Interview Report

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Abstract

This report bases on the interview with a senior engineering faculty. The focus of the interview was on the professor's experiences in teaching and academia. The informant has discussed topics related to issues in the current educational system, implementation of technology in teaching and learning, along with potentials for improvement of the current system. The interview analysis focused on the framework and essential factors for change of the current educational system. Input to engineering education from k-12 is determined as a critical factor. Finally, recommendations for improvement of engineering education through integration of k-12 education are presented and discussed.

Interview report

Introduction

This paper bases on the interview with a senior engineering faculty. The main theme of the interview was on the professors' experiences in teaching and academia, especially those related to the application of teaching innovations and technology in the engineering education. Other themes that the interview was aiming to discuss were relation of relation of engineering and k-12 education, working environment in academia, a perspective from a specific engineering field, along with interesting opinions, examples, and overall wisdom transfer. This paper is describing the research method, findings, conclusions and reflections in separate sections bellow.

Method

The method used was an interview. This method of qualitative research (Gottlieb, 1986) seeks to cover both factual and meaning level data. As a more personal research method, interview is focusing on understanding the meaning of story behind the participant's experience. It is important to emphasize that the interviewer had no previous practical experience with interviews, and only limited knowledge in questionnaires. Since interviewer is a part of the measurement instrument, the transcript of the interview is provided in the Appendix I, at the end of this paper. This would allow further independent analysis by other researchers.

The interview itself was planned for 60 minutes. However, the actual conversation with informant lasted for around 95 minutes, with the discussion before and after the time limit. The interview was recorded only with an audio recording device. The location of the interview was in the student lounge with a slight noise from the next room. The time of the interview was right before lunch. In addition to that, during the first half of the interview, another senior faculty was present in the same room. At the end of the interview there were students coming into the lounge. All these factors have not resulted in the optimal environment for obtaining the interview and the investigator has taken those effects into account while performing the analysis of findings.

There are several additional observations related to the course of the interview. First, they relate to non-verbal gesticulation and other visual sensor information, that was determined as crucial in understanding some of the informant's statements – especially considering that there was a third person in the room. Second, note taking, although used for providing additional information, was also a partial distraction, especially during longer notes. Finally, the investigator noticed the value of having several techniques for directing the course of the interview.

Findings and Discussion

This section presents the summary of the responses to the questions asked and discusses them in the context of relevant literature. The informant has discussed a wide range of topics throughout the interview. This section presents only selected findings and relevant discussion in groups in the sections bellow.

Findings and discussion on the informant's background

This section presents the findings about the informant's personality and background. They are used to provide information for some of the latter findings. Informant is a senior faculty for around 10 years at Department of Computer Science at Virginia Tech. Informant received education from Harvard and Stanford University. From the information provided, the informant had a several points of identity change throughout the lifetime (Gee, 2000; A. Johri & B. Olds, 2011; La Guardia, 2009), that reaffirmed some psychological theories that state that individual identity constantly transforms. The informant's identity varied from a linguist doctor, poet, software engineer, to a professor. In addition to this, it was evident that high quality education in k-12 and a stimulating family environment was influential on developing a strong knowledge base, working ethics, and wide range of interests (Bransford, 2000). The informant also had a dynamic professional career, having changed positions several times. It can be concluded that the career dynamic is correlated to different identities developed throughout the lifetime. The informant was working in different interdisciplinary environments, both in industry and research organizations, which provided the informant with a very broad perspective on engineering. The informant personally experienced learning through apprenticeship model based on self-initiative learning computer science from books and colleagues (Mayer, 2002). The informant had achieved significant results in the apprenticeship style learning, which further motivated the informant to develop a new approach to learning programming. This new approach was assuming a beginners approach (for dummies) where the programming examples were taken from real life and children games instead from abstract science concepts. In addition to the working experience, the informant had teaching experience in k-12 and training experience in the industry.

The informant has quoted (Menand, 2011) while describing personally perceived college roles. The aforementioned article states that college roles are sorting mechanism, socialization, and professional training. The informant has the opinion that selection of the career should be primarily personal instead of teaching goal. The informant emphasized on the socialization as the primary and professional training as the secondary college role. The informant further concluded that the rise in the emphasize on professional training has negatively affected the general approach to teaching. In addition, the attitude of students is also affected, since they are more looking for knowledge of small and straightforward skills then an integrated “state of the mind” engineering approach.

