# Digital Badges Forging Connections Between Informal and Higher Education

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Many high-quality out-of-school-time (OST) programs enable youth from economically disadvantaged backgrounds to gain skills and knowledge in science, technology, engineering, art, and math (STEAM, Afterschool Alliance, 2015; National Research Council, 2011); engage in authentic practices that relate to their own interests; and connect with their peers and their own cultures (Bell et al., 2009; Ito et al., 2013).

However, too often structural inequalities in the resources available to low-income youth, such as a lack of guidance counselors who can help them develop college portfolios, mean that the talents they develop in OST programs may not be communicated to admissions officers when they apply to college (Archer et al., 2012, Calahan et al., 2019; Riegle-Crumb et al., 2011). Since Black and Latinx youth are twice as likely to attend afterschool programming as their White counterparts (Afterschool Alliance, 2015), OST programs can address inequality of opportunities to some extent. However, to fully realize their potential to broaden STEAM participation in higher education and the workforce, OST STEAM programs need not only to help participants gain knowledge and skills, but also to give them tools for communicating their

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accomplishments to college and career gatekeepers (Fishman et al., 2018).

The past five to ten years have seen several initiatives that use digital badges as tangible representations of OST learning (Davis & Singh, 2015). These efforts have had a mixed track record; their impact is related to the quality of the program design as much as to the badges themselves (Abramovich et al., 2013; Hickey & Shenke, 2019). Research demonstrates that digital badges can be effective in documenting the skills and accomplishments of low-income youth when OST programs partner with the education system to ensure that the badges are given real value, such as providing course credits toward graduation and connecting OST inititatives with broadly recognized school programs (Rennie Center for Education Research & Policy, 2018). Digital badges can serve as alternative credentials for college applications only if those who evaluate the applications recognize the badging system (Fishman et al., 2018). This recognition requires negotiation, translation, and partnership among stakeholders in informal, formal, and higher education (Itow & Hickey, 2016).

Mouse, a national nonprofit that provides formal and informal creative technology programs, and Parsons School of Design in New York City established a badge endorsement partnership in a program called Investigating Digital Badges as Alternative Credentials to Broaden STEM Participation Among Underrepresented Youth. This digital badge system was designed to give young people language and evidence to demonstrate to higher education gatekeepers the value of what they learned in Mouse's Design League program. The project formalized procedures through which Parsons faculty co-created the badges and Parsons administrators endorsed them. This endorsement signals to other colleges that Design League meets Parsons's criteria for a high-quality digital design program, similar to a pre-college program. In the process, program developers learned what kinds of content and experience to include in Design League to help prepare young people to attend a college like Parsons.

## The Design League Program

Run by Mouse, Design League is a year-long OST program for high-school–age youth. In its curriculum, Design with Purpose, participants learn human-centered design in order to develop prototypes of assistive technology products for people with disabilities. The program is divided into two phases of learning.

In the first phase, Design Skills Foundations, participants learn the theory and practice of design thinking and the human-centered design process. Learners not only are introduced to the many careers that use design skills to create new technologies but also gain the language and knowledge they need to identify authentic opportunities for design and innovation in their own lives. This phase contextualizes the thoughtful work they will do for the rest of the year and encourages them to see themselves as part of a wider ecosystem of technology and design innovators.

The second phase is Design League Product Design. Learners participate in a human-centered design process from start to finish alongside mentors from academic and professional fields as well as near-peer portfolio mentors. Participants interview people with disabilities to identify their needs, learn question framing and brainstorming skills, and create multiple iterations of a technical product designed to improve the lives of others. They create wireframes and rapid prototypes of early iterations of ideas, solicit user feedback, incorporate new data into future iterations, and publicly pitch and market their products. They finish the program with a solid prototype of their final product, a digital design portfolio, five Parsons-endorsed badges, relationships with mentors, and a more refined idea of their future career prospects.

## The Informal Education and Higher Education Partnership

The development of the endorsement partnership between Mouse and Parsons School of Design can provide a model for other OST programs and higher education stakeholders. Mouse and Parsons participate in a number of collaboratives that focus on building a supportive STEAM ecosystem for underrepresented youth in New York City. Events hosted by the collaboratives bring stakeholders together to discuss their communities' needs, challenges, and opportunities. Interactions at these events between Mouse program developers and Parsons faculty led to the realization that they shared many values around equity, inclusion, and social justice; transformative youth development models; community-based digital design; and increasing diversity in higher education and in STEAM careers.

