

To Be or Not to Be a Teacher? Exploring CS Students' Perceptions of a Teaching Career

Sabiha Yeni
Leiden Institute of Advanced
Computer Science
s.yeni@liacs.leidenuniv.nl

Efthimia Aivaloglou
Leiden Institute of Advanced
Computer Science
Open University of the Netherlands
e.aivaloglou@liacs.leidenuniv.nl

Felienne Hermans
Leiden Institute of Advanced
Computer Science
f.f.j.hermans@liacs.leidenuniv.nl

ABSTRACT

There has been an increasing tendency and an interest to make computer science (CS) a core subject in the K-12 curriculum, however in many countries there is a CS teacher shortage in high schools. In order to define the possible reasons for CS teacher shortage, we investigated the factors that influence CS students' career choices and their preferences about teaching. We also studied the requirements students view as important for their career. Semi-structured interviews were conducted with 18 CS bachelor and master students from four different universities in the Netherlands. The results show that the most important factors influencing the career choice of CS students are organization related expectations such as the characteristics of the organization (scale, reputation etc.), the field of expertise and salary expectations. Regarding CS students career plans about becoming a teacher, a large part (almost 75%) of the students stated that they definitely do not think of teaching or teaching is not a priority career goal. The most cited demotivating factors for following a teaching career are the nature of the teaching job and low salaries. Perceived required skills for good CS teachers are frequently defined as pedagogical skills and social skills.

CCS CONCEPTS

• **Social and professional topics** → Computer science , teaching career .

KEYWORDS

computer science, career choice, teaching, teacher, K12, high school

ACM Reference Format:

Sabiha Yeni, Efthimia Aivaloglou, and Felienne Hermans. 2020. To Be or Not to Be a Teacher? Exploring CS Students' Perceptions of a Teaching Career. In *Koli Calling '20: Proceedings of the 20th Koli Calling International Conference on Computing Education Research (Koli Calling '20), November 19–22, 2020, Koli, Finland, Finland*. ACM, New York, NY, USA, 11 pages. <https://doi.org/10.1145/3428029.3428036>

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Koli Calling '20, November 19–22, 2020, Koli, Finland, Finland

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ACM ISBN 978-1-4503-8921-1/20/11...\$15.00

<https://doi.org/10.1145/3428029.3428036>

1 INTRODUCTION

CS education has the potential to provide fundamental twenty-first-century skills to all students such as critical thinking and problem solving [14]. With the increasing value of CS in people's daily lives, there has been a remarkable interest as well as an important discussion on how to widen participation in computing and integrate CS education into K-12 classrooms [27]. However, finding enough qualified CS teachers to fill the teaching positions in K-12 is a growing problem around the world [19, 34] and there is a significant lack of consistency in CS teacher certification standards [14].

CS students who are enrolled as Bachelor's in CS departments, have varying motivations, prior exposure to, and knowledge about CS [16]. Grosse et al. (2019) classified first-year CS students according to their perceptions related to the CS field [16]: some of them regard programming as the most important part of their subject, some of them focus on abstractions and systems instead of particular applications, another group regards CS as a "translation activity" between man and machine. Differences in students' perceptions of CS may also lead to differences in their career choices.

The motivation behind this study is to explore how CS students choose their career lines by addressing the following research questions: (1) What are the factors (interests, self-efficacy, outcome expectations, etc.) that affect the career choices of CS students? (2) What are the factors that affect CS students to (or not to) prefer teaching as a career? and (3) What are the views of CS students about the requirements for the teaching career?

2 BACKGROUND AND RELATED WORK

2.1 CS Students' Career Expectations

Career plans and expectations of CS graduates are diverse, since many career choices and opportunities are available in industry or academia. Additionally, the job prospects for CS graduates in the world vary widely according to each country's educational and economic situations [18]. There are different studies that have investigated the factors that affect the career plans of CS and engineering students [2, 21, 25, 26].

Leventhal and Chilson (2006) investigated the relationships between CS education, gender, and job expectations [25]. A factor analysis revealed that students have four types of expectations: intrinsic expectations (non-materialistic expectations involving job satisfaction and personal achievement), extrinsic expectations (materialistic expectations involving monetary compensation, status, and prestige), me-oriented expectations, and other-oriented expectations. Subsequent analysis of these factors suggested that students

at higher CS education levels tend to emphasize intrinsic job expectations, while students with less education focus on extrinsic expectations [25].

Alexander et al. (2011) identified the factors that influence the career choice of students from the computer and other disciplines [2]. The data were analyzed using some components of Social Cognitive Career Theory, namely external influences, self-efficacy beliefs, and outcome expectations. They suggest there is a need for new strategies for marketing computer-related courses and there are also distinct differences, related to self-efficacy and career outcomes, between the computer majors and the 'other' group [2].

Itani and Srour (2016) investigated how engineering students' career aspirations affect their perceptions about the importance of various soft skills and how well their universities have prepared them in gaining the associated abilities [21]. The results revealed that, although the students showed a significant understanding of the importance of soft skills (teamwork, communication, and management), some of these perceptions can be attributed to their career aspirations. Emphasizing leadership, communication, and teamwork skills enables engineering students to feel more confident and motivated to transform their innovative ideas into real businesses of their own or within their employer organizations [21, 36].

Winters (2012) identified that the factors influence engineering graduates' career goals near the end of their undergraduate engineering studies, career-related actions taken in the subsequent four years, and their future career plans [39]. They declared that engineering graduates had diverse goals and interests. Graduates generally wanted to find appealing work and acted towards that goal. Relationships with faculty and expectations of positive outcomes heavily influenced participants' decisions to pursue graduate degrees and family commitments geographically constrained career choices while also increasing the desire for stability. The economic downturn impacted job availability for most participants, but many participants were able to broaden their career searches to find interesting and fulfilling work [39].

