

Prepare and Support Computer Science (CS) Teachers: Understanding CS Teachers' Professional Identity

Lijun Ni & Mark Guzdial
School of Interactive Computing
Georgia Institute of Technology
85 5th Street NW
Atlanta, GA, 30332-0760
{lijun, guzdial}@cc.gatech.edu

ABSTRACT

Currently, we are facing big challenges of preparing and supporting K-12 CS teachers. In addition to increasing the number of CS teachers, there is a great need of supporting those teachers to grow and retain as committed, quality teachers. As suggested by teacher identity theory, teachers' sense of commitment and (other aspects of) teaching profession is tightly linked with their sense of identity. This study starts to explore ways of supporting CS teachers through understanding their teacher identity. We start with introducing the unique challenges of preparing and supporting CS teachers, and then describe the qualitative study aimed at understanding CS teachers' professional identity, which has the potential to offer insights for sustaining and supporting CS teachers.

Categories and Subject Descriptors

K.3.2 [Computers and Education]: Computer and Information Science Education—*computer science education*.

General Terms

Design, Experimentation, Theory.

Keywords

CS Teacher, Teacher Identity

1. INTRODUCTION

Computer science (CS) is an important but relatively young discipline in K-12 education. To achieve quality CS education, we need quality CS teachers. The reality is: we still have very few secondary CS teachers. For example, for the AP CS course, which is the only CS course that carries college preparatory credit, we have a very small number of schools that are approved by the College Board to use the AP CS A designation on their transcripts. The number of schools offering AP CS also indicates the rough number of AP CS teachers teaching that course (usually with one AP CS teacher for each school). In 2009, only 72 schools in Georgia and 2019 schools nationally offered AP CS. The number of AP CS teachers nationally is still relatively very small, compared with those of other STEM subjects (e.g., 11206 schools for Calculus AB, 8238 schools for Biology, and 6513 schools for Chemistry).

In addition to the need of increasing the number of CS teachers, there is also the need of supporting those teachers we have recruited and trained to grow and stay as committed, quality CS teachers. As we know, we are facing the issue of low teacher

retention rate in many districts [15,16]. Teacher turnover is significantly high and especially beginning teacher attrition is a serious problem [11]. Based on an analysis from the National Center for Education Statistics, it is estimated that almost half of America's teachers leave the teaching profession within five years [10]. The attrition rate for those who enter through some "alternative" pathways can be as high as 60 percent [6]. Therefore, we are facing a big challenge of sustaining our teachers overall. Considering the current situation of CS education, we are working on preparing more CS teachers. For example, the NSF CS/10K Project is aimed at preparing 10,000 CS teachers by 2015 [5]. Looking forward to 2015, we will have 10,000 well prepared teachers including many beginning teachers. If similar teacher turnover rate happens to our CS teachers, we are going to lose around half of them by 2020. Therefore, the key question for us is: how do we sustain the good CS teachers we have recruited, trained and hired?

In this paper, as one first step, we explore ways of sustaining CS teachers through understanding their professional identity as a CS teacher. This study is intended to gain first understanding about CS teachers' perceptions about their own professional identity and potential factors that might contribute to these perceptions. The two research questions explored in this study are:

- 1: What kind of professional identities do secondary CS teachers bring into their teaching practice?
- 2: What influences teachers' sense of identity as a CS teacher?

2. THEORETICAL FRAMEWORK

2.1 Teacher Identity Matters

Teacher identity theory offers a particular conceptual lens for us to understand the issue of teacher commitment and retention. Here, teacher (professional) identity is defined as being recognized as a certain kind of teacher by self or others [1, 9, 17]. It also reflects a subtle dimension of the complex and ongoing process of self-discovery, a process for teachers to know themselves, their students, and the subject matter they teach [3]. Teachers' sense of commitment is tightly linked with their sense of identity, or sometime seen as one aspect of teacher identity. The emerging literature about teacher identity suggests that teacher identity influences the way teachers teach, the way they develop as teachers, and their attitudes toward educational changes [2]. Furthermore, teachers' motivation, self-efficacy, job satisfaction and commitment are closely linked with their

own sense of identity [4, 7]. The essential roles of teacher identity, as identified by many researchers, inspire us to look at the professional identity that CS teacher might bring into their teaching, which has the potential to offer insights for us to support and sustain CS teachers.

