Charting the Identity Turn in K-12 Computer Science Education: Developing More Inclusive Learning Pathways for Identities

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Abstract: While much attention has focused on promoting computational thinking in K-12 CS education, much less attention has been paid to the equally important dimension of what it means to become connected to—or identify with—the discipline. Previous approaches to CS identity have mostly focused on students revealing their identifications in the form of drawings or survey responses. More recent approaches have started to examine narratives, positionings and critical engagement within a field that historically has marginalized large groups of people, especially women and students of color. In this paper, we chart this "identity turn" in CS education by drawing on metaphors developed in STEM and literacy studies to review how identity has been framed and researched. In the discussion, we address how a focus on learner identities with computing can contribute towards promoting a richer and more critical understanding of learning and teaching in K-12 CS education.

Keywords: computer science, identity, equity, literacy

Introduction

Over the last decade, there has been a nation-wide push to bring computer science (CS) back into K-12 education with national frameworks (K-12CS, 2016) and state standards promoting computational thinking, defined as "involving solving problems, designing systems and understanding human behavior that draws on concepts fundamental to computing" (Wing, 2006, p. 33). Most efforts have focused on examining how students learn computational concepts and practices (e.g., Florez et al., 2018; Grover & Pea, 2013; Rich & Hodges, 2017). While teaching and learning these concepts and practices are important in advancing computational literacies for all (Kafai, Proctor & Lui, 2019), in order to address critical issues in a discipline that historically has marginalized women and students of color (Margolis et al., 2008), we also need to understand how to design learning environments that support youth from nondominant communities, "who learn and develop along racialized, gendered, and class-influenced learning pathways (Bell, Van Horne, & Cheng, 2017, p. 369)," in developing their identification with CS.

This need for understanding disciplinary identity development builds on theoretical premises that see learning and identity as inextricably intertwined (Lave & Wenger, 1991; Wortham, 2006). As learners come to identify with activities, they begin to see themselves as participants, developing a sense of belonging to a larger community. However, as a field and community of practice, CS possesses historically and culturally legitimized practices, norms, and recognized types of participants that have marginalized many groups, in particular women and people of color, from feeling as though they belong in such spaces (e.g., Margolis et al., 2008). Examples of persistent stereotypes surrounding computer scientists are that only White or Asian men are part of this culture (Google & Gallup, 2015) and of their interests and personalities as geeky or socially awkward (Cheryan, Master, & Meltzoff, 2015). Thus, understanding the social and cultural contexts of identity development for learners needs to be an important part of any effort in examining learning activities and designing learning environments and tools for CS education in K-12.

In this conceptual paper, we provide a narrative review of how research studies in CS education have framed identity and which approaches can promote rich engagement with the discipline, especially for participants from nondominant groups in K-12. While computing identity has been a focus since early CS education, a recent surge in publications has generated promising new perspectives. So many in fact that we can talk about an "identity turn"—a term coined by Moje and colleagues (2009) to describe an emerging trend in literacy studies—in CS education research. At first glance, it might appear a stretch to appropriate work from literacy studies for understanding identity development in CS, given that the former deals with advancing textual literacies while the latter is concerned with advancing newer computational literacies. But the field of literacy studies recognizes that reading is no longer limited to the printed word but includes multimodal and interactive texts (New London Group, 1996). Likewise, writing text now includes multimedia productions that have much more in common with programming game and story applications popular in CS education (Kafai & Burke, 2014). Other scholars such as Vee (2013) have pointed out numerous parallels in learning how to write text and writing programming code.

In recognizing learning as a social and cultural process, we shift our attention from focusing on concepts and practices to how the learning environment—which includes people, practices, and structures informed by history and culture—shapes identity. This perspective provides a useful angle for understanding and promoting identity development. In a first section, we examine what we call identity-*in*-computing studies better understand how research has framed identity. A play on "identity-and-literacy studies," we use metaphors developed by Moje and colleagues (2009) that highlight identity as (1) difference, (2) self, (3) consciousness, (4) narrative, and (5) position. These metaphors (explained in more detail in the next sections) can help researchers in CS education make sense of the various ways learners from nondominant communities come to navigate the challenging and often conflicting worlds of CS communities. In the second section, we examine what we call identity-*with*-computing studies to better understand how identity can be supported and developed through learning activities and tools. Here we focus on how identity development can be furthered through promoting connections with (1) community, (2) interests, and (3) history. Using these metaphors, we discuss the current "identity turn" in CS education research to better understand the nuances of how identity has been framed, how it has been researched, and how its contributions to learning and design have been articulated.

