ICT SKILLS AND COMPUTER SELF-EFFICACY OF HIGHER EDUCATION STUDENTS

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Abstract

In this paper we continue our previous research on ICT skills in the higher education student population. We focus on several students' perceived ICT skills, general computer use patterns, and perceived computer self-efficacy. The approach taken is different from the mainstream computer literacy research in not focusing on 'Office-based' skills, but rather on lower-level operational skills that are often taken for granted in a the higher education curriculum. On the moment of writing, our sample holds 195 students at bachelor and master level. We scored 6 dimensions within global ICT skills: File Management, Security, Technical Issues, Legal Issues, Internet and Awareness and compared this to computer self-efficacy levels. We investigated the existence of gender effects, bachelor-master effects, the impact of the chosen study subject and computer use. The results show that students in the sample rate their own ICT skills quite high, apart from the dimensions legal and technical issues. We also found that specific computer use profiles, such as identifying oneself as a 'blogger', renders good self-efficacy predictions. While the gender and study subject effects are limited, significant differences between master and bachelor students have been revealed. The findings form a basis for the continued improvement of the higher education ICT curriculum and future research.

Keywords: Skills, Computer Self-Efficacy, Computer Literacy, Field Study.

1 INTRODUCTION

In today's society, digital literacy acquires increasing importance for any professional profile. Also within the educational community, ICT skills have become crucial to the curriculum. In this paper, we present the first result of an ongoing investigation into the ICT skills of students in higher education in the Flemish region of Belgium. The research is a continuation of an earlier education innovation project within the association of the Catholic University of Leuven (K.U.Leuven, Belgium), aiming at understanding and improving students' ICT knowledge, attitudes and usage patterns (see for instance [13], [15]). There was a need for such research because a number of experienced ICT lecturers within the association felt that, despite the digital age we live in, students' ICT competencies did not always meet the required or expected level, certainly in the arts and humanities curriculum.

In this paper we focus on several students' perceived ICT skills, general computer use patterns, and their perceived general computer self-efficacy. Contributing to the literature that seems to focus a great deal on 'Office-oriented' skills (the use of text processors, spreadsheets, presentation software, etc.), we concentrate on operational skills that are less product-dependent, often taken for granted and overestimated, but nevertheless essential. In order to measure those skills, we developed a new multi-dimensional scale. The scale was tested by means of an online survey in the course of October and November 2011. The survey also comprises a personal profile of the responding student. Next to a validity test of the used scales, the analysis includes statistical tests for gender effects and differences according to other students' profile characteristics such as study level and subject.

In the following, we first give a concise overview of some related studies on computer literacy, and computer usage. Subsequently, we present our research objectives and the project from which the research originated. Section 3 contains definitions and operationalizations of the constructs and variables that we measured. In section 4, we present the results, ending the paper with general conclusions.

2 RESEARCH OBJECTIVES AND POSITIONING

2.1 The Information Companion Innovation Project

In 2007, an innovative educational project was started at the Association of the university of Leuven comprising a multi-disciplinary effort to develop tools for the students to acquire the essential skills to improve their personal information management.

This implies not only a wide range of practical competences, but also more conceptual skills, and a consistent attitude, which is necessary in their educational and professional careers. The strategic goal of the project is to make the students more aware of the need for adequate information skills, and learn that it is their own responsibility to upscale their competences where and when required. There was a need for such research because a number of ICT lecturers within the association experienced that, despite the digital age we live in, a number of students' ICT competencies did not always meet the required or expected level, certainly not in the arts and humanities curriculum.

In order to improve such competencies that are often taken for granted, we have developed a web portal, www.informatiewijzer.be, also referred to as 'the Information Companion". The web portal (written in Dutch), contains three components: an online manual that gives an overview of necessary knowledge, a blog where the project members post news items that grasp the student's attention and a self test that enables the students (but also lecturers) to check their information management skills.