Issues in the current educational system

The informant has provided extensive examples and opinions regarding the issues in the current educational system. Right after the arrival at Virginia Tech, the informant has conducted a series of interviews with faculty. Information obtained from these interviews were not published, but the informant provided some detailed findings from those interviews.

The informant has noted that there was more nuances then systematic change observed in the educational system. The informant stated that there are professors that do care about teaching but that they are essentially fighting “an uphill battle” and have to face too many challenges. In the interviews, some faculty had the opinion that if students “work hard” they will learn, considering that just spending more time spent on task is enough, and not taking into consideration the effectiveness of that time spent (Bransford, 2000). This is essentially resulting in the teacher’s expectations for internally driven students.

The informant provided information on the approach to teaching in the Department of Computer Science at Virginia Tech. The approach to teaching war primarily top-down, with the introduction of complex concepts from the start. The informant is in the opinion that this approach is often hard to understand. In addition, the informant stated that the teaching approach for computational thinking in Computer Science (CS) emphasizes the capability to deal with large systems, primarily in the defense industry. This teaching approach is further related to students’ avoidance of questioning the established frameworks, the expectation to be constantly externally motivated (Eccles & Wigfield, 2002; Svinicki, 2008), and limits in the flexibility for future work in places such as Google that operate with more modular systems. In overall, the informant thinks that current teaching approach is not creating great thinkers in CS. In addition to these issues, the applied top-down approach is more suitable for students that have prerequisite knowledge on computer programming. The informant considers that this creates an entry barrier into CS, since people that take programming courses in high school have very developed logical intelligence or devalue other subjects. In support to this statement, the informant exemplified a very low percentage of females in CS at Virginia Tech (4% in last several semesters).

The informant noted the lack of teaching ethics in CS only in one class and not throughout curriculum as one of the further issues in current educational system. In addition, ethics in CS are different from other engineering fields that have Professional Engineering licenses and established practice/manuals. Some of the students, in contact with students from Ireland, did not have basic understand why are there some ethical issues questioned. Finally, informant noted that students often feel the requirement of creativity in engineering to be the reason for anxiety, since students do not necessarily have these skills developed earlier in k-12 education.

Technology implementation

As one of the planned themes of the interview was innovative implementation of technology, as a part of innovative teaching applications. In general, the informant had good and bad experiences with technology, and a conclusion is that simple deployment is not necessarily going to have positive effects. Technology deployment is often an excuse to employ smaller number of teachers, reduce their expenses and salaries, and expect more. The informant discussed the actual implementation cases, specifically expressing suspicion about deploying technology for distance learning. Presented reasoning is that other factors that can significantly positively or negatively correlate to the capability for learning are often disregarded. The factors discussed were previous education and social investment and impact of current societal network that encourages specific behavior (Brown, Collins, & Duguid, 1989; Felder & Silverman, 1988; Greeno, Collins, Resnick, & others, 1996; A. Johri & B. M. Olds, 2011). This opinion has support in previous learning theories that emphasize on situated cognition and contextual learning. This further relates to individuals identity and sense of purpose, especially for attention-management as the most important component of the learning.

Another topic discussed in the interview related to communication between professors and students through instant messaging software. Although this technology can be used for successful communication between professor and student, informant has observed drawback that that students do not have proper consideration of professor's time. This is the main reason this professor is not using any instant messaging tool, although it did used it during the career in industry. In addition, the informant is firmly against the usage of computers in classroom, unless they are necessary for particular task in class. The informant in under opinion that computer usage has detrimental effects on the attention of students.

As a part of the previous research, the informant has participated in developing a tool for collection and anonymous distributions of student's opinions during class. This is envisioned as collaborative tool designed to aid facilitated discussion while supporting discussant's coordination. The software is designed with easy-to-use interface with windows for thought input and distribution. The design of ThoughtSwap maintains discussion's flow and level of participation, while letting students overcome certain difficulties (Dickey-Kurdziolek, Schaefer, Tatar, & Renga, 2010). The tool provides additional capabilities in comparison to other tools such as online surveys, wikis or Google docs.