There are also papers related to gender differences, exploring why girls are under-represented in CS and how they can be motivated towards CS careers [1, 3, 7, 26, 28, 31]. For example, the influence of different factors on female CS students in choosing a career in the IT field was explored [26]. The results show that female students chose IT career due to their personal interest and abilities. They want to learn technology, become an active member of the digital native world, and are interested in coding literacy [26].

One of the career opportunities for CS graduates is that of becoming a teacher in schools. However, the problem of recruiting CS graduates into the teaching profession and retaining them is a common agenda item of governments. Dolton and Chung investigated why teaching is so relatively unattractive for graduates, and measured the 'profitability' of becoming a teacher compared to alternative occupations that potential teachers could undertake as their professional career [9].

2.2 CS Teacher Shortage in K-12 Schools

There is an increasing interest to teach CS in K-12 schools. Teaching CS meets students' needs in different ways: students gain a deeper knowledge of the fundamentals of computing, which is critical foundational knowledge that will serve them well throughout their lives; students are exposed to a field that drives innovation; and students gain critical knowledge and skills proven to bolster their success in their academic life [14, 33, 38].

Even though CS education has recognized benefits and is the key driver of innovations across all disciplines today, CS is one of the very few courses in secondary schools that is not a core subject in the curriculum of many countries [15]. Currently, in the Netherlands, about sixty percent of all schools offer this elective course, with about ten percent of the students choosing to take it, and the percentage of secondary schools which selected CS course as an elective has fallen slightly between 2012-2017 [19]. Similarly, only 35 percent of public high schools in the United States (for 24 states) offer CS courses [30].

So why is there a decline in the percentage of schools selecting CS courses? A falling trend in the percentage of schools that offer CS courses could be related to the teacher shortage (this is one of the possible reasons, others could be the lack of computational resources or the uncertainty about curriculum policies). An estimated 90 percent of the vacancies for ICT teachers in secondary education are difficult to fill in the Netherlands [19]. Finding enough qualified CS teachers is an issue in secondary education. In 2017, only 100 CS teachers graduated from pre-service teacher preparation programs in the U.S.; by comparison, 10,639 teachers were prepared in mathematics and 11,661 teachers were prepared in science the same year [30]. Additionally, according to European educational reports, trends show that increasing numbers of teachers are leaving the profession after just a few years [13].

2.3 The Requirements for CS Teacher Certification

The Ministers of Education in the European Union recently made a joint recommendation advocating that teachers should achieve a high level of skills during their initial teacher education [5]. One of the reasons for the CS teacher shortage is due to the absence of clear and consistent requirements for the CS teacher certification programs. The recruitment of CS teachers is therefore a growing problem in a number of European countries. Even though the teaching profession seems to have lost some of its attractiveness at present, raising the level of qualifications of teachers is arguably one of the most important means to raise the status and attractiveness of the teaching profession [5]. In contrast to raising the level of qualifications, reducing the barriers that teachers need to take prior to entering the classroom may help alleviate issues of teacher shortages [29]. A report related to the global teacher status was published in 2018 by collecting data from 35 countries and over 1,000 teachers in each country; the report tried to identify the challenges and exploring the best ways for enhancing teachers' professional knowledge and raising teachers' status and the report suggested that higher teacher status correlates well with improved pupil performance as measured by PISA scores [10].

In the case of the Netherlands, there are two different teaching qualification degrees for CS teachers at the secondary school level: first-degree and second-degree. If CS teachers have first-degree educational qualifications (fully qualified), they can teach at higher grades (ten and higher) of the senior secondary education and pre-university education [40]. If students wish to become a CS teacher with a first-degree qualification, they should have a university Bachelor's degree in CS and a Master's degree in the educational program at the university [40]. It is therefore important to investigate how entry requirements, career structures, compensation, and working conditions can help to attract, retain, and motivate effective CS teachers working in schools.

As a conclusion, the motivation behind this study is to explore CS students' career expectations, to address the factors which motivate or demotivate CS students to become teachers, to explain the relation of these factors with CS teacher shortage, to discuss the CS students' views about the requirements for the teaching career and to explain the relation of the perceived requirements with the existing requirements of CS teacher certification programs.

3 METHODOLOGY

The goal of this study is to explore how CS students choose their career lines by addressing the research questions. To this end, 18 semi-structured interviews were conducted with students from CS departments of four universities in the Netherlands. The following paragraphs describe the interview and data analysis process.

3.1 Interview Process

For our study, we aimed to include participants who are aware of their career interests with sufficient knowledge related to possible career options and sufficient experience with Bachelor CS subjects. For this reason, we focused on recruiting students who are towards the final stages of their study years, i.e., the final year Bachelor's students and Master's students of CS departments. Participants were recruited from four public research-intensive universities in the Netherlands, including an university of technology and an university that offers distance learning opportunities. It was not asked whether they have a special interest in education or the teacher profession as inclusion criteria. Participants were invited during their classes and lab sessions, as well as through Slack and other student communication channels.

We conducted 18 interviews, with at least three students from each university. Ten students were final year Bachelor's students, while eight students were Master's students. Four of the Master's students had completed their Bachelor degrees in other universities, three of which in other countries. Our participants self-identified as originating from (alphabetically): Bangladesh, India, the Netherlands, Switzerland, Ukraine and the U.S. Four participants self-identified as being female and 14 as being male. We interviewed participants who declared being autistic, as well as students with speech disorders. The youngest participant whose age is known was 20, and the oldest was 33 years old. The self-reported expected grade of the participants for the degree that they were pursuing varied from 6,5 to 9, with an average value of 7,7 (0–10 scale is used for grading). One Bachelor's student was already trained and working as a teacher in a secondary school for a non-CS subject.

