate of the reliability of the students' self-assessment, in the context of the selection of the schools, and the self-selection of the participants, which may have had the effect of producing a higher level in reported skills.

An assessment of the students' ICT skills revealed that they master textprocessing, graphical processing, information networks, and file management. However, they were not so proficient in authoring tools, desktop publishing, programming or computer hardware. One of the aims of the present study was to examine the nature of students' ICT expertise. Important characteristics of expertise are to function in the role of a mentor or a coach, networking with other persons interested in the domain, being in contact with
students’ ICT skills

professionals of the domain in question, searching for challenging problems and solving them collaboratively. In the following, we will analyze various ways in which ICT expertise of the participants manifested itself.

One of the basic characteristics of expertise is that other persons working in one’s environment repeatedly ask for advice in solving of complex problems that they cannot solve on their own. An agent may achieve a position of an expert in his or her local community even if his or her qualifications are very limited in comparison to professionals. Thus, expertise may be considered as a relative phenomenon. Approximately 32% (n=85) of the male students and 14% (n=14) of the female students estimated that they are more competent in some area of ICT than their classmates. This estimate did not vary according to grade level. About 28.1% (n=76) of male and 9.3% (n=13) of female students reported that they have been asked pieces of advice in ICT-related matters daily or at least once a week. It also appeared to be very common for the students to provide ICT support for their parents and siblings.

Experts commonly provide pieces of advice and support other people in acquiring new skills in a given domain of knowledge. In order to assess the nature of the students’ expertise, we assessed relations between the ICT support the subjects had been receiving and providing. In this data, the teachers appeared to have a central role in facilitating students’ ICT skills; on the whole the students estimated that they receive support more than provide it. However, 17 students, one of them female, provide pieces of advice to teachers at least once a week. Therefore, the students being teachers’ coaches in ICT appears to be an emerging practice at the schools studied, although it is not yet very widely distributed. These students reported that, in addition to teachers, fellow students also provide significant support.

An analysis of relations between received and provided ICT support indicates that the female students’ estimate of the amount of support they had received was substantially lower that the estimate of the male students regarding support the males received (F(1,494)=59.9, p<.0001). The estimated degree of ICT support was also associated with age (F(2,494)=5.46, p<.004); older students’ estimate of the amount of received support was lower than that of the younger students. It was also intriguing that female students’ assessment of the support they had themselves given was higher than that of the male students (F(1,485)=7.7, p<.006). It is possible that while starting to learn ICT skills, the female students are very motivated to share their emerging skills with their fellow female students who might not have any experience of ICT, and, therefore, they tend to remember many situations in which they have been able to share their emerging competence.

With respect to the students’ expertise in ICT, it is encouraging that 10% (n=27) of male and 4.2% (n=10) of female students reported that they are participating daily or weekly in maintenance of ICT in their schools. In addition, 17.5% (n=88) of students, 21 of them females, reported that they are doing ICT related work outside of school weekly. Altogether 54 students (3 females) have received financial compensation from relatives or other adults for helping to solve ICT related problems. Further, approximately 32% (n=86)
of male students and 7% (n=16) of female students are certainly or almost certainly planning to seek an ICT related profession.

Examination of the data revealed that a majority of the students experienced ICT as a tool for collaborative learning. About 60% (n=306) of the students reported that it is much more fun to use ICT with others than alone. Further, 40% (n=199) of them proposed that better learning results are achieved when ICT is used collaboratively. The emphasis on collaboration was not associated with the gender of the students, and there was only a weak association with age (elementary school students emphasized collaboration slightly more than high school students did). In addition, the analysis revealed that the students who were more skilled in ICT emphasized collaborative use of ICT more than less skilled students. This analysis was carried out by dividing the students into three groups according to their sum scores of ICT skills and applying cluster analysis (low ICT skills, n=183; moderate ICT skills, n=181; and high ICT skills, n=107). The mean sum score for the collaborative use of ICT scale was 2.9 (SD=.68) in the low ICT skills group; 3.3 (SD=.62) in the moderate ICT skills group; and 3.6 (SD=.76) in the high ICT skills group (F(1,461)=25.0, p<.0001). Thus, many students clearly saw ICT as a collaborative more than an individual tool.