Finally, the informant has discussed the need for children in k-12 education to learn to be computer users. This included the discussion on k-12 standards of learning that are not looking into future and that are not introducing engineering thinking at this early age. The informant has started with a project to introduce computational thinking for 8^{th} grade children. The idea is to introduce engineering thinking approach to children in their middle school education, as a period of life when they are mature enough to understand some concepts but not overly immersed into preparation for college. Computational thinking is not intended to be a subject in itself, but it will be background topic of already existing science.

Potentials and recommendations for change

The informant has pointed out several potentials for improvement in the current education system. Most of them were spread throughout the interview while some were stated as an idealistic desire in the conclusive remarks. The informant stated that there is a desire by students to deal with interesting things, in addition to obvious monetary benefits that being a computer scientist can bring to an individual. This desire can be identified as the basic psychological need for autonomy, competence, and relatedness (La Guardia, 2009). Furthermore, the informant emphasized on the need to introduce alternative approaches to learning programming. This is partially already achieved with an introductory course now available in CS department – Media Computation. The informant further presented the recommendations for focus on language and music in early children education, along with improving standards of learning in k-12. There was a remark regarding the need for improvement in communication between students, professors, and administration, due to the evident lack of feedback between all the involved sides. Other recommendations were the need for more career pathways in CS, reduction of breadth and class size in introductory engineering classes, and a need for Bachelor of Arts in CS. The informant's conclusive remarks related to the desire that students need to become intelligent people, open-minded, outside-the-box thinkers, effective communicators, prudent, self-critical, and consistent. Teacher's role in all these is to provide students with an exposure to material that will enlighten and empower them as future citizens.

Conclusions

During the course of the interview, the informant discussed a broad range of topics, which were evidently a result of previous reflections. These reflection could have come from informants' motivation based on previous teaching experiences and involvement in teaching technologies research. The informant has discussed topics related to issues in the current educational system, implementation of technology in teaching and learning, along with potentials for improvement of the current system. The informant identified many issues in the current system of engineering education, starting from the classroom up to the institutional levels. In addition, the informant concluded that technology is frequently improperly used for achieving poorly designed requirements. As a result, the informant's opinion is that the system is nurturing the environment of ego-involved and performance-oriented student's goals (La Guardia, 2009).

The focus of all the informant's opinions was in finding the potential methods or techniques for improvement of the current state in CS education and related computational thinking among students. Expanding informant's discussion on potential improvements to a general engineering education, there is a need to first define the functions of engineering and engineers on this wider scale. The prime function of engineering is to create products or product-related techniques (Donald, 2002). This requires a broader set of skills, mainly related to reasoning and learned through practice. In comparison to science, engineering often goes beyond applying a formula, since it requires justification, adaptation, and integration of knowledge into a problem-solving process. Due to the distinction between engineering and other subjects in content, purpose, and process, a successful engineer in a modern world with rapidly changing technology, globalization, outsourcing, and corporate downsizing, faces significant requirements. Topics such as communication, teamwork, lifelong learning, understanding ethics and professionalism, work in the global and societal context, knowledge of contemporary issues, higher-order thinking, design process, adaptive expertise, structural organization, synthesis and analysis skills, approximated modeling, etc. are all different aspects of the “required knowledge” for a new generation of engineers (John et al., 2010; Johri, 2011). This pressure for constant expansion of engineering skills and technological expertise mainly originates from the industry.

The current system of engineering education cannot often fulfill all these requirements, especially if we consider the inbuilt diversity among different engineering areas, which frequently require specific skills and mindsets. In order to achieve the change, learning (cognition) and self-awareness (metacognition) needs to be achieved on the individual, group, and institutional level, thus leading to intuiting, interpreting, integrating, and institutionalizing processes (Crossan, Lane, & White, 1999). Only the coordination of previous three (meta)cognition levels can lead to the related four processes that enable change. The system factors affecting these four processes can be classified as external, inter, and intra factors (Figure 1). Technology development and federal administrative regulation can be considered as examples of the external factors. University organizational management and teaching excellence culture can be some examples of internal factors. Issues of individual’s identity, motivation, and habits can be considered as intra factors for driving the change in the present engineering education system.