2.2 Professional Identity for CS Teachers

For secondary CS teachers, the evolving, young nature of the computing field and its educational practice adds a few challenges of its own to the general list of challenges for teachers to building their sense of professional identity as CS teachers.

First, the relative newness and evolving nature of the computing field itself brings big challenges for teachers to identify the subject matter they are teaching. The study of CS as a scientific discipline is often confused with other uses of computing technology within education, such as computer applications and educational technology [8].

Secondly, current certification situation might make it more difficult for CS teachers to identify themselves as CS teachers. As the CSTA reports [8] point out, there is a significant lack of consistency in CS teacher certification standards in the US. In many states, a CS teaching certificate is not required in order to teach CS courses [12]. In some states, since new teachers cannot be certified as CS teachers due to the lack of certification program for computing education, they must meet the certification requirements in some other discipline. Similarly to the lack of consistency in CS teacher certification standards, CS courses are often offered in a variety of programs, which do not treat CS as an individual academic discipline. This kind of confusing and complex situation makes it difficult for CS teachers to identify what they are teaching and what kind of teachers they are.

Thirdly, since there are still so few CS teachers, these teachers are especially isolated. This kind of isolation might prevent teachers building their own sense of belonging and affiliation with other CS teachers.

As the first step, we would like to understand what kind of professional identities CS teachers bring into their teaching. Here, we use a blended framework of identity constructs to examine CS teachers, informed by the theoretical framework of social identity [18], mathematics identities [14] and science teacher identity [13]. Thus, CS teacher identity is defined in terms of the following three aspects of their belief systems: sense of belonging/affiliation, attitudes to teaching CS and beliefs in the values of teaching CS, as well as their motivation and commitment to teaching CS.

3. Modes of Inquiry

3.1 Data Sources

In this study, we use interviewing [19] as our method to start exploring CS teachers' sense of identity. We conducted semi-structured interviews with nine high school CS teachers at the greater Atlanta metropolitan area, who taught at least one introductory CS course listed in the Georgia computing curriculum (the Computing pathway): Computing in the Modern World (CiMW, which introduces the fundamental principles of computer science and its place in the modern world), Beginning

Programming (B-Prog), Intermediate Programming (I-Prog) and AP CS. Before the interview, the participants completed a demographic questionnaire, which collected basic background (e.g., educational background, teaching experience, school context, and professional development experience, etc).

The semi-structured interview lasted around 60-90 minutes regarding participants' sense of identity. Interview questions were framed by the three aspects of the CS teacher identity introduced above. We asked participants to introduce themselves in terms of who they are and what they teach, to tell the stories of how they started teaching CS, their definition of CS, how they felt about their own teaching, issues and challenges they face in teaching CS, and their participation in professional communities, if there is any.

3.2 Participant Background

Eight of the nine teacher participants came from public schools at the greater Atlanta metropolitan area and the ninth teacher taught at a private school in Atlanta. Here, all the teacher names mentioned in this paper are pseudonyms. Their teaching experience in CS courses varied from two years to over ten years and their school accommodated from less than 500 students to over 2000 students. Among the public schools in Georgia, CS courses are offered in the Business and Computer Science program under the CTAE (Career, Technical and Agricultural Education) department. In the one private school, CS courses were offered in the Business and Computer Technology department, which served students similarly as the Business and Computer Science department in public schools. Therefore, there is no big difference in terms of where those courses were offered in different participants' schools.

