How Students Estimate the Effects of ICT and Programming Courses

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ABSTRACT
The curricula for Computer Science Education (CSE) of many countries comprise both Programming and Information and Communication Technology (ICT); however these two areas have substantial differences, inter alia the attitudes and beliefs of the students regarding the intended learning content. In this study, variables from the Unified Theory of Acceptance and Use of Technology and Social Cognitive Theory were chosen as important factors in students' behavior and attitude towards CSE. This hybrid framework aims to measure the level of the selected key variables on CSE and identify potential differences among ICT and Programming courses. Responses from the total of 126 Greek students, (71 attending ICT courses and 55 attending Programming Courses) were used to measure the variables and to identify the differences between ICT and Programming students. The results revealed several differences in the measured variables. The overall outcomes are expected to contribute to the understanding of students' likelihood to pursue computing related careers and promote the acceptance of CSE.

Categories and Subject Descriptors
K.3.2 [**Computer and Information Science Education**]: Computer Science Education, Curriculum.

General Terms
Measurement, Experimentation, Human Factors.

Keywords
ICT courses, Programming courses, Informatics, Secondary education, Students' Beliefs.

1. INTRODUCTION
The comparison of Computer Science Education (CSE) in different countries uncovers substantial disparities regarding the conception as well as the practice [17]. Some of these disparities are forced by the big differences in the Educational Systems, while others are caused by differences of traditions, national heritage or public opinion. In several CSE has been included in the curriculum as a distinct discipline in secondary education, while it was taught across curriculum in others [17]. Generally CSE focuses on basic concepts about the constructional principles of computers and networks (hardware) and the principles of programming, (formal languages, programming and software development), whereas Information and Communication Technology (ICT) is focused on how to use computers and how to apply software In many countries [17] CSE includes both ICT and programming courses, however, students' sometimes face these courses differently.

Several models and theories have been used to address students' perceptions and attitude towards learning media [10] and curricula [6]. The Unified Theory of Acceptance and Use of Technology (UTAUT) is one of the most widely and successfully used [16, 24]. Other researchers have empirically explained (using UTAUT or its initial form of TAM) several issues regarding students' attitude [10, 26]. As successful CS teaching largely depends on students' perception and beliefs, we aim to identify students' differences among programming and ICT courses. In this light, variables related to students' attitude were chosen and applied to programming and ICT courses respectively. Then a between group experiment was conducted among students participating ICT course and students participating programming course in the context of Greek educational system. Our empirical study aims to indentify the distinct differences among ICT and programming courses in order to provide a vehicle in the differentiation of educators' attitude in these courses which are mostly (in many countries) treated as a common course.

The purpose of this empirical investigation was to measure students' beliefs and to identify potential differences among ICT and Programming courses. As students' beliefs and attitude are highly correlated with their performance and students' perceptions have an impact on what they have already learned and what they choose to do next [21]. Our work is expected to contribute to the understanding of students' performance and intentions to pursue programming and ICT courses in their future studies.

2. RELATED WORK AND RESEARCH HYPOTHESES
All students' perceptions and intentions are considered as important determinants of the learning success. Reluctance towards adoption of CS content implies that research is needed to understand, more comprehensively, how students could be motivated. Although past research [1, 2] has empirically

explained several issues regarding students perceptions and beliefs regards CSE, it is mostly focused on higher education and more specifically on CS departments. In addition, prior studies have studied CSE as a unified (both ICT and Programming) body. As a result, at present, there is lack of empirical studies on students CSE perceptions and the differences between ICT and Programming courses.

Several models and theories have been applied to address issues of students' attitude, perceptions and to identify the cause and the effect of different factors on the adoption of science education. For instance, UTAUT and SCT are some of the most widely applied theories in the context of students' behavior [6, 11]. In addition, Performance Expectancy (PE), Social Influence (SI), Satisfaction (STF), Self-Efficacy (SEF) and Perceive Behavioral Control (PBC) are some of the most commonly used factors [6, 10] affecting students' intention to attend a respective course. In the view of the above we aim to measure these factors for ICT and Programming courses and to identify potential difference in students' perceptions for these two courses. Thus, the study's set of hypotheses is formulated as follows:

H1. Students' Performance Expectancy is differentiated among ICT and Programming Courses.

H2. Students' Satisfaction is differentiated among ICT and Programming Courses.

H3. Students' Self-Efficacy is differentiated among ICT and Programming Courses.

H4. Students' Social Influence is differentiated among ICT and Programming Courses.

H5. Students' Perceived Behavioral Control is differentiated among ICT and Programming Courses.