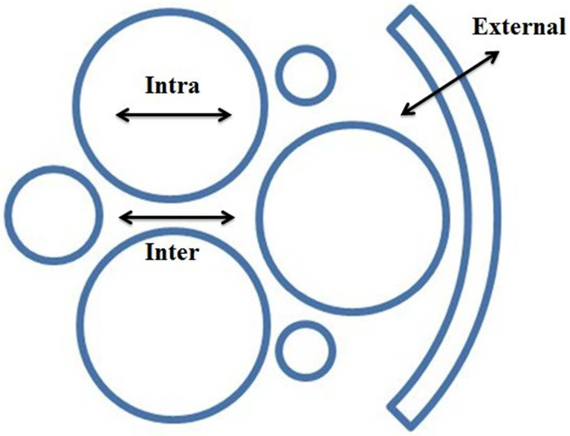

Figure 1: Directions of factors affecting the change in the educational system

Taking into consideration that although there needs to be a coordinated effect of the previous three levels of (meta)cognition, the change primarily originates from the lower levels (individuals and groups). This further leads the conclusion onto the importance of intra system factors – especially the issues of identity, motivation, and social context of/for individual's development. The importance of intra-individual factors is one of the main points that the informant has discussed, providing an example related to distance learning.

Reflection

the analysis of informant's discussion pointed out the importance of the intrapersonal factors in determining the status of the current educational system. However, research in engineering education is often focused on the intrapersonal factors inside this system. Considering this as an external factor, that in time, becomes intra factors (as teenagers mature and apply for college) the intrapersonal features of the input to engineering education is as equally important as the intrapersonal features of the students in the engineering education. Any neglect of parents and k-12 teachers as primary socializing agents, affects the current engineering education system and its potential recommendations for improvement. Engineering education often emphasizes on the idea of thinking and understanding over memorization, so this is the main reason it should establish relations with the early education. This way, the engineering education system would not end up trying to fix the gaps left by k-12 or parental education – as it is now resulting in a continuous pressure to expand undergraduate engineering curriculum.

The most recent study conducted by Intel Corp. whose results were published December 6th 2011 focused on the teen's perceptions of engineering as well as motivations and barriers for pursuing or not pursuing a career in engineering ("Survey of Teens' Perceptions of Engineering," 2011). This study was conducted among 1,004 teens (aged 13-18) with computer access. Some of the key findings of this study were:

- Teens have generally positive opinions of engineers and engineering.
- Consideration of career in engineering is low due to the lack of familiarity with engineering as well as perceived difficulty.
- Learning more about engineering field plays a major role in choosing a career and this can present a significant barrier.
- Exposure to any kind of engineering dramatically increase the number of teens that would consider career in engineering.
- Financial benefits, interest, gratification are key areas that can drive the consideration of engineering as a career.

Other interesting findings are:

- Engineers are considered as smart for those that are not considering engineering.
- Engineering as a career is difficult and even boring for those that are not considering it – more of gratifying and collaborative for those that are considering it.

- People who choose engineering think it will be interesting and can have positive impact on society but also highly paid.
- Teens are more familiar with doctors, police officers, lawyers, and professional athletes then with engineers.
- Currently, around one-third of teens cannot name any potential job opportunities in engineering fields.
- Fifty-three percent of teens in the study said they were more likely to consider an engineering career after they learned that engineers help make music, Facebook, and video games.
- Majority of girls think that engineering is difficult first and foremost and they are harder to convince to consider engineering.
- While all the teens found computer and software engineering to be the most fascinating area of study, the study showed that only girls were more likely to be interested in architectural engineering.
- Research shows the majority of students who focus on science, technology, engineering and math in high school, follow the path in college.

The findings of this study, although not based on a large statistical sample, are casting an interesting light on the issues of the input to engineering education. Fear of the unknown and long list of misconceptions (e.g., engineers need to be excellent math and science) related to engineering rise two very important questions:

- Is the current system structure “weeding out” the real non-engineers by limiting their access to engineering education?