Table 1 Participant Backgrounds

Teacher	CS Courses	Educational Background	Certificate
Alex	CiMW, Web Design, Intro to Animation	Electrical Engineering; Management	Technology Ed, Math Ed, Business Ed
Becky	CiMW, B Prog, I-Prog, AP CS	CIS	Business Ed
Bob	CiMW, B-Prog, AP CS	CIS; Math Ed	Technology Ed, Business Ed
Ryan	Programming in VB, C++ & AP CS in Java	Political Science; Private School Leadership	N/A
Cindy	CiMW, B-Prog, AP CS	Math Ed	Math Ed
John	AP CS	CS and Math; Math Ed	MathEd
Pat	CiMW, B-Prog, I-Prog, AP CS	Business	Business Ed
May	CiMW, B-Prog, AP CS	Management; Elementary Ed	Business Ed
Rose	CiMW	Business Ed	Business Ed

Table 1 lists these teachers' professional background information including the CS courses they were teaching, their educational backgrounds and teaching certificate(s) they held. First, these teachers reported that they all taught at least one of the introductory CS courses listed in the Georgia computing curriculum for the computing pathway. Second, these participants had different educational backgrounds, such as Mathematics Education (Math Ed), Business Education (Business Ed), Management, Political Science, and Computer Information Systems (CIS). Among these nine teachers, only three of them held a computing related degree: one in CS and two in CIS.

As to the certification status, one teacher (Ryan) did not pursue a teacher certificate since that was not required to teach at a private school. Six of the remaining eight teachers got a Business Education certificate, which allowed them to teach CS courses in Georgia. Both of the two teachers (Cindy and John) holding a Mathematics degree got a Mathematics Education certificate. These two teachers reported that they belonged to the Math department in their schools, while the other six teachers holding a Business Education certificate all belonged to the Business and Computer Science program/department in their schools.

4. Findings

This section first presents how the participants identified themselves as teachers in different subjects. The second part of this section reports how the participants explained for their own perceptions as teachers in different subjects: what different background aspects and other factors might contribute to their self-perceptions as CS teachers (or not).

4.1 Perceived (CS) Teacher Identity: Self-Identification and Identity Features

The participants were explicitly asked to introduce themselves and clarify their own teacher identity. Overall, these nine teachers self-identified themselves either as a CS teacher, as a Business teacher, or as both a CS teacher and teacher in another subject (Math or Business). Section 4.1.1-4.1.3 present further information about these three kinds of teacher identities and some of the identity features indicated by the individual teachers, such as their confidence in teaching CS, their beliefs in the values of learning CS, their motivation to strive to teach well and commitment in teaching CS.

4.1.1 I'm a CS Teacher

Four teachers called themselves CS teacher: Alex, Becky, Bob and Ryan. They used words like "computer science teacher", "computer teacher", and "programming teacher" to introduce themselves. For example, Ryan explicitly called himself programming teacher and further explained that he didn't label himself as a CS teacher to avoid confusion about the meaning of "Computer Science teacher".

[Ryan]: "I suppose I would lump myself more as a Programming teacher, because that is most of my courses...Mainly because I think people don't understand what it means to be a Computer Science teacher. It means so many different things to different people. You know, in the past when I've said that,

people want to talk about typing. I'm like, 'Okay.' That's a skill and a technology, but it's not what I'm teaching actually."

All these four teachers understood the broad scope of the field of CS and believed the values for students to learn CS. However, not all of them were committed to the CS courses they were currently teaching since CS is not in the core curriculum. One teacher, Alex, explicitly expressed a sense of crisis as a CS teacher, which drove him to preparing a Math education certificate for job security.

[Alex]: "High schools are much more interested in the core subjects: Math, English, Science, and Social Studies, which have the Georgia High School Graduation test. They're much more interested in those than anything else in the whole world. So, they're much more interested in those than the Career Technology Education classes [including CS]. So, I just took the Math test because I wanted to make sure that I could find a job in a school that I might want to go to...That's the only reason I took that."

Three of these teachers felt they were confident in teaching CS courses with a few years of teaching experience. Meanwhile, another teacher, Becky, was still struggling with how to teaching CS well. Even if she held a background in CIS and had been teaching CS for several years, she did not feel confident. She perceived CS was hard to teach since it is changing and it is hard to explain abstract concepts.

[Becky]: "I struggle with giving everyone the material and being able to explain it to everyone...I struggle with how to be creative with the programming. I have a problem with trying to make the programs have meaning to them...It is hard to teach. It's hard knowing how to teach it, how to give it to them...It's hard to explain...I would have to definitely update my skills. I would have to do something because I don't know if it's old age or what. When I look at kids' codes, they think I should know it as soon as I look at it. For the longest time I thought I should, but I don't have to. I have to study it just like they do."