The project committee consisted of more than 25 members, representing different divisions, faculties or participating educational institutions. They are either ICT lecturers, educational coordinators or directors of various (under)graduate programs. The information companion is perceived as a work in-progress project that will be extended and appropriated in the future. The objective is not only to inform students about this companion, but also to encourage educators and lecturers to integrate parts of the content of the web portal in their ICT-related courses.

The collection of the different opinions and experiences from lecturers, the establishment of the self test and the information companion website led to a first survey research to measure skill and attitudes of students of the association [13]. The measures and methods used in the underlying paper are discussed below. The text included in the sections or subsections must begin one line after the section or subsection title. Do not use hard tabs and limit the use of hard returns to one return at the end of a paragraph. Please, do not number manually the sections and subsections; the template will do it automatically.

2.2 Some Studies on Computer Literacy and ICT Skills

ICT skills and competences have been the subject of scrutiny in various ways. While computer competences were defined as being able to master a limited number of applications and programming languages in the 1980's and 1990's, there has been a shift towards measuring the ability to handle various (web) applications as well as more general competences with respect to ICT and the use information ([4], [16]). Bunz et al.[4] investigate general operating system skills (related to saving, storing and retrieving files), and email and web skills (related to email and internet applications), asking respondents how much thought the listed activities would require. van Braak [16] analyzed word processing skills, next to operating system and web skills. Ballantine et al. [1] and McCourt et al. [10] used several sub-dimensions such as 'knowledge of general computing', spreadsheets, word processing, databases, email/internet and presentation software, both as perceptions and in an objective way to measure computer literacy. Another related studies can be found in [9] – measuring attitudes towards ICT, networking and the collaborative use of ICT, next to typical 'technical ICT skills'

Along with the diversity of meanings and dimensions, the research domain is characterized by the scattered use of several overlapping or even conflicting notions such as: 'computer literacy', 'ICT skills', 'ICT competencies', 'computer knowledge', 'computer or web fluency', etc . In this paper, we would like to use the general notion of 'ICT skills and knowledge' referring to the practice of using and understanding information communication technology adequately within a higher educational context. Although one can distinguish between perceived (subjective) and objective skills, we confine ourselves in this paper to perceived ICT skills and knowledge, as reported by the respondents themselves.

Related to the notion of perceived ICT skills is perceived self-efficacy; a psychological construct that has been defined by Bandura [2] as people's beliefs about their capabilities and levels of performance

in prospective situations. One of the reasons why we also measured this construct is to test for convergent validity of the newly developed scales.

In the next part of this paper, we describe the measures and items used in the survey.

3 CONCEPTS AND MEASURES USED

In particular, we have subdivided and measured ICT skills in six dimensions: file management, technical issues, legal issues, security, internet use, and risk awareness of one's online traceability. Each measure consists of 4 to 6 items, referring to particular activities that are deemed important. The item pool was generated on the bases of findings of the Information Companion project, in with more than 25 ICT lecturers and researchers were directly involved. The activities were very specific such as 'moving several files to a different map or location', 'synchronizing folders between several computers', 'setting up a firewall', '(re)formatting a hard disk', 'adding information to a wiki', 'sharing a digital document with several people over the internet', etc.

The six dimensions can be defined as follows.

- File management: Activities related to (re)naming, moving, finding and making backups of files.
- Security: Skills include setting up a firewall and passwords, and installing spam filters and anti-virus programs.
- Technical Issues: Comprises activities such as burning CDs, creating PDF files, formatting hard disks, understanding HTML and Cascade Style Sheets.
- Legal Issues: Related to the understanding of public property rights of information on the internet, the legal protection of digital information, and terms such as Codecs and Creative Commons.
- Internet: Includes activities such as: sharing electronic documents over the internet, using social network sites, updating information on a Wiki, a blog, etc., using cloud computing and synchronizing files between several networked computers and mobile devices.
- (Risk) Awareness: the degree to which students are knowledgeable of identity traces they leave on the internet when using social network sites or other applications.