H6. Students' Behavioral Intention is differentiated among ICT and Programming Courses.

3. ICT AND PROGRAMMING COURSES IN GREECE

The curricula of Secondary Education in Greece, since the school year 1998-1999, embody a single philosophy implemented by drafting up a Primary and Secondary Education Single Curriculum Framework. In the year 2003 the Interdisciplinary Unified Education Course Framework (DEPPS) and the new – detailed, Curricula (APS) were drawn up for compulsory education, which adopt the inter-disciplinary approach of knowledge. The new school books that were written based on the DEPPS and the new APS orientation have been introduced to the schools in 2006-2007.

In these compulsory education Curricula the importance of Information and Communication Technologies and the role these should play is widely recognized. ICT is not seen only as a separate subject of study, absolutely necessary today for students' technological literacy, but also as a multi-tool: cognitive teaching, information seeking, communicating knowledge etc. The theoretical model adopted, for introducing ICT in lower secondary education, is characterized by the teaching of an "informatics" course and the gradual use of computational and networking technologies as a means to support the cognitive process for all subjects of the programme of study.

The Cross-curricular Single Framework for Curricula for the lower secondary education, through the teaching of Informatics, foresees that the student is to:

- Be able to explain and analyze basic notions and terminology of Informatics (i.e. data, information, coding, data handling, file, save, programme, software, system software etc).
- Be aware of the operations of the main computer units and use with ease a computer system.
- Use generic software tools to record (write down) their ideas, to treat and present them in a variety of ways and means, to resolve simple problems, to use simple projection and control models in order to simulate and test simple problems or results from other cognitive domains.
- Be able to select, choose, analyse and evaluate information through different sources (electronic encyclopedias, electronic dictionaries, www etc) and utilize these for complex projects individual work or teamwork
- Utilize possibilities offered by Information and Communication Technologies (ICT) to communicate, exchange views, wonder, entertain, present their ideas and opinions (the way they choose) and apply simple knowledge of ICT in everyday life.
- Develop critical skills to be able to address problems using computer and to resolve simple problems in a programming environment.
- Cooperate to perform a given project, develop initiatives, design, set objectives, recognize the importance of teamwork in advancing the project, discuss and assess their work and the work of the others.
- Develop an ethics code in regards to their work in the lab, the respect of the work and differentiation of others.

In addition, Informatics has been introduced as a separate curriculum subject which is taught once a week by specialist IT teachers. In the course of Informatics ICT content dominates the curriculum throughout lower secondary education. By the end of the third year the students are introduced into fundamental algorithms and programming using Logo.

In the case of upper secondary education (Lyceum); the 1st grade operates as an orientation year with a general knowledge program. The 2nd grade offers three curricular directions or pathways: Theoretical, Scientific and Technological. In the 3rd grade Lyceum again has the same three directions/pathways. Students who follow the technological direction are taking a course which involves the development of algorithms and programming named Applications Development in a Programming Environment. This course has been taught for ten years. It focuses on the algorithmic approach and on the development of problem-solving skills in a programming environment. This subject is assigned to CS teachers.

The overall aim of 3rd Lyceum programming courses is to develop analytical and synthetic thinking, acquire methodological skills and be able to solve simple problems within a programming environment. This Programming course has not been designed to create programmers, and for this reason it is not designed to teach sophisticated programming techniques; it focuses on approaches and techniques of problem solving with emphasis on structured thinking. Many basic algorithmic and programming concepts, such as conditions, expressions and logical reasoning, are fundamentals of general knowledge and skills to be acquired in general education; these concepts are not presented in other disciplines.

The curriculum states that this subject must be taught (at least partially) in a computer lab. The Ministry of Education has certified specific Educational Software to support the lab work, especially for the Lyceum programming course. The Educational Software has been designed to support teaching, to complement the subject's needs and IT use and to help students consolidate the material. The certified software includes an activity space, a flow chart developer and a programming environment in accordance with the textbook. In addition to that, there are other educational software packages that have been developed by educators and are already in use in many schools.

4. METHODOLOGY

4.1 Context

The empirical study was conducted in the context of secondary education in Greece. As we previously mentioned, the relevant curriculum ICT courses (named Informatics) are mandatory during Gymnasium (lower secondary) years and aim to develop students' skills in the use of ICT (operating systems, word processing, spreadsheets, image processing etc). The first group in our experiment (ICT Group) consisted of students attending the 3rd class of Gymnasium. They have experience on ICT courses and they are asked for their perceptions regarding the ICT curriculum in the under investigation factors.