From the standpoint of the development of expertise, it is very important to be in contact with an expert culture. As mentioned in the principal-component factor analysis, ICT-related networking was typical of students who are very competent in ICT. The sum score of networking increased systematically as a function of ICT skills (F(2,460)=49.5, p<.0001). Simultaneously, the male students' networking was stronger than that of the female students (F(1,460)=15.4, p<.0001). The students were asked to estimate to how many persons they are, on average, in contact with, through the internet, each week. The analysis indicates that 8.8% (n=44) of the students are connected with 16 or more different persons and 11.5% (n=57) 5-16 persons in a week. In addition, approximately 40 students are in contact with ICT professionals at least once a week.

An important aspect of adaptive expertise is an attempt to function at the edge of one's competence, and, as mentioned before, continuously to take on very challenging problems to solve [7]. Examination of the sum scores of progressive problem solving indicated, as expected, that the students with high ICT skills (M=4.0, SD=.68) focused on progressive problem solving much more strongly than did students with moderate (M=3.3, SD=.68) or low ICT skills (M=2.7, SD=.73). The students' age or gender was not associated with the sum score for progressive problem solving. As mentioned above, progressive problem solving was loaded on a different factor (F1) than expertise in ICT (F2). This further indicates that students who are not yet proficient in ICT are ready to take challenges in order to increase their ICT skills.
DISCUSSION

Our evidence from these students, often highly involved in ICT, was that they were frequently developing pre-requisites for such participation, in particular, a positive disposition toward collaboration in thinking and working. Yet the evidence for gender differences in ICT skills raises potential concerns for equality. It was very encouraging that the gender difference in ICT facilitation for learning was not so strong as that of ICT skills. Female students, especially younger ones, appeared to have a rather positive attitude towards ICT in general and the use of ICT as a tool for learning in particular.

Yet more investigation is required to determine the degree to which the attitudes of these highly involved female students are typical of other young female students. In establishing new resources for learning and development to support the female students’ learning, it is very important to integrate educational use of ICT with various subject domains and subsume the use of ICT, thoroughly, under overall pedagogical goals [8,9]. Thus far, however, ICT is mainly studied as a separate subject instead of used as tools for solving subject-domain problems. Further research is needed to determine the prevalence, generally, of this problem in Finnish elementary and high schools.

The study, given the limitation of self-report, indicates that a large number of the students, most of them males, master ICT very well and are able to take responsibility for many kinds of expert tasks, such as maintenance of ICT at school or coaching their fellow students or teachers. Adoption of an expert’s role is closely connected with networking – being in contact with other persons interested in the domain or with professionals. Considering the pedagogical goals of the school, this expert functioning is very positive, and may also significantly facilitate development of other academic skills. The fact that many students who are not experts in ICT were reportedly ready to take on challenging problems indicates that educational use of ICT may encourage a larger numbers of students to set themselves more ambitious learning goals.

Limitations of the data should be noted, in assessing the import of the findings as reported above: First, the 25 schools were selected from those more involved in ICT, in the various provinces. Further evidence is required to determine the extent to which the schools' programs, and students' activities and attitudes might differ systematically from the programs and student characteristics in the other, less involved, elementary and high schools.

Second, even for these 515 students, the self-report data do not necessarily provide a basis for a reliable estimation of these young persons' actual skills or use of ICT. Our evidence suggests that 11-12-year-old male students tended to overestimate their competence of ICT (on the basis of the measures we applied), and we have incomplete evidence about other possible areas of students' overestimation or underestimation. Although the self-reported level of competence in using ICT would not be a completely reliable measure (e.g., because increased understanding may produce more strict criteria for competence), we submit that it is a reasonable hypothesis that, on
the whole, the measures, taken together, provided rather reliable information concerning these students’ attitudes and activities regarding ICT.

Because the study is among the first to address, in detail, particular aspects of ICT in the schools, especially those connected with enhancement of the learning process itself, there is a need to address the limitations of the data through larger-scale studies based on random and stratified sampling, especially balanced for ICT interest (i.e., controlling for the volunteer variable), social class, rural setting, and parents’ background, particularly in relation to computer availability. In other words, it is essential that there be rigorous follow-up based on approaches that give a comprehensive, overall picture of Finnish students in relation to ICT, including those who may be put off by ICT or deterred by the way it is situated or presented.

