Bachelor Computer Science

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Soft Skills in Computer Science

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BACHELOR THESIS

Abstract

Computer Science students shape the future of IT and to ensure that future is forever growing, soft skills are necessary. Soft skills cultivate personal, academic and professional growth by using emotional intelligence to improve workflow, self-image, problem-solving and relationships. With artificial intelligence automating most of the mundane tasks in the business world, soft skills have become a valuable trait in Computer Science graduates. To see whether bachelor Computer Science students nowadays are aware of this importance, eight bachelor Computer Science students from Leiden University and TU Delft participated in semi-structured interviews to talk about their experience with soft skills during their study. This shapes a small insight into what soft skills are already commonly known and what soft skills would profit from more explicit teaching. The method of teaching can take a variety of shapes but contextual learning was the best fit for universities to help their students in preparing them for the future. With the results of this thesis, universities may adapt their curriculum to better suit their students needs for soft skills.

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1 Introduction

Universities teach their Computer Scientists to become bridges between worlds. Translating a problem into a language stakeholders understand is a skill that helps all parties involved. Similarly, soft skills such as: collaboration, planning and creativity can be lost due to poor education, resulting in computers automating our jobs away. We should prepare our CS students for the future but first we need to gain insight into what needs to be improved to give them the best possible assistance.

With this bachelor thesis, insight will be gained into bachelor Computer Science students' view of so-called soft skills. These are skills that one finds useful to improve themselves with in life. Therefore, these skills are interchangeably called $21^{st}-$century skills or life skills and are often lacking in a career that is based on science and results.
Depending on insight gathered from interviews with CS students, higher education may change their curriculum to improve their students' study and potential careers. Therefore, the research question in this thesis is:

> What do bachelor CS students think of soft skills and what experiences do they have with these soft skills during their study that may make the university change their curriculum?

1.1 Thesis overview

This bachelor thesis is the result of research done on the topic of soft skills as experienced by students of the bachelor study Computer Science and Computer Science related studies. The research was approved by the ethical committee of The Leiden Institute of Advanced Computer Science (LIACS)[1] and has been supervised by Dr. A.N. Van der Meulen[2] and T.D. Offerman[3]. This chapter contains the introduction; Section 2 discusses related work and a background of soft skills; Section 3 includes the definitions used for this thesis; The methodology used for this research can be found in Section 4; Section 5 describes the experiments and their outcome; Then section 6 discusses the results of this research with its limitations in section 6.2; Section 6.3 elaborates on potential future research. Lastly, a conclusion is drawn in section 6.4.

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2 Related Work

2.1 Definition of soft skills

Research has been done into the definition of soft skills and the acquisition of soft skills. Starting with the definition of soft skills, we come across keywords such as: " ...communication, flexibility and problem-solving" [1]. These are key elements of the definition of soft skills that we will be using.

Mangala et al [2] gives us an impression of how important soft skills should be. In his work, he tells us that soft skills are equal to emotional intelligence and that we need both hard and soft skills to thrive in life:

> "Hard skills are academic skills, experience and level of expertise while soft skills are self-developed, interactive, communicative, human and transferable skills. Literature suggests that hard skills contribute to only 15% of one's skills success while the remaining 85% is made by soft skills." [2]

Instead of defining a soft skill by a textual definition, *Caeiro et al* [3] defined soft skills by categorization. In this research, 44 characteristics or abilities were considered soft skills needed for the study Engineering in Higher Education, of which 18 skills were considered fundamental:

- Formal, basic knowledge in their field.

- Ability to integrate of knowledge from diverse thematic areas.

- Collaboration, sometimes in multidisciplinary teams.

- Open-mindedness.

- High-level thinking.

- Critical, analytical and innovative thinking.

- Independent and autonomous learning.

- Problem-solving.

- Ability to prioritize.

- Ability to assess information, particularly when coming from diverse sources.

- Ability to follow systemic design processes.

- Implementation and validation of solutions from the perspective of end-users.

- Ability to analyze the factors that contribute to an undesired situation.

- Design and evaluation of alternative interventions towards solving a problem.

- Implementation and assessment of the effectiveness of a solution.

- Integrate and transfer knowledge to the real world.

- Work with limited resources.

- Presentation skills.

The total 44 soft skills can in turn be categorized into five categories [3]:

1. **Technical skills** that comprise skills out of the standard engineering curriculum related to technical aspects.

2. **Metacognitive skills** are those related to the management and improvement of the cognitive process. They are related to the soft skills that help an individual to excel independently of their learning path.

3. **Intrapersonal skills** are those related to ones inner characteristics and also ones attitude toward things, ranging from creativity or flexibility to self-discipline or perseverance.

4. **Interpersonal skills** are skills that improve ones capabilities to work with others. These skills are related to the ability of an individual to collaborate in a group, to communicate effectively, to understand the needs of others, to transfer knowledge to the real world, etc.

5. **Problem-solving skills** are those that help to identify the source of a problem and find a suitable and effective solution. These skills are related to the ability of an individual to motivate others, to communicate effectively, to plan and prioritize, and to see a project through to completion.

Caeiro et al [3] reviewed the perceived importance and teaching of soft skills in Higher Education by means of an online survey sent to Engineering and Economics students from the following five European countries: Denmark, Estonia, Greece, Portugal and Spain. Even though the response rate was 30% and the distribution of respondents was highly skewed, the method and result from this research can be used as a benchmark for our methods 5.

As for the results of *Caeiro et al* [3]'s online survey, the following points are noteworthy:

- Metacognitive skills are deemed most important with the highest average (4.28/5) and lowest standard deviation (0.11)

- Problem-solving- and intrapersonal skills are deemed of similar importance (average of 4.12/5)

- Interpersonal skills have an average rating of 4.03/5 which puts them on third place in terms of importance

- Lastly technical skills with an importance rating average of 3.87/5 and a high standard deviation of 0.25

2.2 Learning soft skills

There are various methods of teaching soft skills, both academically and corporate. According to *Arat et al* [1], contextual learning in an environment for at least three and a half months is recommended to train soft skills. One form of contextual learning has been organized by *Dowdall et al* [4]. They have developed a didactic methodology that can be used in a program for undergraduate students. Their Multinational, Intercultural, Multidisciplinary & Intensive (MIMI) methodology focuses on team-based projects so students can learn from each other and collaborate for a short but intense period of time. The first three letters of MIMI display a need for difference within the team so there are various strategies and ideas for the project, ensuring team members learn from each other. This collaboration between team members of different backgrounds proved to be effective in improving soft skills, especially for Computer Science students.