For the case of Lyceum (upper secondary), ICT is taught as an elective or direction course since 1999. Thus, besides mandatory education (primary, lower secondary), students in all the classes of Lyceum can select certain ICT from a wide range of various subjects. In the last two classes of Lyceum, students select one of three directions, (technological, scientific or theoretical). If students in the last grade select the technological direction, they attend the programming course for which they are assessed through national exams. The second group in our experiment (Programming Group) consisted of students attending the 3rd class of Lyceum. They have experience on the programming course and they are asked for their perceptions regarding the programming curriculum in the under investigation factors.

In view of the above, our between group experiment was conducted among students' of 3rd of Gymnasium regarding ICT courses and students of 3rd of Lyceum regarding programming courses.

4.2 Sampling

The research methodology included a survey composed by questions on background information of the sample and on the six principal factors. The survey was open during the last three weeks of November 2011 at four public Gymnasiums (lower secondary education) and four public Lyceums (upper secondary education) in the northwestern Greece. The final sample of respondents comprised of 126 Students. From the total of students, 71 (56.35%) were 14 years and attended 3rd of Gymnasium (taught ICT course) and 55 (43.65%) were 17 years and attended the 3rd of Lyceum, in addition, 89 were males (70.6%) and 37 (29.4%) females.

Table 1. The Factors definitions and their Items

Factor	Operational Definition	Items*	Source Adopted
Performance Expectancy (PE)	The degree to which an individual believes that attending the respective course is useful for him/her.	Using programming improves my performance in a task. (PE1)	[24]
		Programming enhances my effectiveness in tasks progressing. (PE2)	
		Programming would make it easier to complete a task. (PE3)	
		Programming increases productivity in completing tasks. (PE4)	
Satisfaction (STF)	The degree to which a person positively feels with the respective course.	I am satisfied with the programming experience. (STF1)	[20]
		I am pleased with the programming experience. (STF2)	
		My decision to use programming was a wise one. (STF3)	
		My feeling to use programming was good. (STF4)	
Self-Efficacy (SEF)	The degree of conviction that one can successfully execute the operation required to produce the outcomes.	**I could complete a programming task …**	[26]
		if there was no one around to tell me what to do. (SEF1)	
		if I had never used it before. (SEF2)	
Social Influence (SI)	The degree to which an individual perceives that most people who are important to him think he should or should not attend the respective course.	People who are important to me think that I should learn programming. (SI1)	[16]
		People who influence my behavior encourage me to learn programming. (SI2)	
Perceived Behavioral Control (PBC)	The degree to which a person perceives how easy or difficult it would be to perform an operation in the respective course.	I would be able to complete programming tasks (PBC1)	[26]
		I have the knowledge and the ability to complete programming tasks. (PBC2)	
Behavioral Intention (BI)	The degree of students' willingness to attend the respective course	I intend to continue learning programming in the future. (BI1)	[19]
		I will continue learning programming in the future. (BI2)	
		I will regularly learn programming in the future. (BI3)	

* for the case of ICT courses the questions where the same with the only difference that the word programming has been replaced with ICT

4.3 Measures

The questionnaire handed out to the students was divided into two parts. The first included questions on the demographics of the sample (age and gender) and the second part included measures of the various factors identified in the literature from previous researches. Table 1 lists the questionnaire factors with their items, their operational definition, and the source from the literature review. In all cases, 7-point Likert scales were used to measure the variables.

4.4 Data Analysis

First, an analysis of reliability and dimensionality was carried out to check the validity of the scales used in the questionnaire. Regarding the reliability of the scales, Cronbach's α indicator was applied [7] and inter-item correlations statistics for the items of each variable were performed. According to Fornell & Larcker [9] and Hair et al. [12], Cronbach's α value greater than 0.60 for exploratory research indicates high reliability. In the next stage, the uni-dimensionality of the scales was evaluated, by carrying out a principal components analysis. The existence of uni-dimensionality is very important, since it allows calculating the average of the indicators that compose each construct. Consequently, it is possible to use a sole factor for representing each theoretical construct. Factorial analysis, with principal components and Varimax rotation, was carried out to test uni-dimensionality of our six scales. Afterwards, the differences of students' perceptions among ICT and Programming courses in each of the crucial factors it was examined using Mann–Whitney U-test.

5. RESEARCH FINDINGS

Fornell and Larcker [9] proposed three procedures to assess the convergent validity of any measure in a study: (1) composite reliability of each construct, (2) item reliability of the measure, and (3) the Average Variance Extracted (AVE).