A concluding remark: it is surprising that the students representing schools that are known to use ICT more intensively than other schools, are still not using ICT as an integrated part of everyday schoolwork in Finland, one of the most advanced countries in terms of information technology. An important reason for the low intensity of ICT usage appears to be that computers are usually located in a separate computer laboratory instead of other classrooms where learning and instruction actually happens. Consequently, students and teachers, in many cases, have access to ICT only during special ICT courses. Commonly, an ICT expert teacher may take up 80-90% of computer laboratory time or otherwise control access to the computers. In order to facilitate intensive and pedagogically meaningful use of ICT, it is necessary to bring computers into classrooms and integrate ICT very strongly with studies in various subject domains. The full integration of ICT with all areas of curriculum is something students need to experience in preparing themselves for the information society they will inherit.
References


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Table 1
Age and Gender Distribution of the Subjects

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<td></td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>11-12-year</td>
<td>49</td>
<td>45,4</td>
</tr>
<tr>
<td>13-15-year</td>
<td>85</td>
<td>41,7</td>
</tr>
<tr>
<td>16-18-year</td>
<td>103</td>
<td>53,4</td>
</tr>
<tr>
<td>Total</td>
<td>237</td>
<td>46,9</td>
</tr>
</tbody>
</table>
Table 2  
Scales for Measuring Students’ Skills and Practices of Using ICT

<table>
<thead>
<tr>
<th>Scale</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical ICT skills</td>
<td>How well a student masters applications of ICT from file management and textprocessing to authoring tools and programming?</td>
</tr>
<tr>
<td>Intensity of recreational use of ICT</td>
<td>How often and how many different ways a student uses ICT at home?</td>
</tr>
<tr>
<td>Intensity of educational use of ICT</td>
<td>How often a student uses ICT as a tool for learning at school?</td>
</tr>
<tr>
<td>Attitude towards ICT</td>
<td>What do students think about ICT; is mastery of ICT a very important aspect of answering to challenges of one’s own life?</td>
</tr>
<tr>
<td>Inclination towards learning with ICT</td>
<td>Do the students think that they are allowed to use ICT sufficiently in their schoolwork or would they like to greatly increase its use there?</td>
</tr>
<tr>
<td>Attitude towards using ICT tools</td>
<td>What are the students' attitudes towards using computers as tools of writing and visualization?</td>
</tr>
<tr>
<td>ICT support for learning</td>
<td>Do the students think that the use of ICT improves their learning outcomes and encourages them to study harder?</td>
</tr>
<tr>
<td>Progressive problem solving</td>
<td>Are the students ready to put a lot of effort and continuously take challenges in order to learn ICT?</td>
</tr>
<tr>
<td>Adopting the Experts’ role</td>
<td>To what extent have the students adopted the role of an expert; coaching their fellow students, teachers and other people in learning ICT? Are they doing ICT work outside school?</td>
</tr>
<tr>
<td>Networking</td>
<td>What kinds of connections are there between students interested in ICT and the expert culture in the domain? How deeply are student experts in ICT networked with each other?</td>
</tr>
<tr>
<td>Collaborative use of ICT</td>
<td>Do the students think that ICT socially isolates people from each other, or do they think that the use of ICT strongly involves collaborative activity?</td>
</tr>
</tbody>
</table>
### Table 3
Reliability of the Scales