This recognition of shared values helped to foster trusting relationships among the individuals from the two organizations. They started to look for ways to collaborate, such as applying for project grants

and presenting together at conferences. After some successful joint work, they decided to tackle a complex challenge together. Parsons was interested in increasing the diversity of its student body and recruiting more students from its local community. The Design League program represented a pool of young people from disadvantaged backgrounds who were interested in, and gaining experience with, creative digital design. For Mouse program developers, building a more formal relationship with Parsons would familiarize participants with a higher education opportunity located in their own community and would offer them recognition of their Design League learning from a highly respected institution.

The two organizations decided that co-creating a digital badge system for Design League would be mutually beneficial. Having helped to create the badges, Parsons faculty would know that the badges represented skills and experiences aligned with their requirements. Meanwhile, Mouse educators would know that their program had been vetted by an organization that represented the next step on a digital design career pathway. The two organizations' history of collaboration and trust enabled members to bring in higher-level decision makers who could make change happen, including the director of curriculum development at Mouse and a dean at Parsons. Mouse program developers and Parsons faculty and administrators reviewed the Design with Purpose curriculum to identify which learning activites aligned with Parsons' introductory course in human-centered design and which ones had to be revised. The partners designed the digital badges to represent specific skills in digital design that Parsons faculty have endorsed as being consistent with the skills they seek in applicants. These badges are now considered "plus factors" on applications to Parsons. (A "plus factor" is something a college decides should increase an applicant's chance of being accepted, such as being an athlete, a child of alumni, or a first-generation college student.) In addition, the formal endorsement by a highly respected school of design increases the likelihood that the Design League experiences and skills the badges represent will be valued by other colleges and universities offering digital design and technology majors.

As a part of this project, Mouse and Parsons representatives met with admissions and faculty representatives from other higher education institutions to share their partnership-building experience and endorsement process. They did so partly to make these colleges aware of the badge system but also to recruit them to endorse the badges. By the end of the project, the team had brought on a new partner, Hostos Community College in the Bronx, which offers a number of digital media degrees. More than considering the badges as plus factors, Hostos is in the process of creating an agreement to grant course credit to students who earn Design League badges, giving the badges real-world value for participants who enter Hostos. Hostos and Parsons are also in discussions to establish a pathway in which Design League participants can attend Hostos for one year, split courses between Hostos and Parsons in years 2 and 3, and attend Parsons for the fourth year, so that they have a less expensive means to earn a Parsons degree.

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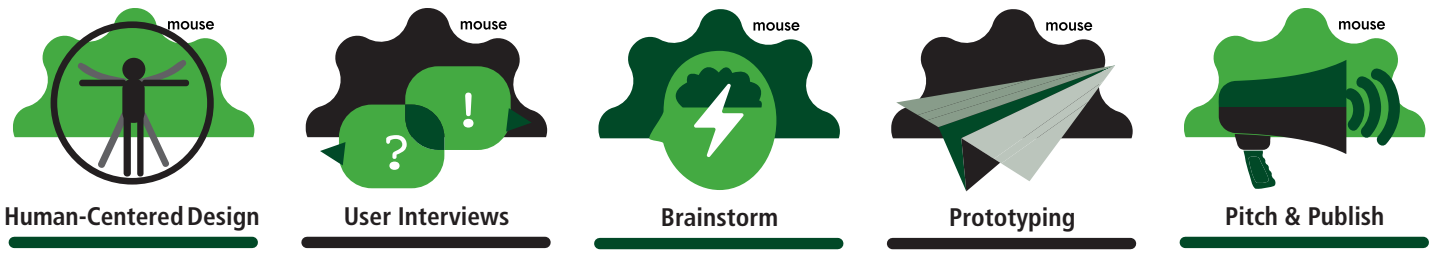
In addition, the project team is now in discussions with a highly competitive engineering college with the aim of having its faculty endorse the Design League badge system. Besides adding a new partner, this endorsement would demonstrate to other engineering colleges the value of Design League skills and content. Design League participants also will benefit, as many want to enter engineering rather than digital design programs after high school. The engineering college will benefit because Design League alumni will diversity its student body.