Examining identities-in-computing

Identity is a construct with many meanings and theoretical implications; therefore, it is beneficial to examine how different models of identity shape our conceptions of computing identities and what are the implications for computing education research. If we are to assume that identities are social constructions, fluid across time and contexts, and recognized by others, how do these conceptions of identity influence identity-in-computing studies? What assumptions about computing are embedded in these views of identity? Using five metaphors identified by Moje and colleagues (2009), we explore how different models for identity influence computing education research.

Identity as difference

The identity-as-difference metaphor centers on the ways people differ from one another based on their group memberships, as well as how groups themselves differ from each other based on distinct ways of being (Moje, et al., 2009). According to this metaphor, people's experiences with groups embed into their memories particular beliefs, values, and schemas about that group, which are then differentiated and adopted as people engage with different groups and move across various contexts over time. As people participate within stable contexts they feel allow them to enact significant identity encodings (e.g., beliefs, values, and schemas), this can lead to a stable sense of self and identity. Such a framing of identity can be seen in discourses surrounding raced, gendered, or class identities. Despite its salience, the identity-as-difference metaphor has been critiqued for producing identity politics or as essentializing identities (Moje, et al., 2009).

Understanding identity as difference has been a prevalent framing in identity-in-computing studies. Whether consciously or not, scholars have used this metaphor in their studies to explore learners' experiences with computing, their perceptions of computing and computing persons, and whether or not learners' self-perceptions align with their perceptions of computing persons. Examples of studies include Mercier, Barron, and O'Connor's (2006) "Draw a computer user" study; Grover, Pea, and Cooper's (2014) design of a curriculum intervention to remedy middle school students' misconceptions about CS; and Hansen and colleagues' (2017) implementation of a "Draw-A-Computer-Scientist-Test" for students aged 8-11. Case in point, Friend (2015) surveyed 71 eighth-grade girls about their experiences and attitudes surrounding computing technology and computing as a future career. The girls in the study shared the computing contexts where they had participated in the past, personal values about computing (e.g. "It is important to me that I am knowledgeable about computers") and indicated adjectives that described themselves and computer scientists. The study found that about one-third of girls were open to computing as a career and saw themselves as more like a computer scientist compared to the remaining girls who did not want a computing career. We could infer that Friend's argument for increasing participation in computing careers by diversifying the image of what a computer scientist is like stems from the identity-as-difference metaphor. By foregrounding girls seeing themselves as more like computer scientists, we are better able to understand which beliefs and values about computing they connect with (or not), as well as situate girls' decisions to participate in computing as linked to their sense of selves as computer scientists.

Another way identity-in-computing studies have incorporated the identity-as-difference metaphor is through examining the stereotypes youth possess about computer scientists. Such a perspective implies that character traits and computing practices are related to a specific group (in this case, computer scientists). In addition to surveying learners to describe computer scientists and what they do in their job, Pantic and colleagues (2018) asked 272 fourth-grade students at a summer App camp to draw a computer scientist (adapted

from Mercier, Barron, and O'Connor's 2006 study). They found that despite perceptions about computer scientists improving, the majority of campers drew stereotypes (e.g. computer scientists as smart men who wear glasses and work at a computer). This study highlights one of the potential critiques of the identity-as-difference metaphor, being that the identities of groups such as computer scientists are reduced to essentialist characteristics of that group, thereby establishing a single "type" of person who participates in computing. Although the identity-as-difference metaphor serves as a foundation from which identity has been explored in numerous computing studies, other metaphors may serve to not only expand the depictions of who can participate but can further illuminate *how* students' identities are developed.

Identity as self

As opposed to focusing on the differences between group identities, the identity-as-self metaphor steps back and foregrounds how selves come to be at all (Moje, et al., 2009). This perspective draws from a wide range of theories, including Erikson's (1994) stage theory of self-formation; Mead's (1934) theory of self as dependent on the awareness of the generalized other; Bourdieu's (1980/1990) conception of self as acquired through unconscious, embodied practices at the whim of institutional structures and power relations; and Althusser's (1971) conception of an interpellated subject who is "called into being" into an identity. Aside from Erikson, these theories of self frame identity as developing without our permission. That being said, Moje and colleagues (2009) note that texts have the power to call readers into certain subject positions, which can happen both unconsciously *and* disrupt our sense of selves, making us aware of how a certain self is called into being. Within identity-in-computing studies, this has been represented through the decisions youth make when choosing to participate (or not) in computing practices, like programming or game testing.

