WIP: An Interpretive Phenomenological Analysis of Computer Science Undergraduate Student Professional Identity Development

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***Abstract*—Becoming a professional is a core identity we develop as we fully mature. This identity is developed quickly as one progresses through college curricula, as this is likely the first major exposure an individual will have to the profession and its members. A well-developed professional identity correlates with many positive characteristics of successful students, such as high resilience and low anxiety.**

This work in progress presents initial results from an ongoing interpretive phenomenological analysis (IPA) on the experiences of computer science students developing their professional computer scientist identities. The individual discussed in this single case (n=1) analysis was a fifth-semester computer science major enrolled in an R1, Southeastern, land-grant University. In this work, we discuss themes of his experience and the implications of connecting his story to his peers in the complete work.

***Index Terms*—Computer Science Education**

I. Introduction

Identity is a psychological mechanism for individuals to build self-confidence, a sense of belonging, and reduce anxiety amid the uncertainties of life [1]. Erikson identifies professional identity as a core component of identity [2] and a major source of social categorization we employ [3]. College students are in a prime position to develop a professional identity as they find their place in their future profession through engaging with their major [4]. Current literature has found that students with strongly developed professional identities have high engagement [5], resiliency [6], self-esteem [7], [8], and low anxiety [9].

Computer science poses specific challenges to students attempting to develop their professional identity. The recency of the profession relative to other STEM disciplines, the high rate of development in the technology sector, and a distant relationship between academia and industry all contribute to computer science students' difficulty developing professional identity. Over the course of a college education, computer science students integrate their knowledge of the field and build their identities from this developing knowledge base.

To better understand the professional identity development of computer science students, we use an interpretive phenomenological analysis (IPA) to critically examine the lived experiences of a student (n=1) who has developed this identity at an R1 land-grant, Southeastern University. We pay particular attention to the meaning that this individual attributes to their computer science identity and the synergy between knowledge and practice that informs it.

II. Research Question and Methodology

To bring these advantages of strong professional identity development to earlier stages of higher education and to support the students engaging in this identity development process, we ask the research question:

> How have computer science students experienced the development of computer science professional identity?

This question is driving the larger study that this single case IPA is a part of. The participant we are working alongside, Alex, is the first of eight to share their experiences developing a computer science identity for this project.

A. Positionality

IPA studies are developed to investigate the lived experiences of the participants interviewed [10]. The full study interviews and the subsequent interpretation process are, therefore, sensitive to the study's investigators. Our experiences shape our interpretations of the world just as the participants' experiences shape theirs. To communicate the participants' experience, we also provide an explicit description of our positions related to the study.

Tim Ransom is the primary researcher for this work and has conducted the recruitment, interviews, and interpretation. He is a computer scientist and is affiliated with the R1, land-grant, Southeastern University that the participant Alex (a pseudonym) was enrolled in at the time of data collection. Tim completed his master's in computer science through the department that Alex was enrolled in but was no longer associated with the department at the time of the study and had no prior connection to Alex.

Matthew Boyer is also affiliated with this University and is engaged with this project to evaluate project quality. James

Huff is not affiliated with the University that Alex was enrolled in, has no relationship with the participant, and is a leading expert in the IPA research methodology.

B. Data collection

Alex was initially reached through a recruiting survey distributed to a computer science class he was enrolled in, as approved by the study's IRB certification. This survey was distributed at an R1, land-grant, Southeastern University, to a small number of computer science courses typically taken during a computer science major's third year enrolled in the program. The survey asked participants to consider times they had not felt like computer scientists and to provide their demographic information and email addresses so they could be contacted for the follow-up interview. At the time of data collection, Alex was completing his fifth semester of college as a computer science major and self-identified as a cisgender, heterosexual, white male. Instances described in the survey were not used to construct the interview protocol but rather to indicate interest in discussing the participant's willingness to discuss their computer science identity. A semi-structured interview protocol was drafted to guide the participants in considering the "chapters" of their computer science story and provided a jumping-off point to an intentionally casual and conversational discussion of the participants' experiences.

Tim interviewed Alex at an on-campus location at a time Alex chose, which lasted about sixty-seven minutes. The interview space was chosen specifically to facilitate a casual flow of conversation. Multiple seating locations were available, the room door and window remained open, and it was in a building not associated with the computer science department in which Alex was enrolled.

C. Data analysis

Interpretive phenomenological studies employ a series of structured annotating and conceptual mapping phases to construct interpretations of the interview that are both holistic and grounded in the text. After an initial re-reading of the interview so that Tim can become reacquainted with the whole text, a phase of exploratory noting creates a space for initial thoughts and descriptions of the episodes described. A second pass through the text focuses on Alex's specific wording and linguistic choices to focus on the meaning communicated through how he phrased and framed his identity development experience. A final annotation pass was then conducted to focus on a conceptual understanding of what Alex was describing. Once these three annotation phases were completed, Tim's interpretation of the interview text constructed a set of emerging personal experiential themes.

These personal experiential themes were then clustered into groups to construct the themes presented in table I.