We also saw another common feature among these four teachers, who self-identified themselves as a CS teacher: they all saw the evolving nature of CS and would like to learn more to keep updated and teach these courses better. In addition, since they were all isolated, they all wanted to keep connected and collaborate with other CS teachers to address challenges in teaching CS.

[Ryan]: "Honestly, the most difficult thing I've had, with at least my journey, has been when machines don't quite handle the software interface and it changes...Also [I had] some issues with [programming] language and paradigm shifts when it went from procedural to object-oriented. There was an interesting journey there of trying to navigate that. That would have been probably better done if I had initiated more contact with other teachers and had a group to work with...It's so important to have a

group of peers that you have collaboration with. That's not just a muse group on the Internet. [That's a group] you actually have some meetings with from time-to-time or you co-teach a unit at some school [with], or have a special program in the afternoons."

4.1.2 Mixed: CS and X Teacher

Three teachers claimed themselves were teachers in both CS and another subject: Cindy, John and Pat. Cindy was a Math and CS teacher, seeing CS as part of Math. John saw himself as both a CS and Math teacher, but more passionate in CS. Pat claimed she was a Business teacher as well as a CS teacher.

- **Cindy: "I'm a Math teacher" and "CS is applied Math."**

Cindy reported herself teaching both (one) Math and (three) CS courses, but she was really a Math teacher since she believed that CS was part of Math. Also, she would like to stay teaching Math instead of moving to teaching all CS.

[Cindy]: "I am a Math certified teacher, so I am a Math teacher who teaches Computer Science. I really think that Computer Science is a Math-type course. It's like Applied Math. You're applying what you know in Math to that...I mean, it really is, in my opinion, a Math class...I want to stay in the Math area as well. I don't want to go all the way over to that other side, because I was trained to be a Math teacher."

Considering CS as part of Math, she used lots of Math problems as examples to be solved by programming in her CS courses. For example, she asked the students to turn the quadratic formula or the distance formula into a Java Statement, or asking them to take a 2D matrix and figure out a magic square by writing a code.

- **John: "I'm a Math and CS teacher, but I'm a better Math teacher."**

John claimed himself as Math and CS teacher, but emphasized that he was more passionate about teaching CS. He studied Math as well to help himself to better understand CS.

[John]: "I would introduce myself as a Math and Computer Science teacher... [I am] very passionate about working with gifted students, especially passionate about learning how to teach Computer Science... Well, I think I'm definitely more passionate about teaching Computer Science. I enjoy teaching Computer Science more...The main reason I'm not teaching CS full-time is, there isn't really a place where I could make that a full-time job. But, if I could ultimately choose what I taught, I would definitely prefer to teach all Computer Science. In school, that was my first choice as a major. I ended up adding a Math degree just so I would be a little bit more likely to understand some of the complex topics in Computer Science."

However, he believed himself was a better Math teacher due to the isolation situation of CS teachers, while the Math teacher community was available for him.

[John]: "Even though I feel like I know Computer Science better than Math and I'm more passionate about it, I still think I'm a better Math teacher, just because I've had so much support. Whenever I have problems, I can talk with the people that I work with, most of who have taught for many years in Math....Every day, I'm eating lunch with Math teachers. So, we can talk about our problems. With Computer Science, I've got nobody to talk to."

- **Pat: "I'm the only Marketing teacher and I'm also the only CS teacher."**

This teacher claimed herself as both a Marketing (part of Business) and CS teacher. She was striving to teach an individual CS course instead of sessions with CS and Business combined.

[Pat]: "This semester, I teach one section of Beginning Programming in a class combined with a section of Intermediate Programming, and one section of Marketing Principles. Next semester, I look to include a class where I might see Beginning Programming, Intermediate Programming, and AP CS in one classroom as one time, Marketing Principles and Sales and Promotion in one class at one time."

All these three teachers reported the issue of (CS) teacher isolation. They all expressed the desire to connect with other CS teachers. In particular, they did not see some Business teachers as their peers for collaboration in CS teaching. For example, Cindy explicitly reported that she could not find colleagues that matched with her mindsets and can collaborate with.