Despite these different yet related ontological understandings for how the self emerges, they risk representing the subject as either an independent agent or as lacking agency within institutional structures and power relations. We can see this tension in a study conducted by DiSalvo and colleagues (2014) where they observe the face-saving tactics of Black male youth who are part of the Glitch game-testing program. Their analysis of the Glitch guys' face-saving tactics draws from the identity-as-self metaphor in two ways. First, the authors positioned the Glitch participants as saving face at the start of the program by sitting back in their chairs and only answering questions when offered candy as a reward. Even though they were motivated to learn, DiSalvo and colleagues posited that the Glitch youth could not act on this motivation due to it being in conflict with their presentation of self, so they used the candy as a tactic to save face and participate. By examining this observation from an Eriksonian identity-as-self perspective, we can interpret that the Glitch youth's decision to hide their identities via saving face were conscious decisions more so than influenced by the classroom activity system or their past computing experiences. Therefore, their identities as only being motivated by external rewards is intentionally being constructed by the youth. On the other hand, the youth's face-saving behaviors could also be seen as less agentic if viewed from a Bourdieuian perspective, situating their behaviors as unconscious practices resulting from prior negative experiences in classroom structures over time. If we were to observe the interactions within the Glitch program from this perspective, we might look to develop pedagogy that highlights the youth's identities by examining ways to change the structures that created these behaviors. Therefore, the identity-as-self metaphor calls to attention opportunities to explore the identities learners as consciously (and unconsciously) called into being through their engagement with computing practices.

Identity as consciousness

Drawing from the theories of Vygotsky (1934/1986), the identity-as-consciousness metaphor emphasizes how a person comes into being as their consciousness (or mind) develops (Moje, et al., 2009). As people participate in new activities, they engage with new tools, which further develops their consciousness, and so on in a cyclical manner (Vygotsky, 1934/1986). Within the activity of computing, we can consider programming a tool to develop one's consciousness and ultimately, their being (or identity). If identity-in-computing studies utilize the identity-as-consciousness metaphor in a way that positions programming as a tool for developing abstract thinking—which can further develop an individual's level of consciousness—they can risk framing individuals who cannot program as being less conscious. While this risk has been seen in literacy studies through the framing of learners as "illiterate," we are not aware of an equivalent positioning (yet) in identity-in-computing studies.

That being said, the identity-as-consciousness metaphor can have positive implications for identity-in-computing studies when incorporating new forms of practices and types of materials. With their work surrounding electronic textiles (hereafter, e-textiles) with American Indian girls, Searle and Kafai (2015) discuss how combining traditional and heritage crafts with maker practices and computing addressed the "identity gap" for girls and youth from nondominant communities. They argue that providing youth with familiar entry points

into computing (in this case crafting) and affording youth the agency to explore aspects of their identity (e.g., cultural identity) can lessen the disconnection between girls' multiple identities (including "computer scientist"). By incorporating the use of new tools and prioritizing girls' agency in constructing their own identity, we can presume Searle and Kafai (2015) drew upon the identity-as-consciousness metaphor.

Identity as narrative

A popular metaphor in identity-in-computing studies, viewing identity as narrative focuses on how identities are constructed through the stories people tell about themselves and their experiences (Moje, et al., 2009). While a prevalent framework across literacy studies, it has been highly contested across scholars due to disputes regarding the mechanisms of how individuals narrate themselves and the methods for how we examine the narrated self. Despite these challenges, we can agree that language plays a significant role in narrating the self as well as how we come to understand literacy. Identity-in-computing studies that conceive identity as narrative tend to explore the ways learners tell stories about themselves through computation, thereby representing their identities through their narration. Even though it is not clear how these stories have been built over time, they provide an entry point into understanding how learners not only claim identity but also construct identities as well.

Through their work with Digital Youth Divas (DYD), Pinkard and colleagues (2017) applied an identity-as-narrative framework to examine how incorporating narratives into project-based design challenges influenced Black girls' interest and identification with STEM. Along with the girls, they co-designed narratives centering a group of girls in a parallel DYD program and their experiences with the curricular computing activities (i.e., e-fashion, e-paper, and e-dance). These narratives were intended to provide storylines that deviated from dominant computing stereotypes, including girls with different racial/ethnic backgrounds, interests, and computing experiences, as well as showed promise in supporting the identity development for girls from nondominant groups by allowing them to "try on" STEM participations in ways that felt safe (Pinkard, Erete, Martin, & McKinney de Royston, 2017). While the narratives in the program provided an entry point for the DYD girls to identify with STEM, the girls were not constructing narratives of their own lives, which could have additional implications for their identity development.

