Educated to Learn

How to enhance the education of computer science and informatics

PAPER WITHIN Informatics
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“Education is not preparation for life; education is life itself.”

- John Dewey

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Abstract

The very nature of computer science with its constant changes forces those who wish to follow to adapt and react quickly. Large companies invest in being up to date in order to generate revenue and stay active on the market. Universities, on the other hand, need to imply same practices of staying up to date with industry needs in order to produce industry ready engineers. By interviewing former students, now engineers in the industry, and current university staff this thesis aims to learn if there is space for enhancing the education through different lecturing approaches and/or curriculum adaptation and development.

In order to address these concerns a qualitative research has been conducted, focusing on data collection obtained through semi-structured live world interviews. The method used follows the seven stages of research interviewing introduced by Kvale and focuses on collecting and preparing relevant data for analysis. The collected data is transcribed, refined, and further on analyzed in the “Findings and analysis” chapter. The focus of analyzing was answering the three research questions; learning how higher education impacts a Computer Science and Informatics Engineers’ job, how to better undergo the transition from studies to working in the industry and how to develop a curriculum that helps support the previous two. Unaltered quoted extracts are presented and individually analyzed. To paint a better picture a theme-wise analysis is presented summing valuable themes that were repeated throughout the interviewing phase.

The findings obtained imply that there are several factors directly influencing the quality of education. From the student side, it mostly concerns expectation and dedication involving studies, and from the university side it is commitment to the curriculum development process. Due to the time and resource limitations this research provides findings conducted on a narrowed scope, although it can serve as a great foundation for further development; possibly as a PhD research.

Keywords
Computing, education, higher education, curriculum development, theory and practice, computer engineering education, informatics
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# 1 Introduction

We live in the world of computer science, a world that is rapidly changing and always presenting new technologies, a world that requires constantly being up-to-date, a world where there is no pause. Due to the nature of our background and the life we choose to practice, having modern and latest education techniques and approaches is of crucial importance. It doesn’t take much to stay behind and as a result of staying behind one has a hard time of making progress. This master thesis reflects on finding out what it is students need to learn, while studying at the university, to successfully adapt in the industry. In the continuation of this paper you will learn how past students, now working in the industry, reflect on the time of their studies, what they have benefited from and if there is anything they could suggest regarding improvement. The second phase of the paper focuses on discussions with lecturers and/or program managers based on the prior findings. Finally, an analysis of findings is presented and discussed upon.

The plan behind this study is to provide us with a better insight about the current education practices and possible ways of improvement, all in the purpose of enhancing education of computer science and informatics.

## 1.1 Background

The main idea behind this thesis is to research for possible improvements when it comes to university studies in the field of computer science and informatics. I wanted to learn, directly from past students that have recently finished university studies, how they feel about their experience at the university, about the quality of the curriculum, about difficulties they had with certain knowledge areas and finally about suggestions for possible improvement. I’ve chosen to work with former students – now engineers in the industry, that have finished a bachelor or master program at the School of Engineering – Jönköpings University [1] (Jönköping Tekniska Högskolan - JTH) and lecturers and lab assistants at the Jönköpings School of Engineering. The study was carried out in both industry and university but the main focus of the research will be regarding the university and curriculum development. My hypothesis is that outdated curriculae might lead to studying now irrelevant matters which can result in not keeping up with the industry requirements. By adapting the curriculum to new technologies and practices, and even to what the industry requires, students ought to be better prepared to what awaits ahead (in the industry). From when the discipline “Computer Science” conceded, in the early 1960s and until now, curriculum development has been of vital importance and studies on this topic have been conducted ever since [2]. In several papers the authors state they have proven that redesigning curriculae lead to more interest for the specific program and that students were more satisfied with the output of their studies [3]. This research does not focus on studying the entire cycle after adapting the curriculum but rather if there is space for the curriculum to update and adapt to the current needs and how to do this continuously following the current needs.
1.2 Purpose and research questions

The purpose of this thesis work is to investigate what impact university studies have on an everyday job as a computer science and informatics engineer and how to best undergo the transition from theoretical studies to practical work within the industry. The focus will be on both the transition and on observing if there is space for enhancing their education through different lecturing approaches and practices and curriculum adaptation/development. This research problem is closely related to the university but might also be a valuable asset to the companies (if they chose to utilize the advantages). The university will benefit by gaining profitable information regarding the education practices their lecturers conduct, overview of their curriculum based on the current technologies/needs of the industry, and the ways students perceive this knowledge that is being taught. On the other side, this research focuses on finding out how knowledge learned while studying is being utilized in the everyday working environment (in the industry) and if it can be enhanced by connecting theory with more practice.

Based on the background of this thesis, the purpose and goals, and in order to successfully conduct this study, I defined the following research questions:

The main goal of the thesis work is investigating what impact the university studies have had on Computer Science and Engineers now working in the industry and how does the knowledge obtained affect their everyday job. This leads to the first research question:

- RQ1: How does university education impact ones’ job as a Computer Science and Informatics Engineer?

One part of the thesis work will be to investigate and evaluate the benefit of the internship courses and final exam work. This could include difficulties to understand and comprehend parts of earlier courses and how they relate to the internship courses and final exam work. This leads to the second research question:

- RQ2: How could the transition from university studies to practical work within the industry be improved?

In order to analyze the current curriculum and propose eventual improvements in regard to improving teaching techniques, practices and ways of getting information from the industry needs this thesis work will investigate what opinions do former students, now CS and Informatics Engineers in the industry, have on the curriculum and how they propose it should be improved. This leads to the third research question:

- RQ3: What measures could be taken regarding curriculum adaptation and development?
1.3 Delimitations

I am aware that a research of this kind has the capability of expanding in various directions, starting from the amount of universities covered, to the amount of subjects studied and the period of time under which the study will be conducted. Due to this being a master thesis I am not able to dedicate much time and resources and therefore am compelled to narrow down my research questions and adapt them to fit in the timeframe and quantum of this project. This thesis will work with a small number of former students now working in the industry and current staff at the Jönköpings School of Engineering in order to answer the three research questions. This thesis work is just one part of a possible larger research project that might even be realized as a PhD research in the near future.

1.4 Outline

After introducing the reader to the research purpose and research questions a theoretical background will be presented. The theoretical background will be presented in such a way that it covers each of the research questions as an independent heading, this practice will continue throughout the paper. Following the theoretical background the method and implementation will be presented, describing various techniques and approaches used. The largest chapter is the findings and analysis chapter where the findings are presented and analyzed. Finally, a discussion and conclusion summarizes the research and ties up the sack.
2 Theoretical background

In order to completely cover my theoretical background and give better understanding to the reader I have divided it into sections relevant to the research and research questions. The theoretical framework will cover the topics of curriculum development and teacher training, learning techniques and university to industry transition.

2.1 Curriculum Development and Teacher Training

Curriculum development affects the universities’ end product – the student directly. The very content of a program and specific courses shapes the students and their knowledge. Having modern and up to date curricula can lead to many benefits for both the university and students. According to a study conducted at the Stanford University [3], after redesigning the curriculum for an undergraduate in Computer Science (CS), the numbers of students applying for a major in CS was increased by 40%. After conducting a survey with newly applied students they learned that 36% of them applied only because the curriculum was redesigned. These numbers show that presenting up to date and modern curricula tends to attract more students, and having the lecturers adapt by providing sufficient training the education level will also be up to date and fresh. But having curricula up to date and following the industry needs is far from an easy task. There are many challenges when it comes to curriculum development but the biggest one, according to the ACM K-12 Task Force Curriculum Committee [4], is having the teaching staff properly trained. This challenge is followed by having content up to date and developing materials in regard to the newly developed curriculae. Having in mind that Computer Science constantly updates it is important to, even if the curriculum does not change, have the teaching staff adequately trained.

