CEAF: A Measure for Deconstructing Students' Prior Computer Experience

George E. Palaigeorgiou
Panagiotis D. Siozos
Nikos I. Konstantakis
Computer Science Department
Aristotle University of Thessaloniki
Thessaloniki, Greece
gpalegeo@otenet.gr psiozos@csd.auth.gr nikonst@csd.auth.gr

ABSTRACT

Information Systems instructors have always sought to analyze the characteristics of their first-year students' prior computer experience so as to inform a variety of instructional decisions and devise optimal classroom management strategies. Despite the extensive research literature that has been published in the last two decades regarding students' computer experience, there is no single definition of computer experience and no universally accepted construct for its assessment. This study supports the need for deconstructing approaches to examine computer experience and proposes an analytic framework for its assessment, based on different variables studied in bibliography. Computer Experience Assessment Framework (CEAF) includes the variables of: knowledge sources, social environment, opportunities for computer use, freedom of use, goals of use, technical environment, breadth of use, perceived knowledge, negative events, and intensity of use. Usefulness, internal structure, and previously reported use of each variable are presented. A questionnaire was developed and administered to first-year students of a Greek university in order to analyze the contribution of each variable in recognizing students with heterogeneous computer experience. The pilot study indicated that the framework could successfully reveal multiple aspects of the students' background. Various ways of exploiting CEAF are discussed in the last section of the paper.

Keywords: Computer experience assessment;

1. INTRODUCTION

First-year students' prior computer experience is a major unknown factor in professors' development of instructional plans in Information Systems and other computer-related academic departments. Educators strive to detect the distinctive characteristics of students' prior computer usage in order to make various instructional decisions and to devise classroom management strategies that meet students' dissimilar needs. Educational researchers also endeavor to recognize students' computer experience so as to construct descriptive or predictive behavioral models that interpret the origins of their behavior and attitudes (e.g. Beckers 2003; Hasan 2003). Such models can advance the design of initiatives that improve students' computer-related knowledge and behavior.

Despite the extensive research literature on students' computer experience published in the last two decades, there is no single definition of computer experience and no universally accepted construct for its assessment (Potosky et al., 1998; Smith et al., 1999; Wilfong 2004). Computer experience is used in multiple studies with different theoretical and practical instantiations (e.g., intensity of use, diversity of use, knowledge sources, computer knowledge etc.) and it is treated as being closely related to other concepts, such as competence, knowledge, past events, and attitudes. Impediment to the elucidation of the concept is the difficulty of deconstructing the phenomenon of human-computer interactions into discrete research axes. Computer experience has moved beyond time and place restrictions; as a result, individuals' goals, actions, and contexts of use are difficult to distinguish.

In an attempt to develop a universally adopted approach for measuring the computer experience, researchers have introduced a number of different constructs that try to provide a comprehensive coverage of the concept (e.g. Potosky et al., 1998; Smith et al., 2000). For example, Smith et al. (1999) proposed a construct that separated computer experience into objective experience ("the totality of externally observable, direct and/or indirect, human computer interactions which transpire across time") and subjective experience ("a private psychological state reflecting the thoughts and feelings a person ascribes to some existing computing event"). However, such holistic views

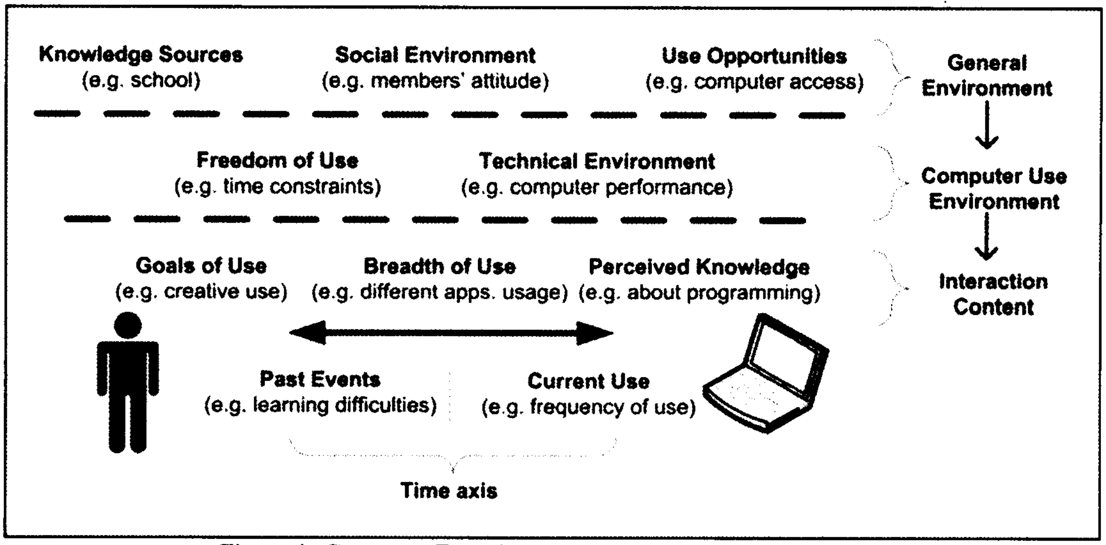


Figure 4 . Computer Experience Assessment Framework - CEAF

fail to overcome the innate difficulties of any effort to provide a complete interpretation of an ill-structured concept. Although the objective-subjective distinction approach implies a sense of comprehensive coverage, we argue that it essentially corresponds to the two common ways of examining experience: through facts and beliefs. Clearly, the structure of the construct does not stem from the inherent characteristics of computer experience.