Another form of contextual learning was studied by *M. Pagel* [5] as he recorded and compared the collaboration between his students by letting them play an online multiplayer game called EVE Online [4] for an extended period of time. Teamwork and communication were essential in this game but soft skills such as high-level thinking, problem-solving skills and working with limited resources proved other categories of soft skills were trained simultaneously. The participating students of *M. Pagel*'s research [5] showed improvement in soft skills and recommended the course to others who want to work on their soft skills. Another attempt at training soft skills in an academic setting was the coaching of bachelor CS students by master students as supervised by *A. Ahmad et al* [6]. This has only been proven useful for the master students.

All these contextual learning approaches were mentored by academic staff and therefore fall under guided methodology. *Caeiro et al* [3] argues there are also expository and active methodologies to learn soft skills. The former being occasions such as lectures, seminars and conferences, the latter having forms such as brainstorming, coaching and role-play or visits. This shows how there are multiple approaches to teaching soft skills to Computer Science students.

2.3 Educational view compared to company view

Having Computer Science students follow apprenticeships to learn soft skills and prepare them for a career beyond academic studies may be a method of acquiring necessary soft skills. Moreover, *T. Young* quotes: "Social intelligence, specifically emotional intelligence is a contributing factor towards ones attitude and in turn, career success" [7], so developing soft skills is important to both the student and future employers. Employers of Computer Science students deem these soft skills important enough to see them as a reason to fire their freshly acquired graduate employees. On top of that, automation is a threat to anyone working jobs that only require hard skills as they can be taken over by computers. Soft skills requiring social cues or involving human emotions are less prone to automation, which is exactly what soft skills are about and should therefore be taught explicitly [7].

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[4] https://www.eveonline.com/

3 Working definitions

As there are multiple definitions of soft skills and having each paper with its own set of skills, this chapter clarifies the definitions we will use in this thesis.

Soft skills are homogeneous with life skills and 21st-century skills since these skills tend to be increasingly important when living in the 21st century. There is no precise definition or requirement for soft skills so there is an ever-changing collection of skills that may be called soft skills, both generally and domain-specifically speaking. Most of these soft skills can be categorized into five categories [3]:

1. Technical skills that comprise skills out of the standard engineering curriculum related to technical aspects.

2. Metacognitive skills are those related to the management and improvement of the cognitive process. They are related to the soft skills that help an individual to excel independently of their learning path.

3. Intrapersonal skills are those related to ones inner characteristics and also ones attitude towards things, ranging from creativity or flexibility to self-discipline or perseverance.

4. Interpersonal skills are skills that improve ones capabilities to work with others. These skills are related to the ability of an individual to collaborate in a group, to communicate effectively, to understand the needs of others, to transfer knowledge to the real world, etc.

5. Problem-solving skills are those that help to identify the source of a problem and find a suitable and effective solution. These skills are related to the ability of an individual to motivate others, to communicate effectively, to plan and prioritize, and to see a project through to completion.

4 Methodology

The goal of this thesis was to gain insight into soft skills of Computer Science students. Therefore participants of this study were bachelor students with studies relating to Computer Science. They took an interview with the researcher to share their opinions on and experiences with soft skills during and outside of their study. The semi-structured interviews with the participants were then transcribed and analyzed.

4.1 Participants

The target group of this study was bachelor Computer Science students, preferably enrolled in a Computer Science program from a Dutch university as we liked to gain insight into this demographic. Because of low-response on online recruitment as explained in 4.2, participation criteria relaxed: Students following Computer Science incorporated studies at Dutch universities (eg. *Computer Science and Biology*, *Computer Science and Economics*) were allowed to participate as well. The total amount of participants was eight persons of which five were female and three were male as seen in Table 1. Their sexes have been recorded to gain a better overview of the participants. As all participants followed Computer Science-related studies at universities, the age of the participants varied between 18 and 30 years old. Having this age range allowed the students to have had previous encounters with soft skills both during and outside of their study.

Number	Sex (Male (M) / Female (F))	Study
1	F	Computer Science
2	F	Computer Science and Economy
3	F	Computer Science and Economy
4	F	Computer Science and Economy
5	M	Computer Science
6	M	Computer Science
7	F	Computer Science
8	M	Computer Science and Engineering

Table 1: Participants overview

Participant 8 was from TU Delft and spoke English during the online interview, other participants all studied at Leiden University and took the interview in Dutch of which two participated online through Microsoft Teams [5].

4.2 Process

Recruitment of the participants described in 4.1 was by means of an online flyer as shown in Figure 1 with a QR-code that if scanned, sent an e-mail to the researcher with a request to schedule an interview, everyone who sent an e-mail was scheduled an appointment with the researcher for a semi-structured interview which lasted 20 to 40 minutes. This same flyer 1 was also shown in a presentation so students present were able to scan the QR code as well. The idea of printing the

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[5] https://www.microsoft.com/en-us/microsoft-teams/group-chat-software

flyer and handing it out had no follow-up because of the Corona pandemic of 2022 which limited physical attendance, contact and transport at/to the university for the researcher. The flyer for online recruitment was distributed over various channels:

- Shown to bachelor students in a presentation for the course Bachelorproject.

- Broadcast message in Slack-channel of *Programming Education Research Lab* [6] -group, a research group based in Leiden focused on programming education.

- E-mails to higher education institutes that teach Computer Science with the request to share the flyer with their students. (Erasmus University in Rotterdam and Technical University Delft).