Another example of learners constructing their own narratives can be seen in a study by Shaw, Fields, and Kafai (2019). Through their work with e-textiles, Shaw and colleagues (2019) examined the use of reflective digital portfolios as ideational resources where high school students could author computing identities. As part of the portfolio assignment, students were required to feature their various projects and reflect on their processes making them, including what they learned across the entire unit. The authors found that the portfolios provided a space where the students developed their own narratives about CS and their place in the field, such as identifying the myriad resources, skills, and personal qualities that helped them construct their artifacts, their new and expanded understandings of CS as a field, and who they could be in the future in relation to CS (Shaw, Fields, & Kafai, 2019). These findings highlight students both claiming and constructing computing identities. However, by limiting the analysis to youth's portfolios, the authors risk representing an overly coherent subject, which is a common challenge within identity-in-computing studies that rely on interviews and other spoken or written depictions of the individual. This challenge illustrates the benefit of observing both the *doing* and *representing* of identities in addition to their narration.

Identity as position

The final metaphor, identity-as-position, builds on Althusser's (1971) concept of how identities are called into being by addressing how positions get taken up and resisted, as well as how they translate into identities over time (Moje, et al., 2009). More specifically, as individuals experience different positions, or labels, they may imagine future positions and selves who move across those positions. This metaphor also considers the role narratives, activities and interactions, artifacts, and space and time play in identity formation. DeGennaro and Brown (2009) appear to draw from this metaphor in their study examining how Black middle school students in Philadelphia develop technology identities through the creation of webpages at a local center. They used interviews to understand youth's positioning via narratives of past experiences with technology as well as used the activity of designing a webpage to allow youth to "take up" a technology identity and articulate future career goals. The authors observed that by valuing the students' cultural histories and identities as Philadelphia youth, the students not only found entry points where they could build their technology identities, but they were also able to mediate their fit within the technology field by designing artifacts that reflected their lived experiences. This lens illustrates how the technology identity is layered or "laminated" on top of the students' cultural identities.

However, challenges to viewing identity as position is locating where identities may shift as people *move across* spaces or viewing identities as fragmented or conflicted. DeGennaro and Brown's (2009) analysis of youth's technology identity took place in one setting—the center—highlighting the methodological limitations if the authors were framing identity as position. That being said, this metaphor spotlights the doing of activity given that researchers must follow individuals through different positions (e.g. physical, social, metaphorical) of their lives and simultaneously document their activity, artifacts, and interactions. Given that identity-in-computing studies tend to observe youth in one setting, there exists opportunities to explore youth's identity as position by applying more ethnographic methods to our explorations of identity and computing.

Developing identities-with-computing

Understanding how learner identities can be framed in learning can contribute towards promoting a richer and more critical understanding of learning and teaching in K-12 CS education. In the final section of this paper, we want to examine another promising turn in CS education research that moves from identity-*in*-computing towards identity-*with*-computing. The identity-in-computing approach emphasizes the social and fluid nature of identity, moving away from the stable representations that have dominated much of the research. The identity-with-computing approaches, however, take a more action-oriented approach towards developing identities in CS education, the goal being to integrate development of identities with the learning of computational concepts and practices. At the heart of identity-with-computing is the idea that learning environments can support or limit particular kinds of identities, especially during periods of time when youth ask critical questions about who they are to become and the roles of computing and technology in their lives. Research has started to examine how disciplinary identity can serve as a vehicle for moving towards more enriching, just, and personally relevant disciplinary learning environments and pathways by situating local learning challenges within larger social contexts, like STEM (Carlone, 2017). In the following sections, we describe examples of three different approaches for how identity-with-computing can be realized, each emphasizing how activities or spaces that address multiple connection points can mediate youth's associations with CS, such a school subjects, media, or youth's cultural backgrounds and personal interests.

Identity as restorying

Restorying is a form of narrative agency by which young people "reshape narratives to reflect the perspectives and experiences that have been routinely marginalized or silenced" (Stornaiuolo & Thomas, 2018, p. 2). In restorying the dominant stories of CS, young people draw upon their experiences with CS to reimagine access to the field by using digital technologies to challenge the reproduction of dominant narratives (e.g., that only white men can be computer scientists). The recent work of Shaw, Coleman, Kafai and Thomas (in press) combines the historical practice of quilting—which has been documented to conceptualize cultural identity and represent histories, particularly for marginalized groups—with programmable paper circuits as a means for youth to reimagine and "restory" dominant narratives of CS through the design of interactive quilts. By drawing from their personal experiences with computing and identifying dominant CS narratives, students designed paper-circuit-based quilts that told new stories about CS—about what computing is used for, how the field came to be, and who participates. In other words, students restoried their connections to CS based on their development of CS skills and engaging in critical literacy practices, thereby illustrating their use of computing to identity with computing in novel ways.