In this paper, we propose that efforts must be directed to more analytical-deconstructing approaches to the computer experience construct. By examining several computer experience variables, instructors and educational researchers could delve into students' prior computer interactions and contexts of use, and thereby develop a wider range of instructional strategies that promote efficient computer learning conditions and practices. Additionally, each distinct computer experience variable could participate in hermeneutic models of students' behavior and offer greater interpreting power and accuracy.

In the following sections, we describe Computer Experience Assessment Framework (CEAF), which was developed through a review of the most often cited computer experience variables. We present the internal structure of CEAF's variables, examples of their use in the past, and reasons for considering them as important components of computer experience. A pilot study exploiting the CEAF questionnaire was conducted. The study indicated that the questionnaire can reveal multiple aspects of the students' background, discern heterogeneous computer experiences and be considered as a constructive instructional tool.

2. COMPUTER EXPERIENCE ASSESSMENT FRAMEWORK - CEAF

After reviewing uses of computer experience in bibliography, we extracted a five-category model of variables (see Figure 1) that covered the concept from different perspectives. CEAF consists of:

(a) A category that focuses on the general environment of computer experience and looks at general computer-related environmental conditions that are not directly related to computer use. It includes the variables of social environment, knowledge sources and use opportunities.
(b) A category that focuses on the computer use environment and examines the specific conditions of computer use. It includes the variables of freedom of use and technical environment.
(c) A category that focuses on the content of prior interactions with computers and investigates the computational objects that users have manipulated, their goals of use, and their perceived knowledge. It includes the variables goals of use, breadth of use and perceived knowledge.
(d) A category that discerns variables on the time axis. It examines current intensity of computer use and prior circumstances that might have influenced students' current use. It includes the variables intensity of use and negative events.
As shown in Figure 1, the first three categories capture computer experience in terms of its progress from a general perspective to a more detailed one, while the last two categories are differentiated along the time axis. Nevertheless, it is important to note that intrinsic to such deconstructing views is the impossibility of unfolding all aspects of computer experience.

2.1 Focusing on the General Environment of Experience
2.1.1 Knowledge Sources
The first variable of CEAF focuses on the learning resources utilized by students. Many studies support the idea that informal learning processes are more compatible with the acquisition of computer knowledge, as long as the school environment maintains its existing structure (Wellington, 2001). In previous reports, students that demonstrated technical competence and more thorough comprehension of computer operations argued that they derived their knowledge from family, friends, and personal efforts (Mumtaz, 2002; Foster, 2000). Conversely, attending

computer learning courses did not correlate with more intensive computer use (Al-Khaldi and Wallace, 1999) or with a more positive attitude toward computers (Karahanna and Straub, 1999). Formal educational environments have not yet assimilated the conditions of computer learning, nor do they offer educational models that strengthen the synergies of training activities in and outside school (Nachmias et al., 2001).

The nature of computer knowledge – its life span, complexity, contexts of usefulness – necessitates access to many different types of knowledge sources and channels. Most of the time, computer knowledge is useful in limited contexts, has a short life span, is not easily organized in abstract theoretical schemas, and may be needed at any time. Computer experts in the family are an appropriate source for this type of computer knowledge; they can provide information quickly and effectively, as they are aware of the knowledge level and comprehension capabilities of other members of the family (Winter et al., 1997). Knowledge with longer life span, such as programming or computer consequences in society, can be provided in school (Tully, 1996). Therefore, there exist many forms of computer knowledge that require distinct "channels" for their transmission.

In our questionnaire, students were asked to identify the sources of their knowledge about four content areas: computer terminology, computer use and maintenance, office applications, and programming. Students specified up to four knowledge sources, ordering them according to their relative importance. Sources were selected from a list of alternative choices: books, magazines, Internet, hands-on experience, television and radio, ICT in school, family, friends, and educational multimedia applications.

2.1.2 Social Environment

Social environments project their expectations on their members and indirectly influence personal intentions and attitudes. A social environment with positive attitudes toward computers has been positively correlated with the computer use of its members (Al-Khaldi et al., 1999), while students have stated that they wanted to use an application because that was what people near them wanted (Coffin et al., 1999). Hakkarainen et al. (2000) claimed that it is very important for students to be in contact with the culture of expert computer users in order to develop computer competence.

In generic behavioral models, such as the Theory of Reasoned Action (Ajzen & Fishbein, 1980), normative beliefs of social environment filter individuals' attitudes before those attitudes become intentions and then behaviors. Studies of negative stereotypes about girls' usage of computers in family environments have shown that these stereotypes influence girls' computer attitude and computer self-confidence (Downes, 1999). Research studies have also concluded that the negative stereotype of computer experts can discourage individuals from using computers outside work (Durndell et al., 1997).

This portion of the questionnaire does not focus on the actual computer attitude and behaviors of the social environment's members but on the students' perceived attitudes and behaviors; it is these attitudes and behaviors that really influence the students (Rice et al., 1991). The variable of social environment was examined with the following questions: "Many of my friends and relatives like using a computer," "My friends and relatives enjoy discussions about computer issues," "My friends and relatives are proficient computer users," "My friends and relatives use the computer intensively."