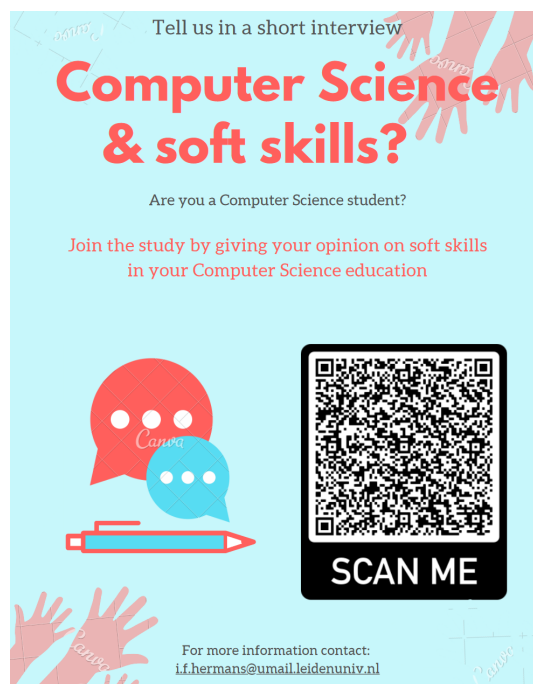- Shared to direct connections (family, friends, lecture rooms)

Figure 1: Flyer used for online recruitment

On top of this approach to recruiting participants, family members were asked for references as they worked in higher education and tech jobs. Unfortunately, this last approach did not provide any participants. Nor did the Slack-channel broadcast and e-mails to higher education institutes. The most effective method of gathering participants was asking in the classroom after a lecture who would like to participate in this study as this approach recruited seven out of eight participants. The last participant was recruited through a referral of a friend. The reason CS students were chosen to be interviewed instead of lecturers or universities themselves, was because to gain insight into the problem (CS students lacking soft skills), the problem should be explored by the CS students themselves first, after which the result could be taken to lecturers to see if this view was

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[6]https://perl.liacs.nl/

accurate from their point of view. All participants signed an Informed Consent Document agreeing to participate in this study and have their data and input analyzed. On top of that, the ethical committee of Leiden Faculty of Science reviewed and approved this study.

4.3   Gathering data

Participants were interviewed by the researcher in an offline- or online semi-structured interview [8] audio-recorded by smartphone or PC for data processing as described in Section 4.4. The reason for choosing a semi-structured interview was because the required data should be a general overview of the CS students' experiences with and opinions on soft skills. Following this form of interviewing allowed the students to freely express themselves, but also to steer them into set topics when the researcher deemed their answer not relevant to the question anymore. Similarly, the researcher asked follow-up questions when the answer was intriguing enough to ask more about, or if the answer was too short to be useful. To prevent the interviewee from feeling uncomfortable when being steered into or away from a topic, the researcher summarised, concluded or asked to elaborate on answers given by the interviewee. This allowed the interviewee to feel heard and encouraged them to continue the interview about the next topic. With the main topics and general flow of the interview set beforehand, this would have been a structured interview. Steering the participants into or away from certain topics made the approach a semi-structured interview.

The following questions [9] were guidelines for the structure of the semi-structured interviews:

1. Why did you choose to study Computer Science?

2. Which subjects in your study do you enjoy most?

3. What did you learn during your study that is not directly taught in your curricula?

4. How familiar are you with the following terms: soft skills, 21st-century skills, interpersonal skills, essential skills?

5. What skills do you think are soft skills?

6. How do you rank your proficiency in previously mentioned skills?

7. How does your study teach you soft skills?

8. How would you like to learn soft skills?

9. Thank you for your participation, do you have any questions for me?

The order of these questions was specifically chosen to provide a natural flow of the interview. The first two questions were introductory questions to ease the interviewee into the interview. Having set a base, the questions were then narrowed down into study-specific questions followed by the introduction of the term soft skills in question 4. As soft skills could be hard to come up with, the researcher prepared various examples of soft skills to help the interviewee visualise the concept. If the interviewee was unable to name any soft skills at question 5, the following examples were given: *teamwork, time management, presenting in front of groups*. The interviewee then came up with similar skills they thought to be soft skills. Now that the interviewee knew what soft skills are and

had examples, the interviewee was asked about their experience with and strength in these soft skills. Insight into how soft skills were practiced was key to teaching new students the necessary soft skills. After their personal experiences and opinions, the interview shifted to a university perspective in questions 7 and 8. Answers to these questions would allow universities to adapt their program into a program more suitable for teaching soft skills to students. The recording of interviews stopped after question 9 when the interviewee had no more questions. Otherwise, the researcher answered these questions in short but these answers were not processed in the data as the researcher was not a participant.

These interviews were done in person with a smartphone recording the conversation or online through the apps Microsoft Teams or Discord with recording software capturing the audio.

4.4   Data processing

After gathering the data 4.3, the first step to data processing was transcribing audio files. To transcribe an audio file, a new document was created for the participant of this audio file, omitting the name of the participant so that the document was anonymous. In this anonymous document, a textual representation of the audio was written manually. On top of the audio written down, timestamps were added every minute of the audio file. These timestamps added structure to the document and allowed for quickly finding parts of the interview from the textual representation in the audio file. Most of the audio was verbatim copied into the document but filler words (eg. *'uh'*, *repeated use of 'so like', 'mmmmh'*) were not written into the document when these words did not add any value to the data. This happened mostly when participants were thinking deeply about their answers.

The second step of data processing was to divide the textual representation of each interview and sort these parts by topics. Considering further processing, the following topics were chosen:

1. Participant (numeric)

2. Sex (Male / Female)

3. Study (name of study)

4. University (name of university)

5. Opinion on study

6. Reason for study (why did they choose this study)

7. Soft skills opinion (generic opinion on soft skills)

8. Known soft skills (skills the participant associates with soft skills)

9. Best subject to learn soft skills

10. Bad subjects to learn soft skills

11. Own strong soft skills

12. Own soft skills that need training

13. How have strong soft skills been developed

14. How should weak soft skills be developed

15. How can the university help develop soft skills

16. Interesting quotes (any quotes with timestamps that were remarkable)

In this second step, each transcribed interview received a Google data sheet in which previously mentioned topics functioned as column headers. Then for each sentence in the transcribed interview, if the context matched any of the topics, this sentence was copied into that corresponding column. For example: the participant talked about how their soft skills could be improved, this part of the interview related to question 14 and were therefore written into column 14's 'How should weak soft skills be developed' in the Google data sheet. Any sentences that did not apply to any of the topics 1 to 15 but did hold valuable information was written into column 16's 'Interesting quotes'. This second step was considered coding the interviews, which provided a means to find information about set topics in set cells of the data sheets.
The order of these column headers resembled the order of the general interview model 4.3 so categorizing the sentences in the interview was often writing the interview from column 1 to 16 with clear distinctions on what sentences belong to what topic.