The skills were listed and respondents could answer on a 5-point Likert-type scale containing the categories 'much thought (mental effort)' , 'quite some thought', 'some thought, 'a little thought' , 'almost no thought at all (automatically)', responding to the question "How much thought or mental effort does it take to execute the following tasks or activities?".

The items belonging to the dimensions 'Legal issues' and 'Awareness' have been presented with different Likert scales. Both dimensions relate to knowledge and not necessarily to practices or activities that one can do, therefore a Likert-type scale based on Bloom's taxonomy of categories in the cognitive domain [3] has been used. 'Legal issues' comprise items such as 'Have you heard of: public property rights, Codecs, Creative Commons?', etc, accompanied by the scale: 'not at all', I have heard of it', 'I understand the concept', 'I can explain the concept to others' and 'I can apply/use/develop it'. Items belonging to risk awareness – such as 'I know what people can find about me when using Google', 'I am aware of the traces I leave when posting something on the internet', etc. – were presented with a scale going from 'totally disagree' to 'totally agree'.

Perceived computer self-efficacy has been measured using 8 items, adapted from the well-established measure of Compeau and Higgins [6]. The survey also gauges the personal profile of students, including variables such as study level, gender, study subject and computer use (intra-curriculum and extra-curriculum). Additionally, respondents could choose between several social profiles fitting their typical behavior, such as 'gamer', 'tweaker', 'chatter', 'blogger', etc.

At the moment of this writing, a sample of 195 bachelor and master students completed the questionnaire; the great majority from diverse human sciences. All measured latent variables have been subject to a reliability analysis.

4 FINDINGS

4.1 Sample Composition

The sample holds 195 students with an average age of 22, (the minimum age is 17 years old, the maximum 40). More precisely, an average of 21,4 and 22,6 years for respectively female and male respondents is recorded. Most of the respondents are female (68%) and 60% of the students are enrolled in an academic bachelor program. The detailed composition of the example is presented in Table 1. Note that the subdivision of study subjects was dependent on the sample; other classifications are of course possible.

Table 1: Sample Composition

	All		Female		Male	
	No.	%	No.	%	No.	%
Type of Education						
Professional Bachelor	32	16,6%	24	12,4%	8	4,1%
Academic Bachelor	116	60,1%	75	38,8%	41	21,2%
Master	45	23,3%	32	16,6%	13	6,8%
Total	193	100%	131	67,8%	62	32,1 %
Study Subjects						
Culture , Linguistics, Arts	148	75,9%	99	50,8%	49	25,1%
Economics, History, Sociology, Psychology, Philosophy, Medical and Exact Sciences	47	24,1%	33	16,9%	14	7,2%
	195	100,0%	132	67,7%	63	32,3%

In Table 2, the degree of computer use of the respondents is portrayed. In general, respondents use a computer (PC, laptop or tablet) 4 to 5 hours a week (mean = 4.39). Approximately 50% of the time they spend on their computer is for their studies, 50% is spent on mere entertainment. Less than 1 hour a day on average is spent on gaming. Male students however use their computer significantly more for entertainment in general and gaming in particular.

Table 2: General Computer Experience, in average hours per day

	N	Mean[1]	Meaning[1]	Std. Dev.	Mean Female	Mean Male
Use in General	195	4,39	Appr. 3 to 5 hours/day	2,07	4,40	4,37
Entertainment	195	2,66	Appr. 1 to 3 hours/day	1,54	**2,41****	**3,17****
Studies	186	2,74	Appr. 1 to 3 hours/day	1,66	2,83	2,55
Social Networking	195	1,93	Appr. 1 to 2 hours/day	1,58	1,86	2,08
Games	195	0,74	Less than 1 hour/day	1,09	**0,57****	**1,11****

[1] 9-point Scale: 1 = < 1 hour per week; 5 = 4 to 5 hours per day; 9 = more than 8 hours per day

**: p<0.05, **: p< 0.01*

4.2 Validation of the Used Measures

Principal component and Cronbach Alpha analysis were used to establish the internal reliability for all the factors with reflective items.