2.1.3 Opportunities to Use Computers

The last variable of the general environment of computer experience concentrates on computer access. The more accessible a device is, the less effort is required to use it (Karahanna et al., 1999). Computers in the home have been associated with incidental learning processes that may be comparable, in terms of their learning value, with more structured and planned learning and teaching processes (Levine et al., 1998). Individuals with access to computers at home use them more (Al-Khaldi et al., 1999), have a better understanding of how they function (Mumtaz, 2002), and demonstrate more positive computer attitude (Seyal et al., 2000). However, Al-Khaldi et al. (1999) showed that computer ownership alone could not function as a predictor of computer use and differentiated computer ownership from computer accessibility. Circumstances in which computer usage is mandated (e.g., computer courses) have also been considered as indicators of opportunities to use computers (Brosnan et al., 1998).

We examined computer use opportunities by asking whether individuals had access to computers at home and school, whether they used friends' computers or those available in Internet cafés, and whether they had used all of them for as long as they desired.

2.2 Focusing on Computer Use Environment

2.2.1 Freedom of Use

This category of CEAF variables focuses on the contexts of computer use. Freedom of use examines whether students choose freely the characteristics of their computer usage or whether these are dictated by others. In school, teachers are responsible for evaluating whether experiences are successes, determining students' objectives, and constraining the time available to perform the various tasks. It is precisely these impositions that may have triggered students to state that they did not enjoy computer use in school, where they had to do whatever teachers told them to do (Downes, 1999). To assess this variable, four questions of the questionnaire concern the ownership of a computer, the individual's responsibility for computer's maintenance and operation, the extent of unsupervised computer use and the extent of computer use for reasons imposed by others.

2.2.2 Technical Environment

The second variable, technical environment, originates from the observation that the performance and the peripherals of the system with which we interact can influence beliefs, such as perceived usefulness and usability (Karahanna et al., 1999). Computers' capabilities may color the quality of students' computer experience, restrict the range of potential interactions, and ultimately determine students' desire to use and exploit computer benefits.

In order to evaluate the characteristics of the technical environment, we examined processor speed, storage space, RAM capacity, screen size, and Internet access speed on each student's most frequently used computer. Additionally, students specified whether they had access to computer peripherals and relevant devices (e.g., printer, scanner, etc.).

2.3 Focusing on the Interaction Content

2.3.1 Goals of Use

Delving into the content of prior interactions with computers, we initially categorized computer experience according to individual's goals of use. Representative computer use, where students use the computer to perform an old task in a new and more productive way, is a different context of use from generative computer use, where the computer plays the role of canvas for the students' creativity (Hokanson et al., 2000). Communication and entertainment via computer are other diverse contexts of use (Downes, 1999; Mumtaz, 2002). Certainly, distinctions among different goals may occasionally blur. Most of the time, our behavior serves multiple objectives, but certain goals prevail in each activity. In order to evaluate students' prior goals of use, we created a list of tasks that can be grouped according to the previously stated goals (e.g., representative computer use consists of questions like "I have used the computer in order to write down some homework for school"). Respondents answered whether they had preformed each task repeatedly.

2.3.2 Breadth of Use

The variable of breadth of use examines the different forms of interactions and computational objects with which individuals have had experience. Computers support a rich variety of interactions and the diversity of possible behaviors provokes the development of non-homogeneous relationships with computers. The variable breadth of use indirectly reveals the individual's knowledge and competence (Smith et al., 1999).

Van Braak (2004) used the concept of "quantity of applications" as the total number of different applications that individuals have used and related it to self-perceived computer competence. Hasan (2003) considered the user's experience with each application to be distinct and examined these separate experiences in relation to self-confidence. However, breadth of use is most often used in combination with intensity and frequency of use, and functions as an indicator of computer use (Smith et al., 1999).

Our questionnaire examined four basic classes of software: entertainment applications (games, DVD/music players, CD/DVD burning software), Internet applications (browsers, e-mail software, synchronous communications applications, file-sharing applications), office applications (text editors, spreadsheets, presentation software, databases) and programming (programming languages). For each specific application, students were asked to indicate the number of times that they had used it; options were many times, several times, a few times and not at all.

2.3.3 Perceived Knowledge

The last variable related to interaction content, perceived knowledge, refers to individuals' self-assessment of their computer knowledge. Computer knowledge has been correlated with computer attitudes (Seyal et al., 2000), computer self-confidence (Levine et al., 1998), and computer experience expressed in years of use, intensity of use, and accessibility of computers (van Braak, 2004).

Most times, in order to evaluate computer knowledge, respondents are asked to specify whether they believe they can perform computer tasks of diverse difficulty (Torkzadeh et al., 2002) or to provide a self-assessment of their knowledge about specific tasks (van Braak, 2004) or software applications. There are also mixed-type approaches to measuring computer knowledge such as those of Potosky et al. (1998) and Winter et al. (1997), who included statements in their questionnaires that indirectly identified the users' level of knowledge (e.g., "I frequently read computer magazines"). It is likely that individuals with high levels of self-confidence will assess themselves as more knowledgeable than they really are (Wilfong, 2004). On the other hand, studies have also shown that the level of perceived knowledge correlates significantly with the level of actual knowledge (Leblanc et al., 1985 as cited in Levine et al., 1998).

Perceived computer knowledge was examined for three knowledge fields: Internet applications, office applications, and programming. The only differentiation between this variable and breadth of use is the absence of entertainment software knowledge. Students were asked to estimate their knowledge of each type of application on a five-point Likert scale.

2.4 Past Events and Current Use

2.4.1 Negative Events

The concept of experience is often associated with past events that seem to have a transparent relationship with current attitudes and behaviors. Past events examined in literature are: first experiences with computers, which might have been negative (Rosen, et al., 1987) or relaxed (Todman et al., 1994), etc. and the "most influential" positive or negative experiences (Weil et al., 1990; Tsai et al., 2001).