It is not only having a well-developed curriculum that is important, one other big challenge, presented by ACM & IEEE Computer Society [5] states that many students might feel that CS relates only to programming, and might be diverted from CS for that specific reason. The curriculum must be developed in a way to show all students that CS is much more besides this stereotype. It is advised to tackle these perceptions and develop extra-curricular activities advertising CS in its true potential because not all students study to become programmers, and not all students that finish CS end up working as programmers. Our research will show the students’ experience about approaching CS programs at the Jönköping University and what is their experience after completing them.

Having students experience the industry while studying might show them what possibilities await and they might connect with something specific. As Goode and Chapman [6] wrote, students need to work with real-world computing projects that address ethical and social issues and are culturally relevant. All of this while still delivering them fundamental knowledge. They are to engage in projects that demonstrate how things are handled in real-world situations. It is obviously very important to allow students to experience the real-world needs while still at the university, in order to better prepare them for what’s upcoming. This approach might require industry involvement with studies and both the university and the industry will benefit from collaborating.
2.2 Learning: Practice and Theory

The act of learning has been studied throughout history, especially learning practice and theory, where they collide, how do we differentiate between the two, and what is the best way to utilize them. Malmberg [7] states that humans best learn by analyzing and combining experiences, or in other words perceiving variations of *techne* knowledge. These variation techniques are probably the best way of providing quality education and providing education that will stick with the subject. Therefore, he advises to present solutions to problems from various different angles and changing the approaches. A very interesting model was developed by R. Bybee [8] which inspired Goode and Chapman [6] to adapt this model (see Table 1), well-known 5E instructional model, and create an inquiry-based learning cycle that will serve for teaching staff to develop approach strategies based on the behavior of students.

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1 *Techne* – Knowledge of; Craftsmanship; Craft; Art – Greek [tékʰneː]
Theoretical background

Table 1 - The Inquiry-Based Learning Cycle (Goode, Chapman 2011 [6])

<table>
<thead>
<tr>
<th>Stage of Inquiry in an Inquiry-Based Science Program</th>
<th>Possible Student Behavior</th>
<th>Possible Teacher Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engage</td>
<td>Asks questions such as, Why did this happen? What do I already know about this? What can I find out about this? How can I solve this problem? Shows interest in the topic.</td>
<td>Creates interest. Generates curiosity. Raises questions and problems. Elicits responses that uncover student knowledge about the concept/topic.</td>
</tr>
<tr>
<td>Explore</td>
<td>Thinks creatively within the limits of the activity. Tests predictions and hypotheses. Forms new predictions and hypotheses. Tries alternatives to solve a problem and discusses them with others. Records observations and ideas. Suspends judgment. Tests ideas.</td>
<td>Encourages students to work together without direct instruction from the teacher. Observes and listens to students as they interact. Asks probing questions to redirect students' investigations when necessary. Provides time for students to puzzle the problems. Acts as a consultant for students.</td>
</tr>
<tr>
<td>Explain</td>
<td>Explains their thinking, ideas and possible solutions or answers to other students. Listens critically to other students' explanations. Questions other students' explanations. Listens to and tries to comprehend explanations offered by the teacher. Refers to previous activities. Uses recorded data in explanations.</td>
<td>Encourages students to explain concepts and definitions in their own words. Asks for justification (evidence) and clarification from students. Formally provides definitions, explanations, and new vocabulary. Uses students' previous experiences as the basis for explaining concepts.</td>
</tr>
<tr>
<td>Elaborate</td>
<td>Applies scientific concepts, labels, definitions, explanations, and skills in new, but similar situations. Uses previous information to ask questions, propose solutions, make decisions, design experiments. Draws reasonable conclusions from evidence. Records observations and explanations.</td>
<td>Expects students to use vocabulary, definitions, and explanations provided previously in new context. Encourages students to apply the concepts and skills in new situations. Reminds students of alternative explanations. Refers students to alternative explanations.</td>
</tr>
<tr>
<td>Evaluate</td>
<td>Checks for understanding among peers. Answers open-ended questions by using observations, evidence, and previously accepted explanations. Demonstrates an understanding or knowledge of the concept or skill. Evaluates his or her own progress and knowledge. Asks related questions that would encourage future investigations.</td>
<td>Refers students to existing data and evidence and asks: What do you know? Why do you think...? Observes students as they apply new concepts and skills. Assesses students' knowledge and/or skills. Looks for evidence that students have changed their thinking. Allows students to assess their learning and group process skills. Asks open-ended questions such as, Why do you think...? What evidence do you have? What do you know about the problem? How would you answer the question?</td>
</tr>
</tbody>
</table>
How one learns to learn depends on the individual, and that was noted by Marton & Booth [9] who spent years researching the experience of learning. They claim that not every student learns the same way and not every student has the same perception of understanding aspects of the world. They came to a conclusion that humans learn by experiencing variation. This was also confirmed by Eckerdal and Thune’s [10] analysis, which showed that by presenting multiple variations to students, in lab sessions, students became more aware of other dimensions (of the learning subject). On the other hand, if there was no or little variation, the understanding was unclear.

I found many publications regarding the practices of learning, one of them being Marton & Tsui [11] which, through the framework they developed, explain that it is necessary to have a pattern of variation and sameness in order to master a specific learning object. Their framework helps identify critical features, and above mentioned pattern of variation and sameness.

But there were also other approaches to learning than focusing on variation, and that is through experiencing practice. Thus, Berglund & Eckerdal [12] conducted a research in order to learn about the relationship between learning practice and theory. Their research shows that learning practice and not fully understanding it actually triggers the students to turn to theory. In this particular case the students had very little fundamental knowledge of the topic and it was interesting to observe how they approached solving the problem. This approach might be a very good autodidactic method for many students learning programming experience and as such can be considered as a helpful method in their studies.

It is also necessary to reflect on how university studies form one as a person, and how students obtain knowledge while developing as individuals. Peters and Pears [13] adapted Entwistle’s [14] Theory of Learner’s Development diagram (see Figure 1) which states that development will lead to “changing as a person” and result in developing a “sense of identity”. The diagram shows that learning is a rather complex process and affects many spheres of life, also concluded by Marton & Booth [9].

A statement made by Pears [15] might lead to needs of drastic changes in current curriculae and program structure. He stated that the higher education scenery is soon to immensely change. His thoughts are that the university education is going to provide more of an individual experience with focus on the student. With these changes challenges arise for the universities to fulfill the needs of these individuals and assure successful interconnection between university, educator and students. My research shows that many former students think in the same way as Pears [15] and express the lack of “more branches” at the university. This will be further discussed in Section 4.

2.3 University to Industry Transition

When it comes to the transition from University to Industry students at Jönköpings University [1], according to the current curriculum, have some assistance from the IPC (Industrial Placement Course) and Thesis work – if they choose to work with a company. The IPC should help students experience how it is working in the industry and even help them gain contacts while in the industry. It should also make them reflect on what theoretical knowledge they need and make use of. On the other hand, they can choose to write their Thesis work in/with a company that accepts their proposal and therefore build a better relationship and open a door towards being hired after their studies are done. Malmberg [7] discusses broadly in his PhD thesis about the gap between industry and how to bridge it. He defines university and industry goals, and also states that the cooperation between the industry and the university
might be a good way of closing the gap. Further on he says that mutual cooperation might result in either positive or negative outcomes, where one or both parties might either benefit or lose.