The interview followed a semi-structured interview protocol and was part of a larger scale exploration of how students perceive their CS education and its prospects. The perceptions of the students about teaching careers were captured using five questions on the student's background, their studies, their expectations and their criteria related to their preferred choice of career or workplace, the possibility of becoming a teacher and the motivating and demotivating factors for it, and the perceived required skills of good teachers. Because it was a semi-structured interview, the researcher didn't strictly follow a formalized list of questions. Instead, she also asked more open-ended questions, allowing for a discussion with the participants, therefore some questions weren't replied by some participants. The first four interviews, of three male and one female Master's students, were used to inform the study scope and to refine the questions of the protocol, which remained unchanged for the other interviews. Eight of the interviews were voice-recorded face-to-face interviews, and ten were conducted through recorded Skype sessions. The length of the interviews ranged from 7 to 18 minutes, with an average length of 11 minutes. The interviews were transcribed using automatic transcription software and were afterwards manually corrected.

3.2 Data Processing

The data obtained from the interviews were analyzed by a qualitative inductive data analysis in order to discover the views of CS students in terms of their career choice. During inductive analysis, the analysis process was not built on a theory or framework, but instead it was identified through the data [4]. The analysis of the interviews was carried out in four phases. First, transcripts were categorized according to research questions. Five main themes were defined based on the research questions of the project, closely in line with the topics of the interview protocol: (1) students' criteria for the career choice, (2) the possibility of becoming a teacher, (3) motivating factors for a teaching career, (4) demotivating factors for a teaching career, and (5) perceived required skills for CS teachers. The next three phases consisted of open coding, axial coding and selective coding [37].

Secondly, the open coding phase was initially conducted on two interviews to define a number of basic labels within these five main themes. Two researchers labeled together two interviews, developing labels based on the data within the determined themes. During this phase, the interview transcripts were fully read and the labels were extracted from the transcripts and linked to themes. Due to the inductive approach, open coding per each theme resulted in a broad identification of ideas and views.

Thirdly, in the axial coding phase, each label was reviewed and the labels were grouped and related labels were combined under new categories. For example, within the theme "students' criteria for the career choice" labels "the scale of the organization", "the reputation of the organization", "work hours", and "location of work" were generated in the open-coding phase, then they grouped as the "characteristics of the organization" in the axial coding phase.

Finally, in the selective coding phase, researchers selected and grouped related categories as new sub-themes. For example, within the theme "students' criteria for the career choice", two sub-themes "personal factors" and "organizational factors" were generated. The

interviews were coded by two researchers. Doubts as to which label was appropriate for a given excerpt were discussed among three researchers.

4 RESULTS

The participants have been assigned numbers and are referred to as S1 to S18. The quotes that are included in the description are verbatim. To protect the anonymity of the participants, identifiable information has been suppressed and person pronouns have been converted to they/them/their as an example of a singular and gender-neutral pronoun. The results are analyzed under three main parts in relation to research questions: (1) CS students' criteria for the preferred career choice, (2) the possibility of becoming a CS teacher and motivating/demotivating factors for a teaching career, and (3) perceived required skills for CS teachers.

4.1 CS Students' Criteria for the Preferred Career Choice

The majority (16) of the students defined what their criteria are for their career choice and their expectations from the workplace. Even though this study is not a quantitative study, Table 1 presents an overview of factors affecting students' career choices and frequencies. It can be grouped under two sub-themes as personal and organizational factors (Table 1).

Table 1: Factors affecting CS students' career choices

Sub-themes	Categories	F
Personal factors	The sense of belonging in the workplace	10
	Self-improvement	6
	Personal passion/interest	4
	Work experience	3
Organizational factors	Characteristics of the organization	8
	The field of expertise	8
	Salary/pay	7

F: Frequency of repetition

4.1.1 Personal Factors. The personal factors influencing students' preferred career choices can be grouped into four categories: the sense of belonging in the workplace (10), self-improvement (6), personal passion/interest (4), and work experience (3) (Table 1). Firstly, students expect to feel **the sense of belonging in the workplace**. Ten of the students want to have good relations with their colleagues and positive attitude to work climate. S8 stated that *"I think it would definitely be important for me that there is also like the team which is welcoming and not like very competitive"* and, similarly, S9 also declared that *"[...] also the colleagues, if the people are nice it is hard to judge and that is important for me."* Students have an expectation of having colleagues who are helpful (S8), social and communicative (S14). Students also pay attention to the hierarchy between people and the way how the team members communicate with each other. They stated that *"I like having, group members or coworkers that are very open-minded [...] they are good at communicating as well"* (S5), *"you can say what you want and everybody is open to criticism or feedback. It's just like a relaxed*

atmosphere overall" (S11), *"[...] everyone works on the same floor on the same level"* (S17).

Secondly, six of the students expect a work climate that encourages the **self-improvement** of employees. Students want to learn new skills and want to be able to follow the rapid changes in technology. Students stated that *"I would probably go for a job [...] if I also learn a lot from that job. So I also want to learn new skills"* (S6), *"it's very important to keep learning [...] I really want to learn new things every time"* (S14). Career development and promotion are also important factors for several (S8, S15, and S17) students. S8 declared that *"if there wouldn't be anywhere to go anymore within that company, that would be a reason to start looking around. Like maybe there is somewhere where I can continue growing"* and similarly S17 stated that *"it is important for me to work in a company where I could maybe have a leading function"*. On the other hand, one of the students (S10) who wants to become a teacher declared that they don't have any ambition for their career development or any expectation of promotion.

As the third category, **personal passion and interest** is defined by four students. Two of them expect CS industry related career options since they have personal passions to work in the software industry and have a personal interest in the field of CS (S4, S6). One of the students (S14) who had teaching experience in high school, mentioned they would really like to teach CS and, for that reason, they chose this field. Similarly, S10 had already worked as a software developer but they quit that job and they chose the CS field since they would like to make a contribution to society and work as a part-time teacher.