Past events have been correlated with computer anxiety (Rosen et al. 1987; Todman et al., 1994), computer attitudes (Tsai et al., 2001), computer use (Weil et al., 1990), the motivation and performance in training courses (Smith-Jentsch et al., 1996), and with feeling computer-literate (Beckers et al., 2003). With regard to the methodology of studying such events, researchers usually specify the type of event they are interested in (e.g., first experience) and present a list of sentiments to the students (e.g., "I felt relaxed").

Our questionnaire focused on negative events that have been shown to increase affective activity, behavioral activity and cognitive analysis. Those events have been considered to be important sources of individual development influencing future knowledge, skills, and motivation (Holt et al., 2000). Our questionnaire included two categories of negative computational events, one concerning computer learning difficulties (difficulties in learning new software, in finding operation and maintenance information, and in understanding computer terminology) and one regarding the problematic functions of software or hardware (loss of data, software crashes, hardware malfunctions) (Holt et al., 2000). For each negative event, students specified the frequency of its occurrence.

2.4.2 Intensity of Use

Intensity of use is almost always included in studies that concern computer experience and is usually expressed in accumulative time or frequency of use. It has been incorporated in most computer-related interpretative models and, for example, has been correlated with computer self-confidence (Torkzadeh et al., 2002) and computer anxiety (Anderson, 1996). It is usually evidenced in four forms:

(a) Duration of computer use, which refers to the time interval since the users' first interaction with computers (e.g. van Braak, 2004; Tsai et al., 2001).

(b) Frequency of use, which focuses on examining the periodicity of users' interactions with computers (e.g., every week, every day) (e.g. Al-Khaldi et al., 1999; Smith et al., 2000).

(c) Intensity of use, which goes a step further by examining computer use in number of hours per unit of time, e.g., per week (van Braak 2004), or per day (Al-Khaldi et al., 1999).

(d) Other measures of quantity of use, which are extracted indirectly by indicators of specific applications' usage (Beckers et al., 2003).

In our questionnaire, intensity of use was measured through two questions; one concerning the frequency of use (e.g., many times a week, every day) and one concerning the mean usage time in each use (e.g., 1 to 2 hours, 2 to 4 hours).

3. THE PILOT STUDY

3.1. Aim of the study

The pilot study aimed at examining the characteristics of the computer experience variables and at analyzing their ability to discern students with heterogeneous computer experience. For each variable, we identified variations in the responses of the more and less knowledgeable students; we looked at gender differences and examined whether their correlations could provide us with interesting interpretative clues. The capability of each category of variables in predicting students' current use was applied as an indicator of its closeness to students' current behavior. The results are presented as an example of CEAF informational value and are not intended to examine specific hypotheses about the relationship of computer experience variables.

3.2 Participants

The questionnaire was distributed to 102 first-year students of a Greek informatics department in the context of a wider research study exploring their computer attitudes, experience, and ethical dispositions to several computer-related scenarios. The questionnaire was administered to students of an introductory programming course. Participants were requested to return the questionnaire in two weeks. Eighty-one questionnaires were collected (79% response rate). Seventy-nine of the returned questionnaires were utilizable, since two of them were inconsistently completed. Fifty students (63.3%) were male and twenty-nine students (36.7%) were female.

3.3 Materials

The CEAF questionnaire consisted of ten parts that corresponded to the computer experience variables. Questions appearing in this report were first translated into English by the authors; after this initial translation, the questions were refined by two English language teachers and one psychologist in order to attain maximum equivalence between statements in Greek and in English. The English version of the CEAF questionnaire is available at http://ierg.csd.auth.gr/questionnaires/CEAFen.pdf

4. RESULTS

A median split on the variable of perceived knowledge was performed and produced two groups of students with the same proportions of males and females, and with different levels of perceived computer knowledge. The first group of the less knowledgeable students consisted of 24 males and 15 females, while the second group consisted of 25 males and 15 females.

Table 1 shows descriptive statistics for each variable, presents gender and knowledge differences identified, and shows the ability of each category of variables to predict current use. Table 2 displays the correlations among the variables of CEAF.

4.1 General Environment of Computer Use

4.1.1 Evaluating the Variables

In order to generate an estimate of knowledge sources utilization, nine variables were calculated for each knowledge field. These variables corresponded to the importance of the nine knowledge sources for the related content area. Selected sources were assigned a value (1 to 4), depending on their ordering by students, while the rest of the variables were set to zero. The average utilization of each source was estimated as the mean of its usage for the four knowledge fields. The variable of social environment was computed as the mean of students' responses in the four corresponding questions and it was reliable with a Cronbach's alpha of .83. Finally, the variable of use opportunities was calculated as the sum of different computer access points, where students were able to use computers for as long as they wanted.