## The Badge System

Mouse designs and publishes OST courses on its online learning platform, Mouse Create, including Design League's core curriculum Design with Purpose. Each course awards competency-focused digital badges. Informal educators facilitating this curriculum use the platform to build playlists of projects, each of which is associated with specific digital badges. The badges,

**Figure 1. Design League Badges**




which are displayed and accessed online, are graphic representations of competencies earned through specific criteria, linked to evidence or portfolio data that educators can review. Figure 1 shows the five badges participants can earn in Design League.

Participants earn badges by creating a portfolio of project work associated with the badge. For example, young people can earn a Prototyping badge by showing evidence of having made a paper prototype, tested it, and gone through three increasingly sophisticated iterations. Their facilitators review submitted work on the digital platform, leaving feedback in each submission's discussion area. The young designers receive an email notifying them that their badge is available on their platform for them to share publicly on social networks or in college applications.

In the current program, two near-peer portfolio mentors—undergraduate students in a digital design field—work with Design League participants to help them build their digital badge portfolios to meet college admissions requirements. These mentors also give feedback on the creation process, help the young designers strengthen their documentation, and share their own stories of pursuing a career in digital design.

## Data Collection and Analysis

To understand what participants were gaining from their experience in Design League—and particularly what they gained from earning digital badges—we collected data from program participants using pre- and post-participation surveys and interviews.

The survey we used was the STEM Career Interest Survey (STEM-CIS; Kier et al., 2014), which is based on the social cognitive career theory framework (Lent et al., 1994). The STEM-CIS asks respondents about their interest in the four STEM content areas: science, technology, engineering, and math. The set of items about each content area is based on six constructs of social cognitive career theory: self-efficacy, personal goal, outcome expectation, interest in the content area, contextual support, and personal input. To these questions, we added our own questions about respondents' college intentions and career interests.

We surveyed all participants in two Design League cohorts, a total of 39 respondents. Of those 39, seven girls and 10 boys filled out both the pre- and post-participation surveys; 10 were first-year Design League students and seven were returning students.

To analyze the STEM-CIS data, we broke down differences between the pre- and post-participation surveys in the four content areas and for each of the six constructs within those content areas. The analysis did not show any significant change in Design League participants' STEM-CIS scores. We think this result can be explained by noting that young people self-select to participate in Design League, so that their STEM interest starts high and finishes high.

However, differences in the pre- and post-participation results do suggest that the project had a positive impact on participants' college intentions and career interests. At post-test, all 17 respondents expressed interest in at least one STEAM career, as compared to 15 at the pre-test. Nine respondents expressed interest in three different kinds of STEAM careers, compared to only three respondents at the pre-test.

We also conducted interviews of about 25 minutes each with Design League participants three times per year for two years of program implementation. We interviewed ten students each year. Six were interviewed in both years; for these, we looked for evidence of growth. The interview protocols were adapted from Zeldin et al. (2008) and from Usher (2009). We also asked questions about why respondents joined Design League and about how they viewed badges and portfolios. We coded interview transcripts based on Bandura's (1997) four categories of self-efficacy: mastery, vicarious learning, social persuasion, and physiological states.

## Credibility Through Endorsement

This outline of our findings uses youth voices from the interviews to illustrate the impact of the program and how the badge system helped to inform the way participants spoke about what they had learned.

### *Speaking the Language of College Admissions*

One value of the digital badge system was that it taught Design League participants to use terminology and examples that the gatekeepers of higher education would recognize and value. The participation of Parsons as endorsement partner was crucial, as the school represents the next step in a career trajectory for youth who are interested in digital design. Because faculty members understand what Parsons expects of students applying to its design programs, their input helped the OST program guide participants through activities that represent key steps of the human-centered design process. From building empathy for users through interviews to brainstorming solutions to problems, creating prototypes of designs, and pitching ideas, participants named these steps as they worked on badges. Earning a badge made explicit for participants what the steps are and what work goes into each step. In this way, participants gained not only the valuable experience of making a project, but also the vocabulary they would need to describe that experience to colleges and employers.

One value of the digital badge system was that it taught Design League participants to use terminology and examples that the gatekeepers of higher education would recognize and value.