- Is the system properly using the potential to develop skills required for modern engineers early in the education?

From this perspective, the two main points for educating teenagers in addressing the lack of familiarity and early development of some engineering skills are:

1. Educating **what** engineers do
2. Educating **how** engineers do

Educating what engineers do

Information on the types of work engineers and their experiences could break the preformed misconceptions among teenagers. Considering that the target population is between 13 and 18 years old, the information could be distributed through shows/educational material on television, video games, or comics. Potentially, this education can focus on following topics:

- Engineers transform ideas into reality.
- Engineers have high positive impact on the society.
- It is rewarding to be an engineer, not just merely difficult.
- Engineering is a multifaceted field with many intriguing areas of specialization and job opportunities.
- Engineers are inventive and cool.

Educating how engineers do

Introducing Fundamentals of (Practical) Engineering in the period between middle school and high school has the potential to introduce teenagers with some basic concepts in engineering thinking. Just as the k-12 education has science and art classes, it would be natural to have basic engineering classes, while the consolidation of concepts would be accomplished later during the undergraduate education. Early hands-on experience with engineering problems and design can have the potential to introduce the teenagers to the concepts of: synthesis, ordering information in importance, identifying, organizing, and modifying critical relations and elements, facing unstructured problems, elaboration, generating missing information, comparing alternative outcomes, validation, group work, performance monitoring, engineering ethics, etc. All these elements are frequently required by engineering students from the start of their undergraduate education, but could start to develop earlier in the children's education. In addition to this, increase in number of engineers in the k-12 curriculum design, administration, and teaching could strengthen the educational foundations obtained in k-12 and relate it to actual requirements for engineers. This would consequently include attract a wider range of diverse thinking teenagers – especially since spatial, naturalistic, kinesthetic, and visual thinking might be more important than logical cognition for some engineering disciplines.

Conclusive reflections

Informing students about engineering careers and introducing engineering state of mind during k-12 education has a potential to make students reflect more and make informed decisions on their careers. However, introducing engineering education into k-12 would need significant coordination between with higher education systems, in order to achieve desired effects. Since a significant experience or studies on these examples does not exist, there is an essential need for extensive research of engineering education introduction into k-12.

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Appendix I – Interview Transcript

Figure 2: World cloud of the interview (People before Technology)

MM: Can you tell me what was your own academic path, starting from college education?

DR T: Actually, let me start far back in time. I went to four different public elementary schools, for various reasons. But, eventually I was sent to an extremely fancy and elite private school for girls in New York, where the classes were fabulous – a whole different world intellectually! I then ended up in Harvard, where I majored in English literature. I was going to be a doctor, and did my premed. That was my vision – to be a doctor and a poet. In the meantime, I helped found a cognitive science society there. This is how I met people at the AI lab at MIT, where I worked as an administrative assistant for 9 months – this was a LOGO lab, which was a computer language for children. Although an English major, I came in with a strong science and technical background. There I was working with all the people that were interested in implementing computers in schools. That period was essentially an apprenticeship. Then I got hired at Digital Equipment Corporation, in their education technology group and eventually became senior software engineer. From there I went to Xerox PARC where I was a member of the research staff, working on early computer supported work systems.

MM: How did you learn to program?

DR T: I have learned how to program from books. Eventually I even wrote an introductory book for the LIST language. I did not like the books from where I was learning.

MM: What was your motivation to write that book? Do you think that your book was easier for beginners since you write that book as “an outsider”?

DR T: I felt that books from where I was learning from used very technical examples, and there was no reason for that. I thought that you can explain the same ideas with examples from children’s games and processes that are familiar, as opposed to, for example, Newton’s method. I thought that people do not necessarily learn relaying on this type of thinking. That book was one of the reasons I was hired at Xerox PARC. Then I went to get my Graduate degree in Anthropology. After graduation, I did a couple postdocs that involved technology and then went to work at SAR International. I was there for a few years. But I always wanted to be a professor so I ended up leaving and accepting the invitation to come to Virginia Tech in 2003.

MM: That is an interesting career path. When you look back at this period, since 2003 until 2011, did you see any changes happening at Virginia Tech?