4.1.2 Examining Students' Responses

All knowledge sources were positively skewed because each student specified up to four sources from the nine available and the rest were set to zero. Descriptive statistics presented in Table 1 revealed that students' knowledge originated mainly from hands-on experience, books, school, and friends. However, three knowledge sources, (magazines, the Internet and hands-on experience) played the most determinative role in students' computer experience. Males

Variables	M.	S.D	Gender Diff. t	Gender Diff. Sig.	Knowl. Diff. t	Knowl. Diff. Sig.	Predicting Int. of Use β	Predicting Int. of Use Sig.	R^2 Adj.
General computer environment									.31
Knowledge Sources									
KS-Books	.86	.87							
KS-Magazines	.56	.62	2.717	.008			.288	.004	
KS-Internet	.20	.37	2.553	.013	2.629	.010			
KS-School.	.81	.80	-2.562	.014					
KS-Family	.39	.63							
KS-Friends	.80	.74							
KS-Hands on exp.	1.14	.87	1.938	.056	2.194	.031			
KS-TV and Radio	.04	.14							
KS-Educ. Appl.	.02	.08							
Social Environment	2.92	.97							
Opportunities for use	1.16	.91	2.802	.006	4.189	.000	.408	001	
Computer Use Environment									.07
Freedom of use	-	-							
Technical environment									
PC performance	2.46	.84	2.456	.016	2.432	.017	.292	.011	
Access to peripherals	1.52	.88							
Interaction Content									.34
Goals of use (All)	7.63	2.81	4.075	.000	4.072	.000			
Entertainment	.64	.27	4.486	.000	3.503	.001			
Communication - Internet	.46	.46	3.142	.002	3.428	.001			
Representative use	.49	.33			3.064	.003			
Generative use	.42	.27	3.284	.002	3.047	.003			
Breadth of use (All)	2.55	.65	3.676	.000	6.363	.000			
Entertainment applications	3.06	.90	5.483	.000	2.527	.014	.499	.000	
Internet applications	2.66	.98	2.638	.010	4.884	.000			
Office applications	2.47	.70			6.658	.000			
Programming	2.28	1.09			3.783	.000			
Perceived Knowledge (All)	2.65	.92			10.713	.000			
Internet applications	2.63	1.13	2.540	.013	6.298	.000			
Office applications	3.04	1.13			9.853	.000			
Programming	2.28	1.08			6.264	.000	.268	.005	
Time axe									.29
Past Negative Events									
Learning Diff.	2.41	.69	-4.166	.000	-2.386	.019	-.550	.000	
Hardware Malf.	2.23	.62					.283	.005	
Intensity of Use	3.58	.87	4.642	.000	2.894	.005			

Table 1: The CEAF "Experience" Map

utilized more the three sources, while the Internet and hands-on experience were used more by students classified as more knowledgeable. The three sources were also the only ones that correlated with other variables of CEAF (see Table 2).

The variable of social environment was normally distributed. Its average value (M=2.92) was close to the mean of the available range of values, signifying that a positive computer attitude from the social environment is not self-evident. Students who indicated a more positive social environment, specified social environment more times as a knowledge source, and demonstrated more experience in entertainment and internet activities. Interestingly, they also realized more generative tasks on their computers and achieved generally more goals.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1.BoU-Intensity (all)	1																									
2.BoU-Internet	**.86**	1																								
3.BoU-Office apps	**.67**	**.39**	1																							
4.BoU-Entert.	**.81**	**.63**	**.29**	1																						
5.BoU-Programming	**.45**	**.31**	**.65**	.16	1																					
6.Kn (all)	**.76**	**.62**	**.74**	**.43**	**.57**	1																				
7.Kn-Internet	**.81**	**.88**	**.34**	**.65**	**.26**	**.69**	1																			
8.Kn-Office apps	**.64**	**.41**	**.84**	**.31**	**.45**	**.87**	**.44**	1																		
9.Kn-Programming	**.43**	.27	**.59**	.14	**.63**	**.83**	.29	**.66**	1																	
10.Social Env.	.27	**.36**	-.12	**.33**	-.06	.08	**.38**	-.03	-.10	1																
11.KS-Books	.01	-.05	.21	-.07	.26	.16	-.04	.19	.25	-.19	1															
12.KS-Magazines	**.29**	.17	.15	**.35**	-.01	.10	-.06	.13	-.04	.02	.10	1														
13.KS-Internet	**.41**	**.35**	.28	.29	.25	**.30**	**.41**	.24	.09	.22	.03	**.49**	1													
14.KS-School.	-.09	-.02	-.01	-.20	.04	.01	-.07	.03	.07	-.11	.08	-.24	**-.33**	1												
15.KS-Family	-.00	-.01	-.05	.09	.00	-.05	-.01	-.09	-.01	.15	-.25	-.15	-.19	.01	1											
16.KS-Friends	-.01	.03	-.04	-.01	-.09	.01	.09	.07	-.09	**.30**	-.28	-.10	-.13	-.05	-.05	1										
17.KS-Hands on exp.	.26	.17	.28	.12	.26	**.34**	.19	**.29**	.29	-.14	-.05	.03	.21	-.16	-.20	-.26	1									
18.Use Opport.	**.58**	**.50**	**.39**	**.41**	.24	**.48**	**.51**	**.35**	**.30**	**.44**	-.10	.16	.27	-.12	.12	.03	.26	1								
19.PC Performance	**.35**	.24	.20	**41**	.15	.27	**.31**	.24	.14	.16	.15	.26	.24	-.08	.02	-.17	.11	.18	1							
20.NE-Learn. Diff.	**-.48**	**-.40**	**-.31**	**-.36**	-.27	**-.46**	**-.45**	**-.37**	-.27	-.20	.06	**-.38**	**-.38**	.17	.11	-.03	**-.39**	**-.32**	-.26	1						
21.NE-H/S Probl.	.09	.11	.04	.09	.06	.06	.06	.05	.06	.02	.02	.01	.15	-.03	.16	.01	-.26	.08	-.17	.28	1					
22.G-Gener.	**.63**	**.60**	**.29**	**.58**	.25	**.48**	**.61**	**.35**	.21	**.33**	-.08	.24	.27	-.07	.15	.08	.18	**.52**	.27	-.26	.05	1				
23.G-Repres.	**.58**	**.50**	**.38**	**.47**	.13	**.37**	**.44**	**.32**	.14	.23	.12	.27	**.35**	-.13	.06	-.15	.13	**.45**	.18	-.22	.07	**.46**	1			
24.G-Commun.	**.69**	**.83**	.24	**.51**	.23	**.48**	**.72**	.23	.24	**.34**	-.10	.12	.27	-.02	.06	.08	.14	**.39**	.21	**-.33**	.08	**.43**	**.45**	1		
25.G-Entert.	**.76**	**.77**	.22	**.77**	.16	**.51**	**.78**	.28	.22	**.43**	-.05	.25	.28	-.15	.09	.03	.08	**.51**	**.36**	**-.33**	.08	**.73**	**.49**	**.77**	1	
26.G (all)	**.83**	**.80**	**.36**	**.77**	.23	**.56**	**.78**	**.37**	.25	**.42**	-.01	**.30**	**.36**	-.13	.13	-.03	.13	**.52**	**.35**	**-.38**	.07	**.75**	**.73**	**.77**	**.92**	1
27.Intensity of use	**.58**	**.48**	**.37**	**.53**	**.29**	**.47**	**.47**	**.34**	**.34**	.04	-.02	**.35**	**.30**	-.12	-.06	-.14	.27	**.45**	.29	**-.50**	.12	**.36**	**.22**	**.47**	**.52**	**.49**