Identity as community critic

This approach uses STEM learning contexts to situate students' political and civic identities in ways that can promote critical reflection of equity and diversity in these domains and develop their computational literacies beyond technical skills. With his work in an after-school program in Oakland, Vakil (2014) designed a learning environment where four Black high school students programmed and designed mobile apps that addressed community issues. In addition to developing students' computational skills and addressing equity issues in computing, Vakil prioritized the development of students' critical consciousness as he elicited students sociopolitical thinking in the development of their apps. While not the explicit intention of this study, findings depicted how students' political identities—their awareness of issues of power and inequality in society and agency to imagine new worlds (Vakil, 2018)—were mediated throughout the course of the app design. For example, students were able to draw upon the recent shootings of unarmed Black teens and their related experiences with family and friends to interrogate root causes and develop an app that made their peers aware of community-based programs and resources. This approach not only demonstrates how students' political and civic identities are foregrounded in the development of computational literacies but can also highlight how their

perceptions and images of technology and computing can be shaped through their participation in these learning activities.

Identity as interest connections

Another example of an identity-with-computing study is a transdisciplinary collaboration that integrates dance with computational and design making. Using dance as a platform to encourage STEM participation, Allen-Handy, Ifill, Rogers, and Schaar (2018) designed a learning environment where Black girls can develop positive STEAM identities and self-concepts through programming designs that are worn and expressed through their dance choreographies. By situating computational activities within a context related to girls' interests, girls were able to not only participate in the application of CS content but were also able to develop computing-related identities while using their bodies for creative expression and as a source of embodied reflection (Allen-Handy, Ifill, Rogers, & Schaar, 2018). Such work highlights the potential of computing to address the need for representation and culturally sustaining pedagogies (Paris, 2012).

Discussion

By using the five metaphors of identity as identified by Moje and colleagues, we examined how different models for identity influence CS education research. The metaphors move beyond the assumption that identity is a stable entity but rather propose that identities are social and dynamic. We note upfront that these metaphors are not mutually exclusive and overlap, highlighting that it is not enough to simply say that identities are constructed in social interactions, multiple, or fluid. Such notions of identity provide implications for research based on how identity is framed and promoted in learning research and design.

The identity-in-computing studies demonstrated how each metaphor for identity provides different implications for how we as researchers methodologically examine identity. For instance, when situating our research to address the lack of diversity in computing, how are we framing the underrepresentation of groups from nondominant communities: with learners actively deciding not to participate or with their lack of participation being influenced by institutional structures? The identity-as-self and identity-as-position metaphors can provide both theoretical and methodological directions. Likewise, while surveys and tasks like Draw-A-Computer Scientist can highlight the traits and practices learners ascribe to members of the "computing community," they do not explicitly showcase the process by which learners assume an identity; incorporating interviews can illustrate the stories they tell about their interactions in prior computing experiences. As we continue to conduct identity-in-computing research, recognizing the different metaphors can highlight opportunities for research directions, such as using ethnographic methods to examine how learners' identities—including their computing identity—shift across spaces (e.g. home, school, or out of school) from a framing of identity as position. By better understanding the nuances behind how we are situating the computing identity development of minoritized youth, we will better understand how to examine their connections with computing and deepen their participation.

But we can also push further and seek opportunities to connect identity development with the learning of computational concepts and practices, as we illustrated in the section of identities-with-computing studies. These studies demonstrated how identity can become a vehicle for engaging youth in critical computing. CS education has assumed historical, racial, and gendered narratives about who belongs in ways that not only exclude individuals from nondominant communities but also shield these exclusionary practices through claims of politically and culturally neutral knowledge and practices (Nasir & Vakil, 2017). Given how learning experiences shape learners' perspectives about themselves and who they can become, it is equally critical to support nondominant youth in interrogating how they (and others) construct their intersecting identities and the implications of these constructions for their future participation in computing. We found that particular identity theories support understanding of how computing and identity work to develop each other, as well as became aware of each metaphor's limitations, analytic methods, and representations (Moje, et al., 2009).

Conclusion

In this paper, we reviewed the various ways in which scholars have theoretically and methodologically examined CS identification among K-12 learners. We charted an identity turn by first reviewing identity-in-computing framings of how underrepresented learners develop connections or disconnections to CS. We then presented examples of identity-with-computing approaches in which scholars have designed and examined culturally relevant CS learning environments with the intention of supporting positive CS identity development in conjunction with learning of computational concepts and practices. As learning science researchers interested

in advancing CS education, these identity perspectives provide a foundation for not only broadening access but also deepening participation in computing to realize its transformative potential.

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