Using Digital Badges to Promote Student Agency and Identity in Science Learning

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Abstract: This paper investigates the potential for digital badges to support youth agency and identity in an after-school science program serving diverse high school students. We conducted contextual interviews with 36 students aged 14–19 participating in the program, inviting them to interact with a badge system prototype designed to help them track their progress through the program. Students were optimistic about the potential for badges to provide visible learning pathways, connect learning across contexts, and establish the credibility of the skills they acquired in the program. They also raised several challenges associated with sharing their badges with external audiences, such as the challenge of demonstrating the value of a badge and privacy concerns. This paper demonstrates how the design of a digital badge platform can successfully embody supports not only for student agency and identity in science learning, but also greater equity in and access to future learning and career opportunities.

Introduction and Related Work

Agency—what learners can imagine themselves to be and to do (Barton & Tan, 2010; Holland, Lachicotte, Skinner, & Cain, 1998)—is key to achieving success in science learning. Agency is developed through everyday practices and active participation within a particular sociocultural context (Lave & Wenger, 1991; Nasir & Hand, 2008). The recognition that students receive from teachers, family members, and peers helps them to define their capabilities, which directly impacts their developing identities as learners (Barton & Tan, 2010; Nasir & Cooks, 2009). In this way, agency and identity are deeply intertwined and central to learning.

Existing research demonstrates how important it is to account for agency and identity in science learning, particularly with respect to reaching diverse learners, who are traditionally underrepresented in science-related fields (Barton & Tan, 2010; Bricker & Bell, 2014). Barton and Tan (2010) explored how youth represented themselves as community science experts in an after-school science program that took place in and centered on their neighborhood community. Students were able to study the scientific process of urban heat islands at their own level of interest. The learners were given the opportunity to take on the role of scientist by presenting their findings to the community, which supported their agency in developing science identities. Similarly, Nasir & Hand (2008) documented the development of agency and self-expression (identity) among a group of African American high school students as they participated in a mathematics class and on their school's basketball team. Students' practice-linked identities were supported by giving them the opportunity to compare themselves to experts in their fields of interest and by allowing them to see what learning pathways were available to them in the future.

In another example, Bricker and Bell (2014) articulated the importance of affirming a learner's agency and identity by documenting a young girl, adopted from Haiti, and her interest in science. During perfume-mixing sessions at home with her mother, the young learner participated in authentic science practices of measurement, tracking and labeling, systematic journaling, and apparatus use, all of which

contributed to her feeling like a scientist. She gained affirmation from her mother, who viewed her as a person capable of doing science activities in everyday life. These jointly constructed science activities positioned the girl on a cultural learning pathway that was grounded in her personal interests and developing science identity (Bell, Bricker, Reeve, Zimmerman, & Tzou, 2012).

This research demonstrates that, for students to experience success in science, it helps if they see themselves as people who can do science and for whom science plays an important role in their lives. This work also shows that informal settings are typically more successful in this regard than formal educational settings, giving students greater control over their learning (Clegg, Gardner & Kolodner, 2010; Crowley, Barron, Knutson, & Martin, 2015). At the same time, informal settings present their own set of challenges with respect to supporting learners' developing sense of agency and identity. Students may receive little guidance in how to manage what they have learned and to plan what they are going to learn next. To make decisions about what kinds of science knowledge they want to learn, students need to see possible options in the learning pathways available to them. They also need channels to display their accomplishments in out-of-school settings in order to gain recognition for their developing science identities (Bell et al., 2012; Ito et al., 2013).

Prior work has explored ways to use sociotechnical systems to support students' science learning, such as Quest Atlantis, River City, EcoMuve, and Whyville (Bruckman, 1998; Kafai, 2010; Kafai & Dede, 2014; Scardamalia & Bereiter, 2014). Using the text-based virtual reality program MOOSE Crossing, for instance, Bruckman (1998) studied the formation of a science-based community of practice among 8- to 13-year-olds. In this online environment, students formed identities and developed agency by sharing skills and knowledge and receiving feedback from others. In another example, the virtual platform of Whyville engaged players from ages 8 to 16 in science activities, many in the form of games (Kafai, 2010). Whyvillians were able to create avatars of themselves that were seen by other players, participate in community message boards, and engage in collaborative science games (e.g., Whypox). Findings from studies of these activities identified how the online collaborative world facilitated a social learning context for constructing science identities through directed play (Kafai, 2010). Virtual environments such as MOOSE Crossing and Whyville enabled knowledge building and supported learners' sense of agency by giving them opportunities to shape objectives, acquire resources, implement strategies, and evaluate outcomes (Scardamalia & Bereiter, 2014).