Bold - correlation is significant at .01 (2-tailed)

BoU - Breadth of use, Kn – Perceived Knowledge, KS – Knowledge Source, NE – Negative Events, G – Goals

Table 2: Correlations between computer experience variables

Opportunities for use were positively skewed, since only 30.4% of the students had more than one computer access point where they were able to use computers for as long as they wished. The variable was correlated with almost all the variables of goals of use, breadth of use, perceived knowledge, and intensity of use and underscored that unrestricted access to multiple computers was an important prerequisite for experienced users.

Generally, we could argue that the three variables of the general computer environment discriminated students from a variety of perspectives. Stepwise regression analysis with all the variable of the category revealed that opportunities for use in conjunction with the utilization of magazines could predict a considerable amount of intensity of use (31%).

4.2 Computer Use Environment

4.2.1 Evaluating the Variables

Answers from questions about freedom of use could not form a factor because the Cronbach's alpha remained very low (>.40) in multiple combinations of the questions. Furthermore, distributions of answers in the four questions were negatively skewed, meaning that students' use was not constrained. For these reasons, this variable was not examined further. Two variables were created to examine students' technical environment. The first one expressed the performance of students' most frequently used computer and the second variable indicated accessibility to peripheral and relevant devices.

4.2.2 Examining Students' Responses

The two variables of the technical environment were normally distributed. Males and the more knowledgeable students had access to more powerful computer systems. The performance of the most frequently used computer was significantly correlated to entertainment and Internet activities. Conversely, access to peripherals and related devices did not help us to identify differences in students' experience, nor did it correlate with other CEAF variables.

In general, the variables of conditions of use did not function as expected. Technical environment managed to predict a small amount of intensity of use (7%).

4.3 Variables of Interaction Content

4.3.1 Evaluating the Variables

Separate principal component analysis with varimax rotation on goals of use, breadth of use, and perceived knowledge produced similar factors. Four factors were extracted for goals of use, which interpreted 58.9% of covariance: (a) computer use for entertainment purposes (e.g., listening to music, watching movies) (b) computer use for communication - Internet (e.g., communicate with friends, create a Web page, search for information) (c) representative use (e.g., write down homework, take notes etc.) and (d) generative use which consisted of only one question ("I have used the computer in order to express my self artistically"). Three distinct factors were extracted for breadth of use which interpreted 64.7% of covariance: (a) entertainment applications (b) Internet applications, and (c) office applications. And finally, two factors were extracted for perceived knowledge which interpreted 75.5% of covariance: (a) knowledge of office applications, and (b) knowledge of Internet applications. Programming usage and perceived programming knowledge, which were excluded from the corresponding factor analyses due to low extraction communality, were also considered as variables of breadth of use and perceived knowledge, respectively.

4.3.2 Examining Students' Responses

It is important to mention that the variables of breadth of use, perceived knowledge and goals of use described quite common characteristics of experience. Each software application serves specific purposes and its utilization requires particular knowledge. However, the usage of an application cannot reveal the students' perceived knowledge or the objectives in using it. In our study, all variables were normally distributed, with the exception of entertainment-related variables which were negatively skewed and programming which was positively skewed. Students used computers primarily for entertainment purposes while the lesser usage and perceived knowledge were indicated for programming. Programming usage seemed relatively independent of students' other computer activities since it did not correlate with any variable of goals of use.

Students who were classified as more knowledgeable used computers for achieving more goals and exploited more intensely a broader range of applications. Interestingly, gender differences were detected in most of the variables except the ones that referred to representative goals of use and typical skills learned in schools, such as office applications and programming. It seems that most females took advantage of the more typical computer characteristics in contrast to males who were more interested in computers for entertaining and creative activities.

As anticipated, the variables focusing on the interaction content predicted a considerable amount of intensity of use (34.2%).

4.4 Time axis

4.4.1 Evaluating the Variables

Intensity of use was computed as the sum of the questions concerning the frequency of computer use and the average usage time of each use. Learning difficulties and hardware/software malfunctions were computed as the mean of the corresponding questions.