Tim conducted all rounds of annotating and initial interpretations under the guidance of James Huff, and the emerging themes were discussed with Matthew Boyer for communicative validation of the interpretation process.

In the full continuation of this work, this process is conducted for seven other individuals' experiences, and group experiential themes are constructed by cross-examining all experiential themes.

III. Initial Themes of Professional Computer Science Identity Development

For Alex, becoming a computing scientist was a multi-faceted experience that evolved from his relationship with himself, his relationship with the tools of computing, and his relationship with his colleagues. We begin analyzing his professional identity development by discussing the value he created in the synergy between his deepening understanding of computer science and collecting various tools to operationalize into code. Alex frames much of his developmental progress as a highly detailed and critical Socratic questioning to himself and those he works with. Finally, we will end this work by interpreting Alex's perceptions of his own efforts relative to his peers and how those efforts were both required for his identity development success and granted additional benefits to his deep understanding of computing science. These three themes are summarized in table I and are a portion of the overall themes constructed from his experiences.

A. Synergy between a deep knowledge of computing and having a variety of tools to enact it

Alex discussed in several ways how his concept of being a computer scientist relies on having a deep understanding of computer science theory and various computing tools. Both were required, and neither was sufficient for him to grow into his computer science identity. This started very early in his computer science journey and only became a larger issue as he progressed:

> "I'll go back to when I first started computer science here. The course had a lot of practice or homework really that made you really think about coding, [...] I felt many times I would just make easiest mistakes known to man and I would lose points. I just couldn't get across what I was... what I wanted and it really started to hurt more and more as it went on."

Alex had received an early (though small) indication through his grades that he was not deeply thinking about coding and heavily discounted his struggle when recounting it. He also began to desire computer science to express his understanding and tools. He saw that communication as an essential skill to develop as he continued developing his identity.

In his early experiences with programming, Alex had far fewer tools available to exercise his level of understanding. As he continued his curriculum progress, he accumulated more computing tools (e.g., additional programming languages, specialized applications for version control and building API calls).

> "I feel like more recently I have the tools other than one course, but beforehand I felt like I was looking stuff up and I felt like I don't really think I should

TABLE I
A SUMMARY OF THEMES REFLECTING ALEX'S EXPERIENCE OF DEVELOPING A COMPUTER SCIENCE IDENTITY

Theme	Example Quotes
1. The synergy between a deep understanding of computing topics and having a variety of tools to accomplish tasks creates the meaning of being a computer scientist.	I feel like if you don't understand what you're doing, you're really again cheating yourself out of what this computer science, this code is meant to teach you, and I feel like after practicing a lot, I begin to understand the basics and even some more advanced stuff, but I always feel like there's a gap in my knowledge and I really dislike that. I feel like understanding what you need to do is definitely a big thing, but I feel like also do you have the tools at your disposal to do it.
2. Efforts perceived as greater than peers (and constant management of those efforts) are required to maintain progress toward becoming a computer scientist but come with additional payoffs.	That I feel like [my computer science peer] is very lax, and even though sometimes I hear he's struggling in certain aspects, he gets on computer science tests, he gets like A's. I don't know if you're struggling, man; maybe you need that one hundred. But there are times where he is like, oh, I've had that done a few days ago. I'm like, damn, I've still been trying to compile this.
3. Precision in communicating with peers, non-peers, and himself is a critical skill that computer scientists practice.	I could explain what needs to happen, what needs to change, what doesn't need to change, and when it came to programming. I would get to a part where I was like, okay, I understand, I understand, don't understand and then they would help to the best of your ability to explain that and then I would ask sometimes a lot to really make sure I understood, but I guess I could understand what instructions call for, what they need. The craving of knowledge. I don't know if that's a good emotion, but I really wanted to understand what he wanted from us and why I would take screenshots of my code sometimes write a paragraph. I remember one [email asking for help] that was three paragraphs. I really wanted to show what I did know and what I did not know...

be needing to do this and at the very beginning computer science courses..."

Alex met several individuals he identified as computer scientists, who he framed in terms of understanding theory and tools.

> I feel like understanding what you need to do is definitely a big thing, but I feel like also do you have the tools at your disposal to do it.
>
> I feel like there was a time I'll go with right now and I'll try and go back with [computer scientist team leader]. He's our head of our team for this, our projects and he seems very knowledgeable in stuff like some different tools like postman, different languages like JavaScript, HTML [...]. He's doing other projects and he's going quick, he is not really stopping and he's going quick with typing. [...] Yeah, I feel like he's a computer scientist. He can multitask too he understands different languages and he can just go at it a lot quicker.
>
> I feel like [my computer science instructor] is [a computer scientist] because he talks like it, but in class I feel like he's not up to date computer scientist. I feel like he knows his stuff but there are times in class when he's going over some certain software we're using like Postman, git, he's learning at the same time we are and whenever we go to ask him for questions he says ask your TA...