The Jönköpings University [1] follows the CDIO Initiative\(^2\) [16] which developed and presented a framework that has the main goal of connecting engineer graduates with real-world systems’ and products’ needs. The vision behind the framework is to develop a curriculum that will ensure efficient simulation and connection with the real-world activities. This framework might be a perfect tool for bridging the gap Malmberg [7] mentions in his thesis and this research will also address these questions.

The CDIO Initiative [16] also developed a syllabus that helps universities adapt to the industry needs and therefore helps students better transition from university to industry. Crawley [17] presented three goals that motivated the choice of content and structure for this syllabus, and they were to:

- Create a structure whose rational is clearly visible.
- Derive a comprehensive high-level set of goals that correlated with other respected sources.
- Develop a clear, complete, and consistent set of topics to facilitate implementation and assessment.

The organization of the above mentioned syllabus is a combination and adaptation of several frameworks that have the goal of enhancing engineering education on the industry needs, and therefore trying to minimize the university – industry gap.

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\(^2\) CDIO Initiative – is an innovative educational framework that provides students with an education stressing engineering fundamentals in the context of Conceiving – Designing – Implementing – Operating (CDIO) real-world systems and products.
Theoretical background

Figure 1 - Peters & Pears [13] Slightly Adapted Version of Entwistle's Theory of Learner's Development [14]
3 Method and implementation

Due to the qualitative nature of this research I have chosen to conduct semi-structured live world interviews with university educated individuals. One of the main objectives of this thesis is to learn from past students, now engineers in the industry, how they reflect on the time of their studies and on their transition from university to industry. Therefore, the method I am using is an interview research, and even though it might seem pretty easy of a task, extracting valuable information, analyzing it and presenting to the public is everything but. According to Kvale [18] there are seven stages when it comes to research interviewing. They are presented and briefly describe hereunder:

1. **Thematizing an interview project** – As every other project, conducting an interview research has a theme of its own.

In my specific case I am to interview engineers that have at least a bachelor’s degree. After successfully completing interviews with my first batch of students (*students working in the industry*) I’ve proceeded on interviewing teaching staff (*lecturers and course managers*). It is obvious that my project has a theme closely related to education at the higher level and also programming.

2. **Designing** – In order to successfully design an interview research, the interviewer is expected to hold certain knowledge in regards to the research area.

I therefore utilized my knowledge obtained through my own education to carefully plan and design the entire process. Designing and approaching interview questions was of crucial importance since I needed to extract specific information from the first subject group in order to have material and address the second and third subject groups. Designing is probably the most important of these seven steps since it will play a huge role on the outcome of the research.

3. **Interviewing** – As many would say, this is the easy part. But on the contrary, conducting interviews requires great knowledge and strong professional conversational skills [18]. Meaning, that the interviewer needs to have sufficient knowledge on the topic to be able to *talk* with the interviewee in order to get the needed information. Even though the interviewer designed an approach, a set of interview questions, it is rarely so that all of the questions are asked or answered in a specific order. According to Guba & Lincoln [19] *the interview is just an instrument* when it comes to qualitative research. The purpose with the interview research is to let ensure smooth communication between the interviewee and interviewer.

I was not completely new to interviews and have luckily had very communicative interviewees. The entire interviewing process was very time consuming, especially finding relevant interviewees and setting up the schedules to fit everybody. Each interview was around 20 minutes and the targeted questions were addressed.

4. **Transcribing** – This might just be the most straight-forward job while conducting an interview research. The recorded audio recordings are transcribed from the audio format to a written (*digital*) format. It is important to have a specific approach towards transcribing and some Patton [20] suggested some measures to ensure this process goes well.
I have experience with transcribing and that came in handy. It takes rather some time to transcribe audio files but in this case it was very productive because I had the chance to go through everything once again and prepare important and interesting parts for analyzing.

5. **Analyzing** – The transcribed data will depend on the amount of interviews conducted and the length of the interviews. More interviews means more data needing analyzing and it is expected to have a rather large volume of material to work with. In this stage it is important to make the data meaningful [21], and analyzing on its own is considered to be the costliest and time-taking stage. According to Kvale [22] there are five methods for analyzing:

- Meaning condensation
- Meaning categorization
- Narrative structuring
- Meaning interpretation
- Generating meaning through ad hoc methods

In my case analyzing was probably the most difficult part, because I had to be very careful not to miss something, and find relevant answers to the research questions. I chose to present the data in two different ways, individual analysis and theme-wise analysis. All of the interviewees had observations and opinions of their own but overall a theme was visible. Good analyzing is what makes a good research so I put a lot of time and effort in it.

6. **Verifying** – When verifying traditional research terms, you need to determine validity, generalizability and reliability [21]. But with qualitative research, such as this one, verification of data correctness is conducted by addressing the source and confirming with them if the analyzed data really reflects on what they meant and wanted to say. Several other ways of ensuring data quality are presented by Guba & Lincoln [23] and they are credibility, confirmability, dependability and transferability.

Due to time and resource limitations I decided to conduct verification within the interview session, either directly after a statement was made or later on after the interviewee finished talking about that topic. I followed-up with questions that helped confirm my understandings and actually verify what the interviewee wanted to say. This technique was not optimal but it did provide verification that later on helped with analyzing.

7. **Reporting** – According to Sewell [21] if we want to adequately communicate findings, then the report must meet some accepted scientific criteria, meet ethical standards and be readable and usable for the reader.

It is upon the reader to determine if I succeeded in this step. Anyhow, I did follow common practices when reporting and tried to meet the necessary criteria. Constructive critics presented by other readers and supervisors were gladly taken and were addressed accordingly. Hopefully I managed to present the findings in a readable and usable way for you, the reader.

After successful completion of these seven stages and eventual refinement the qualitative research is brought to an end. During the course of the research it was
shown that the topic utilized knowledge acquired throughout my entire Master’s programme, ranging from programming experience that I had the chance to practice at the university, to knowledge about industrial project realization, process – methods and leadership. My personal experience regarding transcribing came as great benefit as I did not have any funds allocated for it. It was also very productive to go through the interviews one more time and make notes on things I might have missed while actually conducting them.
4 Findings and analysis

This chapter reports and analyses the findings obtained from the semi-structured interviews. As earlier mentioned, findings will be divided into two phases, general analysis and theme-wise analysis.

4.1 Computer Science and Informatics Engineers in the Industry

The qualitative findings from the interviews conducted with computer science and informatics engineers in the industry showed rather similar experiences whilst describing their university experiences and practices. It is important to mention that findings did vary according to the interviewee’s background as some interviewees had more experience before starting their university studies than others. These findings provided answers on the first two research questions “How does university education impact ones’ job as a Computer Science and Informatics Engineer?” and “How could the transition from university studies to practical work within the industry be improved?” but have also glanced on the third research question of “What measures could be taken regarding curriculum adaptation and development?”. The findings will be presented under quotes and the analysis will be done on a higher, or latent level of analysis, where I’ll deliver a rather interpretive analysis. I will follow the inductive approach of analysing. All interviewees will be anonymous and all will be addressed in a masculine form (He, His etc.)