Step three of data processing was combining the single data sheets into a single table of a new Google data sheet. To do this, every interview was now considered a number, further abstracting the participants of this interview, and received their own row in the compound table of the new Google data sheet that held the same column headers as the individual data sheets. In this document, anything said in any of the interviews about a specific topic was readable immediately instead of searching for the document corresponding to a specific interview.

Eg.: Anonymous document 2 (row with participant number 2) stated the participant studied Computer Science, then Computer Science was added in this row under the header Study.

In Sheet 1 of the data sheet document, anything related to the category was verbatim copied from the anonymous documents into the cells. This gave a verbose results sheet with all relevant data wrapped into categories per participant. Whenever a topic was not discussed in the interview, the cell remained empty. This left gaps in the data of a single individual but due to other participants telling more about certain topics than a single example, these gaps were compensated in the big picture of the data.

The last step of data processing consisted of summarising this verbose Sheet 1 into a compact Sheet 2. Sheet 2 had the same column headers again and copied every cell of Sheet 1 into the same cell in Sheet 2. In this cell of Sheet 2, the data shortened into bullet points or brief sentences that captured only the essentials. Consequently, any redundant words, extra explanations or anecdotes were not present in this cell.

Eg.: participant 2 said *'I have chosen Computer Science at Leiden University because the campus is big and pretty with all the flowers in the summer. It is also super close to my house.'*

In the row for participant 2, Sheet 1 would say: '2', 'Computer Science', 'Leiden University', 'because the campus is big and pretty with all the flowers in the summer. It is also super close to my house.' for topics 1,3,4 and 6 in aforementioned topics 4.4. Then in Sheet 2, the values for these same categories were shortened into: '2', 'Computer Science', 'Leiden University', 'campus big and pretty. super close to my house.'

Due to privacy regulations, audio files recorded for this research on a smartphone or PC were transferred to the servers of Leiden University immediately after the research concluded. The coded results also moved from a local computer to the previously mentioned server.

5 Results

5.1 Background of participants

In total there were eight participants as shown in Table 1. These participants consisted of three males and five females. One of these males attended TU Delft, which made the data not specific to only Leiden University, where the rest of the participants attended their study. These studies were Computer Science and Engineering for the participant from TU Delft, four times Computer Science and three times Computer Science and Economy from Leiden University. All participants from Leiden University took the interview in Dutch, the participant from TU Delft had to take the interview online in English as they did not speak Dutch.

With these different studies, different opinions on their studies surfaced. From the Computer Science study from Leiden University, only one person was completely positive on whether the university supplied them with enough resources to learn soft skills, with a single remark saying there could be a little more time spent on teaching soft skills. The other three Computer Science students had mixed feelings about their study. Collecting reasons why the participants joined their study as shown in Table 2, the positive side included: the study teaches modern techniques to stay relevant and is fairly 'alpha', a participant from Leiden elaborated on this by saying the study is not as focused on hard technical skills compared to the Computer Science study in Delft. Leiden had 'less bridge and transport problems to solve', referring to typical linear algebra and discrete mathematics exercises. The student from Delft had a clear reason to join their study: 'It was pretty well recognized. It had very good academic output and yeah that is kinda it, a national transfer.' On the contrary to this defined reason to join this specific study at TU Delft, a participant from Computer Science and Economy said: 'I was not that great at programming and economy was not my strong suit so it is very random how I ended up here'. When asked about the cause that made them end up here, they replied: 'I think it was the talk at the open days that convinced me to join. It was a funny anecdote that made me think this area has a lot of career potential and allowed me to express my social skills, something that I would miss if I picked a pure Computer Science study.'

According to the other two Computer Science and Economy students, Leiden University was the only university in the Netherlands providing a mix between the alpha economy and beta Computer Science courses. This mix had to consist of mathematical challenges and some form of programming, while still blending in economic courses. One of these Computer Science and Economy students had tried the study 'business administration' but said it focused too much on economy. They

added that 'If we were to go to war, I would not have any practical value with the stuff I learned at business administration. Computer Science sounded practical and useful but pure Computer Science would be too much for me as it has too many mathematical courses. CSE has a better balance between practical and mathematical courses.' Here, CSE is an abbreviation of Computer Science and Economy.

As for the Computer Science students, they all mentioned location as one of their prime reasons to join this study with sentences such as: 'Leiden is a fun city', 'Leiden is small enough to not feel like it is a big massive campus, you still know people personally at the study' and 'Leiden is close to where I live'. This last reason was also mentioned by a CSE student. The reason 'this study is only provided by this academy' was also mentioned by a single Computer Science student who had trouble finding an academy that allowed students who had done mathematics for social studies (statistics) to enroll for their Computer Science study.
The counterpart of these positive reasons of joining the study was that the computer part of the study was not as enjoyable as the students had hoped. Programming turned out to be an aspect of the study that students disliked, two out of eight students said there was too much focus on the computer part of the study. Mathematics and economics subjects seemed to be enjoyed the most by both Computer Science students and when possible by CSE students.