Regarding the six dimensions of the measured ICT skills, one item had be omitted because of a low factor loading. The remaining factor loadings are between .64 and .89 and the Cronbach Alpha's between .76 and .90, values well above the usual threshold values. [8]

To test for convergent validity of our newly developed scales, we used the well-studied measure of Compeau and Higgins [6]. Although the data suggest to split the 8 items of perceived self-efficacy in two factors of 4, we kept one factor, in line with most of the literature, with still sufficiently high factor loading between .68 and .80. The Cronbach alpha is .89.

Using the more conservative Kendall Tau (non-parametric) correlation analysis, reveals a highly significant correlation between our dimensions and the Computer Self-efficacy; thus confirming their validity (Table 3). Other measures do not include plural reflective items.

Table 3: Correlations between ICT skills dimensions and Computer Self-Efficacy

	File Man.	Security	Technical Issues	Legal Issues	Internet	Awareness	Global ICT Skills
Computer Self-Efficacy	.30***	.36***	.31***	.34***	.36***	.32***	.49***

****** p<0.001***

4.3 Mean Scores ICT Skills and Perceived Computer Self-Efficacy

The mean scores for the 6 dimensions of ICT skills and perceived computer self-efficacy are given in Table 4. The Global ICT Skills score is the average of the six dimensions.

The scores seem to be quite different between the dimensions. In general, most students give themselves a very high score for file management, internet and awareness, with average scores of at least 4 for more than 45% of the respondents. The scores on legal issues and to a lesser extent, technical issues, are the lowest, diminishing the global scores on ICT skills. Perceived computer self-efficacy is also quite high with a mean score of 3,83 (on a scale of 1 to 5).

Table 4: ICT Skills and perceived Computer Self-Efficacy (scales 1 to 5)

	Mean	Std. Dev.	% >=4 % High level	% <=2 % Low Level
File Management	4,54	0,57	90,77%	0,51%
Security	3,38	1,05	35,38%	14,36%
Technical Issues	3,03	0,94	21,03%	15,38%
Legal Issues	2,65	0,82	6,67%	24,62%
Internet	3,63	0,83	45,64%	4,62%
Awareness	4,01	0,75	65,13%	1,54%
Global ICT Skills Score	3,58	0,61	26,15%	1,03%
Perceived Computer Self-Efficacy	3,82	0,65	48,72%	1,54%

[1]Presented Scale: 1 (very low) to 5 (very high level)

To give an idea of the distribution of individual answers, the histograms of the global ICT score and perceived computer self-efficacy is depicted in Figure 1. The vertical line represents the midpoint (3). The great majority of the individual scores are between 3 and 5; the distributions of our global ICT scale and computer efficacy are comparable.