4.4.2 Examining Students' Responses

The variable of intensity of use was negatively skewed, since 44.3% of students used computers daily for more than two hours. As shown in Table 2, intensity of use was significantly correlated with most of the CEAF variables and confirmed its characterization as the most representative variable of computer experience.

Students indicated that they had, in the past, confronted more learning difficulties than software/hardware malfunctions. They mainly faced difficulties in understanding computer terminology and when trying to learn new software. Fewer learning difficulties were identified by students who achieved more goals, had a broader breadth of use, and more perceived knowledge. Learning difficulties were also negatively related to three knowledge sources: magazines, internet and hands-on experience underscoring the value of these sources to students' computer learning practices. In contrast, software/hardware malfunctions did not correlate with any CEAF variable.

5. DISCUSSION

The pilot study indicated that CEAF can reveal multiple aspects of students' computer background and can enable instructors to recognize prior computer-related activities and environments of first-year students in information systems or other pertinent departments. Table 1, which summarized students' responses, functioned as an "experience map" and provided valuable information for interpreting students' behaviors and differentiations.

CEAF can inform a variety of instructional decisions and classroom management strategies to better meet the diversity of freshmen needs. For instance, knowledge differences could spur the refinement of instructional decisions concerning team formation in order to encourage greater social interaction between experienced and novice students; detected gender differences could guide the offering of projects that motivate both males and females to exploit computers creatively; the identification of the frequency and type of learning difficulties that students confront could initiate the design of appropriate learning activities for the first phase of their studies; students' goals of computer use could reveal their interests and, hence, enable the creation of more intriguing learning content; the recognition of the students' technical environment could help instructors adapt the learning assignments to the students' constraints; students' selections of knowledge sources highlighted successful learning strategies, which could be pursued by providing incentives for specific informal behaviors. Finally, the long term and repetitive exploitation of CEAF can enable the continuous refinement of instructors' strategies and objectives.

The questionnaire's variables could also be used to develop predictive or descriptive models that identify relationships between prior computer experience and students' academic performance. For example, computer experience variables could be examined in relation to students' grade scores in order to identify experience factors that have a determinative effect on their academic career. Relationships could also be established with other pertinent constructs, such as computer attitudes or computer anxiety, and allow instructors and educational researchers to infer cause-effect schemas for interpreting students' computer-related behavior. However, the results of CEAF studies should be generalized with caution, since distinct cultures and educational systems produce unique outcomes to students' experience. Studies from different countries employing CEAF could facilitate the generalization of conclusions, while the longitudinal monitoring of all variables and their relationships might also help in the profiling of students who enter the academic field of information systems.

Finally, CEAF could be utilized for assessing computer experience in more narrow contexts. For example, it could be applied to study prior experience with programming. Breadth of use (e.g., different functions used), perceived knowledge, social environment, knowledge sources, opportunities to use, technical environment, and negative events could be instantiated for the specific environment and offer a well-organized, multiple-perspective examination.

The proposed questionnaire, in its current form, can be targeted to students of other domains as well. Additionally CEAF can retain compatibility with future instances of the same structure, as deconstructing models are open to the addition and removal of their structural elements. However, efforts to assess CEAF's reliability and validity must be continued, since the questionnaire was tested on a relatively small sample. In subsequent studies, we intend to examine the instructional value of the CEAF more analytically and correlate the corresponding variables to students' academic performance.

6. REFERENCES

Ajzen, I., and Fishbein, M. (1980) "Understanding attitudes and predicting social behavior". Englewood Cliffs, Prentice-Hall.

Al-Khaldi, M., and Wallace, R. (1999) "The influence of attitudes on personal computer utilization among knowledge workers: the case of Saudi Arabia," Information & Management, Vol. 36, No. 4, pp. 185-204.

Anderson, A. (1996) "Predictors of Computer Anxiety and Performance in Information Systems," Computers in Human Behavior, Vol. 12, No. 1, pp. 61-77.

Beckers, J., and Schmidt, H. (2003) "Computer experience and computer anxiety," Computers in Human Behavior, Vol. 19, No. 6, pp. 785-797.

Brosnan, M., and Lee, W. (1998) "A cross-cultural comparison of gender differences in computer attitudes and anxieties: The United Kingdom and Hong Kong," Computers in Human Behavior, Vol. 14, No. 4, pp. 559–577.

Coffin, R., and MacIntyre, P. (1999) "Motivational influences on computer-related affective status," Computers in Human Behavior, Vol. 15, No. 5, pp. 549-569.

Downes, T. (1999) "Playing with computing technologies in the home," Education and Information Technologies, Vol. 4, No. 3, pp. 65-79.

Durndell, A., and Thomson, K. (1997). "Gender and computing: A decade of change?" Computers & Education, Vol. 28, No. 1, pp. 1-9.

Foster, S. (2000) "Australian undergraduate Internet usage: self-taught, self-directed and self-limiting," Education and Information Technologies, Vol. 5, No. 3, pp. 165-175.

Hakkarainen, K., Ilomaki, L., Lipponen, L., Muukkonen, H., Rahikainen, M., Tuominen, T., Lakkala, M., and Lehtinen, E. (2000) "Students' skills and practices of using ICT: results of a national assessment in Finland," Computers & Education, Vol. 34, No. 2, pp. 103-117.

Hasan, B. (2003) "The influence of specific computer experiences on computer self-efficacy beliefs," Computers in Human Behavior, Vol. 19, No. 4, pp. 443-450.

Hokanson, B., and Hooper, S. (2000) "Computers as cognitive media: examining the potential of computers in education," Computers in Human Behavior, Vol. 16, No. 5, pp. 537-552.