Reason	# of participants mentioning this reason
Appropriate mix between alpha and beta	5
Location suits me	4
Scale of study does not feel too massive	3
Only university providing this study	3
Future career	3
Other study was too technical	3
Modern and relevant techniques	2
Other study was too non-technical	1
Well recognised	1
Good academical output	1
Talk at open day	1
A relative goes to the same university	1

Table 2: Reasons to join the study

5.2   Soft skills

5.2.1   Known soft skills

After the introductory questions to get to know the participants' backgrounds, the focus of the interview shifted toward generic soft skills. Being asked questions such as 'What are your favourite subjects?' transitioned the interview into asking what the participant knew about soft skills. This was done in one of two ways: participants were asked what they learned that was not textual curriculum, or they were given a summation of skills they mentioned they learned in their favourite subjects and were then asked 'What other skills do you think qualify as soft skills?'. Because participants did not

have a concrete definition of soft skills, any skills of their replies would qualify as a soft skill. The second approach was a better approach to hearing soft skills because this already gave examples that boosted the likelihood that participants answered with more examples. The former approach, asking what they learned that was not in textbooks, had a more confusing nature which led to three participants asking for examples given by the researcher. The examples given in this situation were: teamwork, presenting and time management, which were also named often by anyone who did not need examples to answer this question. On top of these three soft skills, participants came up with additional skills as shown in Table 3. Especially students who already had an extracurricular background knew multiple soft skills. Most notable was communication, which was mentioned by four different participants. Critical and analytical reading was mentioned twice that uses critical and analytical thinking, similar to receiving feedback, as opposed to giving feedback which was only mentioned once, just like any mentioned intrapersonal soft skills 3: flexibility, enthusiasm, motivation, commitment and eagerness to take initiative. The participants also came up with 11 soft skills that were only mentioned once: organising, flexibility, enthusiasm, positive attitude, motivation, giving feedback, commitment, showing initiative, programming, writing maintainable code and debugging.

Skill	Count
Time management	8
Teamwork	7
Presenting	6
Communication	4
Critical and analytical thinking	2
Receiving feedback	2
Leadership	2

Table 3: Soft skills mentioned multiple times

All previously mentioned soft skills were generic soft skills, but one participant had a particular perspective and named skills that were specific to the IT sector. This participant mentioned feedback, teamwork, time management, presenting and communication similar to the other participants but they also considered programming, debugging and writing maintainable code soft skills. Because they answered an open-ended question asking for their interpretation of soft skills, these skills were not exactly wrong, nor will they be considered by definition 3 in the discussion 6. It seemed this participant was keen on the balance between generic and IT-specific soft skills: 'We have learned how to program, but never to program in a team. It would be useful to be able to get along with each other and write code that is readable for both students of the team.' Their example tied into an example given by another participant: 'I thought to myself: you are probably great at programming but I bet you have never had any proper teamwork with anyone.' When asked to elaborate on that, they said: 'I told him there was something wrong with his code, he did not like that. Later I told him in a subtle way he missed something over here in his code, which made him yell at me. I thought to myself this was not how teamwork was supposed to be'. With these examples, the difference in perspective was clear between these two participants. The former thought programming skills were more important than generic skills, whereas the latter found generic skills more important than programming skills. The latter also never mentioned programming as a soft skill on their own.

5.2.2 Acquiring soft skills

As for how the mentioned soft skills have been acquired, students said these were not explicitly taught in their studies. Instead, they agreed soft skills developed best by hands-on experience. The first example of hands-on experience was a board function at a study association. The association was small enough for them to organise small events which taught them organising skills and leadership. On top of that, this participant also had a part-time job matching businesses to students and gave homework guidance which gave both the students and themselves analytical and planning skills.

The second example of how soft skills were indirectly acquired is by group assignments from the study. This was an example mentioned by multiple participants as this was not specific to any study nor career path. These group assignments were multi-disciplinary as both teamwork and communication were common skills used in this setting. A participant noted that teamwork could go sour when communication was blunt between team members but by continuing they overcame this hurdle improving their communication and teamwork over the years.

The third example of learning by doing was a student making their own planning that improved in preciseness and reliability over time. The planning started out as 8-hour long session dedicated to certain courses, which then evolved into more specific planning using a variety of colours in the calendar app of their phone. Their university slowly taught them how to plan because none of the deadlines were given on the same day as the announcement of the exercise.

The fourth and last example was by doing hobbies. This particular hobby was video game development to learn IT-specific soft skills. Programming, debugging and writing maintainable code were key skills that the participant developed autonomously. Moreover, by working in teams, their interpersonal soft skills also improved.

5.2.3 Strengths and weaknesses

The next part of the interview consisted of participants ranking their proficiency in the soft skills they mentioned. Not every skill had to be mentioned again but it was interesting to see how one skill was a weakness for one participant while being a strength for another participant. For example, the top three known soft skills were categorized as both a strength and a weakness roughly an equal amount of times.

Strength	Weakness
Teamwork (4)	Teamwork (3)
Presenting (4)	Presenting (2)
Planning (3)	Planning (3)
Communication (3)	Reading (2)
Writing (3)	Writing (1)
Leadership (1)	Leadership (1)
Taking initiative (1)	
Flexibility (1)	

Table 4: Strong and weak soft skills

Participants were eager to share their strong skills. They could all give a summation of skills they thought suited them well. Especially presenting and teamwork were strong skills in this group, as

both have been mentioned by four different participants. The ability to present themselves in front of a group and speak about any topic was in the nature of those who classified it as their strong suit. Unfortunately, none of them felt like there were many opportunities to give presentations during their studies. Because of this lack of opportunities, two other participants felt like they would like to become better in presenting. One of the participants said they would get nervous when tasked with preparing a presentation so in order to relax themselves, they would clean the whole house. Also mentioned often were the teamwork and planning skills. Teamwork was mentioned by seven participants on either the weak or strong side and planning had a perfect split of three participants being strong at it and three participants who would like to improve their planning skills. 'First, I need to improve in time management because I have lost my regular schedule even though I have to finish hard deadlines.' signaled a necessary need to improve their planning skills.

After this top three, communication was mentioned three times but only as a strong skill. This skill did however relate to collaboration so anyone who said teamwork might implicitly mean communication within a group as well.

The other mentioned soft skills were: writing, reading, leadership being both a strength and a weakness, taking initiative and flexibility. Whereas writing was mentioned by four participants and was classified as a weakness by a single participant, reading was mentioned only as a weakness: 'Secondly, I have to improve my reading because I feel like I lose part of the ability to read normally with every new beta course. The code and algorithms are very interesting but it is hard for me to analyze a regular piece of text.'

This explanation was the only clear explanation as to why a skill would fall into the weaker category of soft skills for a participant. Other participants failed to reflect upon their skills and gave either vague answers that implied the conditions 'Depends on the group/skills of others', or only said what skill they wanted to improve without further explanation so they could continue to focus on their strong skills. Because of this inability to reflect on their own weak skills, the true cause of why soft skills were not on a desired level could not be discovered.