[Cindy]: "I don't have many colleagues in the county that I can turn to... I've sat and I've talked to people... They all have their own way of wanting to do things [in CS], which is okay. But, you know, we have a lot of people who are Business teachers with no idea what they're doing with this class. I'm hoping to meet more people that I can collaborate with and more people that are more like-minded to my style of teaching so that I can get more ideas that way."

Another teacher, Pat, further pointed out that putting some Business teachers who did not want to teach CS into the CS education community hurt the program.

[Pat]: "One of the biggest problems I see is that Computer Science has been lumped in with Business Education and many of these teachers want nothing to do with Computer Science. [They] consider it too hard to learn, don't have the background to be effective in it, and want to go back to keyboarding and computer applications. They hurt the program because they 'have' to teach [programming and more]... they don't ever want to be technical... If a teacher wants to learn it and teach it they can - but so many don't and the lumping into business education has hurt the progress in my opinion."

4.1.3 I'm a Business Teacher

The remaining two teachers, May and Rose, called themselves Business teacher. Both of them held Business Education certificate and seeing their main responsibility in teaching Business courses, no matter they were teaching mainly CS (May) or only one CS course (Rose).

Both of them saw learning computing or CS was important to every student. However, May was struggling with differentiating computer applications from computing or computer science. She thought the CiMW course is a computing course, which she meant as computer applications (e.g., creating a word document). Overall, she believed that computing as being able to operate the computer, while CS as advanced programming and was only for those smart students.

[May]: "I think, computer science is more for really, really smart people. I'm not saying I'm smart, but I'm thinking that if I have to go take this Computer Science degree, that it's going to be really hard...I think computer science is a much higher level...When I say computing, I think of computing as being able to operate the computer, being able to go in and type a Word document, being able to use the Internet, being able to create a document, maybe create a PowerPoint, just navigate around a computer...I believe that most students can successfully take and complete Computing in the Modern World, but it takes a little higher level of intelligence to complete the Introduction to Programming and the AP Computer Science."

May reported that although she was kind of isolated as the only one who taught CS course, she felt confident in teaching those courses. First, she felt herself got more confident in the process of teaching every year. Second, she felt the general resources she could access from the CTAE department in her local county and the state was sufficient for her. She was not looking for further learning and collaboration opportunities from other teachers.

Another Business teacher, Rose was also confident about teaching the CiMW course, which was the only CS course she was teaching. In particular, Rose was comfortable with the situation of no programming course offered for students interested in CS because she believed that other Business courses can meet students' need instead.

[Rose]: "I think that most of our students, who have been interested in Computer Science and have asked about it, although we're not teaching it, truly do have a desire to learn Computer Science. They were really disappointed that we're not offering it...They truly want it, and I think they've settled for Business Ed classes. I think they might try to be in Programming than in the other Business Ed classes. But I think as an overall department, I think they flow well together, because I think there is some interrelated stuff. So, I think that they mesh well. Some students who want to go into like Programming or whatever might want to own their own business. So, Business Essentials would be great for them, because it teaches them entrepreneurship and the skills behind the scenes that they may need to start their own business."

4.1.4 Summary of Self-Identity by Teachers

The above sections presented how the participants self-identified themselves as teachers in different subjects. Overall, these teachers all taught CS, but they were different in terms of their confidence and commitment in teaching CS, and their sense of the need of learning and CS teacher community.

4.2 Influencing Factors

This section presents how teachers explained for their own perceptions as CS teacher or teacher in another subject. Overall, four kinds of factors contributed to these teachers' self-identity related to their teaching in CS (with at least two teachers reported similarly): their educational background and certification, CS curriculum and department hierarchy, availability of CS teacher community, and teachers' perceptions about the field of CS.

4.2.1 Educational Background and Certification

First of all, these teachers relied on their own educational background to identify themselves as teachers in which subject. For example, Bob claimed himself as primarily a CS teacher due to his computing background.

[Bob]: "[I'm a CS teacher] mainly because my background is in computers. My degree is Information Systems, and because as I said, that's my focus...What I feel like my specialty is and what I want to put most of my interest and my focus, and my attention and time on is the computer courses, and given the opportunity, I'd like to focus on that."