DR T: So, the first thing when I got here, I was in a shock. I have been struggling since I got here. I have recently read an article that I liked – Louis Menand’s article in New Yorker – why we have college? He argued that there are three reasons – the first one is as a sorting mechanism – we sort people into fields and then we rank-order them. I accepted this as more of a personal goal not necessarily a teaching goal. The second one is socialization role. This one I thought is a primary one. Well, learning is about ideas and understanding, and how to do things but you want to know how to do things because they reflect the values – and what are those values – now here is this way of looking at values and there is that way. and those goals guide people – at least that guided me so I assumed that is what guided everybody else too. The third one is professional training. I always thought that this is a side effect. It is important, but I thought that college is this place where you learn about all these different things, and sure, you have a major where you know more deeply but I thought that you would get professional training after you get out. And what Menand argues is that sine 1970s there has been this rise in professional schools at the college level.

MM: What do you think, how is that affecting the other two goals?

DR T: I think that is hugely affecting learning and the way I am teaching. So, I was really shocked by students. I realized they were not really interested in ideas, they just want to know the next little skill thing. When I got here, started a project where I interviewed professors about their attitudes about teaching and learning. Then I realized that all the information was not publishable since I could not publish it without – I was not sure how to think about those information…

MM: It might offend someone?

DR T: Yes… And I did not have the context. Now I am moving more towards the understanding of it. This semester I have been teaching Professionalism in Computer Science, and I gave students to read this article and to write their reflections about expectations coming to Virginia Tech – what they wanted, what they valued, did they got what they wanted. Interestingly, I was able to tell them – look, this is what a lot of you think it is important and there are some other ideas what people think are important. So I could frame those ideas and we can talk about going into the world. And allowing some different voices. So you asked have I seen change – and I said that I had this initial impression of horror. And what I have seen is more nuance than a systematic change. I have also seen that some, not all, but some people in engineering education are much close to my vision of what college education is all about. But they are sort of fighting an uphill battle with the vision of education and training. Our bread and butter business here is not training great thinkers in computer science – it is training a regional market mostly dominated by the defense industry. Most of our students will work in the Beltway and they are going to be responsible for the maintenance of very large systems. So implicit in our curriculum is prioritization of the ability to cope with those very large and messy systems as opposed to, let's say if you want to work for Google that is in a specific way a flexible system. So, since the beginning we teach students Java. And then we teach them more Java. But Google is working with Python, a very light-weight and easy to dance with system. And then you look at the core software engineering classes and it is really, really different from the core education you would get at MIT or Stanford.

MM: Yes, I saw some on line lectures from MIT on Python. They were quite interesting.

DR T: Hmm, Interesting, I haven't look in that. But we do have an introductory course in Python now which is called Media computation and I see it as a sign to some other students that there are some other things in Computer Science. Our students are valuable product and they get paid unbelievable salaries. But I do not think that thought about all that money is not satisfactory for all of them. Yes, many of them want to live a secure life and have jobs but many of them want to do things that are interesting.

MM: You said you have not seen systematic change during the course of the years. Did you notice some critical events that shifted the direction the things have been done?

DR T: I think that introduction of Media computation was a really big critical event for Computer Science. On the other hand, in our introductory Java class we have made things for future computer scientist even worse. We went to objects-first and then to test-cases-first programming approach. So we do not teach procedural programming, but you start from objects.

And I see this as a terrible thing. It does not make sense. Only very few systems where everything is an object make sense. For example, the first object-oriented language Smalltalk had predefined, carefully picked classes. It was designed for children. Things you used objects for made sense, the descriptors made sense. So the things that were difficult to understand were not the things you would encounter first. But here we say – oh everything is an object – then you will have all these declarations that if you have not ever used a computer before you would never know what do they mean – and people get used to a passive "just the way it is" approach with just memorizing. And then we have test-case-first approach that is a very top-down approach which is not really comfortable for a lot people since you are assuming that the person knows what a computer program is and what is it doing. I did a survey in one of my introductory classes, and asked them about their history with computers and everybody has a history as a user. But more than a third have never even interacted with a complex software such a Photoshop as a user. They did not know what a computer program was. And then you ask these people do manipulate strings. So I think you need to teach them some definitions before you can teach them top-down approach. This results in an entry barrier for CS so we end up getting people that have two or three years of computer programming in high school. And whose are those people? People who are so good at math that they do not need to take more math, or those are people who devalued other things and subjects. And this selects out more people that are diverse thinkers. Four years ago we had 4% of women in our undergraduate program. Now we have 10%. In the 80's we used to have 30%. So going back to your original question, I see things going into different directions, not necessarily compatible. In general, I do not see much change in social-cultural environment around computer engineering.