5.3   University and soft skills

The baseline of why soft skills were developed thoroughly was that if the student likes doing something, motivation and development in said soft skill would come naturally to them. According to the student from TU Delft, this motivation came best from within but having organized courses would be useful. The universities could help in strengthening the soft skills of their students but the shape of this help varied per participant. These different ideas ranged from full mandatory courses to no mandatory support, whereas most ideas were only suggested by one to three students. Options were not mutually exclusive, half the participants named multiple possible methods for the university to help improve their students' soft skills.

5.3.1   Full mandatory academic support

Two participants needed a full mandatory course focused on soft skills, preferably in the first year but one of these participants needed a course focused on soft skills every year that focuses on soft skills: 'Sometimes I think it is a little too much, but at one point you will realize it is necessary. Especially because we do not have internships to gain hands-on experience.' The other participant talked about how outside of the university, help in improving soft skills was available: 'Although

within the study, I think I have had only two small courses that touched upon soft skills and even that was not good.' Still, this participant advocated in favor of a mandatory soft skills course 'Because you cannot determine a baseline for all students, you do not know what they can do already.'

5.3.2 Half support

A less rigid form of teaching soft skills would be better according to two other students, they would like to see a single lecture with tips and tricks about soft skills for soft skills suitable courses. Notable was that this form was still taught by a teacher and students would have to listen to their lecture. A more active approach was suggested by two participants who would like to see workshops focused on soft skills. Even in these workshops, mandatory attendance was a point of discussion for these participants. On one hand, they deemed attendance to all workshops mandatory as one could not determine a baseline of weak and strong soft skills for all students so it would be better to group them together and build a general minimal proficiency in all taught soft skills. On the other hand, many students would already be familiar with various soft skills before they started this study so it would be better for them to make the first workshops mandatory for everyone, after which the university would make them optional to follow for anyone looking for more in-depth knowledge about certain skills. This would allow those who need extra training in soft skills to continue honing these skills, while students who have mastered these skills could continue working on other courses of their study.

5.3.3 General support

The line of thought of previous methods was to keep practicing soft skills by spending time on them. Two participants mentioned this without any form of help from their university. Still, without an explicit form of teaching, the university could help improve specific soft skills by doing the following: First, giving deadlines early on to promote time management. 'Mandatory assignments are something that I do not like that much. I know it can help stay on track but sometimes they are done in such a way that creates more stress than help you stay on track.' Secondly, let students do more presentations for presentation skills: 'I thought there were few opportunities to give presentations during the study. Any chance I had, for example in the course Software Engineering, I have really taken it upon myself to give a presentation.' Lastly, provide adequate feedback on exercises to improve the quality of submitted work for these students. 'I always get personal feedback telling me what can be improved. I think that is great.'
These examples were all narrowed-down versions of what two participants said, first would be to 'incorporate soft skills into lectures' and the second was to 'have a good organization of the course by conveying information and expectations clearly from teacher to student.'

5.3.4 No support

Lastly, forms of helping without mandatory courses were also mentioned by the participants. One such form was seminars about specific soft skills so that students could follow these when the study got tough. This form would suit two participants who were strong in numerous soft skills already so they would not be stuck with mandatory attendance to learn skills they already possess. Another form, being mentioned only once, was to follow internships during your study. Internships would

allow students to practice their soft skills in the real world and improve them dramatically. A final form of teaching soft skills was external sources, being mentioned once. This included study associations and student associations that allowed students to flourish and develop their personality as well as their soft skills.

6   Discussion

6.1   Interpretation

Soft skills are skills related to emotional intelligence [2] and can be categorized into: technical -, metacognitive -, intrapersonal -, interpersonal - and problem-solving skills. [3]
The goal of this thesis was to gain insight into the soft skills of Computer Science students. By means of a semi-structured interview, students shared their opinions on and experiences with soft skills. A total of eight students participated in this study with a variety in gender, study and background in soft skills as seen in Table 1.

6.1.1   Background information

In the introductory questions, various reasons were given to join one of three included studies: Computer Science, Computer Science and Economy, Computer Science and Engineering. The most often mentioned reason to join this study was the appropriate mix of alpha and beta aspects. Beta aspects would be hard math problems and programming mostly prominent in Computer Science, whereas the alpha part of the studies included presenting and working together with real businesses as they do in the study Computer Science and Economy. The latter had more alpha aspects than Computer Science which attracted a different kind of student, one who wanted to work together with third parties more.
The most unique reason for joining the study was the international student who chose their study for pure academic recognition. All other students considered not only the content of the study but also the location, the scale of the university and study, and the technical level of other studies. Using this information, universities can promote their technical studies in a more suitable manner to attract the right students.
Seeing how participants valued the mix between alpha and beta aspects in their study, opportunities for bright future careers arose. Because of their different backgrounds, some of these participants already had made a career thanks to their proficiency in various soft skills, this was not study specific as those who talked about their careers came from different studies. Those with a background of already working in an organization had more information to share about primarily interpersonal soft skills, than those who had only heard of soft skills in their studies.

6.1.2   Known soft skills

The next part of the findings concerns knowledge of soft skills, which varied per participant. Having had a small career outside of academic study already showed how soft skills could be developed by a number of participants. These participants mentioned additional soft skills on top of the three most commonly mentioned soft skills. They also showed increased interest in soft skills by talking about the topic with vivid expressions and extended vocabulary.

Overall, time management, teamwork and presenting were the best-known soft skills. Additional skills mentioned were: communication, critical and analytical reading, feedback and leadership, which all fall under interpersonal skills or intrapersonal skills 3 depending on whether it would improve the student, or had to do with other students. Interestingly, students active in extracurricular activities mentioned more interpersonal skills whereas the other students mentioned more intrapersonal skills. These interpersonal skills were presenting, teamwork and communication as working with others in the organization required these skills to be on an adequate level. The Computer Science & Economy students mentioned teamwork and communication more often than the CS students because they had to work with businesses and external stakeholders during their studies. The intrapersonal skills mentioned by students who did not attend extracurricular activities focused on streamlining their own learning process. This showed that the environment of the students shaped their views and proficiency in soft skills. The soft skills planning, feedback and taking initiative helped all students study better and so could be considered general soft skills.