The last category for personal factors affecting career choices is defined as **work experience**. Three of the students expressed that work experience is an important factor for defining expectations from the work environment. S6 stated that *"I don't have any work experience in my field and CS. So, I don't have many expectations"*. Similarly, S10 explained that *"I got a few years of practice as a software engineer and many companies feel like that's more important than getting an extra, actual bachelor's degree"*. S1, who has some teaching experience and would like to do an education master, stated that *"Now I have some more lecturing experience, I'm actually thinking about maybe getting a master at [name of university] maybe as well where you can get your eerste graad [first grade] and tweede graad [second grade], which means you're allowed to teach high school level and all grades and do some university teaching."*

4.1.2 Organizational Factors. The factors affecting the career choices of students as organizational factors are defined as: characteristics of the organization (8), the field of expertise (8), and salary/pay (7) (Table 1). The first category related to organizational factors is defined as **the characteristics of the organization**. It relates to the scale of the organization, the reputation of the organization, work hours, and location of work. Six of the students talked about the scale of organization (such as team size), while clarifying their expectations for their work environment. Several students prefer to work in small-scale companies, stating: *"When I'm dreaming about working in a small team, five or maybe 10 persons"* (S14), *"I don't want it to be too big of a company"* (S17). On the other side, some of the students prefer to work on big companies due to the reputation of organization, *"I think I like a big organization"* (S12), *"if it's a big*

famous company that it's [...] with a good name. It's also something I would want to do maybe because then it's nice to put it in your resume that you worked for this company for this amount of time" (S6). The fact that companies in the CS sector provide remote working opportunities makes this career field attractive for students, "I have a preference for remote work. So this means, working wherever you want, not whenever" (S16), "it's also important that it is possible to work maybe one day from home when I'm a bit older" (S17).

The second factor that was expressed was related to **the field of expertise** (work content) that students desire to work in. Eight students prefer to select companies that are related to the fields they are interested in (such as web development, security, programming, project management, software quality assurance, back end systems, database design) and use current new technologies. Some of the views include: "I don't really want to work with algorithms or statistics or any mathematical, math-related projects in the future really, but I like web development or security or in general programming [...]. So, I would also consider what field it is, what company it is" (S6), "I would like to be a bit more, like into designing and do project management into a software assessment, quality assurance, control testing, like things, I don't want to be a part of the programming aspect" (S7), "the most important criteria for me is techniques, if you work with techniques that are too different or too old then you get a work experience that is a bit useless that is important to me" (S9), "I want to be a better software engineer on the back end systems, I don't care about front end system, that's a, I like database design, not really want to go away from that" (S10), "I'm currently employed at [some organization]. I am a programmer there. It's really not that fun. Why? It's an old architecture. They write in Delphi. It was probably cool in 2006, but really it's not interesting anymore" (S13), "I do not want to do like real coding. I want to be a consultant, more advice side, strategy-wise, something like that instead of the real coding part" (S17).

The last organizational factor that affects the career choice of seven students is related to **salary**. There are two different views about it: salary is an important factor for one group of students (4), "salary would definitely also be important [...] I would also like to feel that they appreciate me and they're happy to have me there" (S8), "[...] first of all, a high salary and then I think a good working environment" (S11), "the salary is important to give value to myself and not because I need the money" (S17), "in this area, everybody gets easily a job with a good salary, I'm not really worried. I'm quite sure everything will be fine" (S18). Salary is less important or unimportant for another group of students (3), "salary for me is probably not the most important thing, I would probably go for a job with less salary if I also learn a lot from that job" (S6), "money has never been a factor for me" (S7), "a good salary is always nice, but at a certain point, it doesn't really matter anymore" (S10).

4.2 The Possibility of Becoming a Teacher

All students replied on whether they would consider becoming a teacher after their studies. Their answers are categorized as yes (6), maybe, but not full time (2), not now, but maybe in the future (6) and no (5). In the yes category, some students were not certain (for example, S9 replied "never thought about it, maybe I will"), while some students were "actually thinking about maybe going into the

teaching area" (S1). S14 was positive, but "not for my whole life. Certainly not to exclusively do that my whole life. No, no. I also like to develop software and it's not enough for me to only teach it." The reply of S8 was categorized in both of the intermediate categories: "I wouldn't want to do that full time. Maybe like in the future I already have like an established career in the industry or wherever, I could do it for like a day in the week."

The students who replied that they would not choose it for now, but maybe in the future, provided several reasons for postponing it, including salary, career development, and accumulating knowledge and experience. S5 explained it as "I would first need to have a lot of experience under my belt and then just sort of like be bored of everything else and like, not really want to move forward in my career. Just sort of do something that still contributes and gives back [...] So probably when I'm much older." Finally, in the no category are students that were definite in their answer, for example "No, that's one thing I don't like" (S12).

4.2.1 Motivating Factors for a Teaching Career. Almost all (17) interviewed students described motivating factors towards a teaching career. These are grouped into personal factors, social factors, and factors specific to CS (Table 2).

Table 2: Motivating factors for a teaching career

Sub-themes	Categories	F
Personal factors	Personal interest and fit to teaching	11
	The prior experiences of students	10
	The opportunities for social interactions	4
Social factors	Positive relate to public recognition	5
	Job safety	1
CS specific factors	Motivate children towards a CS career	4
	The strong interest to computer science	2

F: Frequency of repetition

Personal Factors. The personal factors relate to the prior experiences (10), to their personal interest and fit to teaching (11), and to the opportunities for social interactions that students seek from their profession (4) (Table 2). In terms of **prior experiences of students**, it is notable that students who had served as teaching assistants during their studies (8) had a positive view of teaching. Three of those students specified that serving as teaching assistants gave them self confidence that they can teach. A positive effect of prior experiences was also identified in teaching non-CS classes at a secondary school (1), in serving at educational committees at the university (1), and in having good experiences with university professors (2) ("now I also got a bunch of motivated teachers, I feel like it could be very fun", said S18).