Such efforts to support learning in virtual worlds empower students by creating spaces for them to practice being scientists separate from their real-world spaces (Kafai & Dede, 2014). Another approach to supporting agency and identity through sociotechnical systems is to use them to document and recognize science learning that takes place in real-world contexts. Digital badge platforms represent a specific type of sociotechnical system that aims to do just that. Digital badges are web-based digital icons that contain metadata associated with specific learning goals and outcomes (Gibson, Ostashewski, Flintoff, Grant, & Knight, 2013). As openly networked platforms, badge systems hold promise for promoting equity and access in learning by making it possible for all students to view their learning trajectories and share their skills and accomplishments across a variety of contexts (Davis & Singh, 2015; Riconscente, Kamarainen, & Honey, 2013). Currently, students who already have access to learning and career opportunities in science are the ones who receive the greatest support for showcasing their science achievements (Davis & Fullerton, 2016; Klein & Davis, 2016). Badges hold promise for disrupting the status quo by recognizing and validating science achievement across and within personally defined trajectories for learning, as opposed to a one-size-fits-all model of science

achievement that excludes many learners (Cannady, Greenwald, & Harris, 2014). However, little empirical research exists that explores this promise of digital badges systematically.

We address this gap in research through contextual interviews with 36 high school students participating in an after-school science program. Through these interviews, we explored how students perceived a digital badge platform designed to embody supports for agency and identity in informal science-learning contexts. We discuss how insights from this study can be used to support efforts to promote equity and access in science learning.

Method

The goal of the current study was to investigate how students perceived a digital badge platform designed to embody the conjecture (Sandoval, 2004) that students' developing science agency and identity are supported when their skills and achievements are visible to and valued by audiences of import, and when they are placed in control of their learning pathways. We were guided by the following research question: *What opportunities and challenges did students perceive in the design of the digital badge platform?*

Badge Platform

The badge platform was designed with input from the program coordinators and students in the after-school science program (Davis & Singh, 2015; Klein & Davis, 2016). It comprises a front-facing website in which each student in the after-school program has a personal profile (see Figure 1). When students log into their profiles, they can see the badges they have earned and those not yet earned, keep track of their progress, view their friends' badges, and share their progress with people outside the program.

