

Why Students Drop Out CS1 Course?

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ABSTRACT

This study focuses on CS minor students' decisions to drop out from the CS1 course. The high level of drop out percentage has been a problem at Helsinki University of Technology for many years. This course has yearly enrolment of 500-600 students and the drop out percentage has varied from 30-50 percents.

Since we did not have clear picture of drop out reasons we conducted a qualitative interview research in which 18 dropouts from the CS1 course were interviewed. The reasons of drop out were categorized and, in addition, each case was investigated individually. This procedure enabled us to both list the reasons and to reveal the cumulative nature of drop out reasons.

The results indicate that several reasons affect students' decision to quit the CS1 course. The most frequent reasons were the lack of time and the lack of motivation. However, both of these reasons were in turn affected by factors, such as the perceived difficulty of the course, general difficulties with time managing and planning studies, or the decision to prefer something else. Furthermore, low comfort level and plagiarism played a role in drop out. In addition, drop out reasons cumulated.

This study shows that the complexity and large variety of factors involved in students' decision to drop the course. This indicates that simple actions to improve teaching or organization on a CS1 course to reduce drop out may be ineffective. Efficient intervention to the problem apparently requires a combination of many different actions that take into consideration the versatile nature of reasons involved in drop out.

Categories and Subject Descriptors

K.3.0 [General]; K.3.2 [Computer and Information Science Education]: Computer science education

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General Terms

Human Factors

Keywords

CS1, drop out reasons, non-major CS students

1. INTRODUCTION

Programming is in the heart of computer science, and therefore most CS programs globally start with an introductory programming course. However, regardless of the recognized importance of learning programming, the results are often disappointing. Several multi-institutional studies [19, 16, 23] have indicated that there are serious deficiencies in the learning outcomes of students who have passed one or several programming courses in CS programs. These problems obviously originate from misconceptions on early studies. Poor understanding of basic concepts, procedures and processes is a poor basis for advanced studies.

Another consequence of poor learning results is high drop out rate on introductory courses. Many institutes report drop out rates of 20-40 percents, or even higher, of students on their introductory programming courses. For example, at Helsinki University of Technology (HUT), dropping rates in introductory courses for CS minors have been around 30-50 percents, even though for most such students the course is compulsory. In practice, this means huge loss of resources both for students, who need to solve the assignments again next year, and for teachers, who need to check the work of students who do not pass the course.

The research described in this paper is a part of a larger research project at Helsinki University of Technology that concerns with studying programming. We aim at answering two questions: Why do students decide to drop out the CS1 course and how do drop out reasons cumulate.

The main target group of the research is CS minors. There are two introductory courses in Java directed to them. The fall course has typically around 300-400 students and the spring course about 500-600 students yearly. This means that dropouts are counted in hundreds.

From teachers' experience we are aware of that the reasons behind dropping out are manifold. Many of them are related to learning programming, but there are other important factors, as well. For example, students' preferences in their studies, general studying motivation, being isolated from fellow students, and poor studying skills have their role here. Dropping the course is the ultimate realization of several difficulties a student faces when studying. The problem

with such anecdotal information is, however, that teachers do not gather information systematically, and mostly see only the top of the problems. On such large courses it is extremely rare that a teacher could follow the progress of a single student carefully during the whole course. Moreover, teachers naturally concentrate on problems related to learning the topic, and may overlook other factors involved. Therefore their actions to improve the course may be inefficient, if they tackle only a part of the problems and obstacles students face on the course. To design efficient actions we need a good overall figure of the problem field.

In this research we aim at enlightening and describing the variety of drop out reasons among CS minors at HUT. To achieve this we chose a two-phased approach. First, a questionnaire was submitted to students, who dropped the course in spring semester 2005. In the questionnaire we asked about their opinions on the course and the reasons behind their decision to drop the course. Second, this information was used to design an interview for a smaller number of students, where we wished to dig deeper into the actual reasons for dropping the course. Our approach was qualitative, because the main goal was to get a better understanding of factors involved in dropping the course. Later on, we aim to continue the research by charting the significance of each factor using statistical methods.

The interviewer was a researcher that had nothing to do with arranging the course. All results were processed anonymously. Thus, the interviewed students were free to present their thoughts and feelings about the course without a fear the their opinions might affect their future studies.

The paper is structured, as follows. We present first previous research on dropouts followed by an analysis of known / suspected factors affecting the decision to drop out. Next we present the research target course, the subjects and the methods used in detail. Thereafter the results are given and discussed.

2. PREVIOUS RESEARCH ON DROP-OUTS

Student attrition has been discussed greatly over the years. There are many studies concerning students' drop out and some research on what makes a successful student.

There have been several studies on students' drop out at university-level education. Xenos et al. [20] did a survey on Open University students at a four year Informatics course. In this study they identified five categories for drop out reasons: Professional (62,1% of respondents mentioned this), academic (46,%), family (17,8%), health-related (9,5%), and personal (8,9%). Students were able to give more than one reason for dropping out. Academic reasons included reasons such as student did not feel confident that he/she would be qualified enough to pursue university-level studies and lack of assistance from the tutor's part.

Bennet's [4] thorough study on determinants of drop out rates on business studies departments reveals the multiplicity of the phenomenon. The study reveals several issues that impact stay/quit decision such as financial hardship, personal problems, commitment, satisfaction, the extent of personal investment, self-esteem, academic performance, motivation, and stress. To make the picture even more complex many aforementioned issues are connected with each other. Bennet's data reveals that financial problems alone or connected with low self-esteem or academic performance had the strongest influence on quit decision.

On the other hand there is some research on drop out's flip side succeeding which might help us to see drop out reasons in broader perspective. Boyle et al. [5] have studied what makes CS students to succeed in their studies. They conclude that neither university entry score, school-level success, nor prior maths qualification, and prior computing qualification had any correlation with students' final year grades. This disproves the common conception of mathematics qualification being able to predict the success in CS. Boyle et al. conclude that success is not connected to previously mentioned factors but that they have more to do with other factors such as attitude, students' expectations and their experience of the type of educational methods universities apply.