Other personal factors for motivating a teaching career are related to **personal interest and fit to teaching**. Personal interest and fit to teaching was expressed by describing teaching as enjoyable (7) and specifying that knowledge transfer and helping others are positive aspects (6). S13 described that "I really like seeing people going from not understanding to understanding something", while S1

explained that *“I find teaching to be a very fun experience and, I don’t know, there’s something very fulfilling when you stand in front of a class [...] describe something very complex and you try to make it very tangible, very graspable and then you see all these eyes light up like, oh, I get it, I can do it now.”* Personal interest was also expressed towards exploring and applying new educational methods, as well as towards self-improvement and learning, since *“if you work at an office you learn only things that are used at the office but when you are at school you learn other things”* (S9).

The last category in motivating, personal factors for a teaching career can be identified as offering **opportunities for social interactions**, with S14 expressing that *“I really need that kind of social interaction because otherwise I would end up too much with only my computer screen. I already did that a few times for short periods, but I ended up as a zombie and, and it’s not good for me.”* Working with young students was described as positive by three students.

Social Factors. The social aspects of a teaching career that were identified as positive relate to public recognition (5) and to job safety (1) (Table 2). Specifically, the teaching profession was characterized as *“valuable”* (S3), *“noble”* (S15), *“respectable”* (S5), where *“there’s a small moment of pride”* associated with knowledge transfer (S7). S3 clarified that *“in the Netherlands there’s been a lot of talk about how teachers don’t get enough paid and don’t get enough recognition for what they’re doing. But I think everybody does recognize the value that teachers have in society. So I feel it’s a very honorary job to do.”* A single student (S18) identified career opportunities as a positive aspect *“I think that in education they look for people anyway. So it’s a safe option, something because there are not enough teachers to in whatever year and whatever subject right now. So I think they will always want to have me there. So that’s kind of why it’s a plan B.”*

CS Specific Factors. Some motivating factors for pursuing a teaching career are specific to CS. These are the opportunity to motivate children towards a CS career (4) and the strong interest to CS (2). Motivating children was found important *“because IT is very important and it opens a lot of career paths for everybody who can program or knows a lot about computers. So I think it’s nice to help people with that”* (S11), while S8 expressed that *“I would love to be part of making the next generation less oblivious to their options to enroll in CS because it hadn’t even occurred to me that I could do something like that. So if I could play a role in getting kids excited about that, I would enjoy that.”* Strong interest in CS was motivating to S2: *“I really, really like the subject. I have been interested in CS and even electronics for most of my life now... it’s just my favorite thing and I like telling people about it.”* An additional positive aspect for teaching programming was identified by S14: *“I can see after six weeks of learning to code they have some capabilities, that they actually can code a little bit. And after another six weeks they can create a game and I like that very much.”*

4.2.2 Demotivating Factors for a Teaching Career. Almost all (17) of the interviewed students described demotivating factors for following a teaching career. The most commonly emphasized factors were summarized by S1: *“many people are not interested in going down a career path which provides worse financial and worse job stability, and less endless personal growth than many other jobs, which they*

find to be easier or which they find to be more and more interesting.” S3 described the teaching career path as a sacrifice, especially considering the public recognition and financial gain in comparison to the workload, saying that *“I feel there is a certain sacrifice that comes with it, I’m not willing to make from this early age.”*

The demotivating factors for following a teaching career are grouped under personal factors, factors relating to the nature of the teaching occupation, and organizational factors (Table 3).

Table 3: Demotivating factors for a teaching career

Sub-themes	Categories	F
Personal factors	Lack of personal passion/interest	3
	Self-improvement	2
	Lack of sufficient skills for teaching	1
Teaching occupation	The nature of CS teaching job	10
	Characteristics of school students	6
	Expected workload	2
Organizational factors	Salary	10
	Career development opportunities	4
	Job opportunities in teaching	3
	Occupational prestige	1

F: Frequency of repetition

Personal factors. The personal factors that were described as preventing from following a teaching career are the limited opportunities for self-improvement (2), the lack of personal passion/interest (3) and skills (1) (Table 3). Limited opportunity for **self-improvement** was mainly related to continuing to learn after the CS studies, with S6 describing that *“teaching is teaching something to other people, but I’m more in a stage where I want to learn something from other people.”* A final-year Bachelors student hinted feeling overqualified for a teaching career *“No, that’s [becoming a teacher] one thing I don’t like. I feel like it’s a missed opportunity because we learn a lot here and we don’t really learn how to work in big corporations, but, we do learn a lot. And when you just want to teach it, how do you say it, you lose some skills I think in a long term”* (S12).

The lack of personal passion/interest for teaching was defined explicitly by S17: *“I just, I don’t like the idea. I never liked it actually, always when I thought of teaching I was like, nah, no.”* Two students related their lack of passion for teaching to them to lacking the perceived required personality traits for teaching, for example *“I never thought I could teach someone. I thought I always had like the lowest tolerance or patience to teach someone”* (9). S11 further described **the lack of sufficient skills** for teaching programming, *“mostly I want to have experience and understanding in front of a class because, yeah, I want to get like really good at programming if I would teach.”*

Teaching occupation. The characteristics of the teaching occupation that are demotivating students from following a teaching career relate to the nature of the CS teaching job (10), the expected workload (2), and the characteristics of school students (6) (Table 3). Related to **the nature of the job**, CS teaching is found to be *“boring”* (S15) and *“repetitive”* (S7) because, as S15 explains, *“what would really turn me away from teaching is that as a high school*

teacher, you have multiple classes from the same year. So you have to do the same exact presentation like four or five times a week". On the other hand, teachers also have to "switch between different things a lot" (S6), such as administrative tasks, preparing lessons, teaching different classes, supervision, handling parents and grading. This last aspect of grading was specifically described as unpleasant from three students. Additionally, the content of the lessons was also described by S16 as being at a level that is not interesting, while S5 added the possibly outdated computing equipment at schools as an unpleasant aspect. S14 described difficulties with the diversity of teaching resources: "so I want to make them autonomous a little bit because I have not, the capabilities to give all the individuals what they need in one hour. But it's difficult to show them which resources to use". At the same time, it is necessary to follow developments since "it's important to stay up to date with the industry as a teacher [...]. You need to stay on top of changes and how to use those in your classroom" (S10). Two students described **the expected workload** as a preventing factor, with S3 describing that, as a teacher, "you will probably build up a lot of stress on an early age, that I feel I would not, you know, like being stressed like that for 40 years in my life."