The first interviewee, in further text Interviewee_1, holds a bachelor’s diploma obtained at JTH and has been working in the industry for the past two years. Interviewee_1 compared his job as a programmer to group projects he had at school, but just on a much larger scale:

“I think the best things we did was when we had group projects and did larger things for a longer span of time.” (Interviewee_1)

Later on Interviewee_1 reflected on above said and stated that:

“Maybe we can compare to these projects but on a very much larger scale or something…” (Interviewee_1)

When asked about the impact the university had on his job today Interviewee_1 stated that it probably has more impact than initially realized:

“Probably a great deal more than I think; I think much stuff is probably somewhere in the back of your head at least. There were good courses and bad courses, good courses I remember stuff, it taught me how to think in programming. A lot of that stuff is still there…” (Interviewee_1)

Regarding the transition from university to industry, and how to better prepare for it, after getting a job as a programmer Interviewee_1 said he thought he was prepared, but in reality was far from prepared:

“I fast learned that I don’t know so much. But as I said before, it’s a new place, you have to learn new stuff. I fortunately worked with a friend for 1.5 years so it was an easy way in for me. He had experience and I didn't have enormous pressure on me. I could take my time, but it was still a learning process.” (Interviewee_1)
Interviewee_2 holds a bachelor’s diploma obtained at JTH and has also been working in the industry for the past two years. Interviewee_2 had great interest in programming even before beginning his studies and came to the university with rather good knowledge of computer science and informatics. When reflecting back to the days at the university Interviewee_2 says that most assignments focus on “Does it work” rather on “How it works” and that it should be the other way around in order to better understand, stating that it should be about:

“How you should program, develop how you look at code. Teamwork, a lot of how you work in a team.” (Interviewee_2)

Because of this, Interviewee_2 focused more on autodidacticism3 and after graduation didn’t feel ready to go out to the industry:

“I don’t feel it gave that much. At school, it’s like very basic. I think what I use most is what I learned myself.” (Interviewee_2) and:

“I didn’t feel ready at all, because I didn’t feel like I had the knowledge to work. Although that was my first when searching for a job… What do I do when I start working? Do I, I can’t say what I know…” (Interviewee_2)

I followed up on this by asking if it’s possible to actually prepare individuals for specific jobs, because not everybody is going in the same direction. Interviewee_2 said that after his first year of studies he had a chance to choose web or hard programming. He was unsatisfied with the information provided by the school regarding the programs and he believes that these paths could be more specific, programming language oriented. Although, he stated that after his university studies he gained the basics, and a little bit of everything but would have rather he had specifics.

“When I studied, we had the first year, where everyone went and then the second year you could choose whether to go web or hard programming. I’d guess I’d rather see it be even more specific, I want to maybe work Java or .NET... I went web, and I don’t know why I chose that, I didn’t get enough info, I don’t like web.” (Interviewee_2)

Which lead to:

“.. now you have nothing, now you have the basics and a little bit of everything.” (Interviewee_2)

Unlike Interviewee_2, Interviewee_3 had no experience in computer science and informatics and the difference in opinions regarding how much university studies contributed and impact their everyday job is large. Interviewee_3 holds a bachelor’s diploma from JTH and is working as a developer and server administrator for the past 2 years.

“When I started in school I didn’t know anything about programming besides the basic stuff that I had done by myself... Then in school I gained a lot of knowledge but it wasn’t enough when you get into the real life.” (Interviewee_3)

Interviewee_3 states that, even though he didn’t know much, he took it upon himself to learn and he believes that this is the right thing to do, even while studying, to work on your own and improve more. University studies are all about learning how to learn,

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3 Autodidacticism (also autodidactism) or self-education is the act of learning about a subject or subjects in which one has had little to no formal education.
Findings and analysis

having the university provide basics and directions and leave it upon the student to study/learn accordingly. Investing in your own studies is what is expected from every student, and Interviewee_3 explains it pretty well:

“The reason I learned so much, well I think I learned so much, is because of it takes a lot of time and effort from you, and not a lot of people want to invest in that; and I did. But even after I finished school I felt like I didn’t know enough, and I still do. After, well, 2 years, I still feel like I don’t know enough – and I’m probably going to think that all my life...” (Interviewee_3)

Interviewee_3 reflected on his experience regarding courses at the university, stating that some were better than others and that some teachers had more passion towards what they’re teaching than others. Better teachers even attracted more students to their classes, and the difference was visible. Having passion for what you’re doing will give better results:

“Some of the courses were a little too basic. It depends on the teachers, because some of the teachers really went into depth of everything and some of them just scratched the surface. Some of them really didn’t have an interest in teaching that subject, and it showed in the education. It also showed in how many students came to class...” (Interviewee_3)

It is the “Why?” that matters, not the “If”, says Interviewee_3:

“The WHY - I always believed that as long as you understand something, you can always make it work. Not enough classes had labs that worked like that; most of them want to check out the box and see that you’re done...” (Interviewee_3)

After completing his university education Interviewee_3 was offered two job positions. One better reflecting what he learned at school and the other one where he had to learn new technologies. He decided to go with the second option and states that “knowing the basics well” helped him adapt in the new work environment but once again emphasizes the importance of the “why” it works:

“I think the only reason why I’m able to work at [Company Name] is because I really learned the basics good. So even though I didn’t learn any of the technologies I work with today, I did some basic stuff – but not deep stuff, and because I learned the basics I understood everything that I did. And that I do, even though I haven’t had any prior experience. I believe that teaching students to understand, and teaching them why they do what they do, is much more important than doing specific languages. As long as you understand the basics behind every language and how they work and operate, then I believe every student should be able to...” (Interviewee_3)

The difference in opinions between students that have great knowledge before applying to the university and those that don’t seems to vary regarding some questions, but it most definitely stays the same when it comes to the importance of investing in studies. Interviewee_4 holds a bachelor’s diploma from JTH and has been working in the industry for the past 2 years. His thought is that the university teaches basics, but:

“It was my own interest in programming, that I believe took me to where I am today...” (Interviewee_4)

Interviewee_4 also implies that if you do what the university expects from you, namely to study, take responsibility for learning, practicing and accomplishing, you will learn.
“The university is pretty good – if you take responsibility and really learn the fundamentals...” (Interviewee_4)

He claims that, after finishing the university, it was a rather tough thing to switch to industry, but again emphasizes the importance of being self-driven when it comes to learning both practice and theory.

“Since I took responsibility while studying, I was feeling kind of secure, I know I can do this but it wasn’t like, “I can do it and it’s very easy”. Because it was still a big hill to climb, but due to my responsibilities during my studies I think that I adapted pretty quickly.” (Interviewee_4)

Even this interviewee demonstrated how project work and teamwork at the university helps you better adapt to the industry’s needs and real life work. He believes that students should use the benefits of the university environment and test, explore and learn while being able to make mistakes, and by making mistakes.

“We had two courses that mainly focused on running and planning projects, and those were very good courses because then you tried out your wings at school...” (Interviewee_4)

He also mentions that it is important to continue with the same practice after you get employed because project work is where you learn a lot, from yourself and from others:

“I think that it’s important to become a part of project quickly after you start your employment...” (Interviewee_4)

Interviewee_5 holds a bachelor’s diploma obtained at JTH and has been working in the industry for the past 2 years, as a consultant, tester and programmer. He was very interested in technology and puzzle solving but had no experience within computer science and informatics prior to applying to the university. Interviewee_5 felt that there was an obvious distinction between students that knew how to do stuff, and those that didn’t and that the problem of “getting it done” instead of “how to get it done” was the main reason of their stagnation.

