Off Into the Sunset: Designing for the Inevitable End of Projects

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Abstract

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Ending projects – in whatever form that takes – is a known area of difficulty for research that involves designing and implementing technologies with community partners. The ending process is particularly salient to underserved and marginalized communities and populations. This dissertation explores the project ecosystem and power dynamics in which researchers and participants exist when collaborating on technology design projects involving youth and their communities. From this exploration, I look to identify *types of* and *strategies for ending*, to build a framework for advancing design justice in the ending process.

The first set of empirical studies in this dissertation address the power dynamics and roles within community-based technology design projects and multigenerational co-design teams. From this work we learn how we can encourage youth and their communities to take ownership of learning technologies through participatory design and involvement in the technology implementation process. Subsequent studies focus on the long-term impacts of such projects and how the community and researchers can begin to transition these technologies to community ownership, while understanding the resource constraints of both the researchers and communities, particularly the youth members. The final study — a cross case analysis of two long-term projects — extends this work on power dynamics and impacts, using the

understanding of systems and infrastructure to frame our understanding of the equitable ending process and what different endings might look like. Together, these studies provide grounding for a framework to create a more just and equitable ending process, specifically creating guidelines for designing the end of the research cycle in an ethical and practical manner.

This dissertation provides a number of empirical insights on the development and changes within relationships and power dynamics throughout the course of community-based educational technology design projects involving youth; the challenges, obstacles, and opportunities at the conclusion of the life cycle of the aforementioned projects; and the different ways *ending a project* occurs. The work also has theoretical implications, drawing on value sensitive design, research-practice partnerships, and other theories around community relationships to form an understanding of project ending as a space for design. Finally, this work contributes a theoretically-grounded methodological framework for designing projects involving long-term technology development with youth and their communities that plan for and incorporate the ending of the project, derived from the findings in the previous contributions. Through this work I explore the dimensions and considerations in ending a project that involves a long-term partnership with a community, developing ways to discuss, navigate, and plan for the closing process and facilitating less extractive and more mutually beneficial community research partnerships.

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"It is not your responsibility to finish the work [of perfecting the world], but you are not free to desist from it either." (Pirkei Avot, 2:16)

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Chapter 1 Introduction

Researchers are constantly exploring the newest idea and looking for the next project, whether trying to stay on the cutting edge in the business world or building their tenure case in academia. But what happens to the projects that came before, once the publications are in press and the funding is over? Does a project ever truly end, or does it evolve into something new? What does ending ***even mean*** in this context? And for whom? This line of questioning becomes even more complex when the research involves an ongoing partnership with youth and their communities, such as projects centered on neighborhoods, around churches, in after-school programs, and so on. How do we balance those essential connections and carefully built rapport with the practicalities of time and money, essential not only to the research work but to the lives of our community collaborators?

Over my graduate school career, while engaging in research and technology design work with youth and families, I noted that much of the training of a researcher is devoted to the *beginning* of a project, from developing protocols to filling out Institutional Review Board (IRB) forms. From there – in academic fields involving technological interventions *particularly*, but hardly *only* – researchers work at a rapid pace, and even then, the pace is slow compared to the tech industry, sprinting to develop the latest app or intervention, get published, and move on to the next hot topic that will allow them to get funding and continue their work (Parchomovsky, 2000).

1.1 Publish, perish, flourish?

While in recent years I have begun to notice some pushback against the "publish or perish" (sometimes with an accompanying "quantity over quality") norm of academic culture in various arenas, the world of tech research and innovation in both the private and public sectors still races forward at a breakneck pace (Rawat & Meena, 2014; Wiener et al., 2018). Though there are voices in the academy speaking out about caution, deliberation, and towards incremental and lasting change, the status quo does not incentivize such processes. Cultural change in academia is relatively slow, as is cultural change anywhere. Apps can be prototyped far faster than behavior patterns can be shifted, creating mismatches in values that result in friction.

Continuing the thread of speed and pacing, for the early career researcher, academic culture emphasizes a constant push for more productivity – measured in grants and publications. Even when a tenure-track job is landed, the new prof feels the ticking of the tenure clock over their shoulder. Thus, researchers are always expected to be on to the next thing as soon as possible, starting new projects and initiatives. When it comes to *ending*, there may be some reports due back to funding agencies and other offices to ensure accountability for resources, there may be some formalities to be conducted in closing IRB review or managing data, but what of the ending for the *people* involved? Not only the participants and community partners, but the researchers and assistants who devote years of their life to this work. How do researchers explain

to their community partners that research is ending? That the researchers are moving on? That the technologies they have provided will not necessarily be maintained or sustained?

1.2 "Move fast and break things" vs. "Haste makes waste"

Thus far, we've focused more on the issues with speed and quantity. What of the *endings*? Part of this process is the acknowledgement that things *do* end, so in a world of "move fast and break things," (Vardi, 2018) how do researchers ensure the just and ethical treatment of participants and communities? What do the scientists and designers leave their community partners with as they charge on to the next and newest? We hope for positive impacts of technological interventions, but unfortunately that is not always the case.

Throughout the course of writing this dissertation I've seen many companies make snap decisions on things like Artificial Intelligence (AI) that have gone awry nearly immediately. Many machine learning models are trained on art and writing from creatives who have not given their permission, and even people's images and voices are being used to generate new content without credit and compensation. This is one of the concerns raised during the Writer's Guild of America (WGA) and Screen Actors Guild- American Federation of Television and Radio Artists (SAG-AFTRA) strikes (The SAG-AFTRA TV/Theatrical Negotiating Committee, 2023), as studios try to use the work of creative professionals to remove those same professionals from the workflow. This creative union movement also harkens back to the origins of PD, in Scandinavian workplaces where workers wanted to ensure that technology would not be used to replace them (Floyd et al., 1989). The AI movement is but one example of the problem, but perhaps one that is particularly salient at the time of this writing.

In concert with this rapid iteration and advancement in technical fields is a growing awareness among many researchers and designers of the need to include more diverse participant groups in research and that, ethically, research into technology, particularly with underserved and vulnerable populations, needs to be *in service* to the groups who need it most, not simply what the researchers *think* is needed (Iversen & Dindler, 2013; Katz & Levine, 2015; Sobel et al., 2017). However, these efforts can also create paternalistic dynamics (Harrington et al., 2019), as researchers preaching technosolutionism (the idea that the right application of technology can solve anything) attempt to solve wicked problems without first fully identifying them. While these researchers may have the best of intentions, there is a certain hubris that often leads to the academic valuing their expertise above that of their community collaborators. This also occurs in the technology industry, with hackathons and other charitable initiatives to "make things better" without first determining what "better" is.

One well-documented example is the One Laptop Per Child project's attempt to create child-friendly laptops for marginalized populations, with the goal of bringing constructionist technology tools to these youth (Ames, 2019; Kraemer et al., 2009). While the laptop creators

wanted to help, their focus on what *they* (the creators) wanted the design and implementation to be – based on their childhood experiences – rather than what was practical, feasible, and needed in the children's communities instead created a device that was only compelling to specific demographics and couldn't stand up to the wear and tear of regular use in areas without significant advances in technical infrastructure (Ames, 2019). The idea that the beneficent expert designer can step in and solve complex socioeconomic issues with an app or device is a fantasy, much beloved of nonprofits created by tech CEOs, but addressing the underlying socioeconomic and historical issues is far less fun, shiny, and easy. So, what should we do if we want to work with communities?

1.3 Current conversations

Participatory Design (PD), Value Sensitive Design (VSD), as well as critical and feminist perspectives in HCI have discussed the ways in which researchers and designers might improve their relationships with participants, considering the power dynamics and ethics of the research process, particularly examining the complexity of youth involved in the design process (Dourish et al., 2004; Fiesler et al., 2020; Gustafson & Brunger, 2014; Kawas et al., 2020). While these theoretical perspectives and methodologies differ in their exact approach, they all focus on developing a deep rapport, understanding, and balance with the design partners. Due to the nature of societal ecosystems (Simpson, 2005), achieving equity in the design process is an ongoing struggle, and from many perspectives never fully achieved, but one well worth exploring.

The learning sciences have also explored how to develop long-term partnerships equitably through work with school districts and surrounding communities (Brown & Allen, 2021; Farrell et al., 2019, 2022). While the exact participants and grain size may differ in these perspectives, they are well aligned in core principles and emphasize building trust over time. So why is this type of work not more common in the learning sciences or technical fields such as Human-Computer Interaction? Many projects are still operating under extreme constraints due to practical resource considerations and the culture of academia, which early career researchers find particularly difficult to counter, as they deal with finding their footing in a competitive and complex job market (Penuel & Gallagher, 2017). Researchers may appear as authority figures in their individual research projects, but they also lack a significant amount of agency in certain aspects of their work. The balancing act here can be extremely delicate, maintaining awareness of privilege and status while also needing to stay accountable to higher ups in order to keep funding and positions.

Thinking in terms of value tensions between the fields and communities (Friedman & Hendry, 2019), what happens when the values of innovation and change inherent in rapidly-cycling technology-focused research encounter the idealistic but crucial values of justice and equity? In many HCI or technology development studies that focus on educational technologies, sites such

as communities and schools are brought on board for relatively short durations (a few classes, a month, a semester), with little long-term beneficial impact on the community, though there may be broader research contributions and corresponding benefits down the line. Through some lenses, this might be considered an extractive model of research, using the community for their assets and giving little in return (Kouritzin & Nakagawa, 2018), particularly when introducing technology that is still in development and may not have any updates or long-term support. In the worst cases, this can mean leaving the community with a representation of a broken promise of a better future, promised by "charismatic technology" (Ames, 2019).

Even when researchers partner with communities and organizations on a longer scale, the ending is rarely storybook. Scholars often spend months or even years developing rapport and ensuring that the participants are comfortable with researcher presence (Penuel & Gallagher, 2017), but is the departure from such a partnership as carefully managed? There is a certain level of administrative work involved in concluding a project: closing the IRB, notifying funding agencies, returning equipment, but much of the literature does not discuss the social and relational aspects of the partnership, with a few exceptions (Fishman et al., 2011; Northway, 2000). How do researchers ensure that the community benefitted from the partnership and were left better off than when the research started? These are some of the questions that drove me to this dissertation and to explore what other fields had to say on the topic.

1.4 Drawing on other areas

Some disciplines, such as anthropology, discuss leaving the field – departing the site of an immersive ethnographic study – as a phenomenon (Girke, 2021; Michailova et al., 2014; Van Maanen, 2020). Although this process is distinctly different from technological interventions, I believe that this literal or metaphorical *leaving* is an excellent place to start thinking about how we can improve how community-based research projects in HCI for learning conclude, no matter what form of *ending* that takes.

Additionally, indigenous studies and disability studies researchers discuss how to work in equitable partnership with communities, particularly ones that have faced oppression from the status quo historically (and often still do), changing the power dynamics between researcher and participant into more of a mutually beneficial and respectful partnership (Ball & Janyst, 2008; Castleden et al., 2010; Whetung & Wakefield, 2018). As I have experienced personally in various projects, acknowledging and understanding the power relationships of research, particularly when working closely with youth, are key to developing better mutual understanding and long-term relationships (McNally et al., 2016; Pitt, Bell, & Davis, 2018; Pitt & Davis, 2017).

In addition to some of the design perspectives discussed previously, researchers can also learn from public health initiatives and learning sciences methodological perspectives such as Design-Based Implementation Research (DBIR) and Research-Practice Partnerships (RPP), all of which

place a strong emphasis on working with the community to create a sense of shared ownership with ongoing, clear communication, as well as robust infrastructure (Penuel, 2019; Penuel et al., 2020; Pothukuchi, 2005). While I am sure that these are not the only possible fonts of knowledge to draw on as I develop this work, I believe that these bodies of literature will provide a strong theoretical basis as I work to improve our understanding of best practices for concluding community-based projects in learning technology spaces.

1.5 Research questions and contributions

Drawing on these aligned perspectives, my dissertation explores how core groups in long-term, community-partnered learning technologies research projects understand, design for, and are affected by the end of projects; particularly focusing on the relationships that are built throughout the process and how the ecosystem of the project itself is impacted as it comes to a close (and at the same time impacts the ending. The series of studies in this dissertation focus on the following research questions:

1) What factors in the project ecosystem affect the development of *relationships* and *roles* in and amongst key community groups? How do these relationships change over time?
2) What are the core opportunities, challenges, and trade-offs in *sustaining or concluding* longer-term research implementations, particularly focusing on community-partnered research?
3) What do researchers and communities need to better support and facilitate their involvement in *community research that ends equitably*? How do the technologies factor in? And how do the relationships and roles affect the *progress and conclusion* of the project?

These research questions aim at understanding the complexity and dynamic nature of research project ecosystems, leading to the following thesis of this dissertation:

> *Understanding the role of community member relationships in the life cycle of community-based technology development and implementation projects can support the development of best practices for ending these projects, creating a healthier and more equitable and just research ecosystem.*

Through this work, I will make the following contributions:

1) Empirical insights on the development and changes within relationships and power dynamics throughout the course of a community-based educational technology design project; the challenges, obstacles, and opportunities at the conclusion of a project life cycle; and the different ways *ending a project* occurs.
2) Theoretical insights synthesizing perspectives from learning sciences, value sensitive design, and other fields to develop a more comprehensive perspective on ending

community-based technology research projects, as well as the different meanings of *ending* such projects.

3) A methodological framework for designing projects involving long-term technology development with community groups that plan for and incorporate the ending of the project, derived from the findings in the previous contributions.

In addition to the several interview and case studies described in prior published work and Chapters 4 and 5 to support these contributions, this dissertation also presents new work. In the final study of this dissertation, I explore the ways in which projects evolve and conclude through the perspectives of the community, and the relationships, opportunities, and challenges therein via two in-depth case studies. These studies focus on long-term community based educational technology implementation projects and involve semi-structured interviews with key community members, researchers, research partners, and other focal individuals from each case. From there, I synthesize and develop a theoretical lens and derive a methodological framework on designing projects to end well. "Ending well" can seem like a nebulous term, but in this case, I focus on concluding a project in a way that not only minimizes harm to the participants (as required by many IRBs) but actively strives to benefit the community both in the short and long term, avoiding extractive practices and treating the partners equitably and justly, through the ending of the process. This work supports researchers and communities in their cyclical relationships, confronting the difficult situation of bringing such work to a close. For a summary of the research questions, publications, and contributions, please refer to Appendix A. For definitions of some of the terms used throughout the dissertation, see *1.6 Definitions*.

1.6 Definitions

While these terms will be discussed in context and the complexity of their connotations and meanings explored throughout this work, I want to clarify how they are used in this text.

Ending (a project, study, etc.)

Ending is at the core of this dissertation, so this term will encompass a variety of avenues for "the end" of a research project. When I use the term ending throughout the manuscript, *it refers to the previously active phase of the research program or project concluding in some way*, be that the end of funding, closing of a site, handing-off of technology, or other form of the closing of the previous state. Ending may also refer to the end of the project for a *specific individual*, such as graduation or a job transition. Essentially, I do not use it to mean everything stopping, but a significant change in what was. We will get into more *Ending* in the final chapters and what it might look like in different contexts, for the framework and theoretical perspective.

Long-term projects

The projects discussed in this dissertation have multi-year durations in the data collection phase, though, as we will see, the focal cases span about a decade each from early ideation through wrap-up. To put a clear number on it, I define *long-term projects as lasting at least two years in*

active community engagement and data collection, though it is difficult to quantify the amount of time needed to build a long-term project rapport. Additionally, other factors, such as frequency of site visits, length of time per visit, and so on, may affect the qualitative nature of the relationships. Due to the nature of grants and the pacing of different disciplines, it is challenging to delineate a precise definition for this term.

Community research partnerships / Community-partnered research

This is a broad term I use to describe the variety of design-oriented research approaches from design-based (implementation) research, participatory design, participatory action research, community-based participatory research, and so on. Many disciplines have their own specific terminology for this, but at the core they are all *focused on working with communities to design, build, or collaborate on something for the benefit of those community members and exploring the implementation and outcomes*. In some cases that means the community is a school or school district, a neighborhood, an indigenous group, and so on, but there are many similarities in approach. The term community itself has a variety of definitions, but in this work we are discussing communities as groups of people (youth, families, etc.) who are connected to each other though interests, affinities, or other means and exist together in a digital or virtual space.

Community members/partners/key individuals

In my learning from work in indigenous studies as well as engaging in discussions with peers, I have found that the term "stakeholders," while widely used and understood, has negative connotations to various populations. This term is associated with economic power and other colonial status markers (McGlinchey, 2022). As such, I am focusing on terminology such as *community members and key partners* to mean the groups and individuals most closely involved with the projects discusse*d*. The term stakeholders may still be mentioned when discussing literature or theory that specifically uses the term (such as VSD), and my use of other terms may be imperfect.

Marginalized groups/populations

This is not a definition specific to this work, but I include it here for those unfamiliar with the term. Over the years, language for discussing populations that have undergone historic oppression with long-term impacts has changed, so the term marginalized is now preferred over underserved, underrepresented, disadvantaged, and so on, though in some cases these terms are used interchangeably. Much recent work in HCI and other fields prefers this term, such as (Harrington, 2019).

Equality vs. equity vs. justice

The delineations between equality, equity, and justice are part of a much longer conversation that has been going on for years throughout academia and activist spaces, but when I discuss equity and justice in the ending process of community-partnered projects, I focus specifically on the power differentials and where the burdens or benefits are being allocated. Equality generally refers to resources (whatever form they take) being allocated equally to everyone, while equity

focuses on addressing allocating resources based on the needs of the groups (considering historical injustice and so on). Justice takes this a step further, focusing on changing and repairing the systems that created the inequities in the first place (Green, 2022). Some of the differences between *equality* of idea representation and *equitable* practices are also discussed via Yip et al. (2017) in Chapter 4.

1.7 What follows

For Chapter 2, I begin with a discussion of the bodies of literature I am drawing from and building on in this work – HCI perspectives such as Value Sensitive Design, Participatory Design, and so on; theories and methodologies from the learning sciences; and perspectives on communities and exiting the field from other disciplines such as indigenous and disability studies. In Chapter 3, I provide a summary of the two main research projects that I am focusing on for this dissertation.

To address the first research question (roles and relationships), in Chapter 4 I explain the power dynamics in the *Digital Badges* project between different key groups as well as the development of relationships between youth and adult facilitators in *KidsTeam* and the changes in adult dispositions over time in *Science Everywhere*. For the second research question (challenges in implementation), I discuss the opportunities and challenges that arose throughout the *Digital Badges* project during the development and implementation process, drawing on interviews with various community members and a reflective case study in Chapter 5. In Chapter 6 I address the third research question (needs for ending), conducting case studies of the *Science Everywhere* and *Digital Badges* projects using interviews and triangulation to develop an understanding of the needs of involved community groups in concluding projects. Chapter 7 introduces a framework for ending projects well based on the findings from Chapters 4-6 and Chapter 8 connects the threads and concludes the dissertation.

Chapter 2 Related Work

Through this chapter I highlight specific concepts and theories that support and align with the current work, as well as probe at some open interdisciplinary questions. As I began to delve into these research questions around ending, I found that I could not stay only within my main fields of HCI and the learning sciences but instead needed to take a more holistic view. Perspectives on designing with community partners vary across disciplines but align with a core set of values around equity, access, and justice.

The problems of building relationships, contending with limited resources, and ending projects are not limited to the fields of HCI and learning sciences in which I generally situate myself. Thus, when framing and exploring the space, I also draw on other areas that work with these "wicked problems" (Rittel & Webber, 1973). What follows are three main sections of related work: ***2.1*** focuses on perspectives from HCI and design such as Value-Sensitive Design and Participatory Design. It also touches on critical and feminist perspectives within HCI that highlight the role of values and diverse perspectives in design projects. In ***2.2***, I discuss sociocultural learning theories that underpin the proposed work, as well as the importance to my theoretical and methodological framing of Design-Based Research, Design-Based Implementation Research, and Research-Practice Partnerships. ***2.3*** examines key perspectives on community-based research from external fields.