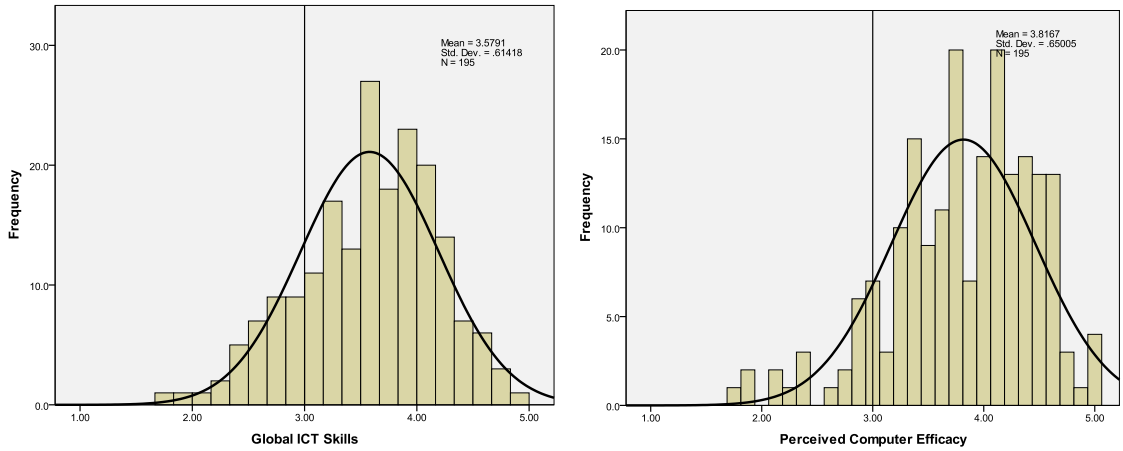

Figure 1: Histogram of Global ICT Skills and Perceived Computer Self-Efficacy

4.4 Single Item Analysis

In a next step we analyzed the 32 single items. In order to distinguish items that respondents feel very confident about (a high score) from those that students feel uncertain about and those that receive a rather neutral score, we developed two indices that we calculated for each item.

The Neutrality index: the percentage of 'neutral' answers (score 3).

The Confidence Index: the number of 'positive' scores (4 and 5) in relation to the total number of non-neutral scores (1, 2, 4 and 5). A high or low confidence index means that the respondents have an articulated opinion, being either very confident or very uncertain about the activity represented in the item.

The application of both indices to the single items resulted in Figure 2. Table 5 presents the items that fall within the marked rectangles of Figure 2. As might be expected - but yet contradictory to certain experiences of the lecturers in the project committee - students rate their file management skills very highly. They are very confident with 4 items (out of 5). Typical activities such as burning CDs and the use of social network sites are also items that score well. Students also indicate that they are well aware or the traces (information) they leave on the internet. The latter again does not fully correspond to the experiences of the involved lecturers.

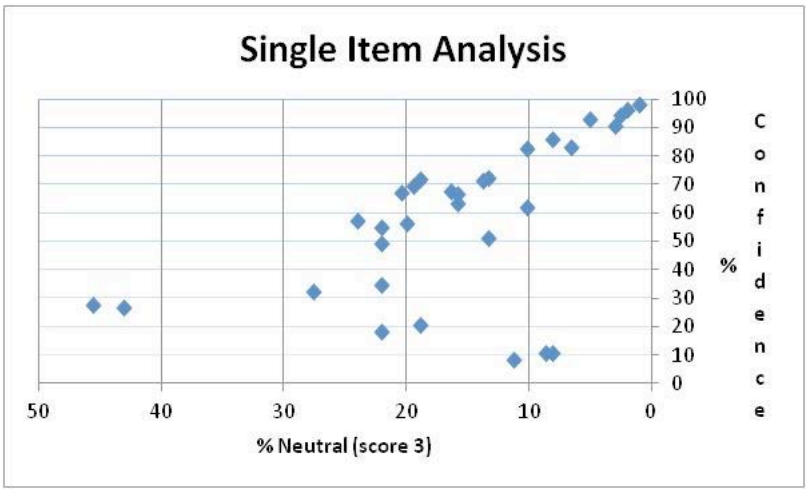

Figure 2: Single Item Differences

Table 5: Items that made a difference

Items respondents feel confident about (Confidence Index max. 80% and Neutrality Index max 20%):	
File Management	- *Searching for a file on my computer* - *Saving a file in a folder that is not frequently used* - *Changing the name of a file* - *Moving several files at once to other folders*
Technical Issues	- *Burning CDs.*
Internet	- *Social networking applications (Facebook, LinkedIn, Twitter...)*
Awareness	- *I am well aware of the information about me that can be found on the internet* - *I am well aware of what information about me can be found on social network sites*
Items respondents feel not at all confident about (Confidence and Neutrality Index max 20%):	
Internet use	- *The application of cloud computing.*
Legal Issues	- *Codecs* - *Creative Commons*
Technical Issues	- *Cascading Style Sheets (CSS).*

4.5 Gender, Study Year, Study Subject and Computer Use Patterns

Using appropriate statistical methods – ANOVA, the Kruskal-Wallis test and Kendall tau correlations -, we also investigated the existence of: gender effects, bachelor-master effects, and the impact of the chosen study subject. In the same vein, the role of computer use in students' perceptions of their ICT skills and computer self-efficacy is analyzed.