“There was a huge gap... and that made it, for us newbies, really hard because we felt so bad... The problem is, that we get an assignment – where we should do this and that, and if we get stuck, the teachers sat down and coded it themselves and then – here’s the solution. And you don’t learn anything with that...” (Interviewee_5)

Here we can see that it’s not important to solve the task as much as it’s important to teach how to learn. He also turned to improving through other resources in order to improve overall knowledge regarding the subject:

“And then I took some other classes, distance, from another school. Then I was really alone, I couldn’t get the help I get here (at the university). So then I had to learn how to solve the problem...” (Interviewee_5)

Interviewee_5 remembers that they had a teacher, that was actually employed in the industry, and that taught them things they’re going to use and gave them real life examples in order to better understand and prepare for the industry. This type of education was what stuck with us until today, says Interviewee_5:

“We had a course where the teacher was really great because he didn't work here. He did part-time teacher, but had a real job working in the industry. So, this is how it’s
Interviewee_5 believes his transition from the university to industry went rather smooth, and believes it’s due to the company that hired him and their approach to newly employed. At his first day he received an assignment in a project and a supervisor to work with. At that time, he had a lack of confidence in his skills but was confident as a person that he’ll be able to learn.

“You always doubt yourself when you go from school. It’s such a protected environment. And then here it was, the real deal. It was money involved, customers and everything. So I doubted, really, really much…” (Interviewee_5)

Interviewee_5 then made a rather contradictory statement saying that the school didn’t prepare him for the industry, but it laid the foundation. This directly relates to the expectations students have from the university and it’s important to elucidate what they’re to learn before the studies even begin. This way future students know what to expect and could take necessary measures to learn more, or learn until they believe they know enough.

“The school didn’t prepare me – but it laid the foundation…” (Interviewee_5)

Interviewee_6 holds a master’s diploma obtained at JTH, has been working in the industry for a year and spent the last year working as a researcher. Saying that every individual has a way of learning, and his was based on doing more practice instead of theory. He reflects back on some courses that helped him learn more, and learn better.

“Maybe other students have a different perspective, but for me the [course name] course was really good and I learned a lot. It was more practical instead of theoretical...” (Interviewee_6)

He believes that is important because:

“... in the industry they focus more on the practical things, not theory.” (Interviewee_6)

Interviewee_6 makes a statement that all the courses that focused mostly on practice instead of theory helped him while working in the industry, and those are the courses that reflect what you’re going to be doing in the industry.

“All those courses that are more technical and practical helped me while working in the industry...” (Interviewee_6)

But when asked what role did theory play for him, and if he thinks the master’s education should be mostly practice based, he acknowledged that it wouldn’t be good without the combination of both because both are important, but in his case practice is what helped him better understand.

“It would be wrong to have only practice, it should be the combination of both... but we should focus more on practice compared to theory because most students get into the industry, while only a couple continue with academics. There, the theory will help but you need to know how to do it practically...” (Interviewee_6)
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Interviewee_6 continued with the subject, and explained how important practice is for the university-industry transition, by far more important than the degree itself, he says:

“Practice will help you get in the industry quickly; you can adopt to things quickly. For example, if you know good theory, it will take time to learn different things (practice). This is why it has to be a combination of both, but at a master’s level you should focus more on practice ... the theoretical knowledge should come from the bachelor's...” (Interviewee_6)

Even though the master’s degree is higher than a bachelor degree it is not made to provide more practical knowledge, and should be considered as a preparation for research compared to the bachelor’s degree that aims to prepare students for industry. This was obviously not what Interviewee_6 expected from the master’s degree, and knowing what to expect prior to starting the program is of crucial importance for the students, and the final results. The interviewee had this view because he believed that more education will necessarily result in more practical knowledge, which is not the case.

“I don’t think my degree helped me get a job ... when I was searching for a job it was more about practical knowledge... It’s not right to think a degree can get you a job...”

Since Interviewee_6 now works as a researcher at a university he believes that the curriculum can always be improved, and mentioned a couple interesting viewpoints regarding the master level at JTH. His opinion is that the first year should be general for all in the program, but then in the second year students should choose a specialization and specialize in that specific field.

“Universities could make master programs with more specializations. The first year can be general, but the second year students should focus on a specific part.” (Interviewee_6)

Lastly Interviewee_6 concluded that:

“The education that came with this degree, this program at JTH, it improved – increased my knowledge, in a sense that it gave me more confidence, it provided theoretical background for various subjects.” (Interviewee_6)

Interviewee_7 also holds a master’s degree obtained at JTH and has recently started working in the industry. He works as a consultant software engineer and worked with various companies for the past 10 months and says he had no trouble getting employed after finishing his university studies and states that the master level worked with high level software development, and that was his ambition.

“I was interested in moving up through the layers of software development. During the master’s program we did nothing low level, it was all high level.” (Interviewee_7)

His current job requires from him to know several programming languages, and he gives credit to the university for being able to work with various technologies.

“By doing the master’s program, I got the mix I wanted...” (Interviewee_7)

Interviewee_7 states that everything he does and uses at his current job is connected to what he did at the university, and he often compares the two, comparing university projects with those at work.
“Since I’m still green, less than one year out of school, everything I refer to is from the time at the university, or projects from home. It (referring to school) still has a great impact on me.” (Interviewee_7)

While talking about practical and theoretical education Interviewee_7 states that it’s fun learning theory, but it’s more important for the industry transition to learn practice, and due to the lack of knowledge he had to take additional courses to get ready for his position.

“We had some courses where they taught us theory about something... that’s more fun for a student but it’s also less time spent teaching us about what’s actually contained in the standard libraries and so on. This is very important when you go out in the industry” (Interviewee_7)

A statement he returns to is:

“Theory you learn from school; practice you get from home or work...” (Interviewee_7)

Interviewee_7 suggests that school should better mix these two, and implies why this is important for future work (at the industry).

“The university should be a mix of it, the theory and the practice. Some courses are better at it than others, some teachers are a lot better than others, mixing good lecturing with good lab assignments...” (Interviewee_7)

“When you sit at home, if you don’t have the theory you’re sitting and working on something; sooner or later you’re going to get your application to work, but you don’t really know why. You don’t know what’s going on and in some areas, or in some businesses, THAT’S MOST IMPORTANT!” (Interviewee_7)

He says:

“I’ve benefited from group assignments, particularly group work, interactive work with teachers and students, other students...” (Interviewee_7)

and also invites teachers to interact more with students, ask inviting questions, help them interact with the class, claiming that this interaction will result in quality knowledge.

“Teachers should be more open, asking inviting questions...” (Interviewee_7)

He says that the luxury of having several chances to pass an exam, having teachers direct you in the right direction, doing stuff for you is all gone once you get an employment at the industry and that it is very important to realize this. He believes the university is trying to make experts out of students, but that also requires a lot of practice.

“The companies that require my services see me as an expert. They have a problem, I go there and fix it, do stuff for them, work on projects... I think the university is trying to do that, they’re trying to teach you stuff, make an expert out of you, but reaching the expert level requires some real practice, real practice time...” (Interviewee_7)
Interviewee_7 believes that investing in the additional education of our lecturers would be investing in the studies of future students:

“Everyone benefits from having education, taking courses, going to seminars. Listen to people, talk to people, participate in hacks or in workgroups, talking about stuff, testing stuff ... the only way you can become an expert in that is by trying to achieve more...” (Interviewee_7)

Having more control over what lecturers teach and even having lecturers learn from each other, using various techniques such as recording lectures and learning from other experts’ lectures is what can probably improve education over all.