Through discussions with a variety of scholars and explorations of the literature, I have found connecting threads from my research space and questions to areas such as anthropological fieldwork, indigenous studies, disability studies, feminist theoretical lenses, and public health research. Each of these areas brings key perspectives to my dissertation work, focusing on different aspects of the importance of careful and deliberate engagement and connection to community partners in research, and how scholars might avoid unintentional damage to marginalized populations.

2.1 Values and democratizing design in HCI

The following subsections discuss perspectives in HCI and design that provide theoretical grounding for my dissertation work, as well as precedent for much of the methodology and technique discussed in my research studies.

2.1.1 Participatory Design

My work focuses on the ethical and practical aspects of involving community members in not only the design process, but the meta-design of the project and implementation itself. Much of the perspective on the role of the design or community partner in this is grounded in my understanding of Participatory Design (PD). PD was developed as a methodological and theoretical perspective that strove to democratize design of new technologies and was originally closely connected to Scandinavian unions, as mentioned when discussing current union efforts

around AI in the introduction. Several core principles are built into the foundations of PD, including democratization, emancipation, and quality (Björgvinsson et al., 2010; Ehn, 2008; Floyd et al., 1989; Iversen et al., 2004; Iversen & Dindler, 2013).

As with any theoretical or methodological perspective in academia, over time the use of PD expanded and changed, and much debate exists over what truly *counts* as PD and whether it is truly democratic and equitable (and what counts as equitable is yet another discussion). After all, the designer or researcher still holds a great deal of authority in the process, so it may not be possible to truly remove power differentials. Particularly in the United States, many researchers and designers engage in what Friedman and Kahn Jr. refer to as "Pragmatic Participatory Design" which is when the methods and techniques of PD are used without regard for the key values (democratization, emancipation, and so on) that are considered central to the theoretical approach that underpins the methodology (Friedman & Kahn Jr, 2003).

In my work, I explore how researchers use PD to develop deeper relationships and democratize technology development, as well as looking at how it can be incorporated into a mutually satisfactory ending process, including on a level of the design of the design process itself. I examine the role of PD both as a theoretical perspective and as a methodology, and how we might further draw on its roots in democratization to increase equity in community-partnered projects. Thus far, much of PD has not focused on the development of longer-term partnerships, with a focus more on the methods and theoretical alignment, though it has often existed as a methodology *within* other projects that involve such relationships. In this dissertation, I explore how PD and long-term projects within communities can be further aligned both methodologically and theoretically, presenting a framework and theoretical approach that engages these concepts and extends them further into the realm of justice-oriented perspectives.

2.1.2 Participatory Design for learning with children and families

My work specifically engages with the complexity of PD and long-term collaboration with children and families, as well as the communities in which they reside, which contributes additional dimensions. Thus, it is essential to understand how youth and families engage with the ecosystems in which the whole situation exists. The role of children in the design of technology can be varied, but researchers and designers have explored ways to engage youth as design partners, drawing on their specific knowledge bases (Druin, 1999, 2002; Yip et al., 2017).

Drawing on the goals of PD as previously described, *cooperative inquiry*, as Druin calls it, seeks to promote agency and democracy of the design group, scaffolding child input and using activity structures that provide an equitable design experience (Bonsignore et al., 2013; DiSalvo et al., 2017; Fails et al., 2013; Guha et al., 2013). This perspective is key to my dissertation work, as it emphasizes youth involvement and equitable experiences. Additionally, the projects that I examine in this dissertation use this perspective and methodology as a key aspect of their work. While there are a variety of other perspectives on children's involvement in design, focusing on

larger groups of children or including them in more limited roles, the nature of *cooperative inquiry* and the relationships developed are core to the concept of ending that I discuss throughout this dissertation.

Scholars have also engaged in work exploring the power dynamics of adults as authority figures and considering how best to support children in co-design, relevant to my first research question. This work finds that while children and teens understand existing power structures, it is possible to reduce power distance through rapport building, and that youth generally perceived their participation in design work favorably (McNally et al., 2016; Morrow & Richards, 1996; Pitt & Davis, 2017; Thomas & O'Kane, 1998). Beyond designing with children, there is also increasing interest in designing with family units and communities, from designing sociotechnical science sharing tools with youth and their parents (Yip et al., 2016) to co-designing robotics programs with indigenous families (Tzou et al., 2020). Researchers at the intersection of learning sciences and HCI are exploring how PD can be used in more complex community environments.

My work extends these ideas by exploring how PD for learning with children and families can be viewed as a method for decreasing power distance between families, communities, and researchers, as well as empowering community members to take ownership of designed technologies. This understanding of the dynamics and how communities take ownership of design work is also essential for designing projects that end well, as that sense of belonging can be a contributing factor to the success of a mutually beneficial ending process.

2.1.3 Value Sensitive Design

My work focuses on the role of differing perspectives, values, and dynamics in the project implementation and conclusion process. This theoretical positioning is strongly influenced by Value Sensitive Design (VSD). VSD is a technology design perspective that focuses heavily on stakeholders[1] and their values, stressing reflective and connective processes throughout the design lifecycle (Friedman & Hendry, 2019). I use the concept of *value tensions* when discussing the power dynamics and conflicts between stakeholder groups. Value tensions, as part of VSD, are a way of thinking about the fundamental values that the various stakeholder groups bring to the table when designing (Czeskis et al., 2010; Friedman & Hendry, 2019; Nathan et al., 2007).

Due to the complexity of stakeholder groups and values within projects that involve children and their families, community leaders, and researchers or designers, value tensions are key to understanding project ecosystems (Czeskis et al., 2010; Flanagan et al., 2005). My work also uses the concept of *reflection-on-action* – a reflective look back on decisions and activities – which is closely aligned with VSD, to better understand project conclusion processes (Schön, 1987). These reflective practices are also incorporated into the framework I present in Chapter 7.

[1] VSD specifically uses the term stakeholders, hence use of the term in this section.

I bring VSD and value tensions to the level of the project development and design, considering how values are built into the framework of a design research project and how tensions exist throughout the lifecycle, but may come to a boiling point when the project concludes. In terms of my goals and intended impacts through this research, VSD also touches on themes of justice and equity as core values in design, specifically viewing them as key themes in stakeholder analysis and other phases of the VSD process. I am also interested in how VSD dovetails and conflicts with other disciplines, as the VSD process can feel drawn-out and ponderous, which may not work well in all contexts. Balancing reflexivity with feasibility in ending is crucial to my contributions in this work.

Additionally, the tripartite methodology of VSD has been influential on the design of my studies as well as the initial framework for ending that I present at the end of this dissertation. This methodology brings together theoretical, empirical and technical investigations, beginning with theoretical explorations such as stakeholder analysis, moving to empirical methods like observations, and then going to technical investigations such as implementations of designed technologies (Friedman & Hendry, 2019). The tripartite methodology can also be recursive and cyclical as new information is brought in or new discoveries are made (Friedman & Hendry, 2019). This reflective approach was instrumental in my development of the study discussed in Chapter 6, as well as forming some of the foundation of my theoretical and methodological contributions through the framework in Chapter 7.

2.1.4 Critical Perspectives in HCI

Building on the concepts of justice and equity, feminist and critical perspectives in HCI bring a much-needed critical lens to counter the aforementioned paternalistic technosolutionism – essentially the idea that the researchers and designers (often privileged Westerners) bring marginalized groups technology that can solve their complex problems – that can be prevalent in tech-focused spaces such as HCI. Through my previous and current work, I explore how the tension between communities and researchers manifests in power dynamics and relationship ecosystems. I use framing from critical HCI and design that specifically focuses on revealing the issues with the status quo and power dynamics that feature in existing systems and technologies (Dourish et al., 2004; Iivari & Kuutti, 2018). Part of this is asking the difficult questions and being willing to sit with the cognitive dissonance that may result, working to resolve it.

Relatedly, feminist perspectives strive towards more inclusion of feminist values such as agency, equity, and empowerment in HCI research, as well as tapping into some of those more critical elements (Bardzell, 2010; Bardzell & Bardzell, 2011; Fiesler et al., 2016; Rosner et al., 2020). More recently, there has been significant discussion in the space of eco-feminism and more-than-human design, thinking about our place in the broader ecosystems of the world (Kannabiran & Søndergaard, 2023; Søndergaard et al., 2022).

These critical and feminist perspectives overlap in some ways with the values discussed in VSD and PD, but they have turned my attention to the structures of research itself, driving me to develop my proposed framework to facilitate better ending of projects with a justice-oriented perspective. I believe that these theoretical perspectives can help researchers better understand project ecosystems by engaging in deep discussions with community members and maintaining awareness of inherent ecosystem tensions. While in some ways the critical and feminist perspectives may clash with the inherent pragmatism in my ways of thinking, I believe that those tensions push my understanding and challenge my work in important ways, that the push and pull of value tensions, of ideals versus feasibility, is key to working towards a more just research ecosystem.

2.2 Research and partnerships in the learning sciences

My prior and current work also builds on concepts from the learning sciences, both in terms of a socioculturally-focused theoretical lens (Bruner, 1997; Lave & Wenger, 1991; Rogoff, 1994; Vygotsky, 1978) but also in relation to the strong body of work regarding working with schools and communities on improving education, systems, and infrastructure (Penuel, 2019). In this subsection, I will summarize the role of the sociocultural/constructivist lens in this dissertation, followed by a discussion of how DBIR and related concepts surrounding long-term projects and infrastructuring in particular relate to my understanding of my dissertation work.

2.2.1 Learning theories involved in the current work

My work is situated in informal learning design projects that draw on socio-cultural and socio-constructivist theorizing, but I also incorporate these learning concepts on a meta level in my work (Atwater, 1996; Bruner, 1977; DiSalvo et al., 2017). Both of the cases feature projects that examine how technology can be used to support learning in specific contextual communities. Prior work from colleagues (A. Bell & Davis, 2016) discusses how learning also takes place in the design process and throughout the design ecosystem. Understanding learning in these communities and throughout the ecosystem, as discussed by scholars such as Rogoff (1994) and Bronfenbrenner (1977), can help us better understand how knowledge is constructed mutually with and within the community-based projects, particularly involving youth, and thus how to better support understanding between key groups (Bronfenbrenner, 1977; Bruner, 1997; Hourcade, 2008; Lave & Wenger, 1991; Rogoff, 1994; Vygotsky, 1978; Wertsch, 1988).

Additionally, through my case study interviews I draw on *funds of knowledge* - the embedded sociocultural knowledges in everyday activities of families and communities - from the various groups of community members involved in the cases (Moll et al., 1992). Finally, from Rogoff's (1994) communities of learners – the idea that people learn together as groups or communities, inherently social – and Gee's affinity groups and spaces – clubs, gatherings, or other ways of connecting based around shared interests (Gee, 2000), I also draw and define my perspective on the term community. I broadly use community to mean a group of people who come and engage together in a space (physical or virtual) with shared goals, interests, and attitudes, whether that be

families in a neighborhood, youth at a science center, or online fan clubs (as discussed in the Chapter 1 Definitions section).

2.2.2 Design and implementation approaches from the learning sciences

In order to better understand how long-term educational projects were implemented in communities, I explored concepts such as Design-Based Research (DBR), Design-Based Implementation Research (DBIR), and Research-Practice Partnerships (RPP), among others (Anderson & Shattuck, 2012; Bang & Vossoughi, 2016; Barab & Squire, 2004; P. Bell, 2004; Hoadley, 2004; Penuel et al., 2011). From DBIR and RPP, I found a specific focus on infrastructuring, sustainability, and the development of longer-term relationships between the researchers and, generally, a school or school system or other educational body (Crowley, 2019; Fishman et al., 2013; Penuel, 2019; Sabelli & Dede, 2013), which is highly relevant to the work at hand.

Penuel et al. (2020) also place a strong emphasis on infrastructuring – the development of institutional knowledge, resources, and so on to support a long-term project – in their comparison of several different approaches to collaborative education research with key community members. Highly applicable to my dissertation, researchers developed several guiding principles for this type of work, focusing on practical aspects of challenging research collaborations (Penuel et al., 2020). Penuel and other RPP scholars focus on developing strong relationships, resilient infrastructure, and sustainable funding in order to maintain these projects and promote equitable practices within and around them.

While these guidelines and principles from the learning sciences aid in my understanding of the lifecycle of creating and sustaining community partnerships, they still provide little guidance on *ending* such partnerships. In fact, Penuel and Gallagher (2017) state that the goal of many research-practice partnerships (RPPs) is for them to continue as long as possible, despite that not being practical for many researchers (though the authors do note that this is an issue that needs addressing (Penuel & Gallagher, 2017)).

Relevant to my focus on the conclusion of projects, and one of the only studies I have found directly confronting this issue, Fishman et al. (2011) document what happened after a new technology-supported math curriculum was implemented in a school district. After there was no longer active professional development support for the new intervention, adoption dropped off and the researchers found close to half of the teachers no longer used it (Fishman et al., 2011). Though my research focuses specifically on community-partnered projects rather than school interventions, the findings from this study provide essential motivation for my current work. Overall, RPPs and DBIR – and their project scoping – also help me develop a scope for what I view as *long-term* or at least *longer-term projects*. For my work specifically, given the factors at hand, I define long-term as lasting more than two years.

2.3 Creating equitable research practices through diverse perspectives

While discussions of the exact phenomenon I explore in the current work – ending a technology (design, development, implementation)-focused project in a community – are scoped to HCI and the learning sciences, the more general issues of how best to leave a project and how to work ethically with a community (which might be a neighborhood, tribe, cultural group, affinity group, etc.) are studied in a variety of disciplines that are relevant to the current work. Research, particularly research derived from the Western scholarly tradition, has a history of paternalistic and colonial actions, influenced by the values of the originators that become ingrained in the process (Kouritzin & Nakagawa, 2018; Whetung & Wakefield, 2018). By examining how other disciplines are working to decolonize and ameliorate the harms of previous research procedures and attitudes, I can help shift perspectives and methodologies toward a more equitable and just approach to community projects in HCI and the learning sciences.

2.3.1 Anthropology

While anthropology has its own problematic history of *othering* – treating groups that are unfamiliar or different as less-than – marginalized groups, contemporary ethnographic research in anthropology does provide a strong precedent for the process of exiting or leaving the field of study (Girke, 2021; Michailova et al., 2014, 2014; Suchman, 2011; Van Maanen, 2020). Additionally, scholars such as Ruth Behar make the case for "humanistic anthropology," where researchers are more personally engaged in the research, instead of maintaining the objective distance that some perspectives call for, allowing a deeper connection to the community (Behar, 1996). Behar (1996) connects strongly to her work and calls for ethnographers and others to make themselves vulnerable.

As my current work focuses on understanding the relationships between key groups throughout the project process, these types of work in anthropology are particularly salient. In terms of more recent technological work specifically, scholars have discussed leaving the field both in the digital sense rather than the physical (Girke, 2021), and in turning technology over to the community (Taylor et al., 2013). Taylor et al. (2013) is particularly well-aligned with the current work and in fact intersects HCI, as the authors discuss the impacts of leaving a prototype with a community, though in a different setting than my work. Understanding this established process of exiting allows me to better construct my case studies and overall understanding of the conclusion process. Arturo Escobar, another anthropological scholar, puts forth a number of ideas surrounding pushing back against the Eurocentrism of modern design practices and instead making space for more place-based design that is specific to the pluriversal world in which it exists (Escobar, 2018). This pluriversal perspective is one that while I do not fully align with but does push my thinking to consider the ways in which communities may engage with design.

2.3.2 Public Health

Public health has a history of long-term engagement with communities, implementing health initiatives in underserved areas, often very similarly to how informal education research in

communities – such as the focal projects of this work – is conducted, though for different purposes. Much like the themes discussed previously in the fields of HCI and learning sciences, public health researchers explore infrastructure (Pothukuchi, 2005), sustainability (Shediac-Rizkallah & Bone, 1998), ethics (Shore et al., 2008), and trust (Christopher et al., 2008) in community-based research partnerships.

As this area of research has experience in dealing with families and sensitive topics such as health concerns, this literature is ideal for developing my understanding of the complex value tensions that exists in communities, as well as practical discussions of how to address these issues. The discussions of ethics and the inherent complexity of gaining trust in marginalized communities is key to developing the framework for ending projects, as well as creating a more justice-oriented research ecosystem in technology-oriented fields.

2.3.3 Disability Studies

Disability research and activism also provides an important perspective and framing for the current work. Oliver (1992), a professor of disability studies, discusses the evolution of disability research from being viewed through a positivist lens, where disabilities are an individual problem to be "solved," to viewing disability as more of a social or even a political issue. Drawing on feminist theory and describing "emancipatory" research, he calls for researchers to join the side of the disabled people and help them, rather than use expertise in an oppressive and alienating manner (Oliver, 1992). The concept of working with the community to address their needs rather than impose beliefs on them is key to my work. Additionally, Northway (2000), specifically addresses the possible negative impacts of ending participatory research with learning-disabled individuals, mentioning the loneliness and loss of social networks that can result, particularly salient to my focus on projects concluding (Northway, 2000). Other researchers have explored how current institutional requirements such as funding models and IRBs can actually have a negative impact on developing relationships with the disability community, as the language and structures may have negative connotations (Gustafson & Brunger, 2014).

Intersecting with HCI, Bennett's work focuses on negotiating disability and accessibility in design research, recently exploring intersections between disability and other marginalized identities (Bennett et al., 2019, 2021; Bennett & Rosner, 2019). There have been efforts to expand child participation in design work, looking at those with disabilities and special needs (Benton & Johnson, 2015). Other researchers have explored intersectional identities in design research, specifically looking at gender and disability in PD with children (Brulé & Spiel, 2019). All this work connects to the values and community connected foci that I have been exploring throughout this dissertation, particularly the intersectional issues faced when implementing technologies in communities that may not have the resources to sustain them. Disability activism has a rich history that contains many hard-fought battles for rights and justice, so the work that exists here is key to developing better research ecosystems.

2.3.4 Indigenous studies

Research in indigenous communities has a troubled and extractive past, but more recent efforts to actively include communities in research has brought about important findings about indigenous ways of knowing and a better understanding of how to interact with underserved communities. Scholars have explored the development of research ethics guidelines with these communities in Canada and Australia (Ball & Janyst, 2008; Dunbar & Scrimgeour, 2006), among others, in some cases even developing the research ethics guidelines with the participating community as a form of mutual respect and partnership (Macaulay et al., 1998).

More recently, Castleden et al. (2010) investigated perspectives on including indigenous communities as co-authors on research publications. The authors contemplate whether anonymization policies are always equitable given research partnerships with communities (Castleden et al., 2010). These perspectives on ethics and partnerships provide me with a better understanding of how to contemplate the role of communities in research and how researchers need to consider the community when closing projects. The focus on participatory ethics is important for developing any guidelines surrounding community work. It is important to note, however, that much of the work that is done to build infrastructure and rapport in indigenous (as well as disabled and other communities) may not be documented in the academic canon, as much of this "invisible work" is not seen as academically relevant (Jurow et al., 2016). As discussed in previous sections, communities that have negative experiences may not welcome researchers into their efforts towards systemic and community change.