Gender has received quite some attention in educational and ICT oriented research. A real consensus on the importance of gender effects in ICT attitudes and the use of ICT in educational settings cannot really be found though ([4], [11]). While some studies report existing gender differences in measures like computer self-efficacy, computer experience or computer-related attitudes and skills, others notice a declining gender gap ([7], [14]). In Bunz et al.[4] for instance, gender had a significant impact on perceived computer-email- web fluency, but not on an actual computer fluency test.

In Belgium, a professional bachelor is a complete three-year program, not leading to an academic master. Contrary to an academic bachelor, it is known to focus more on specialized and professional skills. An academic bachelor also takes three years but is more oriented towards the completion of a master degree (and thus more research and knowledge oriented).

Due to the nature of our survey, we grouped the study subjects into 2 main groups. One group, with the majority of the responses, contains related subjects such as culture, linguistics and arts. The second group comprises students enrolled in economics, sociology, philosophy, history, information management, or other exact sciences. Further subdivisions are possible and useful (particularly in group 2), but this requires a bigger sample.

Table 6 shows the discrepancy analyses. In general, the differences are limited. The only gender effect can be found in the subscale legal issues. Internet skills are significantly higher rated by student belonging to study subject group 2. For both gender and study subject, there are no differences in the global ICT skills score or in the perceived level of computer self-efficacy. The most important differences exist between bachelor and master students. Differences can be seen in two dimensions, technical and legal issues, leading to a significant difference in the global scores on ICT skills. The latter can plausibly be explained by the fact that master students have been more confronted with ICT skills during their academic career.

Table 6: Kendall's tau non-parametric Correlation Coefficients

	Mean	Female	Male	Study Subject: Group 1[2]	Study Subject: Group 2[2]	Prof. Bachelor	Academic Bachelor	Master
File Management	4,54	4,56	4,49	4.52	4.58	4.50	4.48	4.70
Security	3,38	3,30	3,56	3.32	3.59	3.46	3.26	3.64
Technical Issues	3,03	3,01	3,07	2.99	3.15	**2.93**	**2.88**	**3.48*** **
Legal Issues	2,65	**2,55***	**2,85***	2.62	2.75	**2.58**	**2.48**	**3.09*** **
Internet	3,63	3,64	3,63	**3.55***	**3.90***	3.82	3.52	3.77
Awareness	4,01	4,04	3,94	3.98	4.07	4.16	3.93	4.08
Global ICT Skills	3,58	3,56	3,62	3.54	3.71	**3.62**	**3.47**	**3.81****
Self-Efficacy	3.82	3,83	3,79	3,78	3,93	3.85	3.76	3.93

[1]Presented Scale: 1 (very low) to 5 (very high level)

[2]Group 1: Culture, Linguistics, Arts ; Group 2: Economics, Sociology, Information Management, etc.

**: p<0.05, **: p<0.01, ***:p<0.001*

As can be seen in Table 7, the application of the Kendall' tau correlation analysis results in significant correlation coefficients between the computer use measures on the hand and the perceived ICT skills and computer self-efficacy constructs on the other hand. So it is plausible to presume that the more students use computers in general or for entertainment purposes, the higher they rate their ICT skills.