Lastly, several participants mentioned the motivation and willingness of **high school students** to learn about CS as a barrier especially compared to university students who have self-selected their study. S8 expressed that "for high school they're like unruly, they don't want to be there, they're maybe not motivated. So it's like hard to keep that under wraps. So I would definitely be right now intimidated to be put in front of a group of 13 year olds that don't want to be there. And then I have to teach them something, however willing they are." School students were also perceived as being difficult if they are "in the middle of puberty" (S16), if they are unable to grasp the taught concepts (S2), and if they have prior programming experience and "don't want to learn anything more or are not challenged enough I guess. And then they become annoying because of that. And I probably wouldn't enjoy dealing with that" (S13).

Organizational factors. The organizational factors that act as barriers for the selection of a teaching career relate to the salary (10), the job opportunities (3), the career development opportunities (4), and occupational prestige (1) (Table 3). Firstly, **the salary of teachers** is perceived as unsatisfactory compared to the industry and the amount of work. S6 expresses it clearly: "the CS jobs, there is this big demand on that. I feel like high school teacher salary cannot really match that," while S1 connects it to the workload "I hear from almost everyone why would I become a teacher when I can get much better job with less hours and more pay by becoming just a simple code monkey doing things like web development" Repaying study debt makes salary important, "for now I would say, rather focus on getting a better paying job first, mostly to pay off my student loans and to get a comfortable life" (S2).

Secondly, **job opportunities in teaching** are perceived as worse than in the computing or software industry, with the education job market being described as less attractive and lacking offerings for leading functions. Thirdly, according to the participants a teaching career would also offer limited **career development opportunities** and possibly lead to career stagnation, as "there's not that many places you can go from being a teacher" (S15). S8 also described this as "I feel like once you're a high school teacher there is like, and you

want to stay a teacher, there's nowhere to go anymore. So you're, that's what you are and you can be that for 30 years and it will stay the same year after year. So I wouldn't want to do that full time." Finally, S13 included low **occupational prestige** as one of the hindering factors, expressing that "it's not really held in high esteem. If you say you're a high school teacher, people aren't like wow or something. It's not a prestigious job [...]. No one else wanted to do it, so you just [do it], right? That's how it feels. That's also why I don't want to."

4.3 Perceived Required Skills for CS Teachers

Almost all students (15) replied on the question regarding what type of skills are required for a CS teaching career. The required skills were categorized as pedagogical skills (12), social skills (10), content knowledge (8), and personal skills (6) (Table 4).

Table 4: Perceived required skills for CS teachers

Sub-themes	Categories	F
Pedagogical skills	Knowledge of instructional strategy	8
	Classroom management	8
	Knowledge of students' understanding	3
Social skills	Good relation with students	7
	Enthusiasm for teaching	3
Content knowledge	Current technology/content knowledge	6
	Knowledge of resources	1
	Produce effective course material	1
Personal skills	Patience	3
	Calmness	1
	Diligence / hard worker	1
	Self-confidence	1

F: Frequency of repetition

4.3.1 Pedagogical Skills. The pedagogical skills (CS teachers are expected to have) are classified as knowledge of instructional strategy (8), classroom management (8), and knowledge of students' understanding (3) (Table 4). In terms of **knowledge of instructional strategy**, all eight students expect that teachers should know how to teach content to students. S12 described that "Of course the teaching aspect! How you teach it to students. Must be good." while S17 stated that "[...] you have to know different ways to teach." In a similar manner, S15 expressed that "You have to explain it well obviously" and S9 described that "I think it's important to know how to teach for example how to explain things to a class". Students also expect that teachers should be able to present the content in an interesting way by using different teaching methods (S11, S16) and in the right flow speed: not too fast and not too slow (S13).

Classroom management refers to skills and techniques that teachers use to keep students organized, orderly, focused, attentive, on task, and academically productive during a class. Eight students stated that teachers should have sufficient pedagogical skills for classroom management. Being able to keep students focused and draw their attention to the course is one of the most important expectations of students. For example, S10 described that "at least to a degree it's important to grasp the attention of the children there for a few hours a day. That's one of the most important things to me as a teacher". Relating to classroom management, S12 responded in

their native language (Dutch) to express himself better: “*Je moet je maar proberen om de studenten mee te krijgen om zeker hier op de universiteit heb je de studenten die heel snel hun mobieltje pakken en niet gaan opletten. Dus je moet het interessant houden voor de studenten [You have to draw the students’ attention, especially here at the university. You have the students who quickly grab their mobile phone and are not going to pay attention. So, you have to keep it interesting for the students.]*”. Another issue related to classroom management is the teachers’ approach. In particular, one of the participants (S18) expect an authoritative approach and stated that “[...] you cannot make jokes within how the administrative side of everything works. You need to be strict; a good teacher must be strict in the approach”. On the other side, S13 expects a permissive approach and described that “*You can keep the class like quiet enough that it’s doable. Not super strict because I think it’s better if people are allowed to talk to each other in that sense, but quiet enough so that everyone can work, obviously.*” The ability to communicate with children is also classified under the classroom management part. For example, S14 described that “*it’s very nice to interact with children and I think it’s also a skill, many people might need*” and S11 expressed that “*It’s important to connect to the youth, [...] you expect someone who can connect to the people. If you don’t have a connection with the children, they won’t absorb the information and they will not care about the course*”. Also, three students (S11, S15, and S16) emphasized that giving inspiration is one of the important requirements of teachers. S16 defended this idea as “*I think [it is needed to] spark or open the doors for students to show them that there is a lot of knowledge and cool things in the world without just learning from books and you need to do this*”.