Knowing how to use professional language to talk about their work is empowering for young people. In our interviews, participants made it clear that the digital badges signified their ability to accomplish recognized design processes. When asked, "What do the badges mean to you?" interviewees spoke about having a way to show they had completed a piece of work. For example, one said, "Badges? They mean this is the work I've done. So it kind of represents a milestone." Another stated, "The badges show I achieved what I have been doing the whole time.... The badges show all the processes I've been doing." A third described how the badges represent mastery of specific skills or content: "The badges mean that you're experienced with that topic that the badge says…. You actually know something."

Having badges aligned with specific components of the human-centered design process meant that the Design League participants developed the confidence to talk about these processes and to claim expertise. One interview respondent gave the example of earning the User Interview badge: "We're currently interviewing people from [an organization for disabled people], and not everywhere do kids like us really know how to interview people. Usually interviewers are adults. Not many kids know how to do that at my age, fifteen." Another said:

> You could interpret [badges] as "I have put at least a couple of hours into mastering that particular idea or concept." ... I know, for example, how to brainstorm, how to develop good research questions. I have experience with that.

The badges also represented personal growth for some participants. One stated, "For me, the badges mean that there's things that I can do that I didn't really know I could do." When asked whether one badge was more important than the others, Design League participants did not agree on any one. Rather, they valued the badges depending on what they felt they got out of the badges' activities. For example, one respondent chose the Pitch and Publish badge as most important "because I'm a shy speaker. I don't really like to talk to a crowd, to people I don't really know." Another participant said that her User Interview badge represented not only the activities she completed, but also a personal accomplishment in an area she perceived as a weakness: "[The badge] shows me that I've been obtaining a greater level of knowledge of interviewing people, because I was always bad interviewing people." A third participant described how learning about Prototyping was beneficial for him:

> The idea of prototyping and coming up with ideas has been really helpful for me, as it made me focus more on being open-minded and not so set on my original ideas.... That mentality of being open to change has been tremendously helpful in my school life and outside of school.

Other respondents, in contrast, believed that all the badges had similar value because they built on each

other. One participant stated, "I believe all the badges are equally important because … all the badges are actually connected…. That's all how you progress."

The badges helped participants learn a highly specialized professional vocabulary for describing the work they were doing in Design League. Because they earned badges by showing examples of work representing the various skills, participants had to reflect on and understand the skills to make the case that the examples they selected were appropriate representations. This ability to communicate their knowledge and mastery of the design process, using the vocabulary of Parsons faculty, gives these youth tools to show the value of their OST experiences to higher education gatekeepers.

### *Digital Badges Can Clarify Pathways*

Survey and interview results suggest that work on Design League badges led to greater interest in and understanding of STEAM careers. As noted above, our survey revealed that Design League participants started the program already highly interested in STEAM content areas, especially technology. The program did not change their level of interest, but it provided a place where participants could explore and express those interests. What did change was participants' interest in the range of STEAM careers, their understanding of what careers in digital design and technology involve, and their knowledge of what they need to do to be successful in those careers.

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The experiences of two participants we interviewed reflect this evolving understanding. An interviewee we'll call "Andre" participated in the Design League program for two years. From the beginning, he expressed a desire to go into computer engineering. However, during his participation, he changed his understanding of what an actual career in computer engineering might entail. When asked at the beginning of his first year in the program what he did that was related to technology and design, he talked about creating websites, learning HTML, and doing research on YouTube. At the beginning of the next year, in response to the same question, he said:

> There are electronics at my house sometimes I like to repurpose so I can help my family out or make things easier. For example, I had this old computer that no one used, so I turned it into this little tablet that I left in the living room, and it would display things like the weather for the day and reminders on a schedule—so something that would make my parents' lives a little easier.

At the end of his second year in the program, Andre provided a detailed description of how he engaged in the design process, naming two of the badges (Human-Centered Design and User Interviews) that he earned along the way.

> For Human-Centered Design, I learned a lot about creating products that are specific to someone's needs. Human-centered design means … designing a product centered around human life. So regarding our individual project, with the Click Pot, [the user we interviewed] was our focus, and our design was centered around her. We wanted to make it easier for her to move pots around the kitchen. So we went beyond the surface, and we really analyzed what she does day-to-day with her habits in the kitchen with cooking. The user interviews is how we were able to find one of the issues that she faced in her life, and then tackle that issue.