“I think it would be a good idea for teachers to see what other teachers are talking about, they could use it or refer to it, direct students to explore more...” (Interviewee_7)
4.2 Theme-wise Analysis

In order to better summarize the individual analysis I have set up groups of answers belonging together creating specific themes that have been mentioned throughout the interviews. A brief description will be provided for every theme which will then be complemented with the answers themselves.

4.2.1 Learn by doing:

Some interviewees state that you will be well prepared if you work hard on the homework, project work and invest in your studies. They took what school offered and utilized that knowledge of ‘how to learn’ to ‘learn by doing’, and they believe that this helped them become better computer science and informatics engineers.

“The reason I learned so much, well I think I learned so much, is because of it takes a lot of time and effort from you, and not a lot of people want to invest in that; and I did. But even after I finished school I felt like I didn’t know enough, and I still do. After, well, 2 years, I still feel like I don’t know enough – and I’m probably going to think that all my life…” (Interviewee_3)

According to many, the importance of taking on that initiative – studying and complimenting university studies with additional self-studies is what defines successful higher education.

“The university is pretty good – if you take responsibility and really learn the fundamentals…” (Interviewee_4)

It was by now obvious that the approach to higher education and studying depended on the individual, and those that knew what to expect from higher education had more positive reflections on their time as students.

“Since I took responsibility while studying, I was feeling kind of secure, I know I can do this but it wasn’t like, ‘I can do it and it’s very easy’. Because it was still a big hill to climb, but due to my responsibilities during my studies I think that I adapted pretty quickly.” (Interviewee_4)

4.2.2 Solve or learn how to solve makes a difference:

The importance of learning ‘how it works’ instead of just having it work was mentioned throughout almost every interview. Interviewees believe that learning how and why something happens results in better understanding, and that getting stuff finished and just making it work won’t be that helpful. If teachers solve your problems instead of guiding you on how to solve them, you get stuck.

“The WHY - I always believed that as long as you understand something, you can always make it work. Not enough classes had labs that worked like that; most of them want to check out the box and see that you’re done…” (Interviewee_3)

The real question is how to address the issue of teaching “why/how”, and how to help students understand where the “why/how” is, how it happens and why it happens. It is the responsibility of both the student and the teacher to assure the “why/how” is clear, but if one side satisfies with only gaining the “it works” then the final outcome won’t be as productive for the learning student.
“There was a huge gap... and that made it, for us newbies, really hard because we felt so bad... The problem is, that we get an assignment – where we should do this and that, and if we get stuck, the teachers sat down and coded it themselves and then – here’s the solution. And you don’t learn anything with that...” (Interviewee_5)

Teachers are there to direct you and form a certain way of thinking that will help you best understand, but the very essence of learning how to solve lies within the student and their will to learn.

“When you sit at home, if you don’t have the theory you’re sitting and working on something; sooner or later you’re going to get your application to work, but you don’t really why. You don’t know what’s going on and in some areas, or in some businesses, THAT’S MOST IMPORTANT!” (Interviewee_7)

4.2.3 Group projects

Interviewees emphasized the importance of group projects, and how these actually best reflect how the industry operates. The diversity offered in these projects help students learn more about team work and how to act in certain situations.

“We had two courses that mainly focused on running and planning projects, and those were very good courses because then you tried out your wings at school...” (Interviewee_4)

The fact that these group projects aim to simulate the real-life environment helps students understand how to handle problems that come their way, and most importantly how to interact and benefit from working together.

“I’ve benefited from group assignments, particularly group work, interactive work with teachers and students, other students.” (Interviewee_7)

4.2.4 University studies laid the foundation

Many of the interviewees believe that the university studies can’t fully prepare you for the industry but does indeed lay a great foundation on which it’s not hard to build. Some may have expected more from the university studies but still acknowledge the presence of what they’ve learned at the university.

“Probably a great deal more than I think; I think much stuff is probably somewhere in the back of your head at least. There were good courses and bad courses, good courses I remember stuff, it taught me how to think in programming. A lot of that stuff is still there...” (Interviewee_1)

“I think the only reason why I’m able to work at [Company Name] is because I really learned the basics good. So even though I didn’t learn any of the technologies I work with today, I did some basic stuff – but not deep stuff, and because I learned the basics I understood everything that I did. And that I do, even though I haven’t had any prior experience.” (Interviewee_3)

That university studies are not only about learning various subjects, but also about growing as an individual is something Pears [15] covered in one of his publishing’s, and even though most individuals don’t notice it, they indeed do change as individuals.
“The education that came with this degree, this program at JTH, it improved – increased my knowledge, in a sense that it gave me more confidence, it provided theoretical background for various subjects.” (Interviewee_6)

Higher education usually consists of a Bachelor and a Masters level, where the Bachelor level has the aim of being more practical, whilst the Masters level focuses more on theory and research preparation. By doing the Masters level ought to gain a decent mixture of both practice and theory.

“By doing the master's program, I got the mix I wanted...” (Interviewee_7)

With time spent in the industry knowledge obtained from the university might seem to fade, but the new knowledge built on the foundation of university studies will be present.

“Since I’m still green, less than one year out of school, everything I refer to is from the time at the university, or projects from home. It (referring to school) still has a great impact on me.” (Interviewee_7)

4.2.5 Expectation from university studies

There was an obvious problem of wrong or unknown expectations when it came to university studies. Some interviewees expected to learn more while others suggested the university should offer more majors/specializations for students to choose from. If this is possible to accomplish is not the goal of this paper to find out and the quotes below represent views from former JTH students.

“When I studied, we had the first year, where everyone went and then the second year you could choose whether to go web or hard programming. I'd guess I'd rather see it be even more specific, I want to maybe work Java or .NET... I went web, and I don't know why I chose that, I didn't get enough info, I don't like web.” (Interviewee_2)

The mixture of theory and practice and how to gain the best out of them is always a challenge to accomplish. Some courses have more space for mixing than others do, and some teachers probably have more experience than others do and are more successful in doing so. Both theory and practice are vital in higher education because not everyone has the same projected learning outcome.

“It would be wrong to have only practice, it should be the combination of both... but we should focus more on practice compared to theory because most students get into the industry, while only a couple continue with academics. There, the theory will help but you need to know how to do it practically...” (Interviewee_6)

Knowing what to expect holds great value, and expecting great lecturing is just fair, mixing not only theory and practice but mixing teachers and students to work together can result in a win-win situation for both the teachers and the students.

“The university should be a mix of it, the theory and the practice. Some courses are better at it than others, some teachers are a lot better than others, mixing good lecturing with good lab assignments...” (Interviewee_7)
4.3 University Teaching Staff and Program Managers

The second part of this thesis work was directed to answering the third question “What measures could be taken regarding curriculum adaptation and development?”. In order to collect relevant data a program manager at JTH was interviewed, and the qualitative findings from the interview describe what practices JTH takes when developing a new program/curriculum. Even though the findings focus on answering the third research question, the interviewer tried to reflect on findings presented in the previous two sections Section 4.1 and Section 4.2. These findings will also be presented under quotes and the analysis will be done on a higher, or latent level of analysis, where I’ll deliver a rather interpretive analysis. I will follow the inductive approach of analyzing. The interviewee is anonymous and all will be addressed in a masculine form (He, His etc.)

From the very beginning the interview was aiming at finding out practices involved regarding program creation and curricula development. The interviewee briefly explained how a new program starts and all of the roles involved in the creation of one.

“A project for a new program would typically run for 4 years before the first delivery of the program – and you setup a project with a project manager and you have a steering committee and the steering committee works on what the courses should be and the progression of the courses, how they should fit together to make the overall package.”