First, we carried out an analysis of composite reliability and dimensionality to check the validity of the scale used in the questionnaire. Regarding the reliability of the scales, Cronbach`s α indicators was applied [7] and inter-item correlations statistics for the items of the variable. As Table 2 demonstrates, the result of the test revealed acceptable indices of internal consistency in all the factors.

In the next stage, we proceeded to evaluate the reliability of the measure. The reliability of an item was assessed by measuring its factor loading onto the underlying construct. Hair et al. [15] recommended a factor loading of 0.5 to be good indicator of validity at the item level. The factor analysis identified six distinct factors; 1) Performance Expectancy (PE), 2) Satisfaction (STF), 3) Self-Efficacy (SEF), 4) Social Influence (SI), 5) Perceived Behavioral Control (PBC) and 6) Behavioral Intention (BI) (Table 2).

The third step for assessing the convergent validity is the average variance extracted (AVE); AVE measures the overall amount of variance that is attributed to the construct in relation to the amount of variance attributable to measurement error. Convergent validity is found to be adequate when the average variance extracted is equal or exceeds 0.50 [21].

Table 2. Summary of measurement scales

Factors	Items	Mean	S.D.	CR	Loadings	AVE
Performance Expectancy (PE)	PE1	4.61	1.81	0.89	0.75	0.65
	PE2	4.48	1.74		0.80	
	PE3	4.76	1.63		0.85	
	PE4	4.83	1.51		0.81	
Satisfaction (STF)	STF1	5.21	1.40	0.88	0.63	0.56
	STF2	5.20	1.39		0.66	
	STF3	5.63	1.35		0.85	
	STF4	5.41	1.36		0.83	
Self-Efficacy (SEF)	SEF1	3.56	1.90	0.71	0.86	0.71
	SEF2	4.04	1.77		0.82	
Social Influence (SI)	SN1	4.32	1.93	0.86	0.79	0.65
	SN2	4.09	1.92		0.82	
Perceived Behavioral Control (PBC)	PBC1	5.01	1.44	0.86	0.85	0.69
	PBC2	4.78	1.49		0.81	
Behavioral Intention (BI)	BI1	4.63	1.91	0.93	0.83	0.78
	BI2	4.56	1.93		0.90	
	BI3	4.00	1.91		0.91	

At the time of the survey, the respondents had enough exposure to CS courses (both ICT and Programming). Respondents expressed high STF (5.36/7) with CS courses. Additionally, they expressed slightly lower PE (4.67/7) and PBC (4.40/7). High levels of these factors indicate positive views concerning students' experience, usability, control and usefulness regarding CS courses. Also, respondents expressed their positive intentions to attend CS courses in the future BI (4.40/7). However, students' belief for social influence SI (4.21/7) from their friends and relatives in CS and especially their self-efficacy SEF (3.80/7) with computing are not in such a high level.

To examine the research questions regarding the differences in students' perceptions among ICT and programming courses, we used a Mann–Whitney *U*-test [19] including the six factors as dependent variables and the course taught (Programming or ICT) as independent variable. The Mann–Whitney U test does not require normality of distribution nor homogeneity of variance for the two groups in the study. The Mann–Whitney U test was therefore used instead of the t-test because of its usefulness with small samples test and his appropriateness for situations of unequal sample sizes and unequal variances [14]. All statistical analyses reported in this research were conducted with a significant level of 0.05.

As we can see from the outcome data in Table 3, course taught have an impact on students' performance expectancy, satisfaction, social influence and intention to attend. On the other hand courses taught do not exhibit a significant difference on students' self-efficacy and perceived behavioral control.

Table 3. Testing the differences among ICT and Programming

Factors	Mean (S.D.)		Differences	Z	U	p	Results
	ICT	Progr.					
PE	5.14 (1.16)	4.10 (1.58)	1,04	- 3.90	1160	**.000**	S.D
STF	5.63 (0.92)	5.03 (1.39)	0,6	- 2.28	1490	**.023**	S.D
SI	4.72 (1.55)	3.54 (1.90)	1,18	- 3.49	1246	**.000**	S.D
PBC	5.11 (1.22)	4.61 (1.48)	0,5	- 1.72	1601	.081	I.D.
SEF	3.57 (1.46)	4.10 (1.66)	-0,53	- 1.84	1580	.065	I.D.
BI	4.73 (1.59)	3.94 (1.97)	0,79	- 2.23	1501	**.026**	S.D

at level of significance $p<0.05$; S.D., Significant Difference; I.D. insignificant Difference

6. CONCLUSION AND DISCUSSION

At the time of the survey, the students had enough exposure to each course, as the lessons starts at the middle of September. Both respondents' groups expressed high satisfaction in ICT and Programming course respectively. Additionally, they expressed slightly lower perceived behavioral control and performance expectancy. High levels of these factors indicate positive views concerning usability, control and usefulness regarding both courses. Also, respondents expressed their positive intentions to attend ICT courses in the future. However, students' belief in social influence from their friends and relatives in ICT is also ranges in high levels on the other hand their conviction to complete a task with ICT is not in such a high level.