Similarly, John also preferred to teach CS since that was his major. In contrast, Rose saw herself as a Business Education teacher since her major was not in CS but in Business Education.

[Rose]: "Well, I identify myself more as Business Ed. I teach Accounting, also. I've taught Computer Applications and Programming. So, really my degree is not in Computer Science. It's in Business Education. So, that's just my identity."

Beyond self-identification, teachers' personal educational background could also influence other aspects of their identity (e.g., their confidence in teaching) and likely their teaching practices as well. As presented in Section 4.1.2, Cindy felt more comfortable in teaching Math and could "get a good handle on Math" since she was more familiar with Math. She also saw CS as part of Math. In her CS classes, she used lots of Math problems as examples to be solved by programming. Moreover, she would like to stay in teaching Math even if she enjoyed in teaching CS.

Similarly to teachers' educational background, they used the certificate(s) as one kind of criteria to determine their own teacher identity. For example, both May and Rose believed that they were Business Education teacher since that was what they were certified for, as May said:

[May]: "I introduce myself as a Business Education teacher. Even though most of the courses I teach are Computer Science, for some reason, I always say

Business Education... That's what I am certified for."

Meanwhile, Cindy claimed herself as a Math teacher even if she taught more CS courses than Math.

[Cindy]: "I am a Math certified teacher, so I am a Math teacher who teaches Computer Science."

Furthermore, certificates also directed how other entities (e.g., the local county and local school) identified the teacher in related subjects. For example, Bob was seen as an Engineering teacher due to his first certificate in Technology Education, which determined the courses assigned to him and his professional development requirements. In fact, Bob was always interested in teaching CS. He was just confused with which certificate would allow him to teach CS courses and thus experienced a devious path to his CS teaching.

[Bob]: "I had my Technology Education certification first...I originally thought Technology Education would encompass the Computer classes. It wasn't until I got into the school system that I realized or I found out that Computer Science was under Business... [I then did the Business Education certificate] because I wanted to teach the Computer Science classes. I didn't want any justification for them not allowing me to teach them."

Similar to Bob, since there was no specific certificate for CS teachers, John got a Math Education certificate as the route to teaching CS. At the earlier years of his teaching career, he started teaching Math before he was able to teach CS. He was still seen as a Math teacher by his students since he worked in the Math department and his classroom was also physically located on the Math hall.

[John]: "The way that I work, my classroom is on the Math hall. I attend all the Math meetings, and my students sometimes will meet in my room in the Math hall, if you asked the students, they would probably think [AP CS] is maybe even a Math course, because I'm known as a Math teacher, and I teach the class."

4.2.2 CS Curriculum and Department Hierarchy

The teachers also reported that factors like CS curriculum and department hierarchy influenced their identity related to CS teaching. Here, CS curriculum refers to what courses are offered in what order under which part of the secondary curriculum. Department hierarchy means where/in which department/academic unit those courses are taught. These two aspects are actually related. In Georgia, CS courses are offered under the same unit (Business and CS under the CTAE department). These courses are electives instead of core courses. On one hand, such situation might prevent students as well as administrators to see the values of these courses. On the other hand, by putting CS under Business, some Business teachers not interested in teaching these technical courses had to teach those courses. As Pat complained earlier, this situation could hurt the whole community of CS teachers.

Another teacher, Alex further complained the current CS curriculum offered in his school as being a non-core subject and having CiMW first might lead to the loss of student interest. He

further expressed a sense of crisis as a CS teacher, which drove him to preparing a Math Education certificate for job security.

4.2.3 Availability of CS Teacher Community

As we can see from section 4.1, most of these teachers expressed their needs of learning to better teach CS, including all the four CS teachers and the three mixed subject teachers listed above. Most of these teachers were the only CS teacher in their local schools. To some extent, these teachers were isolated with their peer CS teachers. The lack of peers and community for CS teachers did not only prevent some learning opportunities among those peer teachers, it also hurt these teachers' feeling about themselves. These teachers felt that they did not have peers or colleague like themselves. As presented above, Pat was complaining about those teachers who did not care about CS hurt the whole community of CS teachers. Cindy was looking for teachers with similar mindsets for collaboration, those who did not just see CS as computer applications and did not teach programming like teaching computer applications.