Ventura's [22] results second Boyle's et al. [5] results. He concludes in his study that prior programming experience and mathematics did not predict success for object-first CS1 course. Instead, his results show that students' comfort level predicted among other things students' overall success at the course. Cantwell Wilson [27] arrived to similar result concluding that the comfort level in the computer science class was the best predictor of success.

Student's comfort level, confidence and self-esteem could be seen as different sides of the same coin. Could it be that different researchers initially talk about the same thing? Confidence and self-esteem seem to be very closely related with each other. These two again could be seen as prerequisite to comfort level. After all, it is hard to imagine a student that has low self-esteem and no confidence on his/her abilities and still feels very comfortable on a course.

The question emerges; what affects students' comfort level. Barker and Garvin-Doxas [1, 9] have studied learning environments. They conclude that the climate in computer science classrooms is defensive, impersonal, guarded, and competitive. It is not hard to imagine that this kind of environment could have a negative impact on students' comfort level.

3. FURTHER INVESTIGATION ON FACTORS AFFECTING DROP OUT

Studies in the previous section mentioned lack of motivation, commitment, and confidence as issues that affect drop out and therefore also success factors at higher education. Next we will look at these and related issues more closely.

3.1 Motivation and persistence

Motivation is often taken as a contributing factor to dropping out. It is the impression that researchers / teachers share either implicitly or based on their research [4, 21, 8, 11].

It is intriguing to notice how wide-ranging issue motivation is. For example, Oxford English Dictionary defines motivation as "The (conscious or unconscious) stimulus for action towards a desired goal, especially as resulting from psychological or social factors; the factors giving purpose or direction to human or animal behaviour." This definition leaves open the causes of behaviour. However, there are several motivation theories that propose different causes of behaviour such as intentions to reach a goal, expectations of maximum payoff, past reinforcement histories and a desire for fairness [21]. Regulation of motivation is even more interesting line of research. After all, the voluntary regulation

of motivation plays a salient role especially in self-regulated learning and achievement [29].

Individual variety of life situations, the capability, and willingness to cope with demanding situations brings another dimension to motivation. Winn's [28] study demonstrates the versatility of responses people have to the same situation (academic task). She found in her study three types of students: First, the ones that had demanding family or employment commitments and were regardless of this able to take the amount of study expected for a full-time degree student. Second, the ones with extensive responsibilities to family and little time for studying. Third, the students that had few other than study relating commitments but nevertheless spend little time studying.

3.2 Social aspect

There is strong evidence that social factors play a part in learning process. The theory of learning communities [15, 26], the theory of social constructivism [25, 10], and experiential learning theories [7, 14] all stress the social factor of learning process. There are studies concerning the applicability of the idea of learning communities in computer science [2, 3]. It has been shown that learning communities provide students some aspects that are helpful considering the learning process as a whole. Tinto[24] concludes that participation in a collaborative learning group enables students to develop a network of support. This is very important in many levels since a network helps a student to bond to the broader social communities. Therefore, the community of classroom-based peers (network of support) encourages student's attendance and class participation. Learning communities also gives students the possibility to meet both social and academic needs at the same time. Tinto et al. (in [24]) stress that social affiliations serve as a vehicle through which academic involvement is engaged. The authors of this paper second the value of network of support. Especially, students experience the support provided by peers very important and helpful in both factual and social wise. [13]

Tinto[24] continues arguing that both social and academic involvement influence persistence. Traditionally institutions stress the importance of academic involvement. Considering the demands set on institutions when they confront extensive masses of students it is no wonder that academic involvement is minimized. Voluntary mass lectures and passing the course by taking an exam is a good example of minimized involvement. However, Tinto stresses that academic satisfaction is not enough for some students but that they suffer from social isolation. On the other hand, sufficient social involvement can counterbalance the lack of academic involvement. The social involvement is especially important at the first year of studying. After that academic issues become more and more important.

3.3 Transformation from high school to university

There are many differences between required study skills when studying at the high school level and studying at a university. There have been studies [6, 18] addressing the problems first year students confront when entering higher education. There might be conflicts concerning students' expectations (of life in university, subjects that are studied, and teaching style to name a few), and required study skills including self-regulated learning and managing exten-

sive units of information. To complicate the picture we have to remember that the majority of first year students are facing, for the first time in their life, demands of independent living. Confronting all these new requirements at the same time can be overwhelming for some students.

3.4 Cultural issues

In addition to general issues described above there are some issues related to studying culture at HUT that can have an impact on students' decisions at HUT. Some of them may differ considerably from studying cultures at other institutes in other countries.

Computing courses in degree programs

Helsinki University of Technology is the largest technical university in Finland with yearly enrolment of about 1300 new students. It offers a wide variety of degree programs in technical sciences including, for example, electrical engineering, computer science and engineering, forest engineering, chemistry, technical physics, machine engineering and civil engineering. All degree programs except the program of Architecture require one or more compulsory computing courses. The program of Computer Science and Engineering (from here on CS majors) naturally has the most requirements, including several programming courses. For a few other programs one or two compulsory programming course(s) is required. However, for the rest of the programs students can either choose an introductory programming course or a combination of two practical courses (overview of computing applications in technology and a computing tools course). In practice, most students take the programming course, and many also take voluntarily either or both of the practical courses. The number of students enrolling the three parallel introductory programming courses is about 1000 to 1100 yearly including about 150 CS majors.

Entering the university

Students are admitted to HUT based on numerus clausus. There are two different selection methods. A number of students are selected based on their matriculation examination and final degrees from their secondary education courses. The majority of students, however, take part in an entrance examination including exams in mathematics and physics (or chemistry) and their admittance is decided based on their success in the examination. The combination of these methods has also been used. Students have to identify at least one-degree program in their entrance application form. If they do not get enough points for being accepted in their primary choice, but pass the limit of some other program they have applied for, they are accepted to study in the other one.