Observing Figure 1, we notice that the scores of the ICT students are generally higher compared to the Programming students, except self-efficacy (SEF). This is the only factor indicating higher level at programming courses, although this difference is unfortunately not significant. Besides that we could summarize that ICT courses are more popular than programming courses. The most significant difference among the two courses is indicated in students' satisfaction (STF), this may be possibly based to the wide enrolment with ICT in the last few years. In addition PE, SI and BI, are also indicating significance difference among the two courses, this may be possible explained to the familiarity of ICT in students' daily life and the connection of ICT with entertaining processes. In addition, students have noted [3] that with informal learning, they were in control of what, how, and when they learned. When studying a difficult topic, they reported that the slower pace of informal learning was helpful. This possible explanation can shed a light into the high levels of ICT in many of our research factors. On the other hand, SEF and PBC does not indicate a significant difference. Hence, it seems that these factors ranged in the same levels in both courses.

Overall, figure 1 clearly exhibits several differences among students attitude regarding the two courses, so the common approach (of ICT and programming) in many countries may lead to ineffective teaching and confusing students perceive.

Overall, our study contributes to the literature in several ways. First, this study empirically measures students' perceptions and intentions for CSE. Additionally, this study identifies differences among ICT and Programming courses. The current study is one of the few so far, where a CSE empirical assessment is employed among students who attend ICT and Programming courses.

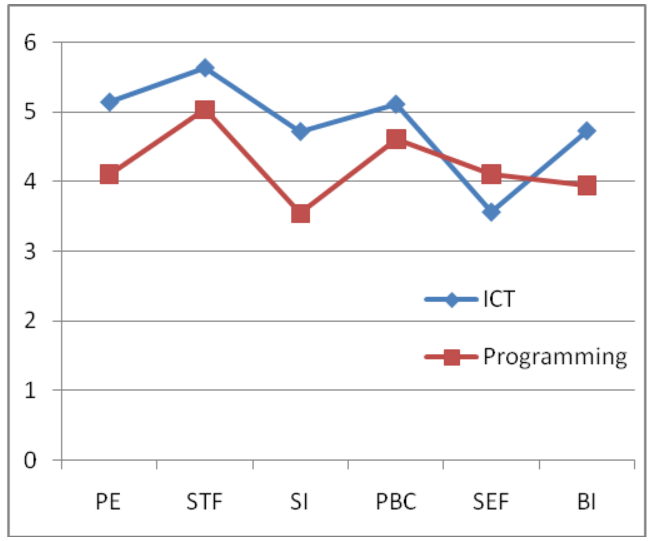

Figure 1. Average amount of each factor at each course, based on its items

Previous studies have shown that students' perceptions of what they have already learned affect their performance and what they choose to do next [20]. In view of the above students' performance and intentions to pursue programming and ICT courses is highly affected by their beliefs. As such, our findings have important implications for understanding how students perceive their learning and achievement in CSE. In addition, the results of the study allow us to argue that the enhancement of ICT in a Programming courses may benefit students' beliefs and change their attitude for programming.

As with any empirical study, there are some limitations. First, in this study the respondents are Greek students, who had attended the Greek educational system; this may limit the extend of the generalization of the findings. However, another study we have conducted among the secondary education students of Greece and Germany indicates that there is no significant difference on their perceptions regarding computer on these and many other factors [12]. Secondly, the data are based on self reported method, other methods such as depth interviews and observations could provide a complimentary picture of the findings through data triangulation. Thirdly, there are numerous factors affecting students' behavior, but this study focused on the specific factors raised from the literature as the most important ones. Last there is an age difference among the two groups (3years), this was made because we want each group to have the same exposure on the respective course, this age difference may have casual effect. However, we know from the literature that age do not impacts on students computers perceptions and anxiety [13]. In addition, Rosen and Maguire [23] reported that the results of 17 studies (8 of which were statistical) did not support the contention that age was a significant correlate of computer anxiety ([23], p. 181).

Future studies with larger sample from different countries (i.e., US, Norway) and educational systems' using wide variety of measures (i.e., observations, interviews) would valuable contribute on the understanding of students' attitude towards ICT and programming courses. In addition, we propose further work in examining the effect of these and probably additional factors on students' actual participation and performance in CS courses.

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