Another example was John. As presented earlier (Section 4.1.2) John felt himself was a better Math teacher than a CS teacher due to the lack of support from peer CS teachers. He was eager to have a community of CS teachers, which could help him go through with CS teaching.

4.2.4 Teachers' Perceptions of the Subject (CS)

The participants also held different perceptions about the field of CS. These perceptions of CS influenced other aspects of their attitudes and beliefs about teaching CS, such as the values of CS/computing, their confidence in teaching CS, the need of learning and the need of CS teacher community.

First, they had different definitions about computing and CS. Most teachers saw the values of learning CS and broadly defined CS or computing as problem-solving using computers. However, the two business teachers had some confusion about CS and computing. Both of them saw learning computing as learning about operating computers (mainly as computer applications). So, they recognized the values of learning 'computing' for every student. Meanwhile, they narrowed CS as mainly about programming. Thus, CS belonged to higher-level skills and was only for those smart students. Therefore, their understanding of CS/computing determined their goals of teaching those courses. For example, May reported (in Section 4.1.3): "Computer science is more for really, really smart people."

Secondly, whether being able to see the changing nature of the CS field also influenced other perceptions of the teachers, such as the challenges of teaching, the need of continual learning as well as a community of peer CS teachers. For example, Becky perceived that CS was hard to teach due to its evolving and abstract nature. As presented in Section 4.1.1, she clearly saw the need of updating her own knowledge and skills. Similarly, Ryan and Cindy also understood that CS was an evolving and broad field, its changing nature made changing answers about best practices and they needed to learning with peer teachers.

[Cindy]: "Well, the best ways, because of change, I very rarely refer to something as the best. It just feels wrong. As soon as you say something is the best, something else comes along to change it...I don't

think I have the answer to that. But it's an always evolving journey and it's different every year."

5. SUMMARY AND DISCUSSION

5.1 Summary of Findings

This study is a first step to look at perceived teacher identity from CS teachers, which has the potential to offer insights for us to sustain and support CS teachers. From this exploratory study, we find that these CS teachers held different teacher identities, and these identities indicate different features related to their motivation and commitment in teaching CS. Some of these teachers were not committed to teaching CS, some were not confident in their teaching, some might hold shallow views about the subject they were teaching. All of them were isolated and looking for connection and community for CS teaching.

Results from this study also indicate four kinds of factors that contribute to these teachers' perceptions about their own teacher identity related to CS teaching: teachers' educational background and certification, CS curriculum and department hierarchy, availability of CS teacher community, and teachers' perceptions about the field of CS. These four aspects are not individual factors and can interact with each other.

First, it is natural for a teacher to pursue a certificate in his/her own major. We can see an overall match between teachers' educational background and the certificate (s) they had. For example, Cindy with Math background had the Math Education certificate, while Pat got a Business Education certificate while having a major in Business.

Second, the political/policy aspect of CS education determines the academic nature of the CS curriculum: under which subject/unit to put CS, where it should be offered and what kind of certificate teachers need to teach CS. Here in Georgia, CS is under Business and teachers need Business Education certificate to teach CS. Such political setting can also result in other issues of CS education. For example, CS as electives can hurt the values of CS itself and lose student interest. This could then lead to fewer students, therefore fewer CS courses offered, and fewer CS teachers needed. Such ripple effect could then cause the isolation of CS teachers.

Third, teachers' perception of the CS field can influence teachers' sense of the need of learning and what kind of community they want to join. With different understanding about things like what is CS, who should learn CS, what are the goals of CS courses and best practices of teaching CS, teachers can form different opinions about themselves and who count as their peers.

5.2 Implications for CS Teacher Professional Development

It is obvious that the political/policy aspects of CS education in current educational system, such as curriculum standards, certificate requirements, are critical in determining other aspects of CS education including our CS teachers' knowledge, motivation, commitment as well as their teaching practices. However, it is hard to change those aspects. Our findings also indicate that CS teachers can be isolated and lack of support and learning opportunities while they feel the need of learning.