Anecdotal evidence suggests that these factors have some effect on study motivation. First, some students who have been selected based on papers only may have used this as a safe option to get a position in a university. Their primary interest may be to study some other field of science, for example, medicine or law. But since competition to get a position in those fields is much harder than to get a position at HUT, they may use their first or second year of studies to prepare also for the next entrance examination on those fields.

Second, students who have not succeeded to enter their favourite field of technology, may similarly aim at the next year entrance examination at HUT, and thus concentrate

on those courses that aid them to achieve better success in the examination. Unfortunately there is no research that has identified how common these behaviours are, but the general experience is that they concern rather small minority of students.

Financial factors

Some general factors related to studying in Finland are also relevant background information for this research. First, studying at Finnish universities is free of charge. The state pays some funding for students to cover life costs. This funding is limited to 55 studying months, which pushes students to graduate within this time. However, at the capital area the funding is typically not enough to pay rents and living, and therefore many students work part time to earn more money. At the later phase of studies most students of technology work part-time or full time at the industry. For example, most MSc theses projects are carried out in companies with regular salary. As a consequence, for most students of technology getting funding for living is a not a factor seriously pushing them to work hard to pass courses.

Second, the educational system does not set any strict limit for the duration of studies in a university. Recently the rules have been changed to limit the overall studying time to 7 years (with two more years possible based on application), but they do not concern students who started their studies before 2005.

Third, at HUT there are typically no practical consequences for dropping a course except that all assignments have to be redone next time. Thus, the university itself does not push students hard to pass courses.

The above-mentioned factors create a studying culture where dropping a course is not such a serious matter as in universities in some other countries. However, most students, of course, aim at completing their studies in 5-6 years to get a good start for their career.

4. TARGET CS1 COURSE

The target course is an introductory course in programming in Java, organized in Spring 2005. The extent of the course is 5 study weeks (8 ECTS units), corresponding to about 200 hours of work totally. No previous knowledge of programming is required.

The course is organized, as follows. There are about 50 hours of lectures that cover most basic Java concepts (variables, types, objects, classes, program control, basic I/O, basic graphical user interfaces in Java, exceptions, interfaces, samples of Java collections). In addition, there are weekly closed labs where students can solve exercises and get help from tutoring assistants (typically 2nd-4th year students).

To pass the course the student has to pass 10 rounds of weekly exercises each with 3-4 simple programming exercises, carry out a personal programming project, where a larger program (some 300-500 LOC, even more) is implemented, and take a written examination. The weekly exercises are graded automatically, and immediate feedback on the submissions is given. After examining the feedback the student is allowed to resubmit the solution several times. Achieving 50% of the maximum points is enough to pass the exercise part of the course, but gaining more points will improve the final grade of the course. The programming project and the examination are graded manually, and they all affect the final grade.

The course has been organized yearly in this format since 1999, with only modifications to the requirements. Weekly exercises are mostly new each year to avoid plagiarism from the model solutions of the previous year. Plagiarism among course participants is observed each year, but the control actions have kept it only as a minor problem. To avoid plagiarism in the programming project each student has to submit the project work to the assistant personally, thus allowing the assistant to assess the working demonstration of the program and to ask questions about the code.

The course has about 500-600 students yearly, the largest groups coming from degree programs of electrical engineering, machine engineering and civil engineering. Compared to the parallel course in the fall, the target course is slightly easier but the difference is not big.

The drop out rate has varied between 30 and 50 percents yearly, when drop-outs are counted from the students who actually submitted at least something in the weekly exercises. Typically more than 50 students drop the course immediately after registration, probably due to deciding not to take it after getting more information what is required to pass the course. This group is not interesting from our perspective.

We have observed that dropping the course seems to take place in each phase of the course. However, the most important points are during the three first exercise rounds, and at the project phase. About 20% of students who pass the weekly exercises drop the course during the project phase.

5. RESEARCH QUESTIONS AND METHOD

In this study we aim to get more information about why so many students at HUT decide to drop the CS1 course.

Due to the somewhat unique educational system compared with many other countries (see Section 3.4) we can not be sure whether the results gained from other studies can be transformed as such to our university. Besides, each country and university probably has at least some cultural related features that might bias the results.

The course personnel is one obvious source of information that we have used. Teachers have experience-based knowledge about what students find hard to learn or why some of them decide to drop out the CS1 course. However, their knowledge is biased since there are 500-600 students at the course and therefore it is impossible for a teacher to get to know individual students and their motives to drop out. This leaves course staff with general feeling of drop out reasons based on assumptions with little actual evidence that we could use. Moreover, the assumptions are somewhat inaccurate and probably reveal only the top of the iceberg.

These aforementioned reasons encouraged us to carry out our own research. We chose to use qualitative research approach because it enables us to reveal possible hidden issues that would not unfold if using quantitative research approach. Our research questions are as follows:

1. Why do students decide to drop the CS1 course?
2. How do drop out reasons cumulate?

Even though we shall analyze only students on the specific course, we believe that the results largely hold for other introductory and intermediate programming courses, as well. The method described below also allows us to easily identify problems that are course specific.

5.1 Procedure

In our case study we used both interviews and questionnaires as a data collection method [12]. Questionnaires were used for gathering general information concerning students' opinion on the CS1 course and drop out reasons. Information collected by questionnaires was also used as starting point to an interview plan. In addition, the questionnaire was a way to find the students that would be willing to come to the interview.

The questionnaire was sent to all (N=212) students at CS1 course who did start the course (returned at least one programming exercise) and did not finish their programming exercises and/or programming project. The questionnaire included both closed ended and open ended questions concerning course content, study material, teaching, perceived difficulties and drop out reasons. Open-ended questions were merely used as "Other reason, what" -type questions.

49,5% (N=105) of students answered the questionnaire. 22 of them expressed their willingness to come to the interview and eventually 18 of them were interviewed. The remaining four students were not interviewed due to incompatible timetables or because students decided they did not want to come to interview after all.

The material and the most interesting data were collected by interviews. The interview was included to procedure because using only questionnaire has a great danger of biased questions and therefore answers. The researcher's standpoint to the topic and the choice of questions/answering opportunities narrows evidently down the variety of answers. Open-ended questions can diminish this to some respect, but typically students' answers to such questions are short and do not reveal to relation and importance of various factors well enough, compared to interviewing students. The interviewer can ask many clarifying questions, and what is important, the interviewee does not need so much the time and effort required to give the answer in a written form.

