WHAT INFLUENCES STUDENTS TO STUDY INFORMATION AND COMMUNICATION TECHNOLOGY?

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Abstract

There is a high demand for qualified information and communication technology (ICT) practitioners in the European labor market. According to recent reports, ICT companies want to hire thousands of ICT specialists but are unable to find the talent. A problem at many universities is a high dropout rate among ICT students, especially during the first year. Therefore, educational research is needed to help universities and ICT companies develop activities to recruit and retain ICT students. To begin to understand the problem of dropouts, it is important to explore what has influenced first-year students to study ICT. Data were collected in the autumn of 2013 from 517 first-year students who started their studies in ICT-related curricula at the three main universities in Estonia where ICT is taught. During the first month of their studies, the students answered a questionnaire that contained multiple-choice and open-ended questions. The results showed surprisingly that a good salary in the ICT field is not a very important reason why students are interested in studying ICT. However, owning a personal computer at a young age had a very large influence on their curriculum choice. Reasons for choosing to work while simultaneously studying ICT at university were also investigated. Financial situation and work experience were the main reasons why students would choose to start working while studying. This study shows that the majority of first-year students are certain that they will finish their studies; however, about one-tenth of the students report a probability of finishing less than 60%. Longitudinal data are necessary to show if and how students’ motivation changes during their studies and how universities can prevent the problem of high dropout rates in ICT studies.

Keywords: ICT, higher education, recruitment, retention, dropout.

1 INTRODUCTION

The role of information and communication technology (ICT) has increased rapidly in recent years in all economic sectors, and the lack of labor with good ICT knowledge and skills is a worldwide problem. In the European Union, for example, the forecasts suggest that the unmet demand for ICT practitioners could rise by 2015 to between 372,000 and 864,000 and by 2020 to between 481,000 and 1,685,000 (according to different scenarios) [1]. In Estonia, the forecasts suggest that the number of higher education graduates needed is 4,200–5,600 (until the year 2020), while the supply remains at the level of 4,550 graduates [2]. It is important that compatibility between supply and demand is questionable for higher education across jobs. For example, 2,289–3,614 of additional employees are needed in software development: developers, test specialists, analysts, architects, and relevant field managers. As the total number of ICT professionals in Estonia is approximately ca 16,000 in 2013, the increase should be remarkable.

The main source for the ICT workforce is ICT graduates from universities. Looking at the developments over the years 2000–2010 shows that the number of ICT graduates trends to decrease throughout Europe after a peak of 127,000 ICT graduates left universities in 2006 [1]. In Estonia, the number of students of informatics and information technology recruited in Estonian higher education institutions increased ca 36% from 2007/2008 to 2012/2013 (from 927 to 1,262) [3]. The total number of ICT students and the level increased ca 31% from 2007/2008 to 2012/2013 (from 2,992 to 3,852). Unfortunately, quite a lot of students drop out before graduation. For example, every year (2008/2009–2011/2012), ca 11%–13% of the total number of students graduate, but ca 21%–23% of the total number of students discontinue their studies. Dropping out in ICT-related curricula is also a problem in other countries. For example, in the University of Illinois in the United States, about 25% of students drop out of the computer science program after the first year [4]. Further, at the Helsinki University of Technology in Finland, about 30%–50% of students drop out of the introductory computer programming class [5]. The average student dropout rate for computer science students in Europe is around 19% [1]. The recommendation is to reduce the rate of university dropouts in ICT studies by one-fifth from 19% to 15%.
In all disciplines, the risk of dropping out is the highest during the first year of studies [6]. A study that investigated ICT students in Croatia pointed out that first-year mathematics courses are obstacles for student retention [7]. Mathematics is also an important first-year course in the Estonian ICT curricula. However, the retention and graduation rates are higher for female students [8], who are the minority in ICT curricula [2]. In addition, academic preparation and college experience are important in predicting dropout: educational aspirations, first-year great point average, and academic and social integration are negatively associated with dropout [6]. In addition, a negative relationship was found between the amount of financial aid received and dropout [6]. In Estonia, ICT students are often offered higher scholarships than students in other fields, but it is not enough to prevent dropout. It is important for universities to consider all options to retain their students.

In Estonia, many ICT students start working while studying, and sometimes work is the reason they do not finish their studies. Still, people with higher education degrees are needed in the ICT sector— a study carried out in the United States (2000–2005) shows that the importance of a bachelor’s or higher degree in most ICT occupations has grown [9]. In addition, employees with higher education earn more within the same occupation [9]. So it is more beneficial when students finish their studies in ICT. Moreover, a study in the United Kingdom found that the majority of ICT employers do not have a degree in ICT-related subjects. The most common degree subjects were math or computing, engineering and technology, physical sciences, and business studies [10].

The ICT field is rapidly developing, and it is widely used in everyday life. Most of the students who enter university have integrated computers in their life since an early age [11]. In addition, students who enter higher education have more confidence in using technology than generations before them [12]. This may be because previous generations used computers mainly in employment, but today’s generation uses computers as part of social life [12]. One reason for dropping out may be that students use ICT every day and think that they have very good knowledge in ICT, but when they start studying it, it becomes more difficult than they thought.

Students should be motivated to study when they enter university. Motivation is important in academic achievement—higher motivation leads to higher academic achievement [13]. Students enter higher education for many reasons. It is possible to differentiate academic and personal intrinsic and extrinsic learning orientations [14]. Students with academic extrinsic orientation are interested in progression through the educational system, and students with academic intrinsic orientation are interested in studying a particular subject in their own way [14]. Students with personal intrinsic orientation are interested in improving themselves as individuals, but students with personal extrinsic orientation are undergoing the course to test their own capacity [14]. It has been found that if a female goes to study ICT, it is mainly because of extrinsic reason rather than personal interest [15]. Motivation is important in finishing studies; this is why we need to find out what motivated first-year students to start their studies in ICT. This information helps to recruit and retain students. A study conducted in Croatia found three motivation groups for entering university to study ICT: employment opportunities, social factors, and curriculum attractiveness [7]. It is interesting to know if Estonian ICT students have similar motivators.

Because dropping out is very important and also a very complex problem, we should better know our students to provide them adequate support. One important issue is to understand the reasons why a student comes to study in the ICT-related curriculum. Knowing the factors of decision making as well as anticipations gives us better opportunities to improve recruitment and also the curricula. The background, factors of decision making, and anticipations could differ in cases of different students. One possible reason of dropout could be the entrance to the labor market before graduation. This issue is under somewhat closer examination in the current paper. Two research questions formulated in this study are the following: (1) What are the reasons why students are interested to study ICT? (2) What are the reasons why ICT students start working while studying?

2 METHODS

Data for the study were collected in the fall of 2013 from 517 first-year students who started their studies in ICT-related curricula in three universities and from eight different curricula: Computer Science and Computer Engineering curricula at the University of Tartu (UT); Computer and Systems Engineering and Business Information Technology and Informatics at the Tallinn University of Technology (TUT); and IT Systems Administration, IT Systems Development, and Information System Analysis at the Estonian Information Technology College (EITC). Together, these three higher education institutions graduate the vast majority of bachelor’s and master’s students in ICT in Estonia.
Of the students, 25% were women. Most of the students were 18–19 years old (66%). This is the age when students usually finish secondary school. Of the students, 34% were 20 years or older—this means that they did not start their studies in ICT immediately after finishing secondary school. Moreover, 7.4% of the students were at least 25 years old, which indicates that many of them started their ICT studies after some other studies or when they have been employed.

During the first month of their studies, students filled in a questionnaire that contained multiple-choice and open-ended questions. The questions were about the factors that influenced them to study ICT, working experiences in ICT, interest and knowledge about the curricula, and opinions about finishing their studies and starting work while studying. A coding schema of categories was inductively developed based on the data of every open-ended question. To develop the coding schema, two raters specified the categories until it was possible to reach 80% of accuracy between two persons. Then two researchers carried out the data analysis following the developed coding schema, and 10% of randomly selected answers were independently analyzed by a second researcher to test for interrater reliability. This resulted in a score of higher than 0.8 (Cohen’s kappa) in the case of all answers to open-ended questions.

Eleven categories were identified from the answers to the question “What was the ‘breaking point’ that caused interest in ICT?” The categories are shown in Table 1 in the Results section. Six categories were identified from the answers to the question “Was the ‘breaking point’ also the reason why they chose this curriculum? If NO, then why?” The categories are shown in Table 2. Six categories were identified from the answers to the question “Under what conditions you should start working during studies?” The categories were (1) financial situation, (2) work experience, (3) having a suitable job, (4) having enough time after school, (5) I will not work under any condition, and (6) other reasons. Five categories were identified from the answers to the question “How many of your friends work in the ICT field?”: (1) none of the friends work in ICT field, (2) 1 to 5 friends work in ICT field, (3) 6 to 10 friends work in ICT field, (4) 11 to 20 friends work in ICT field, and (5) more than 20 friends work in ICT field.

When students were asked about probabilities (e.g., probability of finishing studies, working while studying), then the answers were divided into five categories: (1) 0%–19%, (2) 20%–39%, (3) 40%–59%, (4) 60%–79%, and (5) 80%–100%. For the question “How large is your interest in ICT?” a five-level Likert scale was given: (1) very small, (2) small, (3) medium, (4) large, and (5) very large. For the question “How informed are you about job opportunities in the ICT field?” the five levels were: (1) very poorly, (2) poorly, (3) fairly, (4) well, and (5) very well. For the question “How informed are students about the curriculum they are studying?” the four levels were the following: (1) I do not know much more other than the title, (2) I know generally what the curriculum offers for learning, (3) I know what knowledge and skills I should acquire from finishing these studies, and (4) I know exactly what subjects are in the curriculum and what knowledge and skills I should acquire after completing the curriculum.

Answers from the questionnaire gave discrete quantitative data that can be analyzed to see if there are any differences between observed and expected data. Main issues that were investigated included age, sex, curriculum-related information, and employment. Taking into account the mentioned issues and observing data relations between other data collected with the questionnaire gave enough information to see if there are any interesting factors that can affect the results.

A chi-square test was used to monitor if the deviations were the result of chance or if they were due to other factors mentioned before. The chi-square test is testing the null hypothesis, which states that there is no significant difference between the expected and observed result. The relative standard commonly used in research is \( p < 0.05 \). In this case, using \( p < 0.05 \), you would expect any deviation to be due to chance alone 5% of the time or less. In this study, the chi-square test was used to see if there are any data that are affected by the fact that students are employed. Using the test and calling the null hypothesis, which states that there is no significant difference between the first-year students who work in the ICT sector and first-year students who do not work in ICT sector, the following factors were tested, and the results were evaluated: interest in ICT, expectations to the curricula, knowledge about the opportunities the curricula offer, knowledge about the opportunities that the ICT sector offers, probability of finishing the curricula, having friends who have studied ICT, having friends who work in the ICT sector, and starting time of having deeper interest in ICT.
3 RESULTS AND DISCUSSION

3.1 Reasons to study ICT

There have been many nationally financed activities that focus on increasing the number of students in the ICT curricula in universities. One among others is the union of ICT companies, which is organizing school visits and competitions for pupils. One of the main arguments for working in the field of ICT they forward is higher salary than average and therefore better quality of life. There has not been known quantitative evaluations of the activities held so far. So it is not known if the investments have been effective. ICT companies are interested in getting more labor and universities in getting more ICT students. The results showed surprisingly that a good salary in the ICT field is not a very important reason why students are interested in studying ICT (only 2% of students pointed it out). The answer to the question “What was the ‘breaking point’ that caused interest in ICT?” was open-ended because there was no expectation toward the results. Eleven categories were identified. Categories and results are shown in Table 1.

Table 1. Results of question “What was the ‘breaking point’ that caused interest in ICT?”.

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>First computer, experience of doing something by myself: solving computer-related problems (helping others), building a computer, software developing or trying to make a computer game, web page design</td>
<td>36%</td>
</tr>
<tr>
<td>Computer lessons in school or participation in some other course or competition</td>
<td>9%</td>
</tr>
<tr>
<td>Family member or friend works in the ICT field and recommended the field or was a role model</td>
<td>9%</td>
</tr>
<tr>
<td>Everyday work related to or other contact with ICT</td>
<td>7%</td>
</tr>
<tr>
<td>Computer games</td>
<td>6%</td>
</tr>
<tr>
<td>The field in general is important/promising right now and for the future</td>
<td>5%</td>
</tr>
<tr>
<td>No direct “breaking point,” interest came with time or has been there all along</td>
<td>5%</td>
</tr>
<tr>
<td>Interest in mathematics</td>
<td>4%</td>
</tr>
<tr>
<td>I like it, it is suitable, I can manage it very well, I want to commit myself to this field emotional point of view)</td>
<td>3%</td>
</tr>
<tr>
<td>Later, it is possible to earn a good salary</td>
<td>2%</td>
</tr>
<tr>
<td>Other: I had to make a decision, media, relating hobby to ICT</td>
<td>14%</td>
</tr>
</tbody>
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From Table 1, it can be concluded that students most value computers and hands-on experience. The authors wanted to distinguish clearly the school and home environment, as activities in school are more compulsory than at home. Doing a programming in school might affect pupils differently from the home environment. Although 9% of pupils also remarked activities in the school environment as “breaking points” for interest toward ICT, it is not known how many pupils from the first category had their first experience with computers in school. So it can be hypothesized that ICT lessons should be made available and perhaps compulsory for all pupils in school. The effect of this intervention should be evaluated in further studies. However, it seems that it has a bigger effect on the students’ opinion of computers than lectures by ICT motivational speakers. It was also important to find out the point in a pupil’s life when he/she decided to study ICT. Roughly 55% of the pupils made the decision in high school and 35% after high school. This complies with the time of having their first computer, programming lessons, and other activities in school.

It was suspected that the breaking point might not be the reason for studying ICT. Half of the students answered that this breaking point was not enough for them to make a decision to start studying on a specific curriculum. The next question was “Was the ‘breaking point’ also the reason why they chose this curriculum? If NO, then why?” Six categories were distinguished, and the results are shown in Table 2.
Table 2. Results of the question “Was the ‘breaking point’ also the reason why they chose this curriculum? If NO, then why?”.

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>Curriculum was suitable in personal perspective, develops me, and challenges me</td>
<td>40%</td>
</tr>
<tr>
<td>Interested in ICT or ICT-related field</td>
<td>17%</td>
</tr>
<tr>
<td>Good job, wide range of job opportunities (good salary, interesting, suitable), promising future, lots of ICT-related opportunities</td>
<td>16%</td>
</tr>
<tr>
<td>Someone recommended</td>
<td>5%</td>
</tr>
<tr>
<td>I like ICT or ICT-related field</td>
<td>3%</td>
</tr>
<tr>
<td>Other</td>
<td>19%</td>
</tr>
</tbody>
</table>

These categories include the motivations for entering university to study ICT that were found in another study: employment opportunities, social factors, and curriculum attractiveness [7]. Employment opportunities are in the third category, social factors in the fourth category, and curriculum attractiveness in the first category in Table 2.

Having interest toward ICT does not necessarily mean that students choose ICT-related curricula. They need to have additional personally important reasons for choosing ICT. From the answers, it seems that students do some groundwork and make decisions on personal perspective, for example, how attractive a curriculum seems to be. On the other hand, only a few students answered that they know everything about the curriculum. It might be concluded that students read short introductions about the curricula and that their decision is based on that. From the universities’ point of view, it can be summarized that curricula should be attractive and forward the most important information to student candidates. Few students are motivated enough to seek more information about the curriculum. Most of them feel satisfied with the short description about the curriculum.

3.2 Reasons to work while studying

The data of our study indicate that 8% of the first-year students already work in the ICT sector. Moreover, 14% of the first-year students already have had a prior work experience in the ICT field. Reasons for choosing to work simultaneously while studying ICT at the university were investigated as well. The most important reason why students choose to start working while studying was their financial situation (42%). It is possible for students in ICT-related curricula in the University of Tartu and Tallinn University of Technology to get higher scholarships than in other curricula at the same study level in Estonia. However, it is not enough to pay for all living costs, and many students pointed out that if they lose their parents’ financial support, then they have to start working. Financial situation was followed by work experience (28%), which is important in the labor market, and people with more experience are more likely hired. The other reasons for working were having the suitable job (12%), having enough time after school (9%), and other reasons (6%). In addition, 3% of the students answered that they will not start working while studying under any condition. This study shows that almost all students are open for employment challenges and that universities cannot expect that students will make a choice between working and studying. There is a need to study the effective strategies of coping with both responsibilities and then to support students who might need help in order to finish their studies while being employed.

When students not working in the ICT sector were asked to evaluate the probability that they start working in the ICT sector while studying, answers varied a lot (Fig. 1). Of the nonworking students, 14.9% answered that the probability is from 80% to 100%; 26.7% of the students answered that the probability is from 60% to 79%; 35.6% of the students answered that the probability is from 40% to 59%; 12.9% of the students answered that the probability is from 20% to 39%; and 9.9% of the students answered that the probability is from 0% to 19%. This shows that at the beginning of their studies, students already consider working. The mean of probability of going to work is around 57.7%. This means that they are not certain about working while studying, but they consider it.
The results show that the majority of first-year students were certain that they will finish their studies. Of the students, 59.9% answered that the probability of finishing is 80% or more, and only 1.1% of the students answered that the probability is less than 40% (see Fig. 2.). According to the chi-square test, working is not a factor that is statistically significantly associated with the opinion about the probability of finishing studies ($p = 0.63$). Still, a considerable number of students think that the probability that they finish is not high. Forty-eight students (9.3%) think that the probability is 60% or less. Further investigation is needed to find out why these students started their studies if they were not certain about finishing their studies.

To see if there are any data that are affected by the fact that students work, the chi-square test was used. Some of the factors were found to have smaller probability of being a factor of making a difference between the working and the nonworking students (have a probability greater than 0.05). Those were expectations to curricula ($p = 0.98$), probability of finishing the curricula ($p = 0.63$), having friends who have studied ICT ($p = 0.64$), and when was the time they started to have an interest in ICT ($p = 0.16$), which means that those factors do not make enough of a difference between employed and nonemployed students (only employment in the ICT field was considered). However, there were some significant difference-making factors between students who work in ICT-sector and those who do not.
Evaluating the factor of having interest in ICT ($p < 0.05$), a much higher interest in ICT is among students who already work (see Fig. 3). Employed first-year students had a mean of 4.49, and nonemployed students had a mean of 4.15. More working students answered that their interest is very large, and more nonworking students answered that their interest is just large. This means that working in the ICT field and doing something practical in ICT may cause greater interest in ICT. There were few nonworking students who answered that the interest is small, but none of the students thought that their interest in ICT is very small. So none of the students studied ICT if they were not interested in it.

![Figure 3. Interest in ICT in the case of working and nonworking students.](image)

There were several differences when comparing employed and nonemployed students and their knowledge about the opportunities that university curricula ($p = 0.03$) and the ICT sector ($p = 0.0002$) offer (see Fig. 4). Employed students thought that they were more aware of the curricula (mean = 2.97) than nonworking students (mean = 2.59). Similarly, working students thought that they were more aware of the employment opportunities that the ICT sector offers (mean = 3.77) than nonworking students (mean = 3.20). This seems expectable because when a student already works, then he/she has more contact with opportunities in the ICT field. And when someone who works is interested to go to a university to study in the same field, then he/she will probably discover more about the curricula where he/she is interested to study. Students with no experience in ICT may decide more often only based on the name or short description of the curricula, without having a very good understanding what the curriculum offers. This may cause dropouts if the students find that they are not studying what they thought they were studying during the first year.

One factor that may influence students’ behavior in the university is their friends. The study shows that students working in the ICT sector had more friends in the ICT sector (mean = 1.6) than students not working in the ICT sector (mean = 0.85). This is understandable because students who work in the ICT field meet more people who also work in the ICT field every day. Further investigation will show if the number of friends in the ICT field somehow influences dropping out or finishing studies.

There was also a minor difference in opinion if students work after their studies ($p = 0.015$). Most of the working students remarked that the probability of working after school is rather high (mean = 90.7%), and nonworking students answered similarly (mean = 87.1%). A slightly higher probability may be due to the experience of working in the ICT field that working students have.

When considering age as a factor, the students were grouped into two age categories: students who are 18–19 years old and those who are 20 years or older. The reason is that people finishing high school in Estonia are 18–19 years old. Comparing the results with the working factor in the ICT sector with the chi-square test, the probability of having age as a factor is 0.002 ($< 0.01$), which means that older students had a higher probability of working in the ICT sector than younger students (see Fig. 8). Of the students aged 18 to 19 years, 5% were working in the field, and 13% of first-year students who are 20 years and older were working in the field.
Comparing the perception of probability to finish school, 83% of the 18- to 19-year-old students evaluated that the probability of finishing their studies is more than 80% (see Fig. 5). It seems that older students (20+) were a bit more pessimistic about finishing their studies (68% evaluated that finishing their studies is more than 80%), but the means in both groups are rather similar: 18- to 19-year-old students have a mean of 84.5%, and those 20+ have a mean of 84.8%. It might be due to the fact that older students have studied before and are more aware about their abilities and the direction in their career choices. There were also some students who thought that the probability that they finish their studies is quite small. It would be interesting to investigate those students to find out why they start their studies even if they believe that their probably to finish is quite low.

In addition, there was a difference when comparing older and younger students who do not work in the ICT sector and their evaluation of the probability of being employed while studying (see Fig. 5). Students who were 18 to 19 years old answered with the mean of 55.8% and those 20+ years old with the mean of 62.0% that working while studying is probable. This finding could be explained by the higher occupational and family responsibilities of older students that have been found in the case of doctoral students in education [16]. It means that the older students are probably more reserved in their perceptions about finishing their studies while they understand that learning is not their only responsibility and that their family life needs a job that also takes time and decreases the probability of graduation.
Finally, it was assumed that male and female students could act differently in studying ICT, and in this case, there would be a need to find how to support them accordingly. In our population, the ratio of female students was 25%. It has been shown before that the graduation rates are higher for female students than for male students [8]. However, in our study, no significant difference was found in the ages of men and women ($p = 0.72$) starting to study ICT and whether they are working or not ($p = 0.70$). Male and female students coping with different responsibilities while studying could be an interesting research topic for further studies.

4 CONCLUSION

Recruiting and retaining ICT students is an important issue. Knowing the factors that influence students to study ICT helps to improve recruitment. Another problem under investigation is dropout. One possible reason for dropout is working while simultaneously studying. In our study, 517 first-year ICT students answered questions about the reasons why they came to study this curriculum and what they think about working while studying.

Results show that the most popular reasons for studying ICT are owning a personal computer at a young age, having computer lessons in school, and having a family member or friend recommend the field or if there was a role model available for the person. Interestingly, a good salary in the ICT field is not a very important reason to study ICT.

The majority of students were certain that they will finish their studies. Of the first-year students, 8% were already working in the ICT field. However, the main reasons why they work while studying were financial situations and work experiences. However, interestingly, there were already, in the beginning of their studies, many students who doubted in their graduation.

Some differences were found between the employed and the nonemployed students. Working students have a perception with a mean of 90% that they would start working while studying, while the mean is 57.7% among nonworking students. In addition, older students are a bit more pessimistic about finishing their studies and are more interested in working while studying.

However, longitudinal data are necessary to show if and how a student’s motivation changes during his or her studies and what kind of groups can be differentiated during studies. Based on more information, it is possible to make recommendations on how universities can prevent the problem of high dropout rates in ICT studies.

The problem with the choice of ICT curriculum remains. From these data, it is possible to evaluate students’ perceptions, but not how much these reflect the real situation. Whether a motivating description of curricula is also in place when students discover that ICT is not something they want to continue learning, although it seemed that way in the beginning. These questions can be answered through further longitudinal studies of these first-year students.
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