Knowledge of students’ understanding is marked as a required skill for CS teachers. It refers to being aware of the knowledge that students find difficult to learn, or to prerequisite knowledge for learning specific knowledge. Regarding this, S13 remarked that “*The important thing of being a teacher is understanding what people don’t understand*”, whereas S14 described that “*It’s important to keep reminding yourself, how to explain this, how a student could interpret all of this*”.

4.3.2 Social/Interpersonal Skills. The social skills refer to having a good relation with students (7) and enthusiasm for teaching (3) (Table 4). Seven of interviewed students expect that CS teachers should have **good relations with students**, as “*you do have to love children because you will be with them all the time and I think that is important*” (S17), S10 described that as “*a teacher should be able to enthusiast the children*” and S13 defined that as “*They’re usually fairly social, I think they like talking to people*”. S14 added, “*Enthusiasm to teaching, I think it’s one of the keys[...]*”. Having an informal relationship with students is also thought as another requirement for CS teachers, S7 expressed that as “[...] *if you can speak a little informally to the students, they connect by that and they can ask questions*” and S15 declared that as “*you have to really be open for questions. One teacher [...] was also always super responsive to emails and that was amazing*”. Related to the **enthusiasm for teaching**, one of the students (S18) added “*the social stuff is important and they shouldn’t be scared to do a presentation.*”

4.3.3 Content Knowledge. Content knowledge is categorized as the current technology/content knowledge (6), the knowledge of

resources (1) and the ability to produce effective course material (1) (Table 4). In the scope of CS subject, teaching **current technologies** is an important issue, S10 explained that as “*teachers should stay up to date with current technology*”. There are two different views about being very knowledgeable about content. S17 declared that “*I feel like it’s important that you have to know a lot about the subjects you teach*”. As the opposite of this view, another student (S13) defended that high school teachers do not require a lot of knowledge and they declared that “[...] *It is obvious enough what the teacher is explaining and then it can be fun to be able to explain more, but it’s usually not required. It is better, but it’s not required.*” As related to **the knowledge of resources**, S14 stated that “*You have to show students how to solve the problem in CS [...] but you also have to teach which resources they could use. Because they don’t understand it, if they just copy-paste code [...]. So I want to make them, autonomous a little bit because I can’t give all the individuals what they need in one hour.*” Also, S16 stated that “*A teacher must be able to produce good materials so that it covers the topic well*”.

4.3.4 Personal skills. Six of the students emphasized some personal competencies such as patience (3), calmness (1), diligence (1) and self-confidence (1) as a requirement for CS teachers (Table 4). As related to **patience**, S7 stated that “*you have to have the patience to make the person understand*” and S17 declared that “*you do have to be really patient because I feel like it’s important*” and S5 added, “*Definitely communication and patience when it comes to explaining things*”. Regarding **calmness**, S18 expressed that “*they have to be a bit relaxed? So that you really can listen to the students and, and they’ll respond, relax. And if the students don’t understand it, don’t get angry about that or something.*” S11 described a teacher they admired and emphasized that he is a **hard worker**. While S4 talked about their own teaching experience, they pointed out **self-confidence** about the content is important for teaching.

5 DISCUSSION

CS education has arisen as a subject for inclusion within the compulsory school curriculum. However, there is a lack of CS teachers in schools. This study explored the reasons of this shortage, the factors influencing CS students’ career choices, their perceptions about becoming a teacher and their perceptions about requirements for the teaching career.

5.1 Career Choice of CS Students

The most important factors influencing career choice of CS students are the sense of belonging, organization-related expectations, the field of expertise and salary/pay expectations. Firstly, students expect to feel a sense of belonging in the workplace, they want to have good relations with their colleagues and a positive attitude to work climate. Secondly, organization-related expectations are related to the scale of the organization, the reputation of the organization, work hours, and location of work. Thirdly, students prefer to select organizations according to the expertise fields which they are interested in (such as web development, security, programming, project management, software quality assurance, back-end systems, database design). The fourth most cited factor is related to salary expectations. There are two different views about salary: it is an

important factor for one group of students (4) and it is less important or unimportant for another group of students (3). According to the social cognitive career theory [22], outcome expectations (such as belonging, salary etc.) influence the interests and vocational choice. This is also defined as “imagined consequences of performing particular behaviors” [23]. Career development and promotion are also important factors for several students. On the other hand, one of the students who want to become a teacher declared that they don't have any ambition for their career development or any expectation of promotion. This ironically reinforces the idea that a teaching profession is not actually one that ambitious people would pursue, and therefore reduces its attractiveness to a certain group of students.

5.2 To Be a Teacher or Not?

Regarding CS students' career plans about becoming a teacher, approximately 28% of the students stated that they definitely do not think of teaching, 44% of them stated that they may not think of teaching as a priority career goal, perhaps in the future. Teaching career was not perceived as appealing to CS students because of low salaries and unpleasant aspects of the teaching job (such as switching between different things - administrative tasks, preparing lessons, teaching different classes, supervision, handling parents, and grading). Also, the teaching profession is perceived as a 'last' resort, or second choice by some students, when run out of an ambition to grow in a CS career. Studies have also shown the probability of graduates choosing to enter into the teaching profession to be declining over the years [6]. Poor working conditions and low relative pay consistently emerge as motives for teachers leaving the profession and as reasons deterring new entrants into the profession [6, 9, 11, 35]. Dolton and Chung (2004) investigate why teaching is so relatively unattractive for graduates and they measured the 'profitability' of becoming a teacher compared to alternative occupations that potential teachers could undertake as their professional career [9]. The results show that the rate of return on career choice measures for all alternative occupations (accountants, lawyers, engineers) are higher than the measures obtained by teachers. Such results may act to deter potential teachers from entering the profession as their first choice of the career upon graduating from university.