Therefore, it could be one way to offer support for our current CS teachers and influence their own sense of identity by creating a community of local CS teachers where they can learn and support each other and change their perception of CS, CS teaching and themselves.

5.3 Future Work

After gaining preliminary understanding about the sense of identity our CS teachers might hold and potential factors that might contribute to their self-identity, we are currently conducting a study exploring how to support CS teachers' identity development, through a teacher professional development program with a focus on promoting teacher learning and community building. We are expecting to further our understanding of ways to change teachers' identity into more committed CS teachers.

6. ACKNOWLEDGMENTS

We would like to thank all the teacher participants in this study. This work is supported by the National Science Foundation CPATH program under Grant No. 0829601. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

7. REFERENCE

- [1] Andrew, M. D. What matters most for teacher educators? *Journal of Teacher Education* 48, 3 (1997), 167-176.
- [2] Beijaard, D., Meijer, P. C. and Verloop, N. Reconsidering research on teachers' professional identity. *Teaching and Teacher Education*, 20, 2 (2004), 107-128.
- [3] Cardelle-Elawar, M., Irwin, L. and Sanz de Acedo Lizarraga, M. L. A Cross Cultural Analysis of Motivational Factors that Influence Teacher Identity. *Electronic Journal of Research in Educational Psychology* 5, 3 (2007), 565-592.
- [4] Chan, W.-Y. L., Shun, Nie, Youyan; Lim, Sandy; Hogan, David Organizational and Personal Predictors of Teacher Commitment: The Mediating Role of Teacher Efficacy and Identification with School. *American Educational Research Journal*, 45, 3 (2008), 597-630.
- [5] Cuny, J. Finding 10,000 teachers: Transforming high school computer science. *The CSTA Voice*, 5, 6 (2010), 1-2.
- [6] Darling-Hammond, L., Berry, B. and Thoreson, A. Does teacher certification matter? *Evaluating the evidence. Educational Evaluation and Policy Analysis*, 23, 1 (2001), 57-77.
- [7] Day, C. K., Alison; Stobart, Gordon; Sammons, Pam The Personal and Professional Selves of Teachers: Stable and Unstable Identities. *British Educational Research Journal*, 32, 4 (2006), 601-616
- [8] Ericson, B., Armoni, M., Gal-Ezer, J., Seehorn, D., Stephenson, C. and Trees, F. Ensuring exemplary teaching in an essential discipline: addressing the crisis in computer science teacher certification - Final report of the CSTA teacher certification task force, City, 2008.
- [9] Gee, J. P. Identity as an analytic lens for research in education. *Review of Research in Education*, 25(2001), 99-125.

- [10] Ingersoll, R. M. Teacher Turnover and Teacher Shortages: An Organizational Analysis. *American Educational Research Journal*, 38, 3 (2001), 499-534.
- [11] Ingersoll, R. M. The Teacher Shortage: A Case of Wrong Diagnosis and Wrong Prescription. *NASSP Bulletin*, 86, 631 (2002), 16-31.
- [12] Khoury, G. Computer science state certification requirements-CSTA certification committee report, City, 2007.
- [13] Luehmann, A. L. Identity development as a lens to science teacher preparation. *Science Education*, 91, 5 (2007), 822-839.
- [14] Martin, D. B. *Mathematics Success and Failure Among African-American Youth: The Roles of Sociohistorical Context, Community Forces, School Influence, and Individual Agency*, 2000.
- [15] NCTAF. Unraveling the “teacher shortage” problem: Teacher retention is the key. National Commission on Teaching and America's Future (NCTAF) ,2002.
- [16] NCTAF. No Dream Denied: A Pledge to America's Children. National Commission on Teaching and America's Future (NCTAF) , 2003.
- [17] Ottensen, E. Teachers “in the making”: Building accounts of teaching. *Teaching and Teacher Education*, 23, 5 (2007), 612-623.
- [18] Pennington, M. C. Teacher identity in TESOL. In *Proceedings of the the Quality in Teacher Education Seminar* (London, UK, 2002), [insert City of Publication],[2002 of Publication].
- [19] Seidman, I. *Interviewing as Qualitative Research: A Guide for Researchers in Education and the Social Sciences*. Teachers College Press, 2005.