All mentioned skills taken into account, they would all fit one of the categories of Table 5 using *Caeiro et al* [3]'s categorization and might minimize the misalignment of necessary skills between corporate and academic skills as mentioned by *Young* [7] in due time as there are similarities in skills mentioned by students and skills requested by employers.

Metacognitive	Intrapersonal	Interpersonal	Problem solving
critical & analytical thinking	flexibility, feedback initiative, planning commitment, motivation positive attitude enthusiasm	teamwork presenting communication leadership	time management organising

Table 5: Categories of named soft skills

Ranking the known soft skills categories, intrapersonal skills were the best known, interpersonal second best, then problem-solving followed by metacognitive skills having a single skill, whereas no technical skills were mentioned by the participants. This contradicts the results of *Caeiro et al* [3] where students deemed digital literacy, global awareness and information and media literacy important.

In contrast to how *Caeiro et al* [3] conducted their research, this interview did not provide participants with examples and definitions for all 44 soft skills for the participant to rank according to importance which may have influenced the results. Having a higher amount of mentions would then mean this skill is deemed more important or at least more recognizable for participants of this group.

The results of this interview and the results from *Caeiro et al* [3] displayed similarities within certain categories. In the intrapersonal skills category, eight out of fourteen skills were mentioned of which receiving feedback was mentioned twice and therefore deemed more important in this research than in the research done by *Caeiro et al* [3]. Individual interpersonal skills were mentioned more often which created a more reliable scale of importance of these skills. In this category, teamwork and presenting had the same rank of importance in this interview as in the literature. Besides *Caeiro et al* [3], *Arat et al* [1] and *Dowdall et al* [4] agree these are top priority soft skills to teach as both universities and students are most familiar with them and can be taught in a simple manner.

Being a good listener, transferring knowledge to the real world and social interaction and empathy were not mentioned by the participants but leadership did rank last in this research, similar to how it ranked least important in *Caeiro et al*'s results. The other categories were not mentioned enough to conclude any rank of importance within the category.

With these results, the conclusion of 'these students associate soft skills with team-based or individual learning processes' was reached. Interpersonal skills were associated with team exercises and how to tackle these exercises in a team setting by collaborating, presenting ideas and communicating. The intrapersonal skills showed how students motivated themselves to do what was right. These motivated actions included: initiative, openness to criticism/feedback and self-discipline by making their own planning. This last skill was however not explicitly mentioned by the participants. Lastly, the metacognitive skills and problem-solving skills mentioned were either rare occurrences of students having trouble reading scientific papers or associations with time-management skill. All participants however did fail to mention any soft skill falling into the problem-solving skills category. This category had the highest amount of skills in *Caeiro et al* [3]'s summation of essential skills so missing out on these skills is remarkable. Still, participants naturally work at these types of skills in the exercises when following engineering courses. Not mentioning the skills did not exclude the participant from practicing these skills. As for the reason why these skills were not mentioned, it could be a direct consequence of associating soft skills with a previously mentioned soft skill, which leads to sticking with a single category of soft skills. Having named teamwork, one would think more about skills related to interpersonal skills to continue adding examples of soft skills, instead of naming a skill of a different category. Another cause of missing commonly used soft skills could be because skills were domain-specific. Financial literacy could have been mentioned by economy participants but CS students would not mention such a skill as they had no need to use it in their study. The last cause of missing soft skills could be because nobody knew the skill was a soft skill. A prime example of this with our participants was digital literacy. They either did not know this was a skill or they would classify this skill as a hard skill.

Due to all the missed skills, only 2 out of *Caeiro et al*'s 18 essential skills [3] were mentioned: collaboration and presentation skills, which both fell into the interpersonal soft skills category. Compared to *Dowdall et al* [4]'s list of desirable skills for IT specialists, the participants scored better as they mentioned: the ability to work and communicate in multinational, intercultural and multidisciplinary teams and assertiveness as well. In this literature, a high level of English language skills was mentioned by the participant doing IT projects as well so even if *Caeiro et al* [3] did not consider this and other IT-skills soft skills. Lastly, given the program module of *Mangala et al* [2], assertiveness was said to be an important module yet again. Concluding, participants of this study prioritized a variety of soft skills for their study and future careers that had minimal similarities to important skills according to different literature.

6.1.3 University

As for how the universities can help improve all these skills, a variety of possible solutions were given:

1. Full course

2. Series of lectures with tips and tricks

3. Internships

4. Improve general organization of courses

The full course option was favored by two participants. One of them would like to see a mandatory soft skills course every year, the other would only need such a course in the first year. The second option, given by the same amount of participants, was to have a series of lectures with tips and tricks about soft skills, this would be given in a workshop style so that after several workshops, attendance becomes optional so only those who need extra guidance in soft skills would need to join. Thirdly, internships would be useful according to both participants and literature [1] [7]. Actively learning in a real environment would improve soft skills quickly and tremendously. Lastly, improving the organization of courses would be a general tip for universities. This better organization consists of: early deadline announcements, clear communication channels and a clear structure of the curriculum, then every student will immediately improve in all five categories of soft skills 3.

Seeing how the general trend is to stay in touch with soft skills every year, a solution such as a series of mandatory lectures about soft skills every year might be the best option so that every student can decide for themselves if they need more help while still being reminded of how important soft skills are every year. These lectures may become optional later but it would be wise for universities to display a full range of important soft skills matching both academic and corporate skills before students decide they do not want explicit training in these skills. Lastly, interpreting the academic help, these are all separate parts of data and ideas. There is no universal solution as to how universities can help teach soft skills. Still, the best solution would be a series of mandatory lectures followed by optional attendance in which the academy teaches all different soft skills. Another trend would be to have soft skills actively promoted every year so that everyone knows they exist and help is available if you find yourself struggling with them. The internship option was not very famous among participants but it would prepare the students for working in the corporate world.