MM: Did you have previous teaching experience?

DR T: I have thought introductory computer science at MIT, and I thought for industry and engineers. I also thought psychology at Stanford. But I have not thought computer science in many years here.

MM: Looking at this teaching period, how did you developed as a teacher? Did you made any modifications on the way?

DR T: So I have been continually struggling, not so much with the content, but with this notion of what it is students are hearing and valuing. I constantly rehashing everything from the beginning. The first technical classes I thought here were pretty much a shock for me – again – since I expected students to be more internally driven. I thought that my job was to give them opportunities and theirs was to take them. So, I was experimenting with all sorts of engagement techniques. We have a class called Professionalism in CS – a class that has everything in it that makes someone in CS does not want to be a computer scientist. It is very writing intensive, oral presentations, working in teams. And we are teaching them ethics, and we "cleaning them up" before the job market.

MM: Are there components of this class – for example ethics – in other classes?

DR T: There is only one module in introductory Engineering Ed but nothing else deals with ethics anywhere else. And ethics are different in CS from the rest of the engineering since there is no PE license and ethics are not so clear as in for example Civil Engineering where you have hundreds and hundreds of years of examples. But I have seen some changes in the students too. For example, there is an assignment that I give them – they meet someone at the airport who overhears a conversation they had with a friend about the education in VT and offers them the opportunity that they can send him a cover letter and a resume as a follow up – and it is supposed to be their dream company. So I got this assignment back for the first time and a third of them does not say thank you anywhere in the text. And they say – we did not put it because you have not say that in your rubric. So these things are attitude. And I have been working all these years on changing their attitudes.

MM: But do you ever reach that point to change their attitude?

DR T: This semester I finally did it. I was trying to make them to reflect more. So I gave them this paper from 1980 called “Do artifacts have politics?” and we focused on their reading it, not on writing about it. And what I saw as a limitation on their writing is that many of them do not know how to read.

MM: Is there some other special techniques you implemented as a part of the modifications to your teaching?

DR T: So I have developed this technology in class where people are writing and we can see what they have written anonymously – it is called ThoughtSwap-ing – this made me really understand what were students thinking.

MM: How is this technology specifically working?

DR T: So it works like this – students are writing for some 10 minutes. Then on one side, I can see who wrote what but that also goes to another student in class and it is anonymous. And then that person has to represent your ideas rather than their own. But they are usually bad in counterarguments and taking someone else’s ideas seriously – so I am trying to make them address someone else’s idea. So this is a repertoire and we are trying to catch these things and talk – to get them to focus and imagery in their writing and to connect all the details.

We also had a class where we had outside partners from University of Limerick and they were supposed to do project together with these students. And that was a disaster! So the class here was a required class, and class in Limerick was optional class – so people only took it if they were interested in ethical issues. So it turned out that there is this group of people from Limerick and they are followers of Peter Singer and other ethical thinkers and then I realized that my students do not even understand some of the ethical issues. And I could not devise a way to bridge that.

MM: What do you think about a high-level administrative push for technology in teaching?

DR T: Well it depends what the technology is and what it is used for. Well, this is just one of my thought experiments – what would happen if we decided as a country to make classes a third the size they are now? And I believe that many of the problems that beset the school system would disappear. What are we trying to do with technology? We are trying to solve the problems with technology where technology might not necessarily be the best answer. It is true that we could decide as a country to do education better. Most of the time we decided to do it a lot worse. And I do not know if technology can fix that, but it can stigmata and make some things a little bit better. But most of the time it is an excuse to employ less teachers, pay them less and expect more from them. On the other side, it is clear today that kids need to know how to be users, and some do not even learn this in k-12. And there is also the content area and the role the technology can play in deepening or widening people's understanding of things. And there is technology use at the distance. This last one is considered as the biggest idea and I am the most suspicious of.