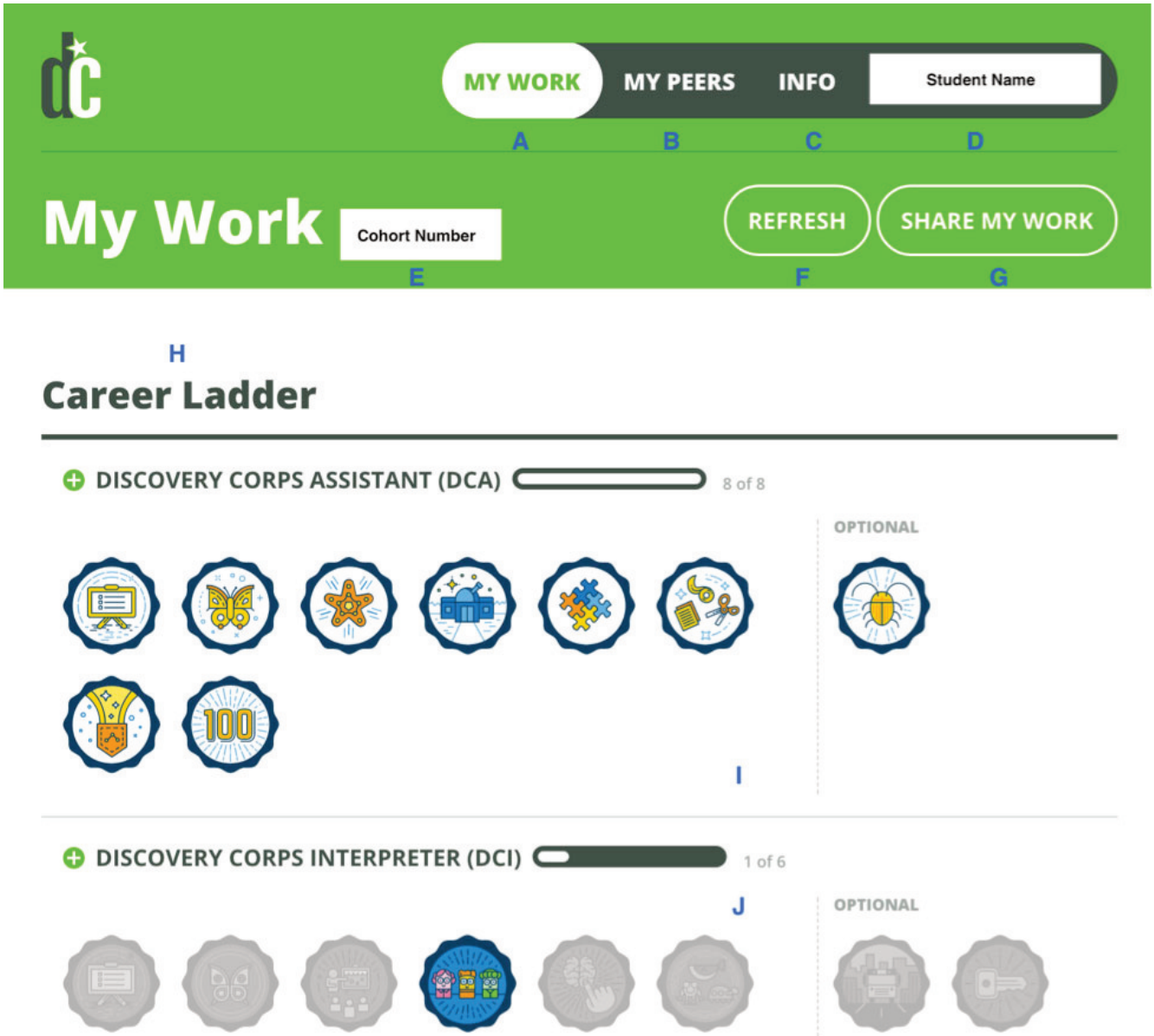

Figure 1. Screen shot of a hypothetical student's badge profile page. A. "My Work" button; B. "My Peers" button; C. "Info" button; D. Student's name; E. Cohort number; F. "Refresh" button; G. "Share My Work" button; H. Career Ladder, showcasing badge pathways; I. DCA Badges: full-color badges represent those badges that a student has already earned; J. DCI Badges: grayscale badges represent unearned badges.

Research Site and Participants

The research site was the Science Center of a major city in the Northwest United States offering an after-school science program for high school students. The program is designed to support science learning and job-skill training among diverse high school students until they graduate from high school or an academically equivalent program. The program is organized around a hierarchical curricular structure called the "Career Ladder," which engages youth participants in increasingly advanced levels of science learning and training. When students have demonstrated their mastery of job positions at one level of the Career Ladder, program coordinators promote them to the next level.

With help from the program coordinators, we successfully recruited 36 of the 65 students enrolled in

the program (55%) to participate in a one-on-one, in-person interview. We worked with the program coordinators to select a mix of students who were representative of the larger student body. Of those interviewed, 53% (19) were girls and 47% (17) were boys, and the age range was 14–19 (M = 16.4 years). The sample was 31% (11) Asian, 22% (8) White, 22% (8) African American, 6% (2) Latino, and 19% (7) identified as other ethnicities. This racial/ethnic breakdown is considerably more diverse than the city's public school system, which was 47% White in 2016, the year we conducted the study. In terms of socioeconomic status, 47% (17) reported that their mother/female guardian had less than a four-year degree, 25% (9) had a four-year degree, and 22% (8) had a higher degree. The remaining 6% (2) responded "unknown."

Data Collection

The research team conducted interviews lasting 30–40 minutes from late April 2016 to mid-May 2016. All interviews were recorded and transcribed verbatim. The interview protocol asked students a variety of questions about their school and after-school science-related activities, their feelings about science, and their plans for pursuing science in college and beyond. The last section of the interview—the focus of the current analysis—was a contextual interview (Beyer & Holtzblatt, 1995) inviting participants to assess the digital badge platform prototype developed during the course of the project. Interviewers displayed the prototype on a laptop screen and asked participants to comment on it. The interview was piloted in December 2015 with three program students and revised according to feedback provided by the students and the project evaluator.

Data Analysis

Using thematic analysis (Boyatzis, 1998), two members of the research team developed a coding scheme based on themes identified in a prior study investigating stakeholders' views of digital badges (Davis & Klein, 2015), as well as themes that emerged inductively from an initial review of the interview transcripts. To ensure that codes were applied consistently and accurately, two coders each coded a set of three randomly chosen interviews and came to consensus (Smagorinsky, 2008). In this first round of reliability coding, the Cohen's Kappa values for the badge-related codes ranged from 0 to 1, with an average Kappa value of 0.71. The second round of reliability coding consisted of another set of three interviews, focusing on the code groups that had Kappa values less than 0.6. The average reliability for this round was 0.96, ranging from 0 to 1. The only code below 0.70 was one of the badge opportunity codes: provides a permanent record of learning, accomplishments, which occurred only once. Because of its low occurrence, researchers decided to discuss and come to consensus for this code each time it arose during the coding process. Having reached acceptable levels of reliability (Landis & Koch, 1977), the coders divided the remaining interviews and completed coding.