CS students have two important sources of motivation for becoming a teacher as a career goal: prior experiences and personal interests. In terms of prior experiences of students, it is notable that students who served as teaching assistants while studying related their experience in this role as having a positive effect in their view of teaching. This vocational choice can be explained with social cognitive career theory [22], which proposes that background context influences learning experiences, which influence self-efficacy beliefs and outcome expectancies. These influence interests, which influence choice goals; goals influence actions, and actions influence performance attainments [22, 24]. On the other hand, Hewner (2012) also found that CS students had difficulty identifying how what they were learning might be useful to them in some later career and they don't know what CS graduates do [17]. For this reason, we asked students what competences they think CS teachers should have.

5.3 Perceived Competencies for CS Teachers

In this case, CS students mostly referred to the pedagogical skills and social skills of teachers. CS teachers are expected to be good at instructional strategy knowledge and classroom management. Additionally, teachers should have competence in facilitating interaction and good communication with children according to students' views. Zhu et. al (2013) investigate teachers' core competencies in relation to their innovative teaching performance. The findings indicate that teachers' educational competency, social competency, and technological competency were positively related to their teaching performance [41]. Additionally, in the scope of the CS subject, teachers are expected to be aware of current technologies.

Considering the CS teacher certification standards, there are significant different implementations across the world. In the Netherlands, there are a few universities where a teacher could become fully qualified by following a Master's in Education in CS. There are no more than a dozen students enrolled at this program in all of these Dutch universities offering this training [15]. It aligns with the results of this study that working in the industry seems more attractive for CS bachelor students. A final-year student hinted feeling overqualified for a teaching career “*I feel like it's [becoming a teacher] a missed opportunity because we learn a lot here ... And when you just want to teach it, how do you say it, you lose some skills I think in the long term*”. Another reason for CS teacher shortage can be related to the demand for CS teachers. While it can be hard to make CS a hiring priority when it is not a core subject, decision-makers at schools prefer to convert a current teacher at a school from their subject to CS [32].

In conclusion, considering the results of the study, it is suggested that there should be increased flexibility with respect to alternative pathways into the CS teaching profession, and certification programs or requirements for CS teachers should be reformed or built from the ground up. The design of entry and qualification requirements should be informed by a range of contextual factors, including recruitment needs and the characteristics of the teacher labour market [29]. Similarly, Dee and Dan Goldhaber (2017) also suggested that requirements for CS teachers must be revised [8] and CSTA (2008) suggested creating flexible teacher certification programs for CS education grounded in the knowledge of the field. Additionally, teaching positions should be enhanced in terms of salaries and working conditions [12]. Remuneration is only one of many factors that can render a profession attractive. Working conditions, opportunities for professional learning and growth, social status, as well as professional autonomy are important to make teaching careers not only financially, but also intellectually satisfying and to attract high-caliber candidates [29]. Similarly, the inability of school districts to attract or maintain highly qualified teachers in the face of salary and benefit competition from industry was identified as one factor, which points to a crisis in CS education at the high school level [12]. So, it is suggested that measures should be taken to increase the attractiveness of teaching positions in comparison to the industry for CS students.

6 LIMITATIONS

We investigated the factors that influence students' career choices and students' preferences about teaching. Several limitations of

this study can be identified. Our research was based on interviews conducted with a small number of students from four universities in one country. The experiences and perceptions of this student population may differ from the ones of other students in the same or other institutions, countries, and cultures. We focused on recruiting students who are the final year Bachelor's students and Master's students of CS departments with aim to include participants who are aware of their career interests and with sufficient knowledge related to possible career options. However, if the first or second-year CS students were interviewed, results might be different. The sample of students interviewed might have been biased by their social-economic status, and that might have affected the results. Regarding the internal validity of our study, a threat is a pressure that the respondents might have felt when disclosing their perceptions about the attractiveness of a teaching career to the interviewer. Overall, all students appeared comfortable during their interviews and not hesitant to give their honest opinion. Still, they might have answered differently with another interviewer or in a more anonymous data collection setting. Additionally, when asked about their perceptions about teaching careers, often students misinterpreted school-level teaching for university-level teaching. For this reason, we clarified at the beginning of all interviews that teaching referred to the high school level. Differences between interviews might also have affected the results: the total duration of the interviews varied greatly, some of the interviews were physical and others online, and most of the students were not native English speakers. Concerning data collection, it is a qualitative research study and researchers gathered self-reported data that rarely can be independently verified. Self-reported data may contain several potential sources of bias such as selective memory, students remembering or not remembering experiences or events that occurred in the past, or difficulty to recall events. Regarding the inductive data analysis, the conclusion drawn in this study was not used to prove anything about CS students' career plans. In other words, the findings show only the current situation, there is no generalization purpose, and the findings need to be tested by new research studies with another pool of candidates. The underlying reasons for CS teacher shortage or lack of CS teacher certification standards, and hence a full diagnosis of the problem, is beyond the scope of the paper. The research is, therefore, exploratory and raises a number of further questions for investigation in the future.

7 CONCLUDING REMARKS

Students, parents, teachers, and administrators continue to value CS learning in high schools. Schools report a lack of qualified teachers and funds as key barriers to offering CS education [20]. So, research studies related to CS teacher shortage and CS teacher certification standards may continue to be interesting and top topics in the near future: (1) a research study can be conducted to explore other pool of candidates for addressing the CS teacher shortage. It can be explored whether other subject teachers or someone who worked in the technical field want to teach CS subjects, (2) it can be explored what kind of requirements are essential for other subject teachers or technical employees to teach CS subjects in high schools, and (3) CS teacher certification programs can be renovated according

to recruitment needs and the characteristics of the teacher labor market.

ACKNOWLEDGMENTS

We would like to thank Marina Milo (Vrije Universiteit Amsterdam) for helping with setting up the interviews and processing the interview transcripts. We thank Vivian van der Werf (Leiden University) for providing help by sharing her valuable feedback with us. We also thank the CS students who agreed to participate in the study.

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