<table>
<thead>
<tr>
<th>Scale</th>
<th>Number of item</th>
<th>Cronbach Alpha</th>
<th>Item mean</th>
<th>Minimum/maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical ICT skills</td>
<td>15</td>
<td>.93</td>
<td>2.58</td>
<td>1.68/3.97</td>
</tr>
<tr>
<td>Intensity of recreational use of ICT</td>
<td>7</td>
<td>.85</td>
<td>1.83</td>
<td>1.31/2.76</td>
</tr>
<tr>
<td>Intensity of educational use of ICT</td>
<td>4</td>
<td>.84</td>
<td>1.64</td>
<td>1.28/2.94</td>
</tr>
<tr>
<td>Attitude towards ICT</td>
<td>6</td>
<td>.79</td>
<td>3.69</td>
<td>2.91/4.15</td>
</tr>
<tr>
<td>Inclination towards learning with ICT</td>
<td>5</td>
<td>.79</td>
<td>3.43</td>
<td>3.00/4.03</td>
</tr>
<tr>
<td>Attitude towards using ICT tools</td>
<td>4</td>
<td>.68</td>
<td>3.56</td>
<td>3.23/3.78</td>
</tr>
<tr>
<td>ICT support for learning</td>
<td>4</td>
<td>.85</td>
<td>3.46</td>
<td>3.0/4.0</td>
</tr>
<tr>
<td>Progressive problem solving</td>
<td>8</td>
<td>.84</td>
<td>3.24</td>
<td>2.44/4.07</td>
</tr>
<tr>
<td>Adopting Experts’ role</td>
<td>5</td>
<td>.65</td>
<td>3.80</td>
<td>3.5/4.4</td>
</tr>
<tr>
<td>Networking</td>
<td>5</td>
<td>.78</td>
<td>2.03</td>
<td>1.52/2.61</td>
</tr>
<tr>
<td>Collaborative use of ICT</td>
<td>5</td>
<td>.57</td>
<td>3.2</td>
<td>2.69/3.70</td>
</tr>
</tbody>
</table>
Table 4  
**Factor Loading of the Scales Used on the Study**  
(Principal Component Analysis, Three-factor Varimax Solution)

<table>
<thead>
<tr>
<th>Scale</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical ICT skills</td>
<td>.701</td>
<td>.400</td>
<td></td>
</tr>
<tr>
<td>Intensity of recreational use of ICT</td>
<td>.810</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intensity of educational use of ICT</td>
<td></td>
<td>.887</td>
<td></td>
</tr>
<tr>
<td>Attitude towards ICT</td>
<td>.784</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inclination towards learning with ICT</td>
<td>.780</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude towards using ICT tools</td>
<td>.733</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICT support for learning</td>
<td>.847</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Progressive problem solving</td>
<td>.716</td>
<td>.465</td>
<td></td>
</tr>
<tr>
<td>Adopting Experts’ role</td>
<td></td>
<td>.610</td>
<td>.468</td>
</tr>
<tr>
<td>Networking</td>
<td>.388</td>
<td>.616</td>
<td></td>
</tr>
<tr>
<td>Collaborative use of ICT</td>
<td>.761</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of variance</td>
<td>33.6</td>
<td>26.1</td>
<td>11.7</td>
</tr>
</tbody>
</table>

**Note:** The three factors explain 71.4% of variance. In the Table are not presented loadings under .30.
Table 5
Mean Factor Scores of F1, F2, and F3 as a Function of Students’
Age and Gender. Mean/Standard Deviation and F-value.

<table>
<thead>
<tr>
<th>AGE</th>
<th>GENDER</th>
<th>ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>11-12 year</td>
<td>-.26</td>
<td>1.1</td>
</tr>
<tr>
<td>13-15 year</td>
<td>.05</td>
<td>1.0</td>
</tr>
<tr>
<td>16-18 year</td>
<td>-.27</td>
<td>.98</td>
</tr>
</tbody>
</table>

F2: Competence of Using ICT

<table>
<thead>
<tr>
<th>AGE</th>
<th>GENDER</th>
<th>ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>11-12 year</td>
<td>-.46</td>
<td>.76</td>
</tr>
<tr>
<td>13-15 year</td>
<td>-.42</td>
<td>.94</td>
</tr>
<tr>
<td>16-18 year</td>
<td>-.34</td>
<td>.72</td>
</tr>
</tbody>
</table>

F3: Intensity of Using ICT at School

<table>
<thead>
<tr>
<th>AGE</th>
<th>GENDER</th>
<th>ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>11-12 year</td>
<td>.18</td>
<td>.88</td>
</tr>
<tr>
<td>13-15 year</td>
<td>.05</td>
<td>.90</td>
</tr>
<tr>
<td>16-18 year</td>
<td>-.69</td>
<td>.80</td>
</tr>
</tbody>
</table>

Note 1: * p<.05, ** p<.01, *** p<.001
Note 2: degrees of freedom: Age (2,499), Gender (1,499), Age x Gender (2,499)
Figure 1.
Self-assessed and tested skills of using ICT in different age and gender groups
Students’ ICT skills

-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1

Self-assessed
Tested

11-12-year old male
13-15-year old female
16-18-year old male

11-12-year old female
13-15-year old female
16-18-year old female