Results

Students' Perceptions of Digital Badges

After being shown the digital badge prototype, 75% (27) of the interview participants reported having an overall positive opinion of using digital badges at the Science Center. Maya (all names are pseudonyms), age 16, stated:

> I think it's a good idea because it would be really hard to explain everything I did in the program on my

> [college] application and just a link would direct college admissions [officers] to my achievements and what I did.

Another 22% (8) of the interviewees were ambivalent about the prototype. Larry, age 17, said: "I'd say I feel personally, pretty neutrally about them. They don't really do a whole lot for me, but I see their potential to be helpful." Colin, age 16, was the only one to express outright dislike for the idea, stating: "I think I'm gonna say that I don't like them very much at all. I feel like they might just create too much competition between members of [program] and that the badges feel very unprofessional."

Opportunities

Consistent with their generally positive attitude toward the badge prototype, students discussed specific opportunities associated with badges more frequently than challenges. Across the 36 interview participants, opportunities were mentioned a total of 195 times, whereas challenges were mentioned just 69 times. The three types of opportunities mentioned most frequently were that digital badges could: (a) provide visible learning pathways (discussed by 83% of students), (b) connect learning across different contexts (78% of students), and (c) establish the credibility of a learner's skills and accomplishments (78% of students).

In terms of *navigating learning pathways,* many students stated that the badge platform would help them to understand their current position in the program and empower them to visualize their future learning goals. Max, age 17, observed: "This [badge platform] would be really helpful to know what next steps do you wanna take or … [w]hat skills do I wanna emphasize first." Students also thought that using digital badges would motivate their learning, as Olivia, age 18, said: "[By knowing] what you need to do to get to the next thing, it might motivate you to work quickly to get more badges." Sarah, age 15, described how using digital badges could give students agency in documenting their own learning pathways: "It's pretty interesting and it's an easy way to keep track of your accomplishments. … Going through your achievements, feeling proud of yourself … and possibly a way to keep up with what you've done."

With respect to *connecting their learning across different contexts*, students saw clear benefits to the digital badge platform. Ross, age 17, said: "I think they'd definitely be more useful than just like a poster in like a room [physical poster in program office]. … Outside of the Science Center, you can have access to that information and to share with others." Students explicitly indicated that using digital badges would help them demonstrate transferable skills in different settings. Yvonne, age 16, explained, "For employers, they are looking for people to hire that have a certain set of skills that they are looking for […] plus since it's not you editing that, it's other supervisors and other employers updating it, you can't lie about it."

Interviewees also highlighted the importance of being able to explain the after-school program in different contexts and how it helped develop their science skills and identity. Maya, age 16, stated: "Well, it would show that you developed all these skills, and that they [external audiences] can see how well you did in that program, and your interest in science a lot." Victor, age 16, particularly focused on the explanatory nature of the badges: "Especially since you guys have descriptions of what each badge meant. … Obviously you would just show them [external audiences], 'Oh, I got this badge,' they wouldn't know what it means, but with the description that would help."

Students expressed that digital badges would *increase the credibility of their learning and achievements* in and out of the Science Center. Ross, age 17, observed: "Especially with the soft skills like teamwork

and leadership, that's something that's really important and there are a lot of core values for a lot of colleges … it's good to have proof of it." Adele, age 17, believed the platform would give her both credibility and more agency:

> This would be really, really useful for college applications because I'm pretty sure if we just went up to them now and said, 'I worked at [program]' … I don't have any proof of anything. … If they wanted anything, I have to go through a really long process of 'Hey, [supervisor]' or something.

Challenges

The most commonly mentioned challenges that students mentioned were that digital badges might (a) be no more valuable than a résumé line/add no value (discussed by 42% of students), (b) place undue emphasis on extrinsic rewards (31% of students), and (c) introduce privacy concerns (31% of students).

Larry, age 17, pointed out that *badges might not add discernable value to a résumé or application* and might even add unnecessary work for college admissions officers, "And that [the system] might be a big positive for some, but for others I feel like it would just be, 'I have to learn this system now; I don't want it. What is this, just tell me.'" Similarly, Colin, age 16, expressed concern about whether external audiences would understand the value of badges: "It feels very … a lot like showing off your video game achievements. I feel like people might see them and say, 'Oh, that's interesting,' and then not take your job as seriously as you want it to be."