The second interviewee, "Valerie," stated at the beginning of her first year in the program that she wanted to do "something in computers and design." At the beginning of her second year, she had decided that she wanted to go into "communication design." By the end of that second year, she had been accepted into a media arts program at a local college. She outlined what she had learned and how she had grown over her two years in Design League through her descriptions of two badges she earned. Of the Prototyping badge, she said:

> The Prototyping badge means that I have experience trying a new thing and seeing if it works or not. If it doesn't, I just find another way that could improve it from the prototype I made and get feedback from my group or the person that

we interviewed. I didn't know about prototyping before Design League because before Design League I did not have any design skills or skills that led to creating things.

In describing the Pitch and Publish badge, Valerie said:

> I'm a shy person even now, but I've improved a lot since starting Design League. I get to be less afraid of talking and also less nervous about presenting to class…. It's stepping away from your comfort zone, being able to not be shy.

During two years of participating in Design League and earning digital badges associated with important design skills, these two participants transformed from having a general interest in design and computers to having far more fleshed-out conceptions of what a digital design career involves. They also had developed confidence in their ability to do that kind of work.

## The Perceived Value of Endorsed Badges

Earning digital badges helped Design League participants learn to describe their work using professional design terminology. Some began to see where they fit on STEAM career trajectories. However, some participants were not clear about the practical use of the digital badges as credentials outside of the program or whether the badges would be valuable in their college applications. One interviewee said that badges could serve as evidence of his abilities that he could use in college applications:

> I believe [badges] are important to me because it's a process that I learned, and these badges can be used as part of my portfolio to show to colleges that I have the skills to do things like this, and I'm proud of that.

Another participant also thought that his badges would reflect positively in a college application, saying that the badges "show what you're doing to colleges. So they can see what kind of work you've done and that you've got experience outside of school."

However, other Design League participants were more skeptical. One interview respondent who reported that badges signified the hard work she had done also noted their limited value unless colleges understood what they were and accepted them. "[Badges] are pretty important, but I wish they were more accepted by other places like colleges and stuff. That increases the importance, definitely."

Some participants suggested that, even if the actual badges could not be shared in a college application, going through the Design League activities and the process of earning badges meant that they could write about the design process in their college essays and talk about the process in their interviews for college, internships, or jobs. One said:

> I could definitely imagine using the [design] terms, especially because they precisely describe what we have been doing in Design League. But as for the badges, I just wish I could mention them. I just wish that they were more recognized by other colleges and institutes, because I don't think many of the major colleges really recognize these badges yet, but I could definitely use them to help describe some of the work that I've been doing in [Design League].

Two participants mentioned that having such well-known institutions as Mouse and Parsons issue and endorse the badges enhanced their value. One said:

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I think that [colleges] don't necessarily care about the badge but more about the backing that the badge has ... and then it's also certified by different parties. So it's more about who speaks behind it than the actual badge.

Another youth agreed that, for the badge system to work as intended, the issuing, endorsing, and accepting organizations must be perceived as mutually credible.

> The badges can help show that you've mastered the skills. I guess they're more symbols of mastery, so rather than having to go through individual images or going through all the series of steps you've taken, badges can be a short cut … and that highly depends on its merit and its credibility. So if it's a well-accepted badge, then it can definitely be used in lieu of showing the step-by-step process of your understanding.

These participants understood the potential of the digital badging system. Many appreciated the way the badges gave them shorthand to encapsulate the range of their experiences and skills. However, it was difficult for them to see how the badges themselves had much currency beyond the program, since they are not formally accepted by colleges other than Parsons and Hostos.

## Next Steps

By partnering with Parsons to create an endorsement relationship for its digital badge system, Mouse is attempting to forge a connection between Design League participants and the kind of higher education institutions they might want to attend. However, that is only the first step of a longer-term process that needs to take place for this OST program and others like it to establish alternative methods for credentialing the valuable experiences they provide for young people.

One way Mouse can address the credibility issue interviewees raised is to reframe how it conceptualizes the badges and presents them to participants. It could, for example, emphasize the way the badges develop skills and the vocabulary to describe those skills, presenting the badges as talking points participants can use to pitch their skills to college and career gatekeepers. However, the hard work should not only be placed on the young people. College and career gatekeepers should also make an effort to understand the activities in which youth participate and the skills and abilities they gain. If the burden is placed solely on the young people, who are already disadvantaged, the inequities Design League was created to address are perpetuated.

A more ambitious goal is to establish a larger network of endorsement partners, eventually reaching enough highly regarded art and design institutions that the badges become widely recognized within a specific higher education ecosystem, in this case, New York City.