Creating a new program at the university doesn’t much differ from a typical software engineer project, there’s a stakeholder, a targeted audience and there’s a batch of processes that need to be addressed before the project is complete. As with every project, creating new programs also has a lot of struggles that need to be addressed, but the main issue is:

“There’s a chicken and egg situation which is that, you have to have the right skillset to build the program. But if you don’t have the program, it’s difficult to get the people with the right skillset. Which of these comes first?”

This situation seems to be one where compromises have to be made and there is no easy answer. From what I understood, the issue should be addressed as the project runs and should be solved in a timely manner, but it is important to have in mind that it might not even be an issue but rather a great match of skillset/program needs.

Going deeper in the structure we see that all of the members of the committee contribute to developing a curriculum:

“All the members of the departments were able to contribute to what they thought, the list of courses should be. And then we expanded that into what the content within the individual courses should be, as a candidate.”

Here we see how courses and the content are developed and who contributes in the development. A practice which is very important is that the university consults with the industry regarding to the newly developed curriculum. They present the companies from the industry, also called “Advisory Board”, in order to get their input on the curriculum, feedback on how it can be improved etc.

“The first real step was when we had a seminar, so industry could send representatives to look at that. So we had that session. We very firmly got them to
prioritize the courses that would go into the new program, with the view of identifying core subjects and then the others could be electives, if required.”

He then states that it is very positive that the university uses companies to help them adequately develop their curriculae but there were also some disappointments because not a very large number of companies from the “Advisory Board” decided to participate:

“I think we have 15-20 companies representative on the ledningsgrupp (Eng. Advisory Board). We didn’t get 20 companies representative in that session, so that was a disappointment.”

Maybe it’s hard to get all of the companies to participate in such a forum but input from the industry was still received regarding the curriculum. They were also contacted to contribute in the development of the syllabus for the courses, which will later on have direct impact on what the students are taught.

“Beyond that, the next things to do was to actually put flesh on each of the courses. So we wrote a summary of what the course was aiming to achieve and a list of contents in terms of bullet points, which effectively created the intellectual foundation for the course syllabus. And we did that for all the courses that we were putting into the program. And that information was then sent out to industry and they were free to comment on it. And we, we got good comments– sorry. Good in the sense of deep, meaningful comments.”

Industry involvement plays a positive role in the entire curriculum and syllabus development as most of the students end up working in the industry. It is necessary to mention that not every program is developed in the same manner as presented above, and it may differ depending on the programs type, industry involvement, committee and managers. This was a practice for one specific program under the Computer Science and Informatics branch, now known as Software Product Engineering. The Software Product Engineering program was created from scratch, and as such allowed the managing parties to adapt it towards their ideas and needs. In regards to already existing and running programs, updating their curriculae may create additional challenges due to limitations caused by, relations built around the program, and the present structure and common practices involved. It is hard to determine if this process would be any faster or simpler than the process of creating a new curriculum.
4.4 Feedback on presented themes

After learning about curriculum development and analyzing the data collected, the next step was getting feedback regarding findings from the first phase. Some answers/quotes from former students, now computer science and informatics engineers in the industry, were presented and the newly acquired findings collected from JTH staff will be presented and analyzed.

In regard to expectations from the university, and the actual possibility to offer a wide range of majors/specializations, a conclusion that the amount of time is not sufficient to teach the amount of knowledge present.

“I think the– there’s a problem with any program of education, I think in general. You have a finite amount of time... As knowledge advances, there’s more and more knowledge to be acquired. And so, you end up with the breadth versus depth challenge within a fixed resource.”

When comparing the amount of time students have, 3 years for a bachelor and an additional 2 years for a master, the amount of knowledge that is actually available to teach by far extends the amount of time higher education has. It is also hard to determine what is relevant and hot on the market, so trying to follow with the industry needs is pretty much impossible. Especially now when so many different technologies are involved, it’s hard to know which one is most relevant, and the possibility to have more teachers requires more resources and there will always be constraints regarding those.

“So there is always going to be an element of being constrained by what resources, teaching resources you have. Then there’s the issue of how do you prioritize what is the hot stuff. And just because it’s hot, does that mean to say that it’s actually relevant?”

Following up with an observation in regard to “chasing the industry needs”:

“So actually, for a university, you don’t move at the pace of industry and you can’t because you can’t change that fast. Just changing a course is– because of the constraints a university is under, changing a course is a significant activity in terms of– I don’t want to use the word incorrectly, I don’t want to use it in a bad sense – there is a bureaucracy involved but it’s there for a very good reason, to make sure that the quality of the education is right. JU being a foundation is actually very, very flexible and we can change things very quickly compared to an average university. But there’s still a limit, how fast you can change. And reacting to the fads of the industry is almost certainly not a way to go.”

This information explains why the university can’t cope with the pace of industry and why it actually shouldn’t, because the industry needs are changing rapidly and it’s nearly impossible for a university to follow along. What is really the issue being the challenge of breadth vs. depth mentioned above. In order to tackle these challenges, the university tries to focus on teaching students how to learn, instead of teaching them everything there is to learn, because that’s not a possibility.

“Now when you do something, like for example, the agile project. We tell them (students), the agile project is not about the code, the system that you deliver - that’s important. But it’s the process that you engage in as a team to get that product. And that’s tough, tough message for students to follow. And I could go back into a very
cynical view about how we teach people— anyway, we— the very expression, how we teach people is wrong. It should be, how we help people to learn.”

In order to help students learn more, the teaching staff should engage into helping students learn. It is crucial for the students to learn how to learn, and to utilize that knowledge in order to learn ‘HOW’ things work, and not only that they work. According to the findings from the first phase, students are looking to learn how, but not every teacher knows how to do the above mentioned ‘HELP PEOPLE TO LEARN’. We can now see that the university staff is aware of the issue, and that they’re trying to address it, but again it all depends on teaching resources, teaching techniques and mostly student engagement and expectations.

Continuing on the same topic a discussion about the importance of group work started, and here the teaching staff expressed regrets that students, by law, have to be assessed as individuals, but they are most productive as a group, and they learn most while working as a group.

“When we develop a course, we put serious thought into how we assess the individual. But, it’s very difficult to get that right when we’re assessing for the individual, we have to by law, okay. But the bulk of the interesting stuff is done as a team and to actually, get into how a team have performed, is difficult.”

Both teaching staff and former students imply that group projects lead to learning on different levels and gaining relevant experience. Earlier in this thesis the CDIO initiative was mentioned but we now learn more about how the university uses it.

“One of the things about the CDIO initiative emphasizes for engineering is, the students shouldn’t be given simple problems. You know, like in a math class, here’s some multiplication questions to do. And you get them right or you get them wrong and it’s simple. So we try to foster in the practical work, the sense that there is no right answer that you can be judged against in an absolute way. You have to come up with an answer that is better or not so good. And you ideally should get feedback to tell you what’s good and what’s bad.”

As some interviewees from the first phase mentioned, it is also important to fail while at school and learn from your mistakes. This is exactly what the CDIO initiative implies at, learning from mistakes, but most importantly getting feedback from the teaching staff on what you have done, where you have made the mistake and why it happened.

“I think one of the key things that is in the CDIO, and you can read this in the pedagogy of how to teach engineering students, they need to have the freedom to fail. Failing is an education in its own right.”

As a final and concluding touch to this analysis an interesting observation is made by the senior lecturer, where he suggests involving students in reviewing and grading other students, and stepping away from the classical teaching model, into another model where the focus would be on teaching, learning, and not actually assessing and grading. Again, he alluded that team-work is very important, mixing various cultures and learning from each other.