Holt, D., and Crocker, M. (2000) "Prior negative experiences: their impact on computer training outcomes," Computers & Education, Vol. 35, No. 4, pp. 295-308.

Karahanna, E., and Straub, D. (1999) "The psychological origins of perceived usefulness and ease-of-use," Information & Management, Vol. 35, No. 4, pp. 237-250.

Levine, T., and Donitsa-Schmidt, S. (1998) "Computer Use, Confidence, Attitudes and Knowledge: A Causal Analysis," Computers in Human Behavior, Vol. 14, No. 1, pp. 125-146.

Mumtaz, S. (2002) "Children's Conceptions of Information Communications Technology," Education and Information Technologies, Vol. 7, No. 2, pp. 155-168.

Nachmias, R., Mioduser, D., and Shelma, A. (2001) "Information and Communication Technologies Usage by Students in an Israeli High School: Equity, Gender, and Inside/Outside School Learning Issues," Education and Information Technologies, Vol. 6, No. 1, pp. 43-53.

Potosky, D., and Bobko, P., (1998) "The Computer Understanding and Experience Scale: A Self-Report Measure of Computer Experience," Computers in Human Behavior, Vol. 14, No. 2, pp. 337-348.

Rice, R., and Aydin, C., (1991) "Attitudes towards new organizational technology: network proximity as a mechanism for social information processing," Administrative Science Quarterly, Vol. 36, pp. 219-244.

Rosen, D., Sears, C., and Weil, M. (1987) "Computerphobia," Behavior Research Methods, Instruments, and Computers, Vol. 19, No. 2, pp. 167-179.

Seyal, A., Rahim, M., and Rahman, M. (2000) "Computer attitudes of non-computing academics: a study of technical colleges in Brunei Darassalam," Information & Management, Vol. 37, No. 4, pp. 169-180.

Smith, B., Caputi, P., Crittenden, N., Jayasuriya, R., and Rawstorne P., (1999) "A review of the construct of computer experience," Computers in Human Behavior, Vol. 15, No. 2, pp. 227-242.

Smith, B., Caputi, P., and Rawstorne, P. (2000) "Differentiating computer experience and attitudes toward computers: an empirical investigation," Computers in Human Behavior, Vol. 16, No. 1, pp. 59-81.

Smith-Jentsch, K., Jentsch, F., Payne, S., and Salas, E. (1996) "Can pre-training experiences explain differences in learning?" Journal of Applied Psychology, Vol. 81, No.1, pp. 110-116.

Todman, J., and Monaghan, E. (1994) "Qualitative differences in computer experience, computer anxiety, and students use of computers: a path model," Computers in Human Behaviour, Vol. 10, No. 4, pp. 529-539.

Torkzadeh, G., and Van Dyke, T.P. (2002) "Effects of training on Internet self-efficacy and computer user attitudes," Computers in Human Behavior, Vol. 18, No. 5, pp. 479-494.

Tsai, C.-C., Lin, S., and Tsai, M.-J. (2001) "Developing an Internet Attitude scale for high school students," Computers & Education, Vol. 37, No. 1, pp. 41-51.

Tully, C. (1996) "Informal education by computer – Ways to computer knowledge," Computers & Education, Vol. 27, No. 1, pp. 31-43.

van Braak, J., (2004) "Domains and determinants of university students self-perceived computer competence," Computers & Education, Vol. 43, No. 3, pp. 299-312.

Weil, M., Rosen, D., and Wugalter, E. (1990) "The etiology of computerphobia," Computers in Human Behaviour, Vol. 6, No. 4, pp. 361-379.

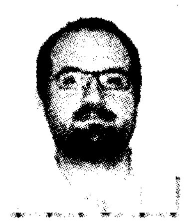
Wellington J. (2001) "Exploring the Secret Garden the growing importance of ICT in the home," British Journal of Educational Technology, Vol. 32, No. 2, pp. 233-244.

Wilfong, J. (2005) "Computer anxiety and anger: the impact of computer use, computer experience, and self-efficacy beliefs," Computers in Human Behavior, (in press)

Winter, S., Chudoba, K., and Gutek, B., (1997) "Misplaced resources? Factors associated with computer literacy among end-users," Information & Management, Vol. 32, No.1, pp. 29-42.

AUTHOR BIOGRAPHIES

George E. Palaigeorgiou holds a PhD in students-computers interactions from the Computer Science Department of the Aristotle University of Thessaloniki. He has several publications in scientific journals such as Journal of Computer Assisted Learning, Computers & Education, etc. and he has participated in many funded research projects. His research interests include Computer Experience and Attitudes, Cognitive Tools, Participatory Design and Computer Ethics.



Panagiotis D. Siozos is a post-graduate student at the Multimedia Lab of the Computer Science Department, at the Aristotle University of Thessaloniki, holding a BS from the same department. He has extensive work experience, both as a secondary education computer science teacher and as a software developer, having taken part in several EU-funded research projects. His research interests include Computer Assisted Assessment, Intelligent Tutoring Systems, Educational Metadata and Computer Ethics.

Nikos I. Konstantakis is a teacher of information technology in secondary education. His research interests are focused on information technology in education, computer attitudes and computer ethics.

Information Systems & Computing
Academic Professionals

EDSIG
Serving Information Systems Educators

STATEMENT OF PEER REVIEW INTEGRITY

All papers published in the Journal of Information Systems Education have undergone rigorous peer review. This includes an initial editor screening and double-blind refereeing by three or more expert referees.

ISSN 1055-3096