Table 7: Kendall's tau non-parametric Correlation Coefficients

	Computer Use	Entertainment	Studies	Social Networking	Gaming
File Management	0.14**	0.25***	Ns.	0.12*	0.19**
Security	0.11*	0.15**	Ns.	Ns.	0.19**
Technical Issues	0.13*	0.15**	Ns.	Ns.	0.18**
Legal Issues	0.20***	0.17**	Ns.	Ns.	0.15**
Internet	0.22***	0.24***	Ns.	Ns.	0.19**
Awareness	0.13*	0.11*	Ns.	Ns.	Ns.
Global Skills	0.19***	0.20***	Ns.	Ns.	0.20***
Self-Efficacy	0.11*	Ns.	Ns.	Ns.	0.18**

**: p<0.05, **:p<0.01, ***:p<0.001*

We also asked the participating students to identify themselves as belonging to one or more social categories of computer use profiles: 'developer', 'hardware enthousiast', 'chatter', 'twitterer', 'blogger', 'video creator', 'social networker' or 'hacker'. No one identified him/herself as a hacker. We found significant relations between global ICT skills and the profile of developer (Table 8), which was expected, but also with many identifications with the profiles chatter and blogger. The 'developers' also score significantly higher on their computer self-efficacy. Follow-up research on this interesting lead will certainly be conducted, specifically concerning the blogger profile. Given the highly linguistic aspect of the blogger profile, differences in contributive and interactive expertise in regards to the global ICT skills can be salient in this profile (considering, for example [5]). This was however not

taken into account in the current survey. Researchers in social media might find this tentative result interesting in their study of active vs. passive participation on the web.

Table 8: Kendall's tau non-parametric Correlation Coefficients

	Averge Sample (N=195)	Developer (N=6)	Hardware (N=3)	Chatter (N=64)	Twitterer (N=23)	Blogger (N=29)	Video (N=12)	Social Networker (N=99)
File Man.	4,54	4.97	4.13	4.64	4.58	**4.73***	4.65	4.59
Security	3,38	**4.47***	3.80	**3.75****	3.59	**3.78***	3.68	3.37
Technical	3,03	**4.40*****	3.53	3.12	3.10	**3.54****	3.35	2.98
Legal	2,65	**3.43***	3.13	2.77	2.94	**3.15*****	2.88	2.54
Internet	3,63	**4.58****	4.06	**3.92****	3.90	**3.95***	4.06	3.66
Awareness	4,01	4.58	3.92	**4.18***	4.27	**4.29***	4.25	4.08
Global ICT Skills	3,58	**4.40****	3.78	**3.76****	3.76	**3.91****	3.83	3.58
Computer Self-Efficacy	3,82	**4.40***	3.92	3.93	3.93	3.96	3.96	3.85

: p<0.05, **: p<0.01, ***:p<0.001

5 CONCLUSIONS

In this paper, we presented our newly developed scales to measure perceived operational ICT skills. Starting from an educational innovation project within the association of the university of Leuven (K.U. Leuven), we gathered the remarks of approximately 25 project members (mostly ICT lecturers and researchers) and developed 6 subscales representing ICT skills and knowledge that are not only useful but also necessary for a student's career (both during and after his education). This approach is different from the mainstream computer literacy research because it does not focus on 'Office-based' skills, but rather on operational skills that are often taken for granted and underestimated in a the higher education curriculum.

The scales, while providing a more detailed understanding of students' perceived skills, have a high internal reliability and correlate significantly with the standardized measure of perceived computer self-efficacy. The latter is a related measure that was used to establish convergent validity.

This paper shows that students rate their own ICT skills quite high, apart from the dimensions legal and technical issues. An individual item analysis clearly indicated that students are most confident with file management activities, and that students are convinced that they are well aware of the traces they leave on the internet (posting information and using social network sites). These findings are not entirely in line with certain experiences of a number of involved lecturers and require further scrutiny. The items students are least confident with are: the use of cloud computing and legal issues.

In the future, we will compare these perceptions to the results of an objective multiple choice test that we also included in our research. As such, we can estimate whether students overestimate their skills or not. The difference between the results of the test and the perceived measures, can lead to an adaption of the ICT curriculum of higher education students, particularly within the K.U. Leuven association.

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