“The best way to learn something, is to actually teach, to be involved. So it’s not a school policy but I think there’s a wide recognition amongst a number of the faculty that we need to actually move away from us assessing and get students to assess each other ... We need to do more to get the team work side...”
5 Discussion and conclusions

In this chapter I will discuss the method and findings used and obtained during this research and finally a brief encapsulation of the main points of the research.

5.1 Discussion of method

Due to the nature of this research and the source of information I chose to use an interview research method [18]. Using this method, the course of action included interviewing students and staff in order to collect valid data, transcribing the collected data and finally presenting and analyzing the findings [20]. The strengths of this type of approach lies in the semi-structured interviewing where the interviewee has the chance to fully express their views and opinions in regard to the research questions [22]. Playing the instrument of interviewing [19] correctly, I was able to gather data directly related to my questions. Also, the data collected comes directly from a legit and reliable source and is therefore considered valid and reliable to a certain degree [23]. As with every method, this method also has its weaknesses, and in my case it was the amount of time and resources required to conduct a broad interview research.

In regard to my purpose and research questions the interview research method adequately provided everything I needed in order to sufficiently collect relevant information. Development of a quality interview structure beforehand somewhat assured collection of valid data, in this case answers to my research questions. Designing and thematizing the interview sessions helped with developing an adequate course of action, which would later on reflect on the very findings. The interviewees were very communicative and were ready to share and express their feelings and opinions, which lead to collection of both valid and invalid data.

When I now reflect back on the overall research process I realize that there was room for improvement. The biggest challenge was appropriately scheduling and organizing the interview sessions so the data collected could be transformed to usable data (audio to text transcription) on time, especially because certain interview questions depended on answers from a specific target group previously interviewed. According to Sewell [21] in order to validate, you need to determine validity, generalizability and reliability. When it comes to a qualitative interview research you need to check with the source if they meant what they actually said. In order to do this, you can either reflect on the analyzed findings later on or confirm directly after the statement was made within the interview. In order to assure the requirements of validity I confirmed with the interviewees during the interview session [21]. On the other hand, validity of the findings strictly depends on the source and can not be easily proven. Due to many sources having shared similar opinions and experiences the collected data may be considered reliable. Therefore, the validity and reliability requirements can be considered as well met.
5.2 Discussion of findings

As mentioned earlier, the purpose of this thesis work is to investigate what impact higher education has on an everyday job of a computer science and informatics engineer. It also focuses on learning how to best undergo the transition from theoretical studies to practical work within the industry. In order to achieve a stable structure in the discussion of my findings I will use research questions as headings and discuss the analyzed findings accordingly.

5.2.1 How does higher education impact ones’ job as a Computer Science and Informatics Engineer?

The main goal of the thesis work was investigating how does higher education impact a job of a CS and Informatics engineer. The analyzed findings present two types of former students and now engineers, those who knew what to expect from the university studies and those that were not that clear with those expectations. Based on this fact, two different categories of answers were presented.

Those that knew what to expect from the university studies actually embraced the knowledge presented by the university and built on it, utilizing various practices in order to achieve better results and accomplish self-set goals. These students had quiet positive reflections in regard to their time at the university. On the other hand, students that did not know what to expect from the university studies, or which expected more than they received, developed a more displeased opinion. Both did indeed refer to courses and practices that helped them with their jobs, and some even acknowledge the presence of what they have learned even after a couple of years working in the industry.

A common comment is that the university studies laid the foundation, and as we know a good foundation is of crucial importance for every building, in this case the building of knowledge – theory and practice. Some expected more than just having the foundation, whilst others decided to build while still at the university, using additional materials provided either by the university staff or other sources. My observation lead to an understanding that students do not realize how much they learn until they reflect back from a somewhat neutral point of view.

All of us perceive studies in a unique way so an accurate answer to this question was not received, however a pattern was noticed with all of the interviewees [13]. As the interview progressed, they realized more and more how university studies impact their job, finalizing the interview with providing constructive comments to current and new students.

5.2.2 How could the transition from university studies to practical work within the industry be improved?

The second research question investigated and evaluated how the university to industry transition may be improved, mostly the benefit of the internship courses and final exam work. This was discussed both with former students and university staff.

Comments and opinions received from former students depended on the placement a particular individual had during their internship course and/or thesis work. Some had the chance to work directly with companies, which later on helped them either to get a
position at those companies or search for other job openings [7]. Many claim that graduating was just the beginning, and that the real work begun with the process of searching for a job. Others had the luck of being recruited straight out of school, based either on their internship courses or thesis work. No matter the case, all claim that you start to practically develop when you begin working.

While discussing with the university staff they expressed their gratitude to the industry because of their involvement with students, nevertheless urging them to commit even more in order to help prepare engineers to their liking. Here, once again, we discussed the benefits and ideas of the CDIO framework [16] and how both students and the industry benefit from it.

It was obvious that the university alone cannot smoothen the transition from theoretical studies to practical work; it should be collaboration between the university, industry and student.

5.2.3 What measures could be taken regarding curriculum adaptation and development?

I interviewed appropriate university staff in order to analyze the current curriculum and discuss practices and ways of getting information from the industry needs. The findings from these interviews provided answers to my third research question on what measures could be taken regarding curriculum adaptation and development.

My findings show that the university puts efforts into their curriculum development and most importantly they invite industry representatives to contribute. This way the curriculae are designed in a specific way covering both university goals and industry needs, as much as it can of course. Even though the industry involvement is present and applauded by the university, it is still far from the degree of involvement the university wants and aims to accomplish. I learned that curriculum adaptation and development is an ongoing process and that it is closely monitored by the university staff, but also that it’s a process that requires time and resources to fulfill.

Interviews with former students provided mixed opinions regarding the curriculum at JTH, ranging from it being insufficient and non-directed, to it being good and specific. These opinions are results of expectations individuals had, and some of them even confessed to not knowing what they should expect, none the less what awaits during their studies. This was later on confirmed by the university staff acknowledging that knowing what to expect leads to better results and more efficient studies.
5.3 Conclusion

The research conducted shows that former students, now Computer Science and Informatics Engineers in the industry still reflect back on university studies while working with their everyday job. Some acknowledge that they daily reflect back on what they have learned while others state that the foundation the university studies laid is there and will always be present. The biggest impact theoretical studies provide are the guidelines and basis for students to endure any obstacle set upon them.

In regard to the transition from theoretical studies to practical work students should make best out of the internship courses and thesis work as these have proven to be very helpful for many of the interviewees. The university is trying to involve the industry as much as possible in order to ease this transition for the students. The collaboration between the student and the industry is a key role for an easier transition.

This research shows that curriculum adaptation and development is a process that involves all three sides, university, industry and students, and that it requires time to develop a curriculum. The quality of the curriculum highly depends on the approach of the university, leader groups, in our case industry involvement and overall encapsulation.

The purpose of this research was answering the three research questions: “How does university education impact ones’ job as a Computer Science and Informatics Engineer?”, then “How could the transition from university studies to practical work within the industry be improved?”, and “What measures could be taken regarding curriculum adaptation and development?” and providing relevant information for both the university and industry to use. The university will benefit from learning the opinions of former students and by addressing their concerns. On the other hand, the industry may benefit by involving more with the students preparing and tailoring them in a company specific way and benefiting from that by receiving future personnel directly after graduation.

This master thesis can serve as a foundation for future research either on the same level or preferably on a higher level as a PhD research with more resources and a broader spectrum.
6 References