Throughout this chapter, I have discussed a variety of perspectives on working with community members for long term research, focusing on participatory ethics and endings. From these scholars I have come to understand the complexity of community relationships more fully, as well as the challenges faced in building community projects. In sum, this work represents a great deal of thought and careful work from a wide variety of academics but may not fully represent the struggles and behind-the-scenes work of the communities and partners. Additionally, while these scholars touch on ideas such as exiting the field and long-term impacts, there is little published work on best practices for ending these community-partnered projects. How can we build on the current knowledge base to develop a more just research ecosystem that creates community-partnered research that ends well?

Chapter 3 Focal Projects

This chapter provides a summary of the two main projects covered in this dissertation, though other research is also mentioned. These two projects were selected because of access to and familiarity with the data, as I have been part of the research team on both for five years (2015-2020) and they focused on participatory design of informal learning technologies with youth and their communities, providing a good basis for comparison over the duration. The projects covered are Digital Badges for STEM Education (Digital Badges or DB for short) and Science Everywhere (SE). In Chapter 6, I will dive into direct comparisons and analysis via cross-case comparison. I detail exact research procedures related to the research questions in their respective chapters. Each project also has several related publications, many of which are cited and discussed in this manuscript, as well as listed in Appendix C.

3.1 Digital Badges for STEM Education

Digital Badges for STEM Education was a National Science Foundation (NSF) Faculty Early Career Development Program (CAREER) funded project, partnered with a science center in the Pacific Northwest and largely conducted on-site at the center. The initial ideation for this project began in 2012-2013, as the MacArthur Foundation, Mozilla, others were driving conversations and funding initiatives around the idea of digital credentialing (Muilenburg & Berge, 2016; Riconscente et al., 2013). Digital badges are a form of digital credentials that can resemble video game achievements or other types of achievement badges, but represent learning accomplishments or certifications (Muilenburg & Berge, 2016).

In 2014, the Principal Investigator for the project, Katie Davis, conducted pilot work at the science center with university students as a capstone project for the students' program (K. Davis & Klein, 2015). In 2015, Davis' CAREER award funded, focused on a longer-term digital badge implementation research and design project. By the summer of 2015, the research team embarked on a multi-year participatory design (PD) project with a local science center, working with youth from the center's science interpretation program to develop a badge system based on the science interpretation program's structure. The logic model for the project describing the types of research and design activities can be seen in Figure 1.

Youth in the center's science interpretation program were high school students from diverse schools and backgrounds. Between 60 and 70 students were enrolled in the program at one time, with cohorts of 10-15 starting once or twice a year, depending on demand. The cohorts of youth moved through a curriculum that was clearly organized into learning pathways, and thus was well suited to being documented with digital badges. Youth involved in the program were also paid employees of the science center, once they had completed initial training, allowing more equitable involvement, as youth who otherwise might need to find other jobs to support their families were able to remain in the program.

The research project was organized as a partnership intended to design, develop, implement, observe, and evaluate a digital badge system that facilitated the science center's daily youth program functions. This system was intended to represent the learning pathways of the program and recognize the accomplishments of participating high school students, focusing on moving the program's learning pathways to a digital format and promoting students' agency and ownership of their learning and achievements. The research team hoped to gain insight into how digital badges could be used in different educational and career-related contexts and whether such a system would be sustainable beyond the duration of the grant. Over the course of the project, the research team examined the design, development, and implementation of a badging system, from inception to widespread use. The team released several publications and presentations related to the research, some of which are discussed throughout this dissertation, see (Pitt, Bell, Strickman, et al., 2018; Pitt et al., 2019; Pitt & Davis, 2017) and others.

Towards the end of 2019, the research team had developed and planned for a training and handoff process (Pitt, Bell, & Davis, 2018), which I will discuss in Chapters 5 and 6. Youth in the program were being trained in onboarding and educating their peers on the system, and the science center staff were working to allocate funding to maintain the technical aspects of the badge system. During the process of establishing maintenance contracts between the science center and the badge system service provider, as well as other aspects of the conclusion of the project, COVID-19 struck.

Unfortunately, the pandemic caused the science center to close for a time starting in early 2020, and the youth science interpretation was first moved online and then suspended operations by the summer of 2020. Many of the science center staff were let go and found positions elsewhere. The project was in a suspended state for approximately a year before it became apparent that the science interpretation program had been suspended indefinitely. During this time, some members of the research team also pivoted to other projects that could continue during pandemic restrictions (Pitt, Hock, et al., 2021). The science center did eventually re-open, but with the science interpretation program still suspended, the badge system was not a priority for the remaining staff and the system maintenance contract has lapsed.

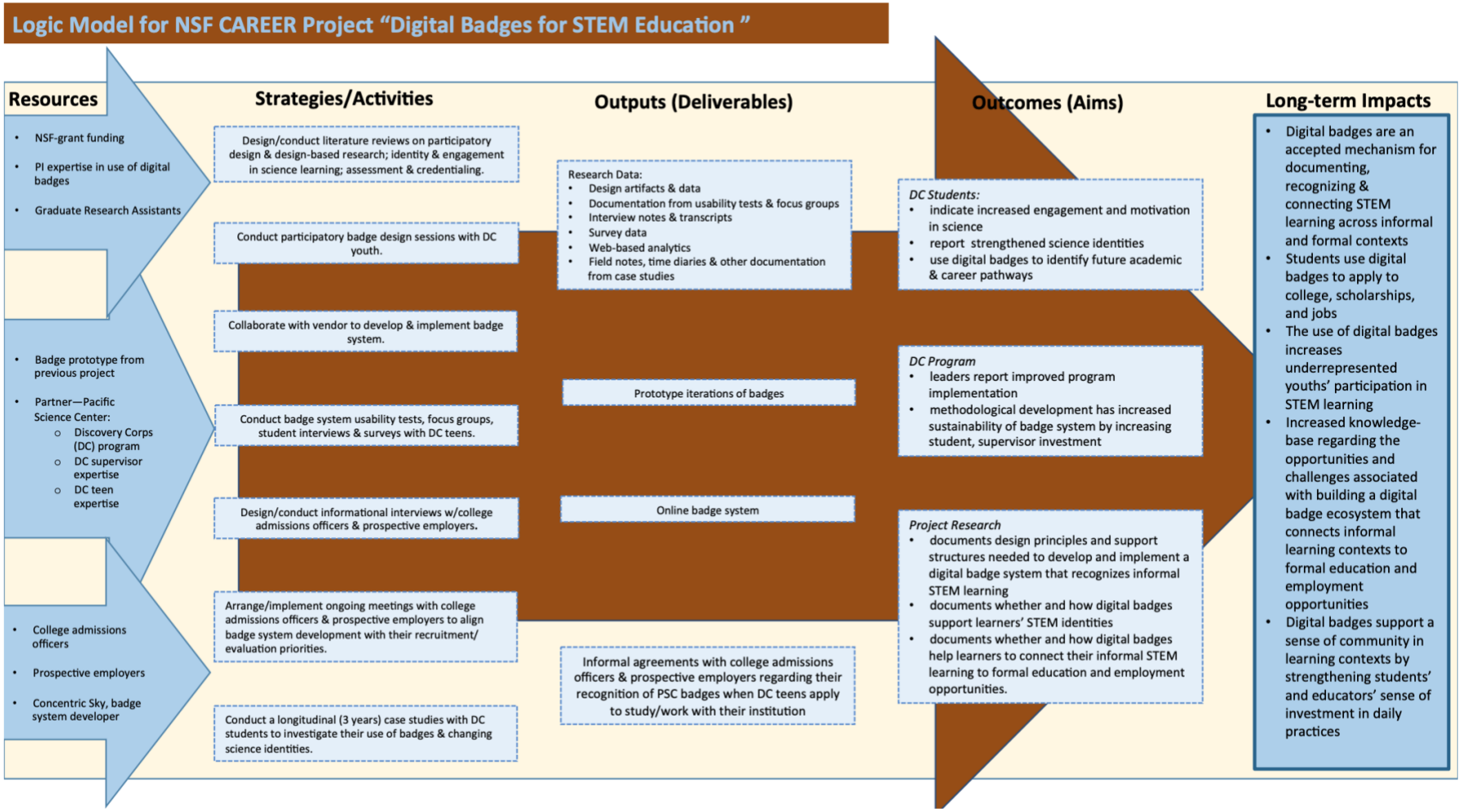

Figure 1 - Logic model for the Digital Badges for STEM Education Project

3.2 Science Everywhere

Science Everywhere (SE) was an NSF-funded project, under the Cyberlearning, Advancing Informal STEM Learning, and Discovery Research K-12 program umbrellas. Initial ideation for what would become the larger SE project began in 2011, with researchers considering the role of social media and mobile technologies in children's science learning and identity, focusing on the social and community aspects of the learning process and how to promote science dispositions in informal settings. At the time, the research group was based at the University of Maryland, developing the grant proposal based on previous work with tools and programs such as SINQ (Scientific INQuiry learning using social media), StoryKit (which led to ScienceKit) and Kitchen Chemistry (Ahn et al., 2012; Bonsignore et al., 2014; Clegg & Kolodner, 2014). Eventually, Tamara Clegg, June Ahn, and Jason Yip received NSF funding for the ScienceKit for Science Everywhere project.

The SE sites were centered in a church community group in Maryland (with additional work in local middle schools) and a public middle school in the Seattle area. The sites were chosen based on relative proximity to the home universities for accessibility, the presence of significant marginalized populations (specifically Title I schools and low-income families), and the community or school's willingness to work with the research team. The three PIs oversaw the project and directed various graduate and undergraduate research assistants over the course of research activities. Clegg was located at the Maryland site and Yip in Seattle, with Ahn taking a more advisory role after moving to a new university.

The project combined the design, development, and implementation of a sociotechnical system involving mobile devices and large touchscreens with science learning opportunities in largely informal settings. Youth and their families were provided with opportunities to engage in science activities in the evening and after school. Early in the project, starting around 2011, design work was focused on the development of the sociotechnical system (Ahn et al., 2012; Bonsignore et al., 2014), focusing on how youth could use mobile technologies to share and explore science experiences and questions in their everyday lives, referred to as *scientizing* practices (Clegg & Kolodner, 2014). The designed web application was an interface that allowed users to make posts like those on other social media platforms, posting text or photos and responding to prompts designed to scaffold scientific noticing and dispositions. Features such as commenting and liking were included, as were "fist-bumps" recommended by youth designers. The application was restricted only to those involved in the program, such as family members, youth, teachers, and researchers. This helped ensure the safety and privacy of the youth involved and helped get schools and parents on board with the project.

Once the sociotechnical system was established in the partner communities, the research team and the participating families co-designed large tangible public displays in order to create a higher-visibility way of sharing and interacting with the science-related posts in the community

(Ahn et al., 2018). During the 2014-2016 period, researchers conducted design sessions and testing of the large displays, incorporating their use into the school library and classrooms in the Seattle area and both the church and school at the Maryland site (Clegg et al., 2023). Communities were encouraged to engage with the large displays by scrolling through posts and awarding badges focused on the scientizing mindset.

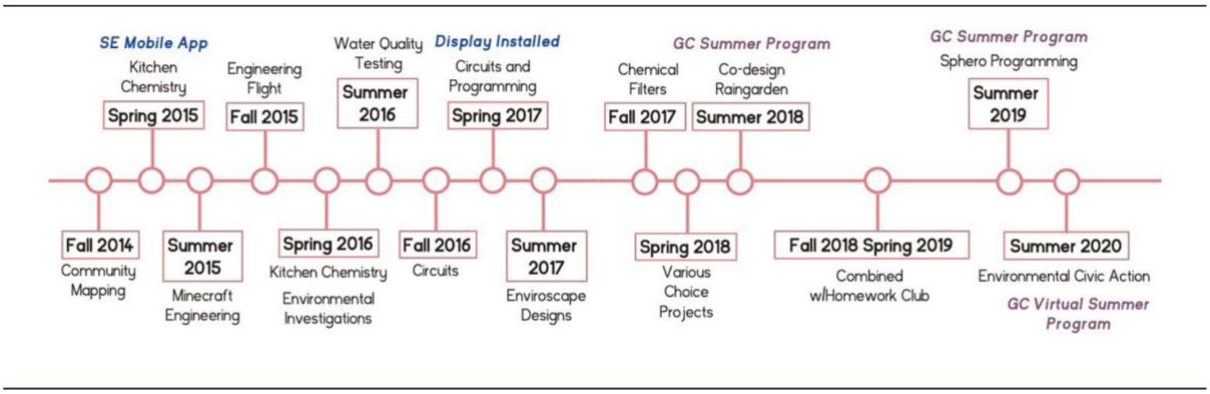

Figure 2 - From Clegg et al. 2023 "The learning sequences each semester in the SE afterschool program [Maryland site], with markers for when the SE mobile app and community display were implemented."

Once the design processes for the technological components of the system had largely concluded, the research team moved to focus more on the implementation and adoption of the technology into more events and programming. The Maryland site extended their implementations to additional school settings, while the Seattle area site continued to conduct monthly family science nights (FSN) at the partnered middle school, with additional proposals and input from teachers and families. Details of the types of after school programming at the Maryland site can be seen in Figure 2 (GC refers to the pseudonym of the church). The researchers also explored the longer-term impacts that SE had on adult science dispositions, which I will discuss in more detail in Chapter 4 (Clegg et al., 2023).

Both sites had community leadership figures who were key to the implementation of the program and faced issues with teacher turnover and youth aging out of the activities or graduating. The SE project was in the process of concluding, including making decisions regarding handing off programming and how to handle the technology that was on loan to the communities, when the COVID-19 pandemic forced many schools and sites to shut down, requiring significant changes to the wrap-up process. The Seattle area site had to suspend activities immediately, while the Maryland site was able to continue some programs virtually, as seen in Figure 2. Note that this dissertation will mostly focus on the Seattle site, as this is where I was embedded.

Now, having introduced our focal projects and how they proceeded (and ended), we move to the first set of studies pertinent to the research questions.

Chapter 4 Relationships, Roles, and Dynamics

To understand how to end community-partnered projects well, we must understand what exactly is *happening* in the project, not just in terms of research procedures, but holistically and ecologically. Each group and demographic will bring their own ideas, concerns, motivations, and areas of expertise. There are also a variety of external and societal factors that may impact how groups of participants and partners interact with each other and the researchers (Bronfenbrenner, 1977). Everyone will experience the project, technologies, and information differently. New technologies and other forms of community interventions will succeed or fail not only on technical functionality but also sociotechnical and sociocultural merits (which will be discussed further in Chapter 5), so it is essential for the research team to understand the complexity of the community and the individuals involved.

To that end, this chapter focuses on studies that help answer the following research question:

> What factors in the project ecosystem affect the development of *relationships* and *roles* in and amongst community groups? How do these relationships change over time?

These studies particularly focus on the *roles and relationships* within co-design projects, providing groundwork for the following chapters and the framework detailed in Chapter 7.

4.1 Designing together?[2]

This study focuses on the first non-pilot year of the digital badge project described in Chapter 3, taking place based on data and interviews from the 2015-2016 period. Using a reflective case study of digital badge design, we examined complex PD work involving several clearly delineated groups, each with their own vocabulary, area of expertise, and position in a perceived project structure hierarchy. To better understand the roles and relationships among participants, we used participant interviews that reflect on the design process, triangulated with video, field notes, and design artifacts. From this data, we determined that the adolescent participants, science center staff, researchers, and industry professionals viewed the design process through distinct lenses based on their *communities of practice* (Lave & Wenger, 1991), which affected how they perceived the project.

4.1.1 Introduction

For this work, we conducted a case study employing Stake's (1995) emergent case study perspective alongside Schön's *reflection-on-action* (1987) within the context of a larger digital badges design and implementation project in order to better understand the dynamics involved in a technology design project with youth as co-designers. Schön and Stake both bring a

[2] Originally published as Pitt & Davis (2017).

particularly reflective focus, though Stake looks more broadly at case studies while Schön focuses on design practice in the creative professions (Schön, 1987; Stake, 1995). I was particularly interested in understanding the perspectives of youth co-designers within the context of the larger project, particularly their understanding of authority and power dynamics, since one of the key goals of PD is democratization of the design and implementation process (Björgvinsson et al., 2010).

The approach of PD, as discussed in Chapter 2, attempts to address power imbalances inherent in the typical design process, allowing the users of the technology to have agency in its development (Björgvinsson et al., 2010; Iversen & Smith, 2012). In more recent years, the principles of PD have been extended to younger groups, involving children in the design of technologies (Druin, 1999, 2002; Guha et al., 2013). The addition of youth changes the power dynamics at hand, as the relationship between children and adults introduces another level of complexity, considering the researcher already holds a position of power in any research or design project (McNally et al., 2016). The principles of cooperative inquiry and PD with children focus on reducing the power distance and creating a certain level of equality and collaboration between the adults and youth, but this can be difficult to achieve, as I will discuss further when I dive into (Yip et al., 2017) later in this chapter.

Additionally, teenagers come with their own set of challenges in design and research work, as their developmental stage (from an Eriksonian perspective) is all about figuring out who they are and testing the boundaries of the status quo (Bassett et al., 2008; K. Davis & Weinstein, 2017; Hansen & Iversen, 2013). Teens also are more acutely aware of social norms and dynamics, making them less likely to speak up or feel like their ideas are considered important to the project (Hansen & Iversen, 2013). Not only were the teenage perspectives of great interest here, but this project also brought together academic and industry perspectives on technology design, which resulted in some friction at times, inspiring me to try to determine what exactly was causing the miscommunications and misunderstandings.

So, I wanted to know: How did youth conceptualize their participation? Who did they believe was in charge of the project? And how did the other groups in the project see the badge system and surrounding project infrastructure overall?

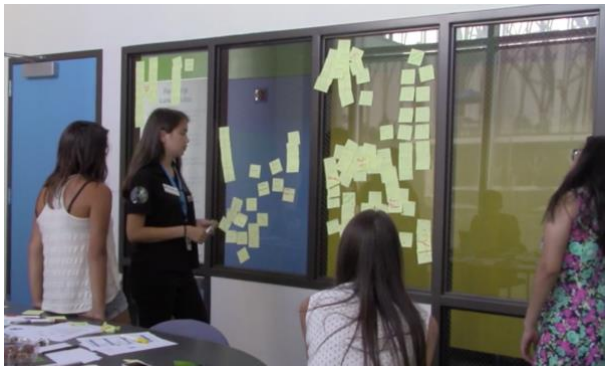

Figure 3 - Youth participants of the digital badge design team organize brainstormed stickies about their science learning into overarching themes in the first design session.

To address these questions, we conducted in-depth interviews with the different groups involved (youth, science center staff, researchers, badge system developers), reflecting on their involvement and triangulating their thoughts with other data such as video and field notes from the digital badge system design sessions and other meetings for the project. We found that though the participants viewed the PD process as enjoyable and beneficial to themselves and the broader program, there were distinct imbalances in power and expertise among the different groups. The teens were acutely aware of the fact that the adults in the project had more knowledge in some areas of domain expertise. Additionally, while the groups were well aligned in terms of goals for the project outcomes, their understanding of the underlying motivations as well as their personal drive to participate varied considerably.

4.1.2 Method

To create a complete picture of the dynamics within the design project as described in Chapter 3, I interviewed not only youth designers (4), but also their science center supervisors (3), my fellow researchers (3), and one of the developers on the technical side of the badge system (1). Interviews were conducted via phone or videoconference and recorded digitally. The interviews were structured to elicit participants' reflections on their role and participation, their views of design, and their interactions with other group members. In total, I had 11 participants, and the data was triangulated with additional materials from design sessions and other research activities, such as analytical memos and video clips.

The interviews covered nine monthly design sessions that occurred during year one (2015-2016) of the project, starting with brainstorming and moving on to more detailed badge development, as well as weekly meetings with the supervisors and the badge developers to discuss progress on the badge system. We interviewed most of the main participants in the design process during this period, listed in Table 1.

Table 1 - From Pitt & Davis (2017) "Pseudonyms, roles, and genders of participants, superscripts: T = teen, R = researcher, P = program staff, D = developer"[3]

Pseudonym	*Role*	*Gender*
Claire^{T}	Teen designer still in program	Female
Naomi^{T}	Teen designer now in college	Female
Felicia^{T}	Teen designer now in college	Female
Lily^{T}	Teen designer now in college	Female
Sandra^{P}	Program coordinator	Female
Tom^{P}	Program supervisor	Male
Becca^{P}	Program supervisor	Female
Anya^{R}	Principal Investigator	Female
Matt^{R}	Research Assistant	Male
Julie^{R}	Research Assistant	Female
George^{D}	Badge system developer	Male

Procedure

I developed the interview protocol, and the project PI then edited it. I conducted the interviews in person or by phone during the late summer and early fall of 2016, based on participant preference. Interviews lasted from 45 minutes to an hour. I asked participants to reflect on project meetings and design sessions, the power dynamics they perceived, and how their perceptions of the project structure and roles changed over time. I also invited the participants to reflect on the challenges and points of conflict or confusion that arose during the year, as well as positive moments and experiences they felt were beneficial.

We triangulated interview data using previously collected data from meetings and design sessions. Design sessions were videotaped and documented using analytical memos written from field notes after each session (A. Bell & Davis, 2016). While video and sound recordings were not taken during other meetings – such as weekly project updates or check-ins with the badge system developer – agendas, notes, and emails were used to verify events and timelines from the interviews.

Analysis

I used an emergent coding process for analyzing the interviews, with relevant triangulation materials (Merriam, 2009; Stake, 1995). Themes that emerged during the interview process were checked against each subsequent interview revisiting whether or not they were reinforced across participants, essentially a form of continuous *reflection-on-action* and member checking (Schön, 1987). In order to triangulate the data, the analytical memos from the design sessions were reviewed, as were any relevant video clips from the design sessions (Merriam, 2009). We then

[3] Roles are at the time of the study. Additionally "Tom", "Becca", "Anya", and "Matt" were also interviewed for the study discussed in Chapter 6, though with different pseudonyms. The pseudonyms in this section are taken from Pitt & Davis (2017).

coded for major themes using an open coding approach (Corbin & Strauss, 2015). I reviewed the interviews and developed a list of possible themes for initial coding, then re-examined the interviews and further refined the thematic analysis. I then discussed initial findings and emerging themes with the second author and an external researcher to check the reasonableness of the initial conclusions.

4.1.3 Results

Through this study, I found that the youth were extremely cognizant of the power dynamics present in the design sessions. They viewed the researchers as a bridge between the science center and the technical backend of the badge system. They felt that while their views were considered they were not sure if they were equal partners in the process. When asked to describe or draw a diagram of what the youth perceived as the project ecosystem, most put the PI at the top of whatever hierarchy that they depicted, an example of which can be seen in Figure 4. Meanwhile, the badge developer viewed the system as more of a client relationship, while the researchers and supervisors were striving to allow the youth to provide as much input as possible.

Participants discussed how the *perceived power structure* of the project as they understood it affected their *agency and identity as co-designers*. We also noticed differences in the *vocabulary and practice* of the different communities and how it affected the interactions. This interconnected system of involved groups provided opportunities for *learning through participation*, where each group was able to learn from and teach the others.

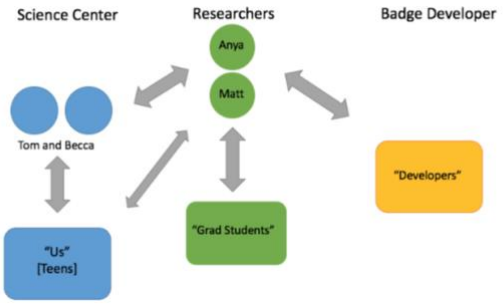

Figure 4 - Hierarchy from Pitt & Davis (2017) "Felicia's (teen) description of the badge project team hierarchy"

Perceived Power Structure

Participants were asked to visualize the power hierarchy and project structure to better understand how each of them viewed the multiple groups involved in the project. Most participants stated that the researchers were the connective bridge between the science center and the badge developers. They also mentioned that the researchers were at the top of the hierarchy, if they were to describe someone as being in charge. Some of the teen designers placed their supervisors above them, or even placed the supervisors in relation to each other (one served in a

supervisory capacity over the others), while others considered them to be on a more equal level in this *particular context* of PD.

Felicia[T] described the following in her answer to this question, see Figure 4:

> *"I guess [Anya[R]] and [Matt[R]] would be the central and then they would flow out to [Tom[P]] and [Becca[P]] as a source of information who referenced them to the [teen] group that was us. And then they took that information and went to the developers…"*

Both researchers and staff mentioned that they held back their input in the design sessions and stressed the ideas of the student designers. As Felicia[T] put it "[Tom[P]] kinda tends to stay out of things like that, so there was no problem there. [Matt[R]] was fairly quiet. [Anya[R]] mostly just asked questions to clarify things…" The badge developer was not directly involved in the PD sessions but expressed that he generally viewed the relationship of the development team with the project overall as an attempt to meet the client's needs, not as a collaborative partnership.

Agency and Identity as Co-Designers

Every teen had a unique perspective on their co-designer role. Claire[T] described her role within the project as "it would be more to narrow down ideas and like a sounding board." A more senior student, Naomi[T], stated that "we really worked with [the researchers] to develop [the badge system], and I feel that it was mostly our group that came up with the ideas." Felicia[T] mentioned that she felt somewhat detached from the more technical backend of the system and would have liked to meet with the system development team.

The teens felt that they were central to the design process, but the science center staff tended to stay more on the periphery. Both Becca[P] and Sandra[P] attended meetings with the badge developer but were often unable to make the design sessions with teens, as they occurred on weekends when the staff were not always scheduled to work. Tom[P] was the main staff member to attend the design sessions, but the duties of his position often took him out of the sessions, and as previously mentioned, he intentionally limited his input to put the focus on the youth.

The badge system developer, George[D], viewed his role as that of a contractor providing a service rather than as a partner in the design process, which produced a different dynamic. The other participants in the project also felt this way about the developer, Sandra[P] particularly mentioning that she felt more like a client to whom the system developer was providing tech support. Overall, the teens identified as co-designers, while others felt that their involvement was more peripheral. Even though the teens did feel like their input was being heard, they still expressed awareness of the dynamics and were not sure of the extent that their input was being considered and implemented.

Vocabulary and Practice
A repeating theme that arose throughout the interviews was domain-specific language and corresponding practices used in the different *communities of practice* (Lave & Wenger, 1991). Researchers often dropped in jargon from the fields of education and human-computer interaction that were unfamiliar to the participants, though any confusion was quickly clarified as this often happened accidentally. The science center also had a great deal of site-specific terminology and *situated knowledge* that the researchers and system developers had to learn, allowing them to translate the program elements into pathways for the badge system (Lave & Wenger, 1991)(Lave & Wenger, 1991). The science center and researchers were based in educational domains, and thus had a certain amount of vocabulary and practice in common. By contrast, the badge system developers came from the technology industry. George[D], the main point of contact, was aware of the educational perspective, but the other groups were not as familiar with the industry terminology, such as agile development cycles, creating points of confusion and challenges with inter-group communication.

Learning through Participation
Participants expressed that they had learned from the other groups and shifted their understanding of digital badges since beginning the project. The science center participants (youth and staff) said they had become more confident in badge-related knowledge and were able to share that knowledge with others. These participants also gained understanding of the participatory design process and how it could be beneficial to the science center and their own learning. The researchers, meanwhile, learned a great deal about the structure and function of the science interpretation program from their science center counterparts (A. Bell & Davis, 2016).

Although the badge developers did not attend the co-design sessions, George[D] also mentioned that this was their first large-scale custom badge project for this style of implementation. All participants worked towards a more shared conceptualization of digital badging overall and developed a better understanding of their own and each other's roles in the project. The teens especially bonded as a team and explored the learning pathways and opportunities in their science interpretation program.

4.1.4 Discussion
Each group involved in the badge design process had their own knowledge, which occasionally resulted in friction when goals or terms were not in alignment (Lave & Wenger, 1991; Rogoff, 1994). Overall, there was not a clear consensus of equity and equal partnership, with the youth being aware of their status as teens in society and the adults doing their best to address the unequal power structure. All participants expressed enjoyment when asked how they felt about their involvement, even though they were unsure of their equal status. This study provides a snapshot of the dynamics and perspectives of groups in a participatory design project with youth, allowing the different groups to express their perspectives on participating in this type of design.

However, this study does not address the change over time dimension of RQ#1, focusing instead on the roles and relationships experienced by the participants at the time of the study, which occurred early on in the badges project.

This work provides insight into the complexities associated with involving youth in a long-term participatory design project involving multiple groups, each with distinct expertise, language, and perspectives. This study lays the groundwork for deeper inquiry into how the different parties involved in a PD process interact with, learn from, and perceive each other, which is vital to those who wish to form strong relationships within and among *communities of practice* in their design research (Lave & Wenger, 1991). In the next sections and chapters, we will delve into this complex set of relationships and their impact on implementation and ending.

The interviews also revealed room for improvement with respect to communication between groups. The friction that can arise when multiple groups with different sets of vocabulary and practices come together is something all design researchers and those who work with community partners should consider. These insights can be valuable in almost any PD project, particularly those with sensitive dynamics such as marginalized groups working with researchers from non-marginalized populations.

We also found that not all participants fully identified as co-designers even after being involved in a year of design sessions. Two of our teen participants expressed that they did not feel a sense of ownership in the process, contrary to some of the goals of PD (A. Bell & Davis, 2016; Björgvinsson et al., 2010; Druin, 2002), so it is evident that reaching this level of personal engagement and ownership can be difficult to achieve. It is incumbent on researchers to consider how the PD process can be improved to promote the development of co-design identities. Most of the feedback from this study was around communication and involvement, with individuals requesting more interaction across groups and more explanations of the research process and rationale. This suggests that while researchers try to balance overloading participants with information and terminology, they must also consider that participants may want to learn in order to further identify with and feel ownership over the project.

Limitations

Case studies in general have limited explanatory power to a broader population (Stake, 1995). I also acknowledge that there are many potential ethical considerations involved in interviewing youth, and assent was continuously obtained and re-verified throughout the research process. Another limitation is that this study involved complex power dynamics in the study itself, as interviewing fellow research team members and contracted developers can create quandaries for the interviewee who is balancing being forthcoming with their employment situation. I am cognizant of the possible biases that come with the dual roles of participant and researcher but feel that a reflective stance is important for improvement of the design process. I further explore this perspective in Chapter 6.

Conclusion
From participants' reflections and insights, we identified both successes and challenges associated with this long-term PD project involving multiple groups. Participants articulated that they were keenly aware of hierarchies in the project, while also appreciating the rich learning experience during the design process. For the youth involved, their awareness of the power dynamics in the project somewhat limited their sense of agency and identity in the design process. While PD as a theoretical perspective and methodology attempts to democratize design and incorporate user viewpoints as collaborators rather than mere informants, power dynamics within a project are still clearly visible. Understanding the dynamics at play allows us as researchers to explore other perspectives and ways that we might address these power differentials that exist in and outside of the structures of our work.

This initial study, while limited in explanatory scope, represents some of the foundational understanding of roles and relationships that are key to this dissertation. To better address the change over time aspect of the first research question, we turn now to two other studies I have assisted with, one of which discusses intergenerational relationships in co-design over a period of months (with a focus on achieving more equitable processes) and another that examines dispositional shifts in adult community members over a period of years, using an asset-based perspective.

4.2 Relationships in intergenerational design[4]

To examine in greater detail how the dynamics of relationships between researchers and community members can change over time, particularly when dealing with intergenerational projects such as those involving children or teens, I turn now to a study conducted in a child-focused co-design group called *KidsTeam.* This approach to including children in the design process was conceived and developed by Allison Druin at the University of Maryland (Druin, 1999), and her development of *cooperative inquiry*, the specific approach and methodology of

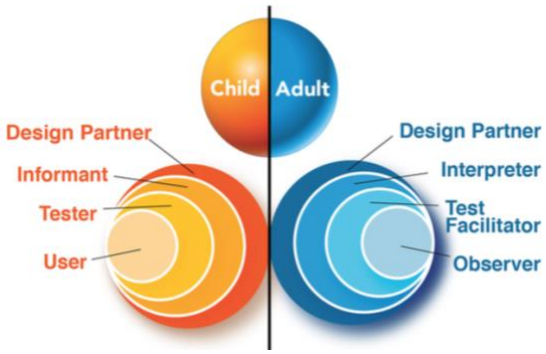

Figure 5 - Expanded onion model, "The complementary roles that adults and children play in the design of children's technologies" from Yip et al. (2017).

[4] This section was originally published as (Yip et al., 2017) .

working with children in this manner, has influenced much of the work in this dissertation, as discussed in Chapter 2.

4.2.1 Overview

I was involved in this study while I was a research assistant in *KidsTeam*, a co-design group at the University of Washington, Seattle where youth ages 7-to-11 would engage in PD activities with researchers twice a week, with the aim of creating a space in which adults' and children's ideas are both valued equally in the design process. We interrogated what "equal partnership" means when working with youth, discussing definitions of equality versus equity in this context and particularly focusing on the dynamics and reflected roles of adults and children in the design process, expanding on work by Druin and others (Druin, 1999, 2002; Guha et al., 2013). Each role of children in the design process (user, tester, informant, design partner) is reflected by a complementary adult role (observer, test facilitator, interpreter, design partner), visualized in the onion model in Figure 5.

Through our work, we came to understand that while the ideal of a completely equal partnership might not be feasible, it is possible to move towards more equitable partnerships that create balanced collaboration and design practices. We use the terms balanced and unbalanced to present this dynamic process and movement towards more equal representation of ideas and the equitable practices used to achieve this movement. This exploration of roles in the context of participatory design builds on the themes of design identity and equity discussed in 4.1.

To understand what was happening during the design sessions with respect to the adult-child dynamics, as well as the changes in the changes in relationships and dynamics over time, we annotated and analyzed video from 36 sessions (90 minutes each) over the course of approximately one year, featuring a total of 13 children and 11 adult facilitators, listed in Table 2, with pseudonyms. We triangulated this video data with design artifacts, memos, and notes. Jason Yip, the PI, also conducted interviews with the children and main facilitators. Using a grounded theory-based approach, we open coded the video annotations in *Dedoose* (Corbin & Strauss, 2015). The codebook resulted in the following overarching code categories: facilitation techniques and response from youth, behavior management, co-design practices, adult-child interactions, and scaffolding and support children needed in the design process.

4.2.2 Results & Discussion

The four main dimensions we developed from the coding process and thematic surfacing were *facilitation, relationship building, design-by-doing,* and *elaboration*. In the full conference paper, we presented vignettes illustrating each end of the four dimensions, discussing how each appears when the partnership is balanced (more towards an equal/equitable partnership) versus unbalanced (Yip et al., 2017). The *facilitation* dimension ranged from adults facilitating only to adults and children facilitating sessions in a balanced manner. *Relationship building* focused on the social distance between the adults and children, with an unbalanced partnership and large social distance on one end and more balanced partnership with less distance on the other. *Design-by-doing* was the range of collaboration in the design work, with adults mostly observing on one end and more balanced partnership of adults and children designing together on the other. The fourth dimension, *elaboration*, is related to *design-by-doing*, but focuses more on the flow of information and how ideas are discussed and handled. In an unbalanced partnership, ideas would only flow one way in the partnership, from the child to adult or vice versa, whereas in a balanced partnership there was more collaborative back and forth and building of ideas.

To illustrate these dimensions as well as explore the changes that can occur over time, we also compared two focal design sessions. One of these sessions was from early in the study period and one from late in the study period, to demonstrate how the dimensions can shift, changing the relationships between youth and adult facilitators and moving towards more balanced partnerships. We found that as the social distance between the adult facilitators and youth decreased, developing more rapport, the youth became more comfortable in collaborating on and leading design work. While the adults still provided most of the facilitation even in Session 30, the relationships were closer, creating a dynamic that allowed for more collaborative design activities. Both adults and children were more comfortable engaging in the improv-style "yes, and…" of building on each other's ideas. The visualization of the contrasts in dimensions between the two sessions can be seen in *Figure 3.*

Child name	Age	Gender	Ethnicity	Adult name	Age	Gender	Ethnicity
Gina	11	Female	Asian	Jason	36	Male	Asian
Aileen	11	Female	White	Caroline	24	Female	White
Athena#	7	Female	Asian/Black	Vivian	25	Female	White
Austin#	11	Male	Asian	Lili	30	Female	White
Riku#	9	Female	Asian/White	Oscar	30	Male	White
Anishinaabe	9	Female	Native	Kung Jin	26	Female	Asian
Animikiik	11	Male	Native	Kari	19	Female	Asian
Simon	9	Male	White	Kiley	26	Female	White
Marlene	7	Female	White	Sijin	19	Female	Asian
Winston#	7	Male	White	Laura	32	Female	Hispanic
Carmen*	9	Female	Asian/White	Edith	19	Female	White
Veritas*	9	Male	Native/Asian				
Martin*	7	Male	Hispanic				

Table 2 - (From Yip et al., 2017) "Demographics of the core co-designers. Names of all participants are pseudonyms, except authors. Asterisk refers to children that came in August 2016 only. Hashtag# refers to children that attended all sessions."*

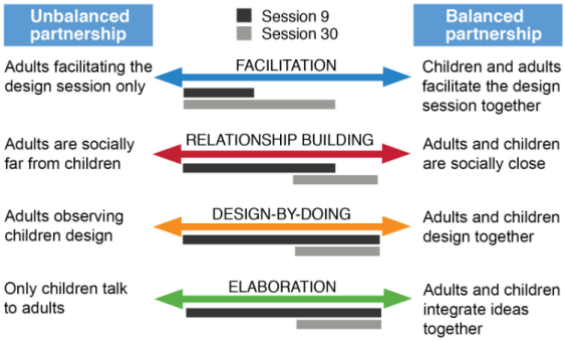

Figure 6 - Dimension comparison from Yip et al. (2017) "A visual comparison of co-design sessions #9 and #30 along the spectra of the dimensions."

Through this work we were able to better understand the complexity of relationships between youth and adults in the design process, as well as the change in relationships over time. This work, combined with Pitt & Davis (2017), provides a nuanced picture of how different community groups, particularly in youth-involved PD projects, view their participation, power dynamics, and relationships with others in the project community over time. These studies also capture important information on the surrounding ecosystem factors that shape and change these relationships, which is crucial to developing a holistic understanding of how projects conclude. The final study I will touch on in this chapter focuses on changes in adult community member disposition and identity, an important aspect of answering the first research question about roles and relationships developed in the community-based design process.

4.3 Changes in adult roles over time[5]

Thus far, I have discussed how roles and relationships are perceived and interact in the moment, as well as over the period of several months, but the focus of this dissertation is thinking about endings and relationships over the longer term. The final study that I will discuss in this chapter comes from the Science Everywhere project (see Chapter 3 for an overview), closely examining the roles of the adults in the project, and particularly how those adults' dispositions towards science and their relationship with the project changed over time, particularly due to their involvement in the community surrounding the project. While this study focuses more on the science dispositions of individuals rather than the relationship dynamics of a project ecosystem, the way in which the relationship dimension found in this study contributes to identity and disposition development in the theoretical lens helps answer the first research question of this dissertation.

4.3.1 Overview

[5] This section summarizes Clegg et al. (2023)

This study was part of the larger Science Everywhere project, particularly focusing on key community adult facilitators from the Maryland site. Drawing on data from a period of several years, the research team followed the dispositional shifts and perspectives on science of these key individuals to understand what was happening as community members navigated their understanding. Much of the previous work in this research project had focused on the learning and identities of the youth involved, but to gain a broader community understanding, the research team wanted to also explore the changes in the adult community members over time. This study draws on disposition research and asset-based community development (ABCD) perspectives, focusing on the ways in which adults conceptualize the role of science in their lives and draw on their own experiences and expertise as assets in the project (Clegg & Kolodner, 2014; García, 2020). This focus on roles and community connects to the previous studies in this chapter.

From a large corpus of data (interviews, video, notes, and so on) the research team noted that adults' reflections on the project shifted over time, and in 2018 decided to conduct focus groups to explore these changes. A total of 18 adults including parents, researchers, and other community members were included in the focus groups and interviews. The focus group transcripts were coded for the motivations surrounding participation, adult experience in Science Everywhere, shifts in thinking about science and science learning, and what that meant for youth learning in the context, using inductive processes (Corbin & Strauss, 2015). The researchers then found two main categories of adult participants, referred to as *communitizing participants* and *traditional scientists*. *Communitizing participants* were involved due to their community focus and engaged in SE motivated by the relationships and connections involved, and these participants expressed some doubts about their knowledge and relationship with science. *Traditional scientists* were motivated by experiences with more formal science learning and experienced some friction with the informal and casual nature of the SE project.

The research team then examined the experiences and disposition shifts of four key individuals, two from each category, selected for the length of their involvement and the depth of the data regarding their participation in the project. The research team built on the previous structural codes (Miles et al., 2014), using additional data relevant to the participants. The research team mapped the dispositions and other elements of the participants' experiences, detailed in (Clegg et al., 2023).

4.3.2 Results & Discussion

We found that the dispositions of the adult participants shifted over time due to relational factors, as participants became more comfortable with their roles and relationships in the project community, leading to the terminology of *relational science disposition*. While adults tended to begin as one type of participant or another (communitizing or scientist), over time the aspects of their dispositions shifted and became less separate, with communitizers feeling more comfortable with science in their own way and traditional scientists coming to have a deeper understanding of

the role of informal science practices in community science learning. The model for the relational dispositions seen in SE can be found in Figure 7.

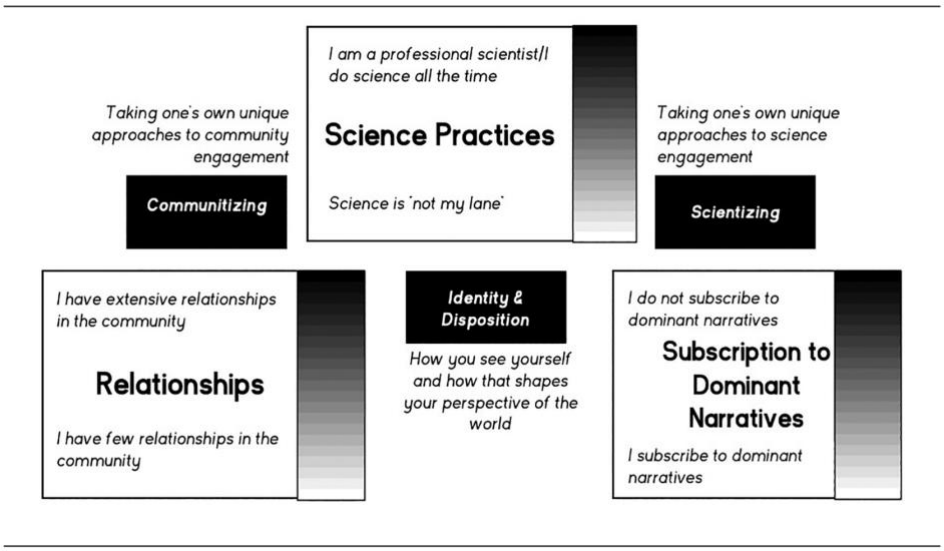

Figure 7 - From Clegg et al. (2023), aspects of dispositions as seen in the study, larger boxes show the aspects and ranges, communitizing and scientizing are external enactments, and identity and disposition is a broader frame of influence

Researchers also found that the SE sociotechnical system allowed the adult community members to create more bridges between scientizing and communitizing, with traditional scientists able to see the value in the more playful informal science interactions and communitizers able to visualize how their relationships and understanding of community dynamics could allow them to contribute to the conversations around science topics. Thus, the technology, in addition to being something designed and developed by the community as discussed in Chapter 3, became a way of facilitating these relational dispositional shifts and supporting community learning. In all of the studies discussed in this chapter, the design of technologies has been a key part of relationship development, but here we also see how the technology supported shifts and growth in community relationships during the implementation stage.

While this study focused particularly on science dispositions, the overall focus on the development of the concept of *relational dispositions* and change in identity and perspective over time based on experience with a sociotechnical system and the community are extremely relevant to the research questions and work at hand in this dissertation. This work also moves us from an interpersonal focus to more of a sociotechnical one, with clear evidence of the influence of the information technology itself on these changes in roles and relationships over time. Throughout this chapter I have discussed several studies that focus on the identities, roles, and relationships and dynamic changes and shifts in the project ecosystem. In the next chapter, I more fully explore the next stage of both the research questions and the design process: sustaining or concluding long-term partnerships and how implementations of technologies can inform our understandings of this process.

Chapter 5 Opportunities and Challenges in Long-Term Projects

Having explored the relationships and roles of the people involved in community-based work, I now turn to what some may view as a more practical concern: how to sustain or conclude a long-term research implementation project, particularly one that involves the development and uptake of a new sociotechnical system. Based on the findings in the previous chapter, the development of the relationships in a project can shape and change the individuals involved and in doing so may alter the course of the entire project.

Thus, it follows that this complex set of roles and relationships may also have implications for the effectiveness of technological or other interventions in communities. Of course, what constitutes effectiveness may vary, and that is part of our discussion of endings. Is the ending of a project the hand off of a technology to a community in a sustainable manner? Or is it a celebration and acknowledgement that the current state of affairs is time-limited and that is not something to be feared? Either way, understanding the challenges and opportunities in long-term research implementations in communities helps facilitate both ongoing project processes and the eventual endings.

Work described in this chapter focuses on the second research question of this dissertation:

> What are the core opportunities, challenges, and trade-offs in *sustaining or concluding* longer-term research implementations, particularly focusing on community-partnered research?

5.1 Designing for digital badge implementation[6]

In this section I discuss work that focuses on the aspect of implementing and sustaining technologies developed through community-based PD projects, addressing the core of RQ#2 regarding challenges and opportunities. I conducted a reflective case study on a long-term digital badges project situated in a youth science interpretation program at a science center in the Pacific Northwest (described in detail in Chapter 3). I used this case study to provide insight into this research question, seeking to explore and understand the factors that go into not only designing and iterating a community-partnered technology design project, but the opportunities and challenges involved in sustaining one.

This work was completed in 2018 and published in 2019, connecting design perspectives such as VSD, PD, and the learning sciences to form the basis of understanding of long-term work. This study was also foundational to my understanding and interest in long-term case studies, building the basis of my methodology for Chapter 6. In this study, we closely examine how the design

[6] Originally published as (Pitt et al., 2019)

and implementation of sociotechnical systems affects the surrounding community over time and vice versa.

5.1.1 Introduction

I drew on a large corpus of data from the Digital Badges project discussed in Chapter 3 for this study, including interviews, surveys, design session data, and analytics over the course of three years. Year 1 consisted largely of initial design sessions and preliminary data collection; Year 2 involved testing and designing additional features; and Year 3 focused on implementation across the science interpretation program and collecting additional data related to various aspects of the study. The table of data from Pitt et al. (2019) can be seen in Figure 8. We worked closely with the science center staff and the badge developer to collaboratively design, implement, and iterate on the badge system. The timeline of these research activities is discussed below and summarized in Figure 8.

Our analysis was guided by the following research questions as more project-specific components of the larger RQ#2 of this dissertation: (1) What challenges did stakeholders face during the implementation of the digital badge system? (2) How can implementation challenges be anticipated and incorporated into the initial design process? (3) What role can ongoing co-design play during the long-term implementation of a digital badge system? The data analysis process revealed three categories of implementation challenges: *sociotechnical*, *sociocultural*, and *technical*. These challenges are key to understanding the long-term sustainability and concluding of projects, identifying a number of potential stumbling blocks to the concept of *ending well*. From these categories, the research team developed a set of guiding recommendations for implementation of a digital badge system in informal education environments, and these insights can also be applied to our understanding of endings across many sociotechnical design projects in community settings. I build on these recommendations in the work discussed in Chapters 6 and 7.

5.1.2 Method

To better understand the implementation challenges faced by the badge system design, development, and implementation process, we conducted an in-depth retrospective case study, examining the substantial data corpus from the project and drawing on concepts such as the democratization and community ownership perspectives of participatory design (Floyd et al., 1989), the reflective and interactional stance of VSD (Friedman & Hendry, 2019), and previous work in Design Based Implementation Research (DBIR) and Research-Practice Partnerships (RPP) from the learning sciences (Penuel & Fishman, 2022). For more detailed discussions of each of these perspectives please refer to Chapter 2.

5.1.2.1 Case study parameters

The broader summary of the Digital Badges project is covered in Chapter 3, but this particular study covers the first three years and incorporates the following data and research activities:

In Year 1 (2015-2016) of the project, the research team brought pilot work (K. Davis & Klein, 2015) to a participatory design group of five youth and two staff members. This group participated in nine monthly design sessions to develop the initial badges, pathways, and interface design for the badge system website, using techniques such as stickies, layered elaboration, and big paper prototypes (Walsh et al., 2013). During this first year, the research team also interviewed 30 external community members (a mix of college admissions officers and human resources managers) about their digital badge opinions and familiarity (Pitt, Bell, Strickman, et al., 2018). Prior to the launch of the badge system near the year's end, the research team surveyed 64 and interviewed a subset of 36 program youth about digital badges and their science identities.

Year 2 (2016-2017) marked the deployment of the first iteration of the digital badge system, with site usage analytics collected as the badge system was incorporated into weekly science center routines. Design work continued, with a new group of seven youth designers who designed features for the website and assisted in testing and addressing first iteration issues. Towards the end of Year 2, researchers requested supplemental funding to incorporate newly designed features generated from this work. At this time, the research team began to introduce onboarding trainings and include more announcements during meetings, as many of the youth were not engaging with the badge system on a weekly or even monthly basis.

Year 3 (2017-2018) focused on the implementation of new features designed in Year 2, as well as incorporating onboarding trainings and designing for incorporation into workflows and regular use (Pitt, Bell, & Davis, 2018). A third year PD team, with four youth, worked to fit the system into the existing schedules and ecosystems of the science interpretation program. Customizable portfolios and a program calendar, requested by the youth, were introduced around

Table 2: Research activities summary (* denotes supplementary/secondary sources)

Phase	Research Activities and Badge System Status	Data Sources
Year 1	1st year design sessions: initial features Community stakeholder interviews Pre-implementation / Baseline student surveys and interviews Badge system in development	Community stakeholder interviews (n = 30) Youth pre-implementation surveys (n = 64) Youth pre-implementation interviews (n = 36) Design team interviews (n = 11) Design session memos and artifacts Meeting notes and correspondence*
Year 2	Badge system launched at start of Year 2 2nd year of design sessions: additional features User testing	Design session memos and artifacts Meeting notes and correspondence* Website analytics
Year 3	3rd year of design sessions: implementation Post-implementation student surveys and interviews Badge system feature updates and UX changes	Youth post-implementation surveys (n = 50) Youth post-implementation interviews (n = 19) Design session memos and artifacts Meeting notes and correspondence* Website analytics

Figure 8 - Research activities from Pitt et al. (2019)

the middle of Year 3. Involving senior program members in onboarding training and increasing awareness of the badge system showed a marked increase in use of the website application (Pitt, Bell, & Davis, 2018). The research team conducted post-implementation interviews and surveys at the end of Year 3, building off of the protocols used in Year 1 (see Figure 8).

5.1.2.2 Analysis

My colleagues and I engaged in a collaborative reflective and open coding process of the data, developing major themes and refining them iteratively (Corbin & Strauss, 2015; Miles et al., 2014). We developed this analytic approach based on precedent in educational and HCI research, where multiple groups of researchers have engaged in multi-year reflective analysis of the implementation and impact of work such as curriculum innovations or retrospectives (Charalambous & Hill, 2012; E. A. Davis et al., 2017; Fitzpatrick & Ellingsen, 2013; Romance & Vitale, 2001).

The research team worked to develop emergent themes and focus on the most salient design implications that would address integrating a new sociotechnical system into an existing informal learning program and sustaining it over the long term. The Year 1 interviews had previously been coded for opportunities and challenges (K. Davis et al., 2018). We drew on this coding schema to review and code Year 3 interviews and surveys. From there, the authors reviewed the data set elaborated in Figure 8 focusing on the analytic memos from the design sessions, the website analytics, and the interviews and surveys. Additional research data, such as email correspondence, meeting notes, and design session artifacts, were also used as points of triangulation (Maxwell, 2012).

We identified three categories of challenges associated with digital badge system implementation: sociotechnical, sociocultural, and technical (see Figure 9). We then discussed the development and implementation of resolutions for each type of challenge, as well as examples. For instance, when faced with the challenge of many youth not being aware of the interpreter program badge system, we designed and facilitated onboarding trainings that allowed the students to teach each other about the system. Insights from this process were used to develop broader recommendations.

5.1.3 Results

In terms of the challenge types we identified, the *sociotechnical challenges* related to how the badge system was incorporated into the day-to-day activities of the science interpretation program. The three main challenges in this category were awareness, access, and relevance. General *awareness* of the existence of the badge system beyond those directly involved in the design process was low, particularly as new youth joined the program and older youth graduated, something that particularly touches on the idea of *endings*, as there may be many types of departures, conclusions, and endings throughout a project. Another challenge was *access*, as students did not have many opportunities to use and view the badge system. The schedules at the

science center did not permit much free time for looking at the system, and the youth were not allowed to have their phones while on duty. They also simply did not check outside of the science center because they felt the badges lacked *relevance* to non-science center activities.

To address these challenges, we introduced new trainings and schedule items into the science center workflow, finding ways to incorporate the technology in a way that was not burdensome. This concept is also important when considering designing research projects to end well: not increasing the burden on already busy systems. When thinking about the potential ways of ending for a sociotechnical community project, researchers must have a clear understanding of the existing workflows and norms… and whether their intervention has sticking power. Will the technology be maintained once the research is over?

The *sociocultural challenges* focused on how the badge system was perceived and functioned beyond the program – particularly in terms of credibility. Because the science center community did not feel that there was a lot of *value* and *credibility* outside of the science center – which I will discuss in more detail in the next study later in this chapter, see 5.2 (Pitt, Bell, Strickman, et al., 2018) – they did not feel a lot of ownership or commitment to the system. Additionally, they were concerned about the *privacy* of the badges, not necessarily wanting the context collapse that comes with having this after school science activity able to be shared on social media, despite this possibly increasing the *credibility* and *value* dimensions. Youth are often warned of the perils of social media and online presence, so introducing a sociotechnical system that encouraged sharing of achievements presented somewhat of a conundrum. For more detail on the context collapse aspect that is outside the scope of this dissertation, see (Pitt, Bell, et al., 2021) which focuses on individual case studies of the ecosystems of several of the program youth. We addressed these three challenges by gathering input from college admissions officers and human resources professionals (Pitt, Bell, Strickman, et al., 2018) to demonstrate the external credibility and thus the value of the badges. Additionally, we made sure that the system was only visible to those in the program, though youth could make public-facing portfolios to share with a wider audience if they preferred.

The *technical challenges* addressed issues of usability and system error, as well as slowdowns in the troubleshooting process. These challenges are key not only to digital badge systems but also to many other community technology design and implementation projects, revealing the practical day-to-day concerns of the community members as well as higher level ideas such as broader perceptions of digital badges in the public sphere (more in 5.2). Newly designed technologies, particularly those on academic budgets, are prone to bugs and errors, resulting in user frustration and diminished use. Many of the youth did not find the interface intuitive, given that they were more used to frictionless mobile applications, and the system often broke or had errors that could take considerable time to resolve, as this required contacting the back-end developer. This was another challenge, as the communication lags between multiple busy individuals (a principal

investigator, science center supervisor, badge system developer) could create long delays in getting badges granted or updated for youth, who then were less interested in the system as a whole. The research team leveraged the existing relationships and design strategies that we had developed as a form of social infrastructure to mitigate these challenges, but these issues are faced by many technology implementation projects. Additionally, given the cycles of project funding, it may be impossible to maintain the technologies and, as discussed in Chapter 1, they become quickly obsolete. We again must consider the balance of resources, infrastructure, relationships, and time.

Sociotechnical Challenges	
Awareness	Students, staff unaware of badge system
Access	Students have trouble accessing badge system during daily workflow
Relevance	Students, staff do not understand the role of badges in the program
Sociocultural Challenges	
Value	Students, staff do not appreciate unique value that badges contribute
Credibility	Stakeholders question the credibility of badges
Privacy	Stakeholders express concerns about student privacy
Technical Challenges	
Usability Issues	Students, staff face problems in navigating user interface
Troubleshooting Process	Communication lags, barriers to changes and fixes

Figure 9 - "Three categories of badge implementation challenges" from Pitt et al. (2019)

5.1.4 Discussion

Based on these challenges, we developed guidance for others who want to implement and sustain community-based technologies. We found that placing a strong emphasis on ensuring that the technology was not only easy to use but well-incorporated into community habits or workflows was essential to sustainability. Additionally, providing detailed but non-academic explanations of the functions and meaning of the badges such that the youth could easily explain them to others was important, as we also trained the youth to teach each other about the badge system. This training process empowered the youth and helped them gain a sense of ownership, allowing them to take on the badge system as their own, even though many of the original designers had graduated (Pitt, Bell, & Davis, 2018). This work also centered the process of infrastructuring, including making sure that technical support was provided and that the research team was a regular presence (Penuel, 2019).

Our recommendations mostly focused on sustaining a sociotechnical initiative in an existing program, but the findings are also relevant to considering ways of ending, as one ending process is the handing-off of a project to the community group. In terms of *sociotechnical* recommendations, we emphasized continued researcher presence on-site for as long as possible,

continuing the relational aspect discussed in Chapter 4. Also, the system should be built in such a way that it can be incorporated into existing practices, to minimize friction with the flows of the community. Much like in Chapter 4, a deep understanding of the context will aid everyone in creating a beneficial outcome. The *sociocultural* recommendations focused on education and outreach, both internally to the community and externally to other groups that might be connected or interested in the sociotechnical system or intervention. This does, however, come at a cost in terms of researcher energy and resources, as discussed in Chapter 1. Community outreach and updates are important but do often fall by the wayside in the push to publish in academic settings. Our *technical* recommendations focus on communicating the technical details of the system to all groups and facilitating the resolution of any issues by serving as a mediator between the groups. This connects back to the vocabularies and roles discussed in Chapter 4, where the researcher may serve as a translator between the different communities. This does not, however, address the issue of what happens to this mediator/translator role when the researcher leaves or the project ends, further emphasizing a need to develop better ways of ending.

These challenges and recommendations focus on the relational aspects of sociotechnical system design, not only the connections between the groups but also between the people and the technology. Creating a sense of ownership and value through respect and collaboration while minimizing friction and frustration helps implement interventions that are more sustainable. Still, even the handing off of a system to a community group is an ending. And even all the efforts in the world to teach and build infrastructure may be insufficient to sustain a project. So how does it end? Is it possible to garner external support? Have we considered all the potential tradeoffs?

5.2 External Perspectives on Digital Badging[7]

As mentioned in the previous section, here I provide some additional context on the perception of sociotechnical community projects from a broader ecosystem, and the role that larger overarching infrastructures may play in the sustaining or concluding of projects.

5.2.1 Overview

As part of the badge design and implementation project described in Chapter 3 and discussed in 5.1, the research group also interviewed 30 external individuals from relevant fields – largely college admissions officers and technology hiring professionals – who were willing to discuss how they perceived the potential of digital badges in college admissions or hiring (Pitt, Bell, Strickman, et al., 2018). While less central to the work at hand, this interview study surfaced a number of challenges and opportunities surrounding digital badges that are important for considering the long-term impacts, sustainability, and potential endings of projects.

[7] This section draws on and summarizes Pitt et al. (2018)

5.2.2 Methods & Analysis

In terms of analytic approach, members of the research team conducted a thematic analysis of the interviews, which were digitally recorded and transcribed, adapting a previous coding scheme regarding perspectives on digital badges (K. Davis & Singh, 2015; Smagorinsky, 2008). The codes addressed participants' experience with digital badges; perceived opportunities and challenges; and an overall assessment of participants' views of digital badges (i.e., generally positive, generally negative, or ambivalent). Codes for emergent themes were also added. Researchers performed several rounds of consensus coding (Smagorinsky, 2008) to achieve agreement on the definition and appropriate application of each code. After several rounds to achieve agreement, two researchers coded the same set of transcripts separately and then calculated reliability scores for each code using Cohen's kappa statistic, setting the threshold at 0.7 (Landis & Koch, 1977).

5.2.3 Results & Discussion

Through the coding process, certain challenges and opportunities arose more often than others, standing out as key to the interviewees' perceptions of digital badges. In terms of challenges, they were concerned about credibility, workflow integration, and triviality. Much like the youth in the badge program, these interviewees raised concerns regarding who was granting the badges and what authority they had, and whether they could trust them as *credible* sources of accreditation. As we noticed in the science center, *incorporating the badges into existing workflows* was often a concern. College admissions and human resources officers often already have specific software packages and ways of reviewing documents, and many interviewees were not sure if badges would work well in the context of their existing infrastructure. The interviewees were also concerned, similar to credibility, that the badges would be *trivial*, not bearing any significance. Since badges could be used to represent any type or amount of learning achievement, interviewees worried that the credentials might be awarded for small or academically meaningless things.

Interestingly, *credibility* was also mentioned as a possible opportunity, as participants mentioned the potential of backing from well-known institutions. The interviewees also saw potential for the *equity* element of digital badges, moving away from traditional assessment methods and allowing for visualization of *learning pathways*. They also noted the potential for supporting *assessment practices* and *sorting applicants*, allowing them to quickly move through college or job applications.

We found that while many of the interviewees were intrigued by the potential of the technology, they were concerned about the credibility, as well as the resource and infrastructure cost of incorporating it into their systems, similar to the previous study in 5.1. The perception of such projects by external and indirect community leaders and gatekeepers is key to sustainability of long-term projects, as they all exist in a broader ecosystem. While the interviews in this case were focused on digital badges generally, the ideas around needing to adapt infrastructure and

change ways of thinking is very applicable to the current topic. Thus, when we consider how projects conclude, we must also consider the impacts the conclusion may have on these groups and what form it might take.

For instance, depending on how funding agencies, local colleges, employers, and others view something like a youth co-designed badge system, the system might be supported through broader connections beyond the immediate community, creating funding and infrastructure to allow the community to continue to use it without additional burdens. However, if there is a great deal of skepticism and no strong community champions who leverage social capital (Simpson, 2005), then the system may quickly fall apart. This leaves the community and youth who were involved in the design not only without the technology, but also potentially feeling discouraged and let down by the perceived failure of the badge system. Understanding how the surrounding social ecosystems perceive the designed technologies can be key to creating a clear and actionable process for ending projects in a more mutually beneficial manner, balancing ownership and burden.

Together, the studies in this chapter provide a deeper understanding of the opportunities, challenges, and trade-offs involved in sustaining a long-term community technology research project, though they do not provide as much insight on *concluding* one. To tackle the specific ending dimension of RQs #1 and #2, as well as develop a framework for ending projects well, I move to my final study and RQ #3.

Chapter 6 The End of Projects?

The beginning of the end, in a way. This chapter marks the last of the empirical research studies, building on the findings from previous chapters and leading to the design work and conclusion.

6.1 Introduction

Previous chapters have focused on exploring the literature around long-term projects and their conclusions, particularly in HCI and the learning sciences (Chapter 2) as well as understanding the individual roles and relationships that develop in participatory design projects, as well as how those roles impact the long-term implementation of such projects (Chapter 4). I have also explored the challenges, opportunities, and trade-offs in long-term projects (Chapter 5). Despite all of this, there is little literature on best practices for ending a community-based technology research project. When we discuss the ethical implications of work with communities and the long-term impacts we may have, how we conclude is crucial to non-extractive research practices (Bang & Vossoughi, 2016; Kouritzin & Nakagawa, 2018). So, how do we *end projects well*?

For this study, I use two projects that I have worked on for over five years as my focal cases – *Science Everywhere* and *Digital Badges for STEM Education*, as described in detail in Chapter 3. I build on the previous work discussed in Chapters 4 and 5 by conducting comparative case studies using interviews with key stakeholders from the two cases, triangulated with archival data and supporting documents. I found that the interviewees generally viewed their involvement in the projects positively, though they expressed concerns and frustrations with the ending process, as well as with breakdowns in communication. Many participants had strong relational bonds with others in the project and found these to leave lasting impacts. They also expressed a desire for a clear ending process. Based on these findings and the rest of the work presented in this dissertation, I develop a framework for designing research projects that end equitably, discussed in Chapter 7. See Appendix A. for an overview of the published papers included as part of the dissertation.

This work addresses the third research question of this dissertation:

> What do researchers and communities need to better support and facilitate their involvement in *community research that ends equitably*?

I begin with a positionality statement and acknowledgement of my connections to this work; then provide the methodological background and details for the case studies. For a logic model of this study, please consult Appendix B.

6.1.1 Positionality Statement

When discussing equity and justice, as well as the complex theoretical intersections I am striving to combine through this work, it seems only fair that I speak to my involvement in some of the

projects I am analyzing in these studies (Liang, 2021). As one of the researchers in both the *Digital Badges* and *Science Everywhere* projects, I am deeply associated with the work that I am examining and thus my values may be in tension (Nathan et al., 2007) with some of the other stakeholders throughout the interview and analysis process. Additionally, research which requires interviewing other researchers is accompanied by its own considerations in terms of ethics and consent, though I strongly believe that involving researchers as participants is key to better understanding and improving the research process (Wiles et al., 2006).

I believe that there is no truly neutral or objective research process, and that to believe oneself to be an objective and dispassionate observer is, in fact, counter to the goals I set forth in this document (Behar, 1996). Through this work I strive to acknowledge and be cognizant of my privileges as a white, cisgender woman from a high socio-economic status background, enrolled in a doctoral program at a highly regarded research institution, with funding and support networks, and the biases that I inherit and perpetuate based on that background, particularly as I intersect and interact with participants and communities from a variety of backgrounds and experiences. It is my responsibility to be aware of my position and reflect on my impacts (Kouritzin & Nakagawa, 2018; Schön, 1987). With this understanding, on to the case studies.

6.2 Case Studies

This work consists of two comparative case studies of projects that I have been involved with for five years. While somewhat limited in transferability to other contexts, case studies allow researchers to explore specific phenomena within a defined space, examining the complexity of the ecosystem (Merriam, 2009; Stake, 1995; Yazan, 2015). Yin (2013) mentions that cross-case comparisons can be particularly insightful if well-constructed with clear boundaries. Given the variety of possible unit sizes for cases – from a single individual to an entire school system – and the need for clear delineation, I specifically bound my cases to these two projects, with clear inclusion and exclusion criteria for participants (see Appendix B for details, as well as the participants section below) (Creswell & Poth, 2016; Merriam, 2009; Yazan, 2015). In the following subsections I provide a summary of the project cases and prior research in the projects (more detail can be found in Chapter 3), followed by further details of the study methodology and analysis process.

6.2.1 Case A: Digital Badges for STEM Education

Digital Badges for STEM Education is an NSF CAREER grant project that developed research on digital badging. The project explored the development and implementation of a digital badge system in an informal learning setting, examining the benefits and challenges of digital badges.

6.2.1.1 Prior Work in Digital Badges for STEM Education

This research built upon prior and pilot work on digital badging (K. Davis & Klein, 2015; K. Davis & Singh, 2015). Subsequent studies from this project include exploring the learning experiences of youth in participatory design, as well as their perceptions of power dynamics in

the design process, as discussed in prior sections (A. Bell & Davis, 2016; Pitt & Davis, 2017). More recent work explores the challenges and opportunities of badges from the perspective of college admissions officers, strategies for encouraging implementation, and case studies of youth interactions with technology (Pitt, Bell, et al., 2021; Pitt, Bell, Strickman, et al., 2018; Pitt et al., 2019). As I have been heavily involved in a great deal of the data collection, analysis, and publication of work from this study, it was easy to access data for triangulation.

6.2.2 Case B: Science Everywhere – Seattle-area site

The *Science Everywhere* project is a two-site informal learning research project focused on the development of sociotechnical systems for increasing community *scientizing* – seeing science in everyday activities – via social technologies and informal science programming. In this case I focus particularly on the Seattle area site as it is the one with which I have direct experience and creates the best cross-case comparison with the digital badging project. The other site in Maryland will be touched on but not the focus here.

6.2.2.1 Prior Work in Science Everywhere

As a multi-site study that began data collection in 2014 and continued into 2020, the *Science Everywhere* project has a considerable amount of prior published work, much of it focusing on the concept of scientizing and PD with families (Ahn et al., 2012, 2014, 2018; Bonsignore et al., 2014; Cabrera et al., 2018; Clegg et al., 2023; Mills et al., 2018, 2019; Yip et al., 2016). There is also at least one journal article still in preparation. Drawing on prior work in *Science Everywhere*, there is a substantial corpus of data and information available, thus providing a wealth of triangulation materials, though much of it is from the Maryland site, while the focus in this study is specifically the Seattle area site.

6.3 Methodology

Methodologically, interviews with key stakeholders form the backbones of the focal cases, supported by additional triangulating data (Stake, 1995; Yazan, 2015; Yin, 2013). This allows me to develop a holistic understanding of the support and facilitation needs from key community perspectives, particularly when concluding long-term research projects. Through this work, I have discussed the *ending of projects* directly with stakeholders, providing insights for RQ#3 (Merriam, 1985; Yin, 2013). Because these two cases take place over approximately the same time period and cover similar durations, they provide an excellent basis for comparison (Yin, 2013). They also differ on a variety of factors such as community structure, number of sites, type of location, ages of participants, and so on, while still having substantial overlap in areas such as the type and source of funding, field of the project, and location. This allows for more focus on the community and other relational and dynamic aspects, limiting some (but certainly not all) confounding factors.

Both Yin (2013) and Stake (1995) emphasize interviews as critical components of case studies, despite their epistemological differences, providing perspective directly from the stakeholders

and gathering information that may not be directly observable. I used semi-structured interviews particularly for their flexibility and direct interaction with participants, allowing the researcher to ask for clarifications and further details on specific aspects (Corbin & Strauss, 2015; Creswell & Poth, 2016; Merriam, 1985, 2009). The semi-structured interview is most applicable to this work, as it allows interviewees to have agency to steer the conversation while maintaining focus on the core research questions and themes. In contrast, focus groups can be swayed by an authority figure or high social status individual in the community (though the role of the researcher as interviewer should also be considered) and too much structure can impede findings in this type of emergent study (Creswell & Poth, 2016; Yazan, 2015)

6.3.1 Participants

The participants for this study were selected based on having participated in one of the two projects for an extended period of time (baseline criteria is two years of participation, though most were involved for longer). During the recruitment phase, I aimed to interview participants from all the following categories: principal investigators, grants administrators, researchers/assistants, community leaders (teachers, parents, staff), and youth. As I was conducting interviews, I was encouraged to also speak to the project evaluator of the Digital Badges project, so I reached out to her as well. Unfortunately, the grants administrator for Science Everywhere was unable to participate. In all, 15 participants agreed to be interviewed and completed the process, with participant details provided with pseudonyms (some chosen by participants, others did not respond or asked me to choose) in Table 3 (Allen & Wiles, 2016).

Table 3 - Case study interview participants

Pseudonym	***Project***	***Role***	***Years Involved***[8]
Robin	Digital Badges (DB)	Principal Investigator	2013-2021
Jacob	Science Everywhere (SE)	Principal Investigator	2011-2023
Trisha	SE	Principal Investigator	2012-2023
Arik	DB	Research Assistant	2015-2019[9]
Alberto	SE	Research Assistant	2015-2017
Delia	SE	Research Assistant	2015-2017
Helena	DB	Staff	2014-2020
Pesky	DB	Staff	2015-2020[10]
Enid	SE	Staff (teacher)	2018-2020
Kacey	SE	Staff (librarian)	2016-2020
Kara	SE	Parent	2016-2020
Kamal	DB	Youth	2019-2020[11]
Brennan	DB	Youth	2017-2019
Andy	SE	Youth	2016-2018
Sally	DB	Evaluator	2018-2021

[8] Based on participant recollection and triangulated with additional data
[9] Continued to be involved in publications after departing active research participation
[10] Changed job titles within this time period but still checked in and attended some sessions
[11] Was involved in the pivot to COVID-19 experiences for teens in 2020, see (Pitt, Hock, et al., 2021)

The final set of interviews consisted of three PIs, three research assistants (one graduate and two undergraduate), four staff members (two program supervisors, one teacher, one librarian), one parent, three former youth (all were over 18 at the time of the interview), and one evaluator. There were eight interviewees for the Science Everywhere project (seven from the Seattle-area site, one PI from the Maryland site) and seven interviewees for the Digital Badges project. I found 15 interview participants to be reasonably satisfactory as researchers have found that around 12 participants can be sufficient to surface major themes (Guest et al., 2006; Hennink et al., 2017). Given that I interviewed former youth participants, I made sure to draw on the ethical precedents as is part of my focus and positionality in this work, providing clear plain-language explanations of assent and consent, continuous opportunities to make decisions around agency, and so on (McNally et al., 2016; Morrow & Richards, 1996; Wiles et al., 2006).

6.3.2 Procedure

I contacted all participants who agreed to participate in the interview via email and sent a consent form via DocuSign and given a chance to ask any clarifying questions via email. The interview protocol focused on each participant's involvement and experiences throughout the course of the project in which they were involved. The interview protocol was customized for each participant, and the flexibility of the semi-structured interview allowed me to omit or include questions as needed. I structured the interview around the three main research questions of this dissertation, focusing particularly on the third question but making sure to touch on the connecting aspects (see *Appendix D* for the main version of the interview protocol). Due to the retrospective nature of the study, participants were given the opportunity to check their emails and notes, ask any questions, and generally receive any clarifications related to their involvement that they wished. As I will discuss in the findings, many participants were concerned about their memories, given the time that had elapsed (approximately three years) and the global pandemic that had occurred in the meantime.

I conducted the interviews from February through May 2023. I conducted all interviews via the online videoconferencing platform Zoom and recorded them digitally. Consent was reconfirmed at the time of the interview and an opportunity for clarification was given before recording. The interviews were transcribed using Zoom's automatic captioning and transcription features, which are not perfectly accurate but sufficed given my familiarity with the subject matter and the participants, producing usable transcripts for coding. Each interview lasted between 50 minutes to two hours, with the intended interview protocol duration of 70-90 minutes (interviews were scheduled for 90-minute blocks). Only one interview required two sessions due to scheduling issues. At the end of the interview, I asked the interviewee if they wished to be contacted for member checks later in the study or further research, and all 15 were amenable. After the interview, I thanked participants via email, and sent them a $30 digital gift card.

I asked participants if they wished to choose their own pseudonym in an effort to support their agency and ownership of their involvement (Allen & Wiles, 2016). The responses to this were

mixed, with some of the youth not understanding why they had to use a pseudonym at all (there is something interesting to be said here about modern social media practices, but that is beyond the scope of this dissertation). In terms of the adult pseudonym selections, some chose one, several stating that I could choose, and others not responding at all.

6.4 Data Analysis

I used a thematic qualitative coding approach to analyze the interviews, drawing on best practices for case study data analysis as discussed by various scholars to ensure rigor and validity (see the discussions of triangulation and other practices below) (Stake, 1995; Yazan, 2015; Yin, 2013). The interviews have been transcribed verbatim, with my supporting notes and reflections, and the data in *Appendix C* was used for triangulation (Stake, 1995; Yin, 2013).

6.4.1 Qualitative coding process

I used a mixed inductive and deductive thematic coding approach for data analysis (Boyatzis, 1998; Corbin & Strauss, 2015). The codebook draws on emergent themes from the completed work, and key factors found in my review of the literature, such as value tensions, emotional state, and major values found in community projects (Boyatzis, 1998; Miles et al., 2014). Through this work, I use a thematic coding approach, thus calculating interrater reliability is not needed, though I am triangulating with additional data and checking with members (Hammer & Berland, 2014; McDonald et al., 2019).

I assembled a preliminary codebook based on my interview notes, previous work, and major themes (discussed below) before coding the interviews using the MaxQDA qualitative coding software. I then expanded and iterated on the codebook as I coded the interviews and further codes emerged (Hennink et al., 2017). Much of the codebook draws on the research questions (relationships with other community members, perspectives on ending) as well as the challenges and opportunities (technical issues, awareness) identified in Pitt et al. (2018) and Pitt et al. (2019).

Some themes that drew on the interview protocol and emerged from the coding process included the *emotions* expressed by participants regarding the end of the project (negative and positive, as well as repeated mentions such as stress and frustration), as well as their descriptions of their *own roles* and *the roles of others* and, of course, *perspectives on* and *ways of ending*. Though I was unable to recruit additional coders given funding and time constraints, I did and continue to discuss findings with other scholars and check back with the interviewees. I explore this further in discussing the validity and limitations of this study.

6.4.2 Data Triangulation

I used the interviews as the main source of information, triangulated with additional data as needed to verify events and timelines (Yin, 2013). Combining the interviews with archival data helps clarify various aspects of the cases (Yazan, 2015; Yin, 2013). For instance, much of

Chapter 3 was detailed and clarified via a combination of the interviews and additional information from grant applications, yearly reports, and other data.

6.4.2 Validity

I am aware that this methodology and approach face some validity challenges, particularly in terms of generalizability to other contexts, and I address them through appropriate structure, definition, and qualitative rigor (Creswell & Poth, 2016). Validity in qualitative research can be complex to define, and even different case study experts take different perspectives on it, with Yin (2013) focusing on parameters, boundaries, and precision, while Stake (1995) emphasizes authenticity and thick description (Geertz, 1973). Meanwhile, Merriam (1985, 2009), falls somewhere in the middle but more towards Stake (Yazan, 2015).

Yin presents validity tests and methods of addressing each from a more positivist paradigm, while Merriam's more constructivist perspective on validity and generalizability is better matched with my own epistemology in this work (Merriam, 1985, 2009; Yazan, 2015; Yin, 2018). Drawing on Yazan's (2015) examination of Yin, Stake, and Merriam, where he posits that it is possible to draw on multiple approaches to case study work simultaneously, I have incorporated a variety of techniques to enhance validity and reliability, though more strongly cleaving to Merriam's views. Using this as a reference point, I can state that I am using member checks and multiple sources of evidence (triangulation) to ensure *internal* and *construct validity* – the extent to which my method and techniques do what they are stated to do. To further address *internal validity* from a more constructivist and pragmatic perspective, I have made my potential biases and positionality clear through my positionality statement, and am grounded in participatory approaches (Merriam, 1998; Schön, 1987; Yazan, 2015). I have also created a logic model to ensure the structure of my study is logically consistent.

In terms of *generalizability*, I am connecting carefully to theory as well as using detailed qualitative analysis (though perhaps not to the extent of textbook *thick description* (Geertz, 1973)) and multiple sites to promote *external validity* – demonstrating how, while not necessarily completely generalizable, my work connects to broader perspectives and can be understood in detail by external reader (Merriam, 1998; Yazan, 2015). And finally, I am developing clear documentation of process and data sources to support *reliability* – to show the logical throughline of my research process, all of which support validity through largely interpretivist/constructivist epistemology in qualitative case study research, as well as some forms of validation that are not incongruent with positivist perspectives.

I have and continue to discuss the findings with the participants who stated that they were interested in engaging in this part of the research, as discussed by both Stake (1995) and Yin (2013; 2018)(Merriam, 1998; Yazan, 2015). Some of this was done during the interview process, confirming details and themes with later participants that were originally surfaced by earlier ones. There is some discussion on the validity and importance of member checks, debating their

utility and potential tradeoffs (Birt et al., 2016; Candela, 2019; Harvey, 2015), however, given that I am doing the majority of the analysis for this study, I feel that, due to the strong community and equity component that I have foregrounded in this work, member checking is key to the process. In my considerations of analytic process, I circle back to the positionality statement near the beginning of this chapter, and the commitments I made there to foreground equity and community voices.

6.5 Findings

The interviews from this study, triangulated with the additional data from these projects, creates an incredibly rich narrative of youth and communities that found their dynamics and relationships changing and growing as they learned from each other and explored the design research process. The data also paints a picture of something that many people during this time experienced: the abrupt and unfair disruption and *ending of things* created by the global pandemic in early 2020. The pandemic certainly had an impact on the data and on this dissertation – I had planned pilot work on ending projects, using co-design in-person at the Science Everywhere site, in the early months of 2020.

In these findings, I will note some key and interesting points of similarity and difference between the projects for a cross-case comparison, then discuss the views on roles and relationships that the interviewees shared. Next, I will tackle the complex emotions that emerged as the participants reflected on their involvement several years later, and how they processed the experience. Finally, I explore their perspectives on endings, and what that means to these community members. The experiences with endings here are varied, from those who departed on their own terms to those abruptly set adrift by the pandemic. In all, these fifteen interviews do not encompass every view on project ending, but combined with the previous work, they inspire the preliminary framework I set forth in Chapter 7.

6.5.1 Cross Case Comparison

First, it is important to note some of the similarities and differences between the cases. Doing paired case studies allows us to see what is consistent and what is not, drawing insights through comparisons. These cases were chosen specifically because of their matching on a number of factors, making the differences all the more apparent and salient to the work.

Both projects were community-partnered informal learning and technology design research projects funded by the National Science Foundation (NSF), and for both many of the participants were at least somewhat new to their roles within the study, including the Principal Investigators interviewed. The timelines of the projects, while not perfectly aligned, also matched up sufficiently to be facing similar technological innovations, challenges, and disasters, including the COVID-19 pandemic (see Table 4 for time ranges).

Table 4 - Case Comparison

Digital Badges	Cross-case	Science Everywhere
1, Seattle area	**Project sites**	2, Maryland and Seattle area[12]
Science center	**Site type**	Public schools, church community
NSF CAREER	**Grant type**	NSF Cyberlearning
2015	**Funded**	2014
$894,984.00	**Funding amount**	$1,419,391.00
Yes	**No cost extensions?**	Yes
2015-2020	**Years in active data collection**	2014-2020
2013-2021	**Initial idea to end of writing**	2011-2023
1	**Principal investigators**	3
Adolescents (high school)	**Youth target ages**	Pre-teens and families
Science center staff	**Community members involved**	Teachers, church leaders, parents
Yes	**Participatory design?**	Yes
Digital credentials to open nontraditional pathways, improve science identity	**Research focus**	Sociotechnical systems for community science identity development
Digital badge system with features for sharing achievements across settings	**Technology design goals**	Mobile-based sociotechnical system and large touchscreen displays for sharing everyday science

Additionally, in both cases, multiple interviewees mentioned that members of upper management at the community sites (school principals, science center leadership and so on) were enthusiastic about the project but generally hands off when it came to encouraging participation and other infrastructural elements. This hands-off approach became a source of frustration when attempting to develop long term plans for the ending process. Endings happened in multiple ways for both cases, with youth graduating or aging out of programs, graduate or undergraduate research assistants graduating or leaving the projects for other reasons, and teachers or staff members changing jobs (a number of which were due to pandemic fallout), sometimes creating gaps where key members of the community were suddenly removed, causing social infrastructures to collapse.

Despite the similarities, there were also some key differences between the cases. While both projects had the element of science identity in their research goals, the focus of the research and design was quite different, exploring different age groups and applications of social technologies. The Digital Badges project was situated in an independent, not-for-profit institution that charged admission, while the Science Everywhere project took place in a church and multiple public schools, revealing differences in infrastructure (the science center was more likely to provide ongoing support for the technology after the research was over – at least until the pandemic hit).

In terms of endings, the Digital Badges project was thrown into immediate hiatus by the pandemic when the science center suspended operations, and then gradually petered out when it became apparent that the science interpreters program was suspended indefinitely and therefore

[12] Seattle area site is the focus of this work, but the overall project model still makes an impact on the outcomes

unable to take over management of the badging system. Science Everywhere had very different scenarios for the two sites. At the Maryland site, where they had been preparing to have the church group take over the activities, they were able to have a virtual summer program in 2020, while the Seattle area site found that online activities were not feasible given the circumstances.

6.5.2 Roles and Relationships

But what of the individuals involved in these projects? How did they see their involvement and the involvement of others? How did they view the overall project structure and the other community groups and partners involved?

Roles

The principal investigators often described their roles as more administrative, focusing on keeping the parts moving and making sure paperwork was filled out and contracts were in. Robin, principal investigator of the Digital Badges project, mentioned feeling like the center of a solar system, while Jacob, one of the PIs of the Science Everywhere project jokingly referred to being the PI as a "pyramid scheme." Trisha, another Science Everywhere PI, mentioned that before becoming a PI she never realized how much administrative work there was and that she much preferred engaging in design work with the kids but knew she had to do it. Meanwhile, other interviewees tended to view the PIs as top of the hierarchy, the decision makers who were in charge. When the PIs described their visualization, they put themselves at the center of the action, slightly towards the top of the hierarchy, while other interviewees put them solidly at the top.

The research assistants viewed themselves as the feet on the ground. Arik (DB grad student) described himself as "Scotch tape" holding different aspects together socially, as the senior graduate research assistant on the Digital Badges project. Meanwhile, Delia, an undergraduate research assistant (SE) described herself as the "hype man", someone who was there to keep the mood up and keep things lively during Science Everywhere after school sessions and family science nights. Alberto, another undergraduate assistant, saw his role in Science Everywhere as someone who was there to interact with the youth and help them learn about science. He specifically mentioned being far more interested in the hands-on aspect of the activities than the writing up of the research.

Research assistants were seen by others as either helpers or, in some cases, as the ones in charge. As Arik (research assistant, DB) and I grew more experienced and Robin (PI, DB) went on sabbatical out of the country, we became the main coordinators of Digital Badges research sessions, and many of the interviewees from the project mentioned that it seemed that we were somewhat in charge and the main point of contact. I was also the only graduate student assistant for the Science Everywhere Seattle area site, and several interviewees mentioned that Jacob (PI, SE) and I appeared to them to have similar roles, though Jacob was technically the PI.

Teachers, staff, and parents seemed to view their role as that of advocates for the youth, or administrative coordinators. Pesky, one of the supervisors at the science center, sat in on many sessions but focused on making sure that the youth had a chance to provide their input rather than joining in the design work himself, which was reminiscent of some of the behaviors seen in Yip et al. (2017) when adults do not view themselves as design partners but more as facilitators. Helena (staff, DB), another supervisor, was unable to attend as many design sessions as Pesky (staff, DB), but was more involved with the backend of the project, attending more meetings with the PI and badge developer. She saw her role as more behind-the-scenes.

In Science Everywhere, Enid (teacher, SE), the technology education teacher collaborating with us in the later years, showed similar characteristics to the traditional scientist role discussed in Clegg et al. (2023) and Chapter 4, though through her experiences she began to encourage the kids to take a more active role in planning and focusing on community building. Meanwhile, Kara (SE), one of the parents involved, played more of a *communitizer* role – focusing on bringing people together (as discussed in Chapter 4 and in Clegg et al. (2023) – though she also had an engineering background. She tried to recruit more families to come to family science nights from the local elementary school and said she would have liked to take a more active role in planning and recruitment.

Some interviewees, particularly the youth, explained that they viewed their role as consumers of the content or technology that the researchers brought. Andy (youth, SE) described his visualization of the project as the researchers in a board room coming up with the technology while the family science night families were consumers of the science content. He noted that he did not view this in a negative way, this is just his way of viewing the project structure. Others described hierarchies or systems that resembled the ones described by the youth in Pitt et al. (2017), as discussed in Chapter 4, with the researchers somewhat higher in the hierarchy, PIs at the top and other researchers further down, but with some collaborative and back and forth movement depending on the situation.

These roles and hierarchies seemed to be somewhat dynamic, depending on expertise and type of session, reminiscent of the relationships discussed in Yip et al. (2017), as seen in Chapter 4. Youth like Brennan (DB) were pleased to have their voices heard in the design process, and he stated that he sometimes felt like a researcher or scientist when engaging with the design work. Overall, interviewees seemed to position themselves within the project ecosystem but did tend to silo themselves to particular roles, not expressing a feeling of fully equal partnership. This may be attributable to a variety of factors, including participants moving in and out of the project, level of comfort with research overall, and so on. These aspects and facets of identity as they develop within research project contexts are complex and may warrant further exploration of identity formation, particularly among youth, when involved in research, in order to better understand what is needed for moving towards equal partnership.

Relationships

As we saw in Chapter 4, the dynamics and relationships between different groups and individuals can have some impacts on the identities involved and equitable practices of design research. In the Digital Badges project, the staff interviewed were friends with each other who socialized outside of work. Pesky (staff, DB) also became good friends with Arik (research assistant, DB), based on similar backgrounds, and they remain friends even though they have both since moved on to new jobs.

The science center staff members and Robin (PI, DB) had a collegial relationship, and Arik (research assistant, DB) referred to Robin as a mentor and "auntie" who was very supportive. Arik also made friends with one of the administrative assistants at the science center, and still remembers the conversations with her fondly. The youth mostly saw the supervisors as friendly, but still in charge, while the researchers were perceived as friendly outsiders who brought snacks. Over time, as the teen designers became more acquainted with the researchers, the relationship became more open, but still maintained some professional distance, as discussed in Chapter 4, since teens are very hierarchy aware.

In the Science Everywhere project, the relationships were partially affected by the larger ecosystem of the school environment and location. Trisha and Jacob (two of the PIs, SE) had met when Jacob was a doctoral student and Trisha was a postdoc at the same university, and they were good friends and collaborators. The librarian and teacher (Kacey and Enid, SE) expressed somewhere between a collegial/collaborator and client relationship with the research team, working together but also acting as the client of the services being provided by Science Everywhere. Kacey (librarian, SE) mentioned that, looking back, she would have liked to be more hands on and have more activities in the library throughout the day, and Enid (teacher, SE) similarly mentioned that she was frustrated about not being able to get more kids involved and that she would have used different strategies in hindsight.

Kara (parent, SE) had a friendly relationship with the research team and the staff members, enjoying the chance to connect to the community, as the school did not have a Parent-Teacher Association, which meant there were not as many opportunities for parent involvement. The undergraduate research assistants (SE) formed friendly and collegial bonds with the other community members and researchers, but they did not become particularly close. Both expressed interest in knowing how the youth were doing but did not maintain any close ties with the teachers or youth. Delia (undergraduate researcher, SE) and I did become friends and socialized outside of the project after she had graduated, but mostly before the pandemic. Andy, one of the Science Everywhere youth, did not express any strong attachments to anyone else involved, aside from one other youth who he regretted not connecting with at the time before she moved to another school after middle school.

Given how these interviewees felt about their roles and relationships within their respective projects, how did they feel about the project's conclusion? How did their experiences end?

6.5.3 Emotions and Endings

Memory and emotion are strongly tied, and thus the long-term impacts of a project may be partially attributable to how the project and its ending made the community partners *feel*. Understanding how people feel about the ending of a project helps us not only understand how the ending of a project may be improved to be more justice-oriented and satisfying, but also to acknowledge the very human aspect of endings and finding closure. I asked participants about their experiences with the ending, their emotions at the time versus their emotions about the project now, having had time to reflect, and what they would like to see in future ending processes in research projects like the ones they had experienced.

Perspectives and feelings on ending

The dominant emotions expressed by participants were satisfaction, sadness, and frustration. While overall the experiences that the interviewees had with the project were positive and they were satisfied with what had been done and achieved through the collaborative work and experiences, the way the projects had ended left a lot to be desired. Additionally, those whose endings were not related to the pandemic had mixed feelings about their departure, though they felt their time was well spent. These different experiences with endings also gave me insights into the many ways participants, researchers, and projects as a whole might experience endings.

Arik (research assistant, DB), for instance, had to step aside from working on the project due to teaching and his own dissertation work. He brought on another graduate student to help and "replace [him]" but still felt somewhat bad for leaving the project and the friends he had made, though he believed his decision was the right one. Arik also had an interesting perspective on the impact of the pandemic, stating that this meant that in some ways the project "couldn't fail" since it was halted by external factors. Arik's discussion brought me back to the theme of pressure for constant success in academia, as presented at the very beginning of this dissertation. Delia and Alberto, undergraduates on the Science Everywhere project, knew that they would graduate, and felt satisfied with their contributions, though Delia admitted to being a bit sad and reflected on not being aware at the time that "this session would be the last one." Brennan (youth, DB) had also graduated from high school and thus the science center program before the pandemic struck, and mentioned that while his overall memories were fond, he did regret not being able to see more of the outcomes of the project.

For those who did remain involved through the start of the pandemic, there were a series of negative emotions surfaced, not all related to the projects but tied up in their experiences at the time. Kara, the SE parent, was sad that things could not be moved online but mentioned that the experience inspired her to do more experiments with her children at home. Both Pesky and Helena (staff, DB) were let go from the science center when it suspended operations, and up until

that point Helena had been working closely with Robin (PI, DB) to develop a maintenance plan for maintaining the badge system after it was handed off to the science center. All involved expressed frustration and some sadness that this plan fell through. Enid and Kacey (teacher and librarian, SE) at the middle school in which Science Everywhere took place were somewhat saddened by the ending but overall expressed more frustration with school administration not being more actively involved in promoting and sustaining the activities in the first place. Additionally, Enid and Kacey both ended up leaving the middle school and eventually getting positions as specialists in the same district, Enid in Career and Technology Education and Kacey in Digital Learning, thus further separating them from the project.

Robin, as the PI of the badge project, stated that at the time there was worry and an overall feeling of being stressed and overwhelmed. At the time of the pandemic, she was in Europe and ended up remaining there for an extended duration due to several factors. She also felt some guilt for leaving the project largely in the hands of the graduate students but was secure in their ability to handle the project. In terms of the ending, she was somewhat disappointed in what happened but now takes more of a philosophical approach, considering the lessons learned and what can be applied to future projects.

Jacob and Trisha (PIs, SE) had different experiences based on the two sites. In the Seattle area, things were already coming to a close, with many activities at the school handed off to me for planned pilot work for this very dissertation focusing on co-design activities for families around how they wanted to see the project end (which naturally had to change when the school shut down). Thus, Jacob mostly mentioned the processes of eventually going to get the large displays back from the school and regretting not being able to say goodbye to the families. Meanwhile, the Maryland site was in the process of transitioning the program over to the church group, of which Trisha was also a member. Due to the affordances and infrastructure of the site, they were able to have an online summer program in 2020 (discussed in Chapter 3) but did eventually have to wind down the project as the funding concluded, so while Trisha still felt the impacts of the pandemic, she was pleased with what they had managed to achieve. She did mention that while the Science Everywhere team had planned an online resource of informal science activities to serve as a resource and archive for the families and communities long-term, plans fell by the wayside as graduate students and professors became involved in other projects.

Desires and plans for ending

Many of the participants had difficulty articulating what exactly they wanted out of a community-based research ending process. This is not entirely surprising, as discussed throughout this dissertation how little research has been done in this area, as the ending of these projects is not usually prioritized. Those who did provide specific details often compared them to end-of-year celebrations in schools and other programs. Enid, the teacher at the middle school (SE), mentioned wanting the researchers to present more of the work to the community, a

sentiment echoed by Brennan (DB), one of the youth at the science center. Kara (parent, SE) and Pesky (staff, DB), as well as others, called for some form of party or other celebration, such as a dinner with everyone in the community that involved sharing memories and findings from the work. Pesky and Helena (staff, DB) mentioned that it would be nice to have some sort of event at the university, sharing the researchers' space as the youth had shared theirs, since one of the goals of the project and the science interpretation program was college readiness.

The researchers, when asked about what they wanted for ending in the community, focused on figuring out what the community members wanted, suggesting design work or communications with the community to determine what was appropriate and equitable given constraints. Enid and Kacey (teacher and librarian, SE) also expressed a desire for more communication and information about the ending of the project to allow for more preparation and understanding. Both had some familiarity with acquiring smaller grants for school resources and wanted to gain a deeper understanding of the project cycle. Sally, the evaluator, felt that she, in some ways, did experience a certain amount of closure when working with projects as the one who prepared some of the final reports and discussed the projects with principal investigators. This somewhat mirrored the reflections of the PIs, who seemed satisfied and philosophical regarding the work overall, even with the pandemic impact. This suggests that the reflective process of creating concluding documents may be of use not only in maintaining a paper trail, but also formalizing the ending process. In all, the participants provided me with some practical and tangible ideas for developing the ending framework, in addition to a number of further questions to think on.

6.6 Discussion

As I've explored in the findings, each individual involved in this study had a complex relationship with the project, with their own way of defining the roles, interactions, structure, and exits or endings. From this data, there are several elements that arose repeatedly as essential for developing a clear, feasible, and justice-oriented ending process for community-based technology projects involving youth.

In this section, I focus on the role of *infrastructuring* on the sustainment and conclusion of the project, and what types of resources are necessary. I also look at the impacts of *burden* and *memory* on the ending process, as these relate to infrastructure, capacity, and the long-term impacts of community-based projects. Finally, I discuss some of the ways of *ending* explored in this study, as well as the reflective process of this interview study itself.

6.6.1 Infrastructuring

The role of infrastructuring in community-based projects is commonly discussed, from DBIR and RPP to public health (Chen et al., 2023; Greenberg et al., 2020; Penuel, 2019). In this study what particularly stood out was not necessarily a need for technical infrastructure support, funding, or space (though those are also crucial) but the key roles of personnel and time. When key individuals moved on from the projects or changed jobs, things were often thrown into mild

disarray, with momentum and institutional knowledge lost, even with documentation and notice. The first teacher we worked with at the Science Everywhere Seattle-area site left the school to travel the world and could not be contacted (though an attempt was made for this study), Pesky (staff) in the Digital Badges project moved to another part of the science center and couldn't attend design sessions as often, and Arik (research assistant, DB) eventually had to leave the project for other research and teaching work. All of these departures, a form of ending, had significant effects on the projects, requiring more time and adjustment getting others used to the change and up to speed. The tendency of workflows to revert to the norm – the ways that things had previously been done – once the active parties enacting the intervention depart should also be considered, as occurred in a study on the professional development of mathematics teachers (Fishman et al., 2011).

Changes in participation also meant that newer participants and community members who were less familiar with the initial design process no longer felt as much of a sense of ownership and collaboration, seeing the technologies introduced as products from the research team, not their own community, and thus no longer felt as compelled to incorporate them into their activities. This aspect of ownership and identity can also be thought of as some of the infrastructure that holds a community-based technology project together, particularly one that tackles equity issues. Trisha (PI, SE) addressed this point in an interview, wondering if projects should be sustained if the project community has completely turned over (graduated, changed jobs, and so on). Is it really the same community at this point? Do they feel the same way about the project?

While the technical and monetary elements of infrastructuring are more well-known, considering their impact on the ending of projects is worth examining. Sometimes, it may not be possible or even worth it to maintain technical infrastructures if the funding and the key individuals are no longer there. And given the rapid advancement of technologies and the tendency of planned obsolescence for hardware in recent years, it is easy to end up with useless technology in relatively short order. But it does behoove the researcher to find a way to maintain documentation and information of the design work as an artefact and evidence of the collaboration for the community, though even that may not be able to exist in perpetuity, as we have already discussed with the difficulty of maintenance. In some ways the situation reminds me of Shelley's "Ozymandias," trying to figure out what the legacy of the work will be in the future (Shelley, 2014).

How should we make decisions around how we, as researchers, end projects? What can the infrastructural breakdowns that can be found at the end of projects tell us about what our commitments are? And how do we resolve or change those infrastructural issues as a project ends? Based on this work, a clear understanding of the community, their resources, and their relationships are key to untangling this issue.

6.6.2 Burden and memory

In considering infrastructure and relationships, it is also important to be cognizant of the larger ecosystems in which the communities and individuals exist. Even with knowledge systems and distributed cognition via technologies (Hutchins, 1995), humans are limited in their capacities, memories, and executive function (Gestsdottir et al., 2022). Teachers are overburdened and stressed (Fishman et al., 2011), adolescents are dealing with complex times in their lives (K. Davis & Weinstein, 2017), and researchers, particularly in their early careers and graduate school, are dealing with many responsibilities and mental health struggles (Forrester, 2021; Murguía Burton & Cao, 2022; Puri, 2019). Given these circumstances, it is important to consider burden when approaching ending projects from an equity and justice perspective.

From this study, I found that many participants, dealing with the pandemic and other things going on in their lives, had a difficult time remembering details about their experiences. We worked together to surface names and specific events, drawing on records and sharing anecdotes. However, their impressions of the project overall were generally positive, they found the experience fun, enriching, and valuable. As researchers, we must understand what communities, and particularly youth, will take away from our work with their long memories.

6.6.3 Maintaining, reflecting, ending

Based on the experiences of the interviewees and what we know of the role of infrastructuring, I believe that developing guidelines and structure for designing for the end of projects could be beneficial to all community members at a number of levels. For instance, creating infrastructure for a shared base of knowledge – such as a website, wiki, or other collaborative effort – would assist with the communication of shared knowledge and the development of an institutional (or in this case community) knowledge base. This might look like, for the Digital Badges project, a website or wiki focusing on the history of the project along with input from the original youth co-designers, and guidance on how to use and discuss the badge system. In the Science Everywhere project, it might include documentation of the design process as well as science activities to do at home with everyday materials and how to discuss the scientific concepts, connecting back to the initial principle of promoting science in everyday life. While this does create some initial burden of setup, I believe that it would support identity and relationship formation, allowing community members to feel that they were participating in knowledge production and helping maintain the goals of the project (Simpson, 2005).

This type of knowledge structure is also part of the planning for ending, as it can create a shared resource as part of the legacy of the project both for the community and the researcher. While the researchers may have archives of data and academic publications, many of these are not accessible to the community both from a practical standpoint (data security, paywalls) and a language standpoint (academic terminology), so this approach also promotes equitable practices. In many cases, the community has very little besides their experiences and perhaps the prototype technology, which can be valuable, but as I have discussed, is less useful without the relevant supporting infrastructure. Considering the many ways and types of ending can be daunting,

particularly for early career researchers, but the constructs of the research process can also be used to aid us here. There are a number of ways to use existing research design structures to move towards just practices, which I will discuss further in Chapter 7.

Additionally, I believe that the reflective role of the interviews I conducted for this study was a positive one, somewhat similar to the satisfaction that Sally (evaluator, DB) found in the ending reports. Many participants thanked me for bringing them back and said that they enjoyed recalling and discussing their previous experiences. It also gave them a sense of closure as the pandemic had disrupted their experiences. This comes back to the concept of *reflection-on-action* (Schön, 1987) and how endings and reflection can be cathartic and satisfying. I am often reminded of this quote from a podcast that I heard early in my graduate studies:

> *"When someone leaves your life, those exits are not made equal. Some are beautiful and poetic and satisfying. Others are abrupt and unfair. But most are just unremarkable, unintentional, and clumsy." – Griffin McElroy (McElroy, 2017)*

This quote is not only poetic, but also helps frame some of the ways of ending I explore through this dissertation. Some endings are planned and carefully conducted, while others, like the pandemic, are more abrupt. While I cannot cover every contingency, I can at least use what I have found out about endings through this research as a step towards ending projects in a more equitable way. Considering the ways in which people navigate their experiences, people have ceremonies for major events in their lives, including endings. Sometimes these are celebrations, for graduations, retirements, new jobs, and so on. Sometimes they mourn or remember tragedies. But this closing of a phase is common to many events in our lives, and thus we might consider how it can be incorporated into the lifecycle of our research projects. In Chapter 7, I present the initial framework design for incorporating the ending process in a mutually beneficial and justice-oriented manner, followed by further discussion including the limitations of this work, key takeaways, and plans for the future in Chapter 8.

Chapter 7 Framework Design

This dissertation research reveals a need for support in the process of designing community-partnered technology projects that end well. As I have discussed in previous chapters, ending takes many forms, and many community members and researchers are already overwhelmed with demands on their time and responsibilities. This creates a wicked design problem (Rittel & Webber, 1973) of balancing a careful and deliberate equitable ending process with the awareness that many in the community, including youth, are already overburdened. How then should we create change without making this scarcity of time and resources worse? To address this issue, I have developed a methodological framework grounded in the understanding of ending based on the theoretical perspectives of interdisciplinary fields (values analysis and reflection from VSD, infrastructuring in both information science and learning sciences, power and agency from feminist perspectives) and the empirical findings of my work. This framework is specifically designed to be implemented *alongside* existing workflows, with *flexible* action items, *paced* and *guided* reflection, and many opportunities to *revise* plans for ending. Additionally, in building the ending process into the entire lifecycle of the project, it does require slightly more time spread over the project timeline, but greatly reduces the burden at the end of the project itself.

7.1 Thematic incorporation and transformation

The first stage in developing this framework was to take the major themes and critical aspects from the previous studies and consider which ones could be converted into actionable components of the design research process (Boyatzis, 1998). From there, I drew on what researchers and collaborators are already *obligated to do* in terms of IRB and funder mandates, as well as institutional requirements and standard practices.

Drawing on the previous studies and building on the literature in participatory and value sensitive design, I have created a preliminary framework for the End of Projects, to be *added to existing research processes*. This framework focuses on phases of the research process (Boser, 2006; Simpson, 2005), with existing workflow items to build on, actions that the researchers could potentially take, and key questions to be answered regarding the design process in each phase (Schön, 1987). These will help focus the researcher, designer, or community member on the longer term and conclusion of the research, taking inspiration from Yoo's work on multi-lifespan design reflection (Friedman & Yoo, 2017; Yoo et al., 2018). In section 7.4.3, I discuss the future iterations of the design and in section 8.3, I explore additional potential work from this initial design.

7.2 Framework design considerations

In the development of this framework, I applied my knowledge of design considerations to the parameters and needs of the communities, examining the design domains and focusing on feasibility (Schön, 1987). In keeping with the tripartite methodology of VSD, though not

precisely following the structure, my interview study and previous works serve as conceptual and empirical investigations, conducting stakeholder analysis and engaging directly with the community groups (Friedman & Hendry, 2019).

I knew that the theoretical and methodological underpinnings that I wanted to incorporate into this design needed to be done in such a way that the – to put it in tech terms – user experience would be straightforward, albeit not frictionless. While I see researchers as the most likely audience for this framework, I also want it to be clear and accessible to those outside academia. The goal is to encourage reflection and thoughtful friction, such that some choices *should* take time and thought because they are difficult choices worth the time (Tomalin, 2023). What then came to mind is the set of three questions that Wendell Berry poses in *Preserving Wildness*, and though the focus in that essay is on our relationship to nature, which also connects to some of the discussions of eco-feminism discussed in Chapter 2, I find them useful in building out the framework in a feasible manner:

> *"What is here?*
>
> *What will nature permit us to do here?*
>
> *What will nature help us to do here?"* - *(Berry, 1987)*

If "here" is the design research space and "nature" is thought of as the current research ecosystem, we can draw on the assets of the communities, including the research community, and consider what the existing structure of the research lifecycle can support and what will work well in this context (Clegg et al., 2023; García, 2020). Thus, I propose a framework that is flexible and adds to existing research processes to encourage reflection, collaboration, and equitable practices, rather than trying to drastically reshape existing workflows, which I know from prior research is challenging (see Chapter 5).

7.3 A Framework for Ending Well

Below is the framework, presented as a table. The intention is to create something that is flexible and malleable to fit the needs of any long-term community-based technology research project, with the potential to adapt to other projects as well. It breaks the project lifecycle into four main stages: Ideation, Beginning, Throughout, and Ending, with Throughout being a cyclical element that can be repeated on a cycle that works for the duration of the project, such as yearly, every six months, or another interval.

The "Builds on" column presents a number of activities and processes in which the research team and/or community are *already* engaging. The "Potential actions" are intended to be incorporated or adapted to these existing processes such that it is less like adding a whole new process and more like adding a new technique or set of questions, more easily incorporated into

workflows. Each stage is accompanied by "Guiding questions" to help researchers and community members reflect on and explore important concepts and goals at each point in time.

The intention of this framework is to provide scaffolded supports for those who wish to incorporate more justice-oriented perspectives into their community-partnered technology work particularly when working with youth, as well as those who wish to develop clearer ending processes for their long-term projects. It is my hope that this framework might continue to be iterated on and expanded to more contexts and fields.

In Table 5, I present the stages as well as the existing activities, tasks, and questions. This framework can be adapted and adjusted to begin at any point in the research cycle, though incorporating it from the very beginning of a project's development will provide the most support and opportunities for incorporating an equitable and justice-oriented approach throughout all aspects of the project. After the framework I discuss types of endings one might see in this process as well as how a researcher or community leader might engage with the framework in their community-partnered technology design work.

Table 5 - Stages, actions, and guiding questions for the End of Projects Framework

Stage	Builds on…	Potential actions/tasks	Guiding questions
Conceptual/ideation	• Grant proposals • Literature reviews • Logic models • Budgeting and resource allocation • Personnel onboarding • Administrative planning • Startup processes	• Stakeholder analysis (VSD) to determine who key community groups are, as well as views on technology (as relevant) • Value scenarios (VSD) to envision potential outcomes • Positionality statements for awareness of dynamics, particularly when working with youth • Setting of norms and values within the research team • Consider budget items for maintenance contracts or ending processes • Incorporate funding for ending processes into the grant proposal(s) • Identifying additional funding for ending processes if needed	• What are the research goals with respect to community impacts and justice? • What are the potential ways of ending given what is currently known? • What are the time and resource constraints? • What is the overall timeline for this work? • If working with youth, how can youth voices be incorporated?
Beginning/forming relationships	• Introductory activities • Orientations • Meetings • Contracts and consent procedures • Establishing rapport	• Co-design of communications plans and information infrastructure, including youth voices • Plain language consent and information documentation,	• What does the community want from this work? • How do we work towards mutually beneficial systems and norms?

	• Identifying key individuals • Introducing research and technology terminology and concepts	for youth and others in the community • Agreements for sharing of research findings • Plans for checking in with different groups and individuals • Introducing the ending of the project as a future event • Mutual norms setting, particularly around youth and technology • Engaging with culture and activities of the community	• Who are the key individuals to sustaining this work? What happens if they ***leave***? • What do we need to know about the community? • What are the community's experiences with ending?
Throughout (cyclical/intervals)	• Yearly reviews to IRB and grants • onboarding of new community members • consenting processes • new research activities or stages • yearly welcome or kickoff activities (such as the beginning of a new school year) • yearly wrap-up activities (such as the ending of a school year)	• Co-design of information systems, archives, and public-facing communications • Initial designs and brainstorming around endings, to be revisited periodically • Celebrating or acknowledging ***individual endings*** as they occur (graduations, job changes) • Regular check-ins and conversations (formal or informal) with groups of community members • Revisiting agreements and consent processes	• What has changed since the last reflection period? What do you see in the previous reports and reflections? • What relationships and roles have formed, changed, increased, diminished, or otherwise altered? • What does the community want or need now? How has that changed from before? • What are the ***potential endings*** at this juncture? Have their been any endings? What have they been like?
Throughout (project cycles)	• As above (iterative)	• As above (iterative)	• As above (iterative)
Ending(s)	• Final project reports • Publications • closing with the IRB • closing with the granting agency • leaving the field or research site • handing off or removing the technology	• Co-design of final information system, presentation, or other media • Co-design of ending event(s), making sure to incorporate youth voices • Focus groups or interviews to reflect on the project • Collaborative decision making around the future of the technological and/or design interventions	• What does the community want and need from this ending process? • What do you need from this ending process? • Are equity and justice being foregrounded in the ending process? How? • What are the ways of ending that are occurring here?

		• Retrospective analysis and conversations with the research team	• What comes next?
Post Reflection	• Additional publications • Future work that builds on previous • Further service with community	• Reflection-on-action • Following up with the community and particularly youth, updating on outcomes • Engaging community in upcoming work	• Do you feel that this process promoted equity and justice? Does the community? By what measures would you consider your success or failure? • Do the community members feel heard, respected, and like collaborators? • What is the research legacy within and outside of this community?

7.3.1 Types of endings

As I've explored throughout this dissertation, there are many types of endings that can occur and *will* occur in any given community-partnered project. It is within this ending space that there is an opportunity to think about the dimensions and features of these endings, and how they are further complicated by the dynamics that exist in community-partnered technology work.

One component of this is the ***who*.** For whom is this an ending? Is a single person leaving, such as the undergraduate researcher Delia in Science Everywhere or the Digital Badges youth Brennan? The entire research team? Or is everyone concluding the project together? A single ending, a *microending* as it was termed in a meeting with colleagues, might seem like participant drop-off well-known to researchers, but could also have huge ramifications. If the key champion of the project in a school leaves, this can irreparably damage the ecosystem. So, we must consider not only who is leaving but who is impacted by that leaving and what that might do to the infrastructure and dynamics across the system of the project.

Another key component is ***how*** and ***when*** the ending occurs. In this dissertation, the focal projects were cut short by COVID-19, which is not something one generally expects or plans for. However, natural disasters and other emergencies are not unknown to research ecosystems, and individual emergencies are even more common. A planned ending, with preparation and celebration, may seem easier to address, but what of an unplanned exit or ending? Well, we (as researchers, community leaders, humans) must contend with a certain level of uncertainty, and awareness and preparation will aid us in this struggle. Throughout the framework I include opportunities to consider the types of endings, and the unplanned ones I particularly urge you to consider. A graduation is foreseeable, but youth may move schools at any time. Additionally, emergencies and tragedies can be found in many communities, and we never know when someone may simply stop showing up. So, consider, how does the community deal with loss?

How do they celebrate? What does an ending look like *in this space*? What do we do after an unexpected ending? While no researcher or community member can see the future, we can prepare for the uncertainty.

If we do have control over the ending process, rather than it sneaking up on us, we might exert some agency over the ***what*** and the ***where***. Endings and departures can take many forms, from a boisterous graduation celebration to a quiet email in the middle of the night. Understanding the dynamics and relationships in the community with which the research group is partnered can help us understand what form those endings will most likely take. The parents and teachers from our projects wanted celebrations and showcasing of achievements, while youth wanted a sense of ownership and closure. From this we can also consider *endings* a theoretical space for design, in which the framework provides a basis for designing and constructing endings that the community wants, focused on equitable practice.

7.3.2 Using the framework

This framework is intended for implementation and use in community-partnered design projects, particularly those involving youth and/or family co-design of technologies. Those interested in using the framework should begin by reviewing the entire framework and determining whether it is a good fit for their work in terms of theoretical framing, values, aims, and structure. While I have intentionally designed it to be flexible, it may not be feasibly applied to all projects, particularly given the resource constraints I have discussed in this dissertation. I can try to make something lightweight, but I cannot make it entirely weightless.

From there, the research team should assess which procedures in the research process they are already committed to and how components of the framework could map on to their existing commitments. The Potential actions are deliberately ***potential*** and should be used as they apply. This framework was designed with the knowledge that everyone involved in these projects is overwhelmed, and thus there is an expectation that not every action suggested in the framework will be implemented. The research team should ideally establish a mutual and clear understanding of the framework and how it will be used in this project with each other as well as the key members of the community with whom they will be collaborating. From there, an overview of the process should be shared with the community, in plain language and an approachable manner.

Researchers will likely need to spend some time figuring out the exact pacing and iteration of the activities and actions posed by the framework, as each community will have their own rhythm. I strongly advise developing a clear information system and repository as soon as possible, accessible to both the research team and the community, as this framework relies on being able to revisit and update previous designs and reflections. This will also facilitate the ending processes that this framework emphasizes, as well as general project operations. Ideally, once in

place, this framework will add to the existing processes of the design research in such a way that enhances, rather than adds burden, but that remains to be seen.

7.4 Discussion

In this work, I draw on substantial precedent and a broad set of literature to support this design theoretically, empirically, and methodologically. As with any design, there is potential for iteration, but I believe that the guidance provided by this framework could be of great help, particularly to those who wish to incorporate more equitable and justice-oriented practices into their work but are unsure of where to start.

7.4.1 Why a framework?

As previously discussed, it seems like everyone involved in the research process is overwhelmed to some degree. Much of the time, the development of community-based projects involves a great deal of trial and error for early-career researchers, even if they have advisors and the literature to fall back on. This framework promotes *reflection-in-action* and *reflection-on-action*, scaffolding metacognitive processes that may go by the wayside when a researcher is overwhelmed (Schön, 1987).

By foregrounding the ending and outcomes throughout the process and encouraging the researchers and community members to revisit goals, consent, agreements, and other aspects, the framework promotes the development of deeper partnerships and shared mutual understanding of the design and research processes. In Chapters 4 and 5, I discussed how some of these relationships developed over time, and in Chapter 6 I explored what happens to these relationships at the end of the project. This framework helps not only build projects that end justly and well by providing guidance and incorporating community perspectives, but also promotes the development of equitable relationships by building clear steps and actions into a reflective overarching structure.

Also, in a pragmatic sense, this framework makes the ending process visible, explicit, and practical. As I discussed in Chapter 1, this has not generally been the case. Thus, by using the theory and method of design research to develop a methodology that emphasizes ending throughout the design process, we incorporate ending on a meta level.

7.4.2 Limitations, future iteration and design

As discussed in Chapters 4-6, the limitations of smaller qualitative case studies do result in less generalizability, though they can provide rich insights. This framework, built on multiple of those studies, faces some of the same issues. Since I am the sole designer of this initial framework, it is limited by my perspective and knowledge, however, I do have future work planned to address these issues. In doing so, I will be able to refine and iterate on the framework, as well as discuss possible implementations.

Having developed a framework and guidelines based on my empirical research, the next step is to invite interested participants from the case studies and others in the community of practice who wish to participate to engage in a series of design workshops. Much like with codebook development, I