For credentialing alternatives like badge systems for OST accomplishments to address inequalities in higher education admissions, endorsement partnerships must become commonplace. Although creating these partnerships has its challenges, the Design League project can provide a model for how OST organizations can work with higher education partners to prepare participants to demonstrate their talents and take the next step on their chosen college and career pathways.


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## References


Abramovich, S., Schunn, C., & Higashi, R. M. (2013). Are badges useful in education? It depends upon the type of badge and expertise of learner. *Educational Technology Research and Development, 61*(2), 217–232.

Afterschool Alliance. (2015). *Full STEM ahead: Afterschool programs step up as key partners in STEM education.* http://afterschoolalliance.org/AA3PM/STEM.pdf

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2012). Science aspirations, capital, and family habitus: How families shape children's engagement and identification with science. *American Educational Research Journal, 49*(5), 881–908.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* Freeman.

Bell, P., Lewenstein, B., Shouse, A. W., & Feder, M. A. (2009). *Learning science in informal environments: People, places, and pursuits.* National Academies Press.

Cahalan, M., Perna, L. W., Yamashita, M., Wright-Kim, J., & Jiang, N. (2019). *2019 indicators of higher education equity in the United States: Historical trend report.* Pell Institute for the Study of Opportunity in Higher Education, Council for Opportunity in Education, and Alliance for Higher Education and Democracy of the University of Pennsylvania. http://pellinstitute.org/downloads/publications-Indicators_of_Higher_Education_Equity_in_the_US_2019_Historical_Trend_Report.pdf

Davis, K., & Singh, S. (2015). Digital badges in afterschool learning: Documenting the perspectives and experiences of students and educators. *Computers & Education, 88,* 72–83.

Fishman, B., Teasley, S., & Cederquist, S. (2018). Micro-credentials as evidence of college readiness: Report of an NSF workshop. https://deepblue.lib.umich.edu/handle/2027.42/143851

Hickey, D., & Shenke, K. (2019). Open digital badges and reward structures. In K. Rennigher & S. Hidi, *The Cambridge handbook of motivation and learning* (pp. 209–237). Cambridge University Press. https://doi.org/10.1017/9781316823279.011

Ito, M., Gutiérrez, K., Livingstone, S., Penuel, W., Rhodes, J., Salen, K., Schor, J., Sefton-Green, J., & Watkins, S. C. (2013). *Connected learning: An agenda for research and design*. Digital Media and Learning Research Hub.

Itow, R. C., & Hickey, D. (2016). When digital badges work: It's not about the badges, it's about learning ecosystems. In D. Ifenthaler, N. Bellin-Mularski, & D-K. Mah (Eds.), *Foundation of digital badges and micro-credentials: Demonstrating and recognizing knowledge and competencies* (pp. 1–22). Springer. https://doi.org/10.1007/978-3-319-15425-1_22

Kier, M. W., Blanchard, M. R., Osborne, J. W., & Albert, J. L. (2014). The development of the STEM Career Interest Survey (STEM-CIS). *Research in Science Education, 44*(3), 461–481.

Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice and performance. *Journal of Vocational Behavior, 45*(1), 79–122.

National Research Council. (2011). *Successful K–12 STEM education: Identifying effective approaches in science, technology, engineering, and mathematics*. National Academies Press. https://doi.org/10.17226/13158

Rennie Center for Education Research & Policy. (2019). *Expanding the boundaries of education: Two cities' efforts to credential real-world skills through digital badges*. https://www.renniecenter.org/sites/default/files/2019-02/Expanding%20the%20Boundries%20of%20Education%20Jan%202019_0.pdf

Riegle-Crumb, C., Moore, C., & Ramos, A. I. (2011). Who wants to have a career in science or math? Exploring adolescent future aspirations by gender and race/ethnicity. *Science Education 95,* 458–476.

Usher, E. L. (2009). Sources of middle school students' self-efficacy in mathematics: A qualitative investigation. *American Education Research Journal, 46*(1), 275–314. https://doi.org/10.3102/0002831208324517

Zeldin, A. L., Britner, S. L., & Pajares, F. (2008). A comparative study of the self-efficacy beliefs of successful men and women in mathematics, science, and technology careers. *Journal of Research in Science Teaching, 45*(9), 1036–1058. https://doi.org/10.1002/tea.20195