MM: What would be the reasons for your suspicion?

DR T: For example, if you are very privileged person, and you come from a very high socio-economic standing environment, you can sit down in an online course, and say these are my objectives, and I am going to sit here and make sure that I understand, I am going to persist, and I am going to get all the ideas out of this course. Why? Because I am already highly educated, I know why I am doing it, and I have a large social network of people that encourage that kind of behavior. Likewise, the way I got into computer science was that someone handed me a textbook, I did not actually had a class. And I was able to sit there and work and just persist. Because I was already highly educated. Now you take someone who does not have privilege, that sense of purpose and that enormous societal investment from various sources. What is to keep the attention there? Attention-management is typically the hardest part of learning. And what happens when you hit something hard? What will keep you on task? That assumption that all you have to do is have the information, which I think is the easy part, but that pick up of the information, and that is what encounters for high and low performance. And the situation is even worse if some people prosper since no one usually tends to question what enabled them to do it. We tend as a society to present the examples of some people, as if it just will power, but it is much more complicated, and there is usually that preexisting skillset that is valued by the society. For some people technology can be a solution, but some might react totally different.

MM: Yes, I agree, it is that investment in time of all the people before you that lead you to that moment or achievement – and that you always accomplish in a social context. That goes back to our initial discussion about your class and relation to k-12 education.

DR T: Yes, as I said, there is not enough computational thinking going on in the k-12 curriculum. I think in this case we are not teaching engineering – we are hiding it. The idea is trying to locate existing activities, in core curricular areas, which are mathematics, science, language, and social studies, where we can identify computational thinking components, and then doing something, which I ideally think, will increase the level of computational thinking and the content area, hopefully. This is hugely political because teachers care about standards of learning and those standards do not look to the future. They have very low bar for knowledge.

But we were approached by Henrico County, so this is very exciting and it will allow us to think about what is it that kids could do or the teachers to increase that bar. Eight grade is a good place in American educational system, because in 9th grade, if you are a serious student, you have to do X, Y, Z, and the teachers are very focused on college preparation. So, 8th grade is where there is a little bit more flexibility but the kids are old enough to engage.

MM: Any conclusive thoughts on the technology in teaching?

DR T: So coming back to the issue of technology – I had good experiences with technology, I had bad experiences with technology. For example, during my career at AI lab and other places, I was on IM, and I made myself available all the time. But, as a professor I cannot do that and I do not want. Because students have to think about my time and they do not.

MM: What about being available at specific intervals of time?

DR T: Well I have office hours where they do not come to. But, they expect me to respond to their emails in short order and I absolutely cannot do that all the time. I also made them shut their computers during class – I hate that but I have not yet found a better way to do it and not to sound like their mom. But the fact is that their use of computers is a disaster for them – and they do not even know they are not paying attention to know it. And they hate it, I can see it from their body language. But then I am thinking why are you here and paying all this money if you do not want to listen?

MM: For the end, let me ask you how would you imagine your ideal education world? What would be changes in present world – either realistic or idealistic?

DR T: In my ideal world I would teach small kids languages and music, until they are like 7 and 8. But in my teaching I am limited by the boundaries of my own imagination. I still need to work on the engagement and the ways to talk to those kids that I teach. The techniques for students to be heard, for me to hear them and to move them from where they are. I would like to see in CS program more pathways that would emphasize on more career pathways in CS. I would like to see BA in CS. As far as we are talking about introductory engineering classes, I would say that they are trying to do too much – too many things to too many people. A lot of design opportunities that are given to them in the first year are coming too early for them to appreciate. They do not really know how to be creative and makes them really anxious to ask them to be creative. So then they resist it. And then is it real creativity or just checklists? The TAs are often not clear. So it is overall a waste of opportunity. There is very little feedback to the departments of goals what should we be doing. And there is a wide variety of possible audience. I also think that College of Engineering has too many required courses. You are often fulfilling department requirements through distribution courses rather being able to pursue things that interest them. Oh, we have done one good thing in our department – we now have advisory tracks – they do not have official status but we advise people depending on their interests.