The type of interview used in this study was methodologically between an informal conversation interview and an interview guide approach [12]. This means that there was a loose plan (Appendix 1) that guided the conversation in some respect. Depending on interviewee's personality and "talkativeness" the interview reminded more one or the other methods. However, the most essential topics were covered in any case. In addition to questions concerning the CS1 course itself, we included some social factor and comfort level related questions in the interview plan. This decision was based on past research, which indicated clearly that the reasons to drop-out are manifold (for example, [20, 4, 1, 9, 24]).

The time used for interviews varied between 35 - 85 minutes. The average time was nearly 50 minutes. The interviews were tape-recorded and transcribed. In four cases tape recording was not possible because interviewees did not want that or due to technical difficulties. In those cases notes were taken.

The transcripts were thereafter read through several times and addresses that concerned drop out and difficulties students had confronted during the course were picked up. As we had no existing categorization of relevant factors, we chose to work using a data-driven analysis method. In each address concerning drop out reasons, we identified the reasons mentioned. This allowed us to categorize each address so that addresses with similar reasons were combined, and

a more general title for each category was given. Typically we identified a few main categories, which had two or more subcategories. In addition, several addresses were unique. As a result we have a number of categories describing qualitatively different reasons for dropping out the course that gives us a fair overall picture of students' problems.

Since it turned out that the majority of respondents had more than one drop out reason, we decided to look more closely at each case in hope that we would find some similarities/differences between the cases. To facilitate the comparison we decided to draw what we call *drop out reason networks*. That is a visual picture showing what were the reasons that drove the student to drop out the course. This enabled us to reveal visually the chain of events/situations that led to drop out.

5.2 Subjects

Subjects (N=18) in this study are non-major computer science students at Helsinki University of Technology. For majority (N=12) the CS1 course is compulsory and for the rest it was optional. However, most of them are not required to take any other programming courses during their studies if they do not choose otherwise. The model study plan provided by the university suggests that students take the CS1 course at their second study year. Yet, students can take the course whenever they choose. Out of those 18 students interviewed in this study ten of them were studying their second or third year and the rest of them had been studying four or more years.

Six (33,3%) of the interviewees were female and 12 were male, females being slightly over represented compared to gender division at the CS1 course. The department distribution of the interviewees corresponds roughly the CS1 students' department division.

6. RESULTS

In this section we will discuss first the results we got from questionnaire since they were the ground for interview plan. Only after that we will move to the results we got from interview.

In the questionnaire we asked the students to give reasons why they did not finish their programming exercises and programming project. Three major reasons for not completing programming exercises were: 1) making exercises took too much time and the student decided to drop out in order to be able to concentrate on other courses (38 mentions, 36,2% of all that answered the questionnaire), 2) the student did not know how to do the exercises (26 mentions), and 3) the student started doing the exercises too late and did not have time to complete them before the deadline (24 mentions).

When giving opinions on programming project students stated the following issues: 1) the course did not give good enough prerequisites to do the project (33 mentions), 2) preparing the project took too much time and they decided to concentrate on other courses (31 mentions), and 3) 30 students stated that they would have needed more help doing the programming project. There were some answers concerning what students perceived as the hardest part of starting the programming project: The most frequently mentioned difficulty was the experienced difference between the hardness of exercises and the hardness of the project (12 mentions). Difficulty of managing the large program and difficulty of time managing both received five mentions.

In summary, previously mentioned difficulties were the most frequently mentioned drop out reasons. In addition, there were other reasons, such as not being able to understand the course content (18 mentions), not being able to use as much time to the course as previously planned (18 mentions), personal reasons (10 mentions), plans to drop out studies at HUT the next year (3 mentions), job related commitments, and the decision to start reading to entrance examination of another university and therefore dropping out the course (4 mentions). It is worthwhile to note that many students gave more than one drop out reasons.

6.1 Drop out reasons

The interview data suggest that there were two major drop out reasons: 1) no time (12 interviewees mentioned this) and 2) no motivation (5 interviewees). As such they are not surprising results. However, it is more engrossing to dwell upon why students do not have time and motivation. In addition to these two major categories there were other smaller ones (mention-wise) categories as well. We would like to point out already at this point that almost all dropouts gave more than one reason, which indicates the complexity of the problem.

Next we will discuss each drop out reason separately and only thereafter concentrate on real life cases where the cumulation of reasons can be seen.

6.1.1 Category 1) No time

This category could be divided further into three subcategories, which were: No time because of

- 1.1) The student decided to prefer doing something else,
- 1.2) The student had not booked enough time for the course in the first place,
- 1.3) Some parts of the course were more difficult than students expected and therefore the course took more time.

The first of these includes reasons such as:

- A student has a lot of assignments, which connect to other courses (courses that are compulsory and are prerequisite to other courses and therefore it is more vital to pass them instead of CS1).
- It is possible to postpone the course without any consequences (for example, CS1 is not prerequisite to any other course, or course content is not likely to change much over the years).
- The course is optional (some students took the course out of curiosity or they thought that programming skill might be useful in a future. All the same, since the course is optional it is first to go when timetable gets booked up)
- A student has job/hobby related commitments (for example, has to leave for a long work trip in the middle of the course)
- A student decides to use time to prepare for entrance examination of an another university.

The following texts are translations of the transcriptions of the interviews¹.

¹The interviews were carried out in Finnish, and all analysis is based on the Finnish transcriptions. The translations given here are not exact, as it is difficult to translate spoken language to another language.

Student 4: *I had really a lot of courses. I had greedily taken little bit too many [courses], over 20 study weeks. And then there were so many other exercises and exams and then as this is an extra [optional] course for me. So, I took this course merely out of my own personal interest. As all the exercises started to accumulate I had to drop something out. As this wasn't compulsory course I decided that I rather drop out this course than risk all my compulsory courses.* (student 4: address 44)

The same interviewee continues:

Student 4: *On the other hand I had already made those programming exercises meaning that I already know the basic stuff and I had already gained the goals I had set to myself concerning this course. If you think about my studies I don't actually need programming but if we have to make all sorts of programs for machine tools and others. Then it is good to understand all this, how to make subprograms and how to use them in main program and all these loops and others. To understand how they are constructed. That is useful to know. and otherwise it has also helped me to understand. In that way I had already attained my goals. I don't know how much added value the programming project would have brought. Well, of course I would have got the study weeks.* (4:50)

The second subcategory was no time because one has not booked enough time in the first place.

The next sample is from a student that had started the CS1 course many times but had always dropped out it at an early phase of the course.

Student 12: *...in a way I never stopped to think how much time this course would take in a worst case and how much I should invest to it in order to pass the course. I always dropped out at the early stage of the course. That is why I never got the proper picture of how much time it could require. So, that is why I [dropped out] so many times* (12:30)

The third subcategory, some parts of the course are more difficult than expected and therefore the course takes more time, we will look at closer a bit later.

6.1.2 Category 2) No motivation

The other major category no motivation was also divided into subcategories, which explain/give reasons why some students did not have enough motivation to finish CS1 course. Three subcategories emerged:

- 2.1) No study motivation in general,
- 2.2) Payoff is imbalanced and therefore motivation drops,
- 2.3) Some parts of the course were too difficult and therefore motivation drops

The first one of these included different cases such as the student was not at the department he/she wanted to

be. For example, the student was studying at the Electrical and Communications Engineering department because he/she did not have high enough entry scores to study the area he/she really was interested in and therefore had more general difficulties to orient to university studies.

Student 14: *Well, I didn't have any big courses at the same time or other courses in general either. That it was little like that my study motivation was low in general. That is why, that is probably why I decided to drop out the course.* (14:54)

Interviewer: *Have you thought of what might have caused that your study motivation dropped?* (14:55)

Student 14: *It was probably because of I was in the wrong department. Those studies there didn't interest me. That was probably mostly it.* (14:56)

The second subcategory concerned the experienced imbalance between the amount of work needed and the gains achieved. Students felt that the course required more than other courses with nominally the same extent in study weeks. The source of imbalanced payoff concerned both the time and effort required and the achieved level of the programming skill.

Student 4: *My motivation dropped because the workload would have been so huge compared to what I would have received [ECTS units]. Since I wasn't short of study week². My funding wasn't hanging on these study weeks.*(4:52)

Student 12: *Well, sometimes it was like that I asked [the tutor] many times and it [programming exercise] got just a little bit further. And then it took several hours of work and two, three visits at the programming exercise group that I was able to finish one programming exercise. In addition, I had been thinking about it by my self. I felt so frustrated that I spend almost ten hours to the program that counts the mean of three numbers. There is no creative thinking there. It just fighting that you get the program to work.*(12:56)

Student 3: *5 study weeks doesn't apply to me. It should be 10 study weeks if you use the time used to the course as a dipstick.* (3:108)

The third subcategory, some parts of the course were too difficult, we will discuss next. These reasons are also related to category 1.3.

6.1.3 What students consider difficult at CS1 course?

Many students said that the course or a part of it was hard. This experienced difficulty was partially connected to both 1) no time and 2) no motivation drop out reasons. Difficulty was in some cases the reason why the course required more time than anticipated. It also affected negatively on motivation. During the interviews students were encouraged to expand on what particularly they found difficult. In this paper we will discuss only the reasons that were connected

²Students get funding from the state only if they study certain minimum amount of ECTS units per month.

to the actual drop-out decision because there were numerous difficulties that students connected to inconvenience but not necessarily to dropping out. These include difficulties explained below and difficulties with problem solving, implementing, perceiving the structure of a program and the way the programmer is supposed to think. In this paper we will not discuss these difficulties any further since they are a large topic themselves.

1) Cannot find errors

Interviewees mentioned that they found it difficult to find errors in their code. They got frustrated as the error was usually a minor/trivial one and it still took hours to find it.

Student 1: *Yes, there was enough [time to complete exercise]. But then when you can't figure out some occasional point and you try to figure it out one day after another. That can result that you run out of time.* (1:137)

Student 6: *I wasn't able to figure out where the problem was. I was able to check the code until the object came. But then the automated assessment system didn't give me any points even though I thought that the most of my code was correct.* (6:86)

An example of the type of error that required a lot of time to discover:

Student 9: *Some things were in a wrong order when doing those loops, like some for loops and similar. They often had some minor things, such as, how it goes through those elements. In those situations I had somehow defined it wrong so that it goes over or something similar. It was quite hard to think what happens in a loop. It might have been a small error and compiler didn't tell so exactly where the mistake was even though it told the location of the error. This kind of things took a lot of time, as you didn't get any help"* (9:65)

2) Managing extensive unity

For some students, the size of the project work was difficult to handle.

Student 12: *It was the programming project as you had to do a larger unit. At that point I stared to freeze. It was so hard to implement all those things I had learned earlier.* "(12:80)

Interviewer: *So, was it difficult because it was a large unit or because you had to write more complex code or what was the thing that made it difficult?* "(12:81)

Student 12: *Well, it was such a big unit altogether. It felt so extensive job to do. Even if you aim for the lowest grade you have to do a lot of work. At least I spend quite a lot of time doing it.* (12:82)

3) Not enough information/ability

Some students felt that their knowledge on programming concepts and their programming skill were insufficient.

Student 3: *It was so laborious to do the programming project considering the knowledge that had been given so far. There remained a lot of rustling up to do. I know how I could have managed to do the project but since it was not absolutely essential for me to do it* (3:90)

Interviewer: *Was the laboriousness of the project the crucial thing here?* (3:91)

Student 3: *No, not the laboriousness but the lack of knowledge. My subject was a family tree and it proved to be pretty hard to do those branches...* (3:92)

4) Tutor can not help

In some cases students felt they did not get enough help from the teaching assistants.

Student 2: *I didn't get what I was looking for at the programming exercise groups I think it is not enough that tutor knows something. He/she has also been able to mediate that knowledge to the student. [The tutor] has to be able to analyze student's questions and based on that insight and tutor's own knowledge about the subject matter be able to tell the answer to the student so that he/she understands it. That is something I did not notice there. There were only two tutors who were something of the sort of teachers.* (3:80)

Interviewer: *So we should invest some energy in tutor's pedagogical education?*(3:81)

Student 3: *Yes, definitely. They [tutors] should not just snatch the keyboard and start to potter. And finished!* (3:82)

Student 3: *Many [tutors] just were there. They were able to cope with the keyboard but things didn't get any clearer for me. I was left alone to wonder about the code There was an incident when tutor came and messed up the code and then left because he /she couldn't figure it out.* (3:84)

Other reasons

Besides these two major categories and their subcategories there were other reasons to dropping out, too. In two cases students had to drop out after they had been caught on plagiarizing their programming project. One student explained plagiarism with more liberal study culture at other departments saying that teachers are looking the other way and that collaboration is informally if not formally allowed. The other student explained that he and his friend did not know that plagiarism/group work was not allowed and that they did it because programming project was hard.

Some students (two references) decided to drop out the course because it did not look likely that they would pass it or would pass it with good enough grade. These students were ambitious and wanted to understand and pass the course with a good grade instead of merely just passing.

At the few latest programming exercise round there was a planning exercise that was to be made in a group of two to four students. It was possible to pass the exercise round

also by doing all the other exercises on that round but that required very high scores on those remaining exercises. Some students found it difficult to find a group where to make the planning exercise. These students did not have any friends at the course. In some cases the age difference between students increased the difficulty to find the group (a few students were over 20 years older than the others).

Student 1: *..I didn't like the group works that we were supposed to. It didn't cover actual programming I generally don't like group works I decided already at the beginning of the course that I would not do those exercises at all.* (1:20, 22, 24)

Interviewer: *Did you have any friends at the course?* (1:94)

Student 1: *No I didn't. That was the main reason why I didn't do those exercises that required group work. Because I didn't know anybody from there.* (1:95, 97)

The age difference affected also in more general level. Two interviewees reported that they were discriminated by other students because they were more mature than majority of students.

Student 3: *I have noticed a lot of age racism here.* (3:124)

Interviewer: *Epecially here at HUT?* (3:125)

Student 3: *Yes. During the first study years there were very few people that wanted to know me We sit day after day next to each other at the lecture hall. For example, if we arrive the lecture hall at the same time they look the other way. I can't even say hello because they don't give me the opportunity to eye contact. And I don't want to hurt anybody's feelings by shouting hello if they don't want it. The situation is different if they are tiddly or they need help. Then they know me from far.* (3:126)

An another student has similar experiences.

Student 8: *Students are not used to more mature students. Until now they have only been at school with coevals The majority of students are males aged between 19 and 25. They think they know everything and they tend to rate every human relation as possible/not possible courtship relation. In addition to that they are still in a phase where they are becoming independent. A female student that is almost the same age than their mother — well that is something they want to get rid of.* (8)

These were not primary drop-out reasons but affected students' general comfort level and therefore, with other difficulties, have an influence on dropping out.

One student dropped out because he was on a wrong course. This was due to misunderstanding concerning degree structure reform and its effect on students' studies³.

³The degree structure reform was implemented in the fall 2005 at Helsinki University of Technology.

This change may have confused some students, since not all of them were aware of whether they needed this course or its parallel course in order to complete their studies.

6.1.4 Cumulative feature of drop out reasons

As mentioned before, almost all interviewees gave more than one drop-out reason. To demonstrate how drop out reasons tend to cumulate we drew the following networks. We used visual networks to easily view the cumulative and concurrent nature of drop out reasons. Our first intention was to try to find some typical networks. However, it turned out that each case was unique and no typical networks were to be found within our data.

Smaller boxes include drop-out reasons students gave during their interview. However, not all reasons are directly connected to drop-out decision. Instead, they tend to concatenate. For example, in Figure 3 the student had some previous knowledge about programming before he entered the CS1. Therefore he assumed that course would not take so much time. This assumption proved to be incorrect resulting the student to run out of time and finally to drop out the course. In this case, arrows can be interpreted as "has an influence on". In some other places arrows are stating more a general connection between the state of affairs. For example, in Figure 4 the achievement oriented student aims generally at good grades. As the course proceeds, it becomes clear that a good grade is not probable. This fact contributed to the drop out decision.

Figure 1 (student 1) This network demonstrates how dropping out was caused originally by other courses requiring time, getting stuck on a "black spot", the fact that programming exercises got more complex and that student did not have any friends at the course.

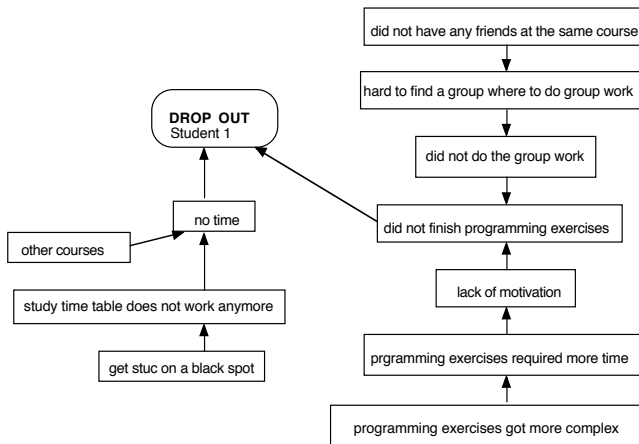


Figure 1: Case: Student 1

Figure 2 (student 6) This case is somewhat similar with the first one in a way that this student had also difficulties with programming exercises that got more complex. This time it was connected with lack of time and no lack of motivation as previously. In addition there were issues like tutor's inability to help, other courses and the fact that the course was optional.

Figure 3 (student 15) The third network demonstrates a

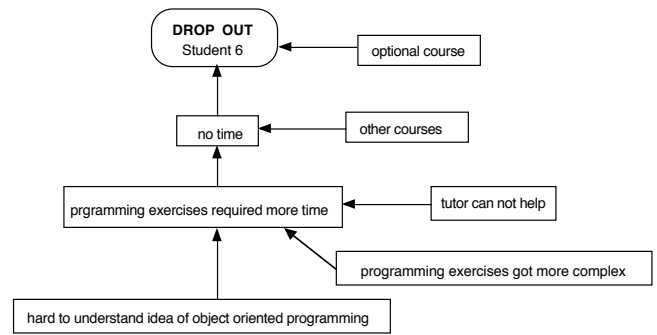


Figure 2: Case: Student 6

situation where the student misestimated the time required to take the course in addition to other courses and activities. These reasons plus the fact that one can take the course later without any consequences or inconvenience resulted in dropping out.

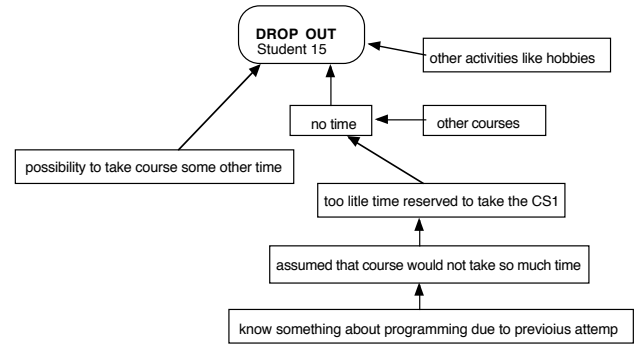


Figure 3: Case: Student 15

Figure 4 (Student 8) This network demonstrates a student who is achievement oriented, wants to understand the course contents well and aims at good a grade. As these goals were not met, the decision of dropping out is made. In addition, this student's comfort level at HUT is low and tutor is not able to help the student.

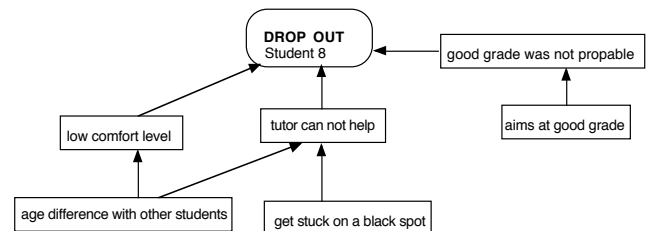


Figure 4: Case: Student 8

Figure 5 (Student 3) This network is a good example of the complexity of drop out reasons. There exists a majority of all drop out reasons found in this study.

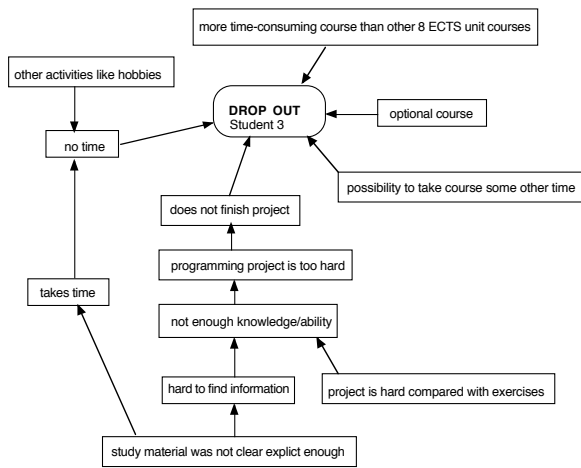


Figure 5: Case: Student 3

Figure 6 (Student 2) The picture serves as an example of the opposite type of network to the previous network. The drop out reason is pretty clear in this case.

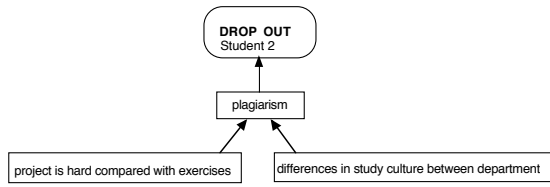


Figure 6: Case: Student 2

In summary, each drop out network is unique and no archetypes were found among. The variety of networks is almost overwhelming. This indicates that we are dealing with very complex phenomenon here.

7. VALIDITY

In this paper we have described a qualitative research process. Thus, the discussion of the validity of the results differs from one that would take place if this would be a quantitative research. Validity itself is multi-faced concept that includes several different types of validity. When speaking of validity of qualitative research one usually refers to plausibility, credibility, trustworthiness and defensibility of the research. One can also include issues such as the depth and richness of the data and the extend of triangulation to validity. [12, 17]. In the following, we discuss how well the chosen approach generally fits the research goals, the size of the interviewed group of students, the generalizability of the results, and the bias caused by the researchers' actions and decisions themselves.

The aim of this research was to reveal an overview of drop out reasons, i.e, map the phenomenon. A qualitative approach is necessary to achieve such a goal, since the factors to be investigated were initially poorly understood or simply unknown. The questionnaire revealed some information about the generality of factors that we knew/presupposed

had a role here. The open-ended questions revealed some new factors, but only the interviews could reveal the complexity of the phenomenon.

In qualitative research, the size of the sample and generalizability of results are not major purposes [12]. A small number of people is enough, as the factors found tend to saturate soon (no new factors seem to appear after a number of interviews). Obviously the method does not guarantee identifying all factors involved (which would require interviewing all students several times), but we are confident that for the set up goal almost all the most relevant factors have been identified.

On the other hand, the research revealed the complexity how drop out reasons cumulate. Having found 18 different cases with 18 interviews, we simply conclude that there seems to be no clear archetypes of the reasons behind dropping out. Carrying out much more interviews might reveal something, but would require extensive amount of work respectively.

The generalizability of the results, in the sense that the revealed drop out reasons exist also for other courses at HUT and other institutes, is not the primary purpose of this research. For example, we clearly identified cultural issues (e.g. dropping out the course has no consequences for other studies), which may not appear in many other institutes. However, this research provides us useful and necessary data to design further quantitative researches where the distribution and importance of various drop out reasons will be studied. The degrees of references found in this research also give us a rough guideline that helps us to form hypothesis for the quantitative research, such that would be hard to define without this work.