Alex firmly established the team leader as a computer scientist because of their knowledge of both the tools for the project and how they are used to complete the work. The instructor, although still a computer scientist, had a major caveat attached to their identity status because of the perceived lack of tool knowledge.

B. Precision in communicating as a critical skill of computer scientists

As Alex met more and more colleagues in his department, he began to find value as a computer scientist in the highly precise way he communicated. He expressed a direct connection between his computer science identity and being able to contribute computer science topics to the discussion effectively.

> I felt like when I was explaining stuff I've already done, that's when I really felt like I was actually a computer scientist.
>
> It's like when they're asking questions like I when I was in [course title] with Dr. [introductory instructor], there were times where he was asking for notation. He was doing a program on the board and he said, what do you do here and what do you do here? And I remember being maybe one of the only ones that actually raise their hand and answer. That's probably the one time I felt like maybe not the one time, but another time. I felt like a computer scientist.

In both a classroom and a group project setting, Alex felt a strong sense of identity when he could provide information to his peers.

C. Required extra efforts come with bonus payoffs

Alex consistently discussed the amount of effort he felt was required to succeed in his studies. One of the earliest

experiences he discussed on his computer science journey was poor performance on a test and the immediate negative emotions he experienced. He later generalized this intense emotion and connected it to his invested efforts:

> I felt like I will say this with my chest I put as much effort or more into this stuff than probably you need to, and I feel like when I get nowhere I really just, it bogs me down and I feel like maybe I'm putting that effort in the wrong place sometimes, but there are times where I just wish I could be like that have it done the day of.

This quote from Alex brings up his negative feeling of low return on effort and the fact that a possible solution he sees to this is better management of his effort. He also benchmarks his effort against what he thinks another computer scientist might need to invest. We interpret this combination of points to mean that Alex sees his efforts as either insufficiently effective or needing closer management to achieve the same results as his peers. Because of Alex's value of deep understanding alongside operationalization

IV. Future Directions

Identity is a highly complex phenomenon, as we have demonstrated from the previous breakdown of Alex's experience. To finish this work, we present some insights we have found along with the immediate next steps. We see this work helping computer science educators guide students to identify as computer scientists.

From these three themes of Alex's experience, we can interpret a brief understanding of his computer scientist identity development. We want to confirm with the reader that Alex's experiences are from his life but also contain indicators of the identity development process that others encounter. While not every individual will have the same experience of the complex phenomenon of identity development, we value the specific experiences of individuals as indicators of the whole process.

Alex provided excellent insight into his development as a computer scientist and demonstrated his method of self-construction through his experiences with both the curriculum content and his colleagues. When he began his college career, he had a very narrow understanding of computer science and was motivated by an interest in developing video games. Like many students, he had an incomplete understanding of the reality of the profession before choosing his major. Despite his initial experiences motivating a possible major change, he found support through a family member to persevere. Alex's father was not involved in computer science, suggesting that computer science identity development can be fostered even by those not in the community. All other instances of such high emotion were resolved internally through Alex's own internal efforts.

Alex's primary method of self-improvement in computer science (intense questioning) aligned with both his primary source of meaning in being a computer scientist (the synergy between understanding and performing) as well as his interactions with all others (including peers, instructors, and non-peers). While he may have begun to develop this skill separately from his computer science identity, his connection between its continued development and computer science indicates that it is desirable for computer scientists. Using his primary computer science trait in non-computer science contexts suggests he sees it as a universal skill. This points to understanding computer scientist identity as tapping into a broader thought that highly analytical questioning is valuable and needs to be even sharper around peers. Fulfilling this requirement of precise communication with peers contained meaning to Alex's computer scientist identity, and other students could also.

Alex experienced finding identity security when he accepted not needing to know every aspect of computer science was enabled by his confidence that the knowledge that he didn't have "is not the end of the world." At some point in his computer science knowledge, he attained a satisfactory understanding and sufficient exposure to computing tools to enable this. Investigating students' thresholds into accepting the computer scientist identity would help computer science education reach higher levels of authentic engagement and focus support to that specific developmental phase.

There is a concerning work culture implication to Alex's need to put in "extra" effort as compared to his peers. Computer science, like many other STEM fields, has a history of overworking employees to the point of burnout [11]. Alex was aware of this issue when he described why his motivation to complete his degree shifted from developing video games to more general computer science careers but he did not mention it after his motivation shift. This linguistic shift indicates he is no longer concerned with the possibility of having his passion exploited. We would like to investigate further the role of computer science college programs in navigating their roles as both institutions for education and career readiness providers. Are college's efforts for extracurricular computing activities (e.g., hackathons, game-jams, maker spaces, programming challenges) communicating to students that marathon-length, extracurricular programming activities will be expected in their careers to distinguish themselves?

As mentioned, this work is an initial interpretation of one individual's experiences as they developed their professional identity. Two remaining themes from Alex's story still need to be integrated into his story, and there are seven other individuals whose stories are currently being interpreted. Once the group experiential themes are constructed, a better understanding of computer scientist identity development can be formed and used to facilitate computer scientists' growth in the profession.

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