Although many interview participants described how digital badges could motivate them to move forward in their learning pathways, several students thought that badges might *promote competitiveness* in a negative manner or make the process of advancing in the program seem daunting. Alex, age 18, explained: "Yeah. [I think there might be] a little bit of extrinsic motivation … with being able to see everyone else's [badges]. I think that there might be a little bit of … jealousy and stuff." Colin, age 16, also expressed mixed feelings about the extrinsic nature of badges:

> It's just like a wall of like empty badges that you need to fill. It does feel a little intimidating. It's kind of like when you enter a new video game and you haven't completed all of the levels and you complete them and then you look back, and you're like, "Whoa, that's a lot." I feel like it can seem a bit intimidating as well.

Colin was concerned that the badge system would place undue focus on completing achievements rather than documenting learning.

Some students raised *privacy concerns* linked to displaying their achievements through the badge platform, as Lily, age 15, said: "I think it depends on whether they [students] feel comfortable in sharing that information. And it also depends [on] what kind of information [is shared]." Nathan, age 15, explained:

> [An admissions officer said] "Anything that you put on social media, and these websites, they look you up, and they find all of it. There's nothing to hide on the Internet." And, again, if someone didn't get that many badges, and everyone else's profiles are on there, I'm afraid that it would make me or some of [the] other members look bad.

While students such as Nathan felt comfortable having the badge platform as a personal and program resource, they were more cautious about sharing their achievements with broader audiences, citing privacy concerns and trepidation about linking their work with their social media profiles.

Discussion

The current investigation explored the potential for digital badges to support youth agency and identity in an after-school science program serving diverse high school students. This work is motivated by the recognition that agency and identity are important factors for engaging and supporting the success of students who are typically underrepresented in science-related subjects and careers (Barton & Tan, 2010; Bricker & Bell, 2014; Nasir & Hand, 2008).

The results demonstrate the potential for a sociotechnical system—in this case digital badges—to document and recognize science learning that takes place in real-world contexts, as opposed to systems designed to support learning in virtual worlds that are separate from students' real-world spaces (Kafai & Dede, 2014). Our contextual interviews showed that students were generally enthusiastic about digital badges, identifying considerably more opportunities than challenges. The top opportunities they identified suggest that students were able to recognize the potential for digital badges to help them gain recognition for their achievements and experience control over their learning pathways in the science program. Recognition of alternative forms of credentialing has the potential to increase equity in science-learning pathways by allowing students to use experiences from outside the classroom as evidence of their learning accomplishments (Tyson & Roksa, 2016). Increased awareness and use of these alternative credentials may allow more diverse students access to science-learning and career opportunities (Spaulding & Johnson, 2016; Wyn, Cuervo, Crofts, & Woodman, 2017).

At the same time, the students identified challenges associated with sharing one's badges to external audiences, which align with previous related research (Davis & Klein, 2015). Doubts about the external credibility of badges, as well as privacy concerns related to sharing badges publicly represent challenges that must be overcome if badges are going to succeed in realizing the potentials documented in this study.

Limitations and Future Work

The diversity of our sample of high school students represents a strength of the current investigation, allowing us to capture the experiences and viewpoints of a wide range of learners. At the same time, we must acknowledge that this sample was drawn from one science program in one particular city in the United States. It would be worthwhile in future work to examine the experiences of students in different geographic regions across the country, particularly more rural areas, which are not represented in the current study.

The results point to the potential for digital badges to support learners' science agency and identity. In our future work, we will investigate the extent to which this potential is realized in the implementation of the badge platform in the after-school science program. Specifically, we will track students' use of the platform and how their opinions of it change over time, paying particular attention to whether and how badges help place students in control over their learning pathways and help them to display their accomplishments to audiences of import.

Conclusion

Prior work has demonstrated the importance of agency and identity in science learning, particularly for students who have traditionally been underrepresented in science. The current investigation extends

this work by demonstrating how supports for student agency and identity in science learning could be embodied successfully in the design of a digital badge platform intended to track and showcase their learning in an after-school science program. Students in the program were overwhelmingly enthusiastic about the badge platform and identified numerous opportunities associated with its incorporation into the program. The findings from this investigation point to the potential not only to support science agency and identity, but also to provide supports for increased equity in science-learning pathways.

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Acknowledgments

The authors thank the National Science Foundation for its support of this research under grant DRL-1452672. They also thank the Science Center staff and students who participated in the research.