Since an initial view of soft skills for CS students has been established 3, the university can also determine what soft skills they would like to teach to their students in the first place. Choosing a set of basic soft skills that are generally applicable to every study could contain soft skills that are mentioned often as students recognize these the best, regardless of whether students are already fluent in these skills. Were the university to give a more tailored solution to improving soft skills, they could look at Table 4 and pick the weaker skills. However, this research is not suitable for a generalisation of CS students so care should be taken into picking the right soft skills for CS students. The choice of setting a baseline dictated by the university, lecturers and employers, might be influenced by how commonly recognizable a skill is, what skills are necessary in a specific domain, what skills are generally applicable for every study and career, and what skills are in need of improvement from a student's point of view.

6.1.4 General topics

Naming skills was doable for all participants but ranking themselves in their proficiency of said skills proved to be hard for them. Soft skills they were strong in would be answered within seconds but examples of weaker soft skills needed more time to think before answering. Moreover, these weak skills answers would become vague or unclear. Phrases such as 'and that kind of things', 'or

something' and 'I guess' appeared more often in the responses related to this topic than any other topic in the interview. This could be attributed to shallow self-reflection or the participant having mentioned only skills they are strong in. In the latter situation, participants picked a strong skill they would like to improve further. This skews the data as it is not clear in the results what the participant truly thinks of these stronger or weaker soft skills.

6.2 Limitations

6.2.1 Expected limitations

This study was conducted among a small group of only 8 participants. Therefore data cannot be trusted to be a reliable representation of the full student body. Even though multiple channels were used to gather participants, only a few students were willing to participate. Recruiting more participants would allow for a better view of what bachelor CS students think of soft skills. This can be done using more channels, starting early with recruiting participants and following up with people as soon as possible. Nonetheless, eight participants did create a small image of the knowledge of soft skills among these students, which was the goal. The data is still relevant for at least the Computer Science studies at Leiden University. The soft skills corporations or universities deemed important were not compared to the results of this small group. Since this view came from bachelor CS students, it should be noted that this is a one-sided view of soft skills. It is possible for lecturers, studies, universities or employers in general to already have resources available to improve this image of soft skills for students.

6.2.2 Unexpected limitations

When gathering data 4.3, answers to the interviewer's questions were sometimes not straightforward enough to immediately make it to the transcription and analyzis step. Luckily, with a semi-structured interview, there is still room to improve data during the interview by asking more questions about the topic if the answer was vague or short, or asking to repeat a sentence if the participant did not articulate properly.

Furthermore, participants had a hard time coming up with skills they needed to improve. This made data harder to analyze as vague answers such as 'or something like those skills' or answers that were long but had too many different topics, made incoherent stories. A drawback of these longer answers was the motivation of the participant impeded the gathering of relevant data and instead added unnecessary details. One such instance was the participant talking about IT-specific skills. Their hobby was worth a lot of background information but half the skills they mentioned were not soft skills according to the literature used in this paper. Even the biggest collection of soft skills in this paper's literature [3] did not explicitly list programming, writing maintainable code or debugging as soft skills. Therefore, it might be useful to give a clearer definition of soft skills at the start or at least before they come up with soft skills themselves. These results show the distinction between hard - and soft skills is not clear for many students. Giving the participant more time to reflect or changing the interview questions to ease the participant into opening up about soft skills that need training would be an improvement.

6.3 Further Research

According to the results of known soft skills 5, most of the mentioned soft skills fall within the interpersonal- or intrapersonal categories. This bears the question of whether students know what soft skills are, as there are other soft skills that do not relate to interpersonal or intrapersonal gains in an academic setting. In further research, better examples of each category can be given, or more in-depth research can be done into what students define as soft skills.

Adding onto the interview examples, in further research, the interview itself could be more detailed. Going from general questions to more specific topics of questions already proved an effective flow of conversation, but noticing how students were struggling to name their own soft skills that need training, it might be more useful for the researcher to confirm the participants fully grasp the concept of soft skills before asking about their strengths and weaknesses in these skills.

Another more in-depth research can be done into what universities already do to improve the soft skills of their students. The questions asked in this interview were focused on what students thought they needed from the university. These suggestions were not checked against what the universities already offer their students to improve soft skills on their own or with help from the university. An interesting research could therefore be what resources universities already provide, and to what extent these available resources are used and contribute to a better understanding or use of soft skills in their students.

Lastly, only eight interviews were taken into consideration of which seven participants came from Leiden University. Further research could expand the scope of this research by conducting similar research with more participants from Leiden University, or it could provide national or international results by interviewing students from other universities. This can be done by interviewing a significant amount of students from chosen universities that will create insights into that specific university. Doing so with various universities, a national or international insight can be gained into what soft skills students of this scale deem important and what soft skills should be improved during university to match the corporate needs of soft skills.

6.4 Conclusion

After semi-structured interviews with 8 participants following Computer Science related studies at Leiden University and TU Delft, an initial view of soft skills in their studies was created. This is a very small group, making the results not suitable for interpretation in a generalized sense but still interesting to analyze. Students had different backgrounds which played a role in their limited knowledge about soft skills but the general picture is that there is a need for better education in soft skills for CS students as knowledge about this topic was limited. Students who had done extracurricular activities proved to be more refined in soft skills than students who kept themselves to their study's curriculum. The former mentioned mostly interpersonal skills because of necessary communication and collaboration with others mainly in the study Computer Science & Economics. The latter mentioned mostly intrapersonal soft skills which they would improve such as planning and openness to criticism/feedback. Most participants managed to name multiple soft skills but none of them included problem-solving soft skills. Instead, inter- and intrapersonal soft skills were the best-known categories and can therefore be considered most important for these students. The skills these participants would like to develop more are teamwork, presenting, planning, reading,

writing and leadership. Universities could focus on these soft skills these CS students would like to improve, or they may choose to teach a set of basic soft skills everyone should know, regardless of study. To improve soft skills, the best choices of academic help would be contextual learning in a prolonged internship, or to start a series of mandatory lectures showing the full range of soft skills. Later these mandatory lectures may become optional allowing students to join whenever they want to develop a certain skill.

With all the insights gained in this thesis, 8 bachelor CS students shaped an image of limited knowledge about soft skills but eagerness to improve themselves in them or perhaps more soft skills had they known a more detailed definition of the term soft skills. To help them, CS students, or students in general, develop soft skills, universities can implement a variety of methods with internships and series of workshops being the most prominent solutions as these apply contextual learning the best in this fast-paced world where soft skills are extremely valued by both employees and employers.

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