The research bias is a potential threat meaning that a researcher finds what he/she wants to find. The bias is often a result from selective observation and/or recording of information or allowing one's own personal views to affect the procedure. [12]. In this research all interviews were taped or notes were taken. Since the interviewer has her background in education science and not in computer science, there might be some differences in what kind of questions she emphasized compared to someone with computer science background. The paper's second writer has his background in computer science having extensive experience on teaching and has good overall picture of computer science education and it's challenges. The questionnaire and the interview plan were prepared jointly to avoid such biased question sets.

Someone might allege that there is a bias how results are represented, meaning that some issues are stressed more than others. On the other hand, that is also a matter of standpoint. Somewhat prolific amount of text samples is included not only to give an example of phenomenon but also to give the reader a change to make his/her own conclusions concerning how successful our conclusions were.

In order to enhance the validity of the categorization, we also used investigator triangulation in analyzing and interpreting the data. The third person we used for triangulation has also computer science background and he has several years experience on teaching the parallel introductory course in programming, and therefore has first hand knowledge on difficulties students confront.

8. DISCUSSION

We have focused on revealing non-major CS1 course students' drop-out reasons. The results second partially previous studies on the subject. One of the two major categories related for drop out reasons, *no time*, was divided further into subcategories. Reasons concerning time managing can be straightly related to Cook's and Leckey's [6] finding that time managing is one of the most frequently mentioned problem spots for students. The other subcategory, *decides to prefer something else*, has more to do with culture/course-specific issues & expectations such as the lack of consequences if the student drops out and, furthermore, low study motivation as students are not sure if HUT is the place where they want to continue studying.

The other major drop out reason was *no motivation*, which was divided into subcategories as well. The first of them, *no study motivation in general*, had to do with previously mentioned culture specific reasons. The second subcategory, *experienced imbalance of payoff*, can be related to motivational theories. Some motivational theories stress expectations of maximum payoff as a cause of behaviour [21]. Accordingly, if the payoff is imbalanced with the given time and effort, there is no motivation to study.

Another issue concerning *the no time and no motivation* drop out reasons is that there is individual variety in how students respond to the same situation [28]. The same amount of exercises and other commitments can result in different reaction with different students. Some stress out and settle for dropping out and others survive difficulties by investing notable amount of time and effort. There are most likely several reasons behind this versatility of reactions. Nevertheless, this could be one reason why we did not find any typical network for drop out.

Contradictory to Bennet [4], financial problems did not seem to play a role in drop out. At least interviews did not reveal any such reasons. This might have to do with cultural issues. Getting some funding from the state probably helps most of them to avoid any major financial hardships.

The issues students experienced as difficult at the CS1 course were diverse. They range from topic-specific issues, such as programming language specific problems, and problems that have to do with finding errors, and managing larger program units to the issues concerning tutor's pedagogical abilities, and perceived low comfort level. These aforementioned issues demonstrate that there are fundamentally different types of difficulties students confront, some of them being easier to tackle with than others.

This study corroborates previous research [4, 22, 27] that stress the importance of students' comfort level as one issue affecting success and drop out decisions. This is an issue that needs to be taken under serious consideration. Fortunately, there are some possible interventions that can be carried out in order to improve the learning environment [9, 1] which in turn most likely positively affects students' comfort level.

The case based networks reveal the unique, cumulative, and concurrent nature of dropout reasons. Students are multidimensional persons each having their own individual commitments, motivations, preferences, and abilities. Any study that tries to force that multidimensionality to two-dimensions (text or picture) will inevitably result only in a pale and simplified reflection of the reality. In addition, it is good to remember that the interviewees will tell the researcher only the issues/factors they want and remember to

tell. This being said, we are not claiming that the networks presented in this study would be accurate pictures of the reality. They should be interpreted as possible models of the phenomenon called dropout.

9. CONCLUSION

The result of this study do not make a happy reading to those teachers and researchers who expect simple answers how to make a proper intervention to reduce drop out rate on their programming courses. We have brought forward the fact that there are many different kinds of drop out reasons, which, in addition, cumulate individually. In practice this means that no intervention that is aimed only at one or few difficulties is likely not enough to help the students. For example, visualization tools or learning environments can help with some difficulties students confront, but definitely not with all. It is good to keep in mind the spectrum of drop out reasons when planning interventions or new pedagogical help devices. Moreover, it is clear that there are many such problems that are out of scope for a single teacher to handle, and need actions on the institute level such as study counselling, better coordination of model program courses, support for teaching better, studying and time management skills for students, and support for social interaction among students. Some problems are related to students' experience of studying on a wrong department or institute. Tackling them is extremely difficult.

Our future research will concentrate on two issues. First, we shall perform a quantitative survey of the distribution of the identified drop out reasons, to get an overview of the population on a CS1 course having problems that we can address on different levels (course level, department level, or institute level). In addition, we shall carry out more specific analysis on the programming related difficulties students confront on the course. There the main focus will be on those issues that can be tackled by the course personnel.

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APPENDIX

An interview plan

1. Warm up questions that concern issues like study year and department
2. At which point of the course did you drop out?
 - (a) How many exercise rounds did you submit?
 - (b) Did you work with the project plan?
 - (c) How much of the programming project did you complete?
3. Feedback concerning the course content, lectures, study material, programming exercises and project, teaching, and exercise groups.
 - (a) What could have been done better?
 - (b) Was something so badly arranged that it affected your decision to drop out?
4. Course content
 - (a) What was the hardest part to understand?
 - (b) What part of the course was most time-consuming?
5. Why did you drop out the CS1 course?
 - (a) If the reason is "no time"
 - i. Why did you not have time?
 - ii. Were you able to use your working time efficiently?
 - iii. Was there something that disturbed your studying?
 - iv. Do you use some time-managing system?
6. Did you have any friends on the course?
 - (a) How significant was it that you had/did not have a friend on the course?
7. How do you feel like studying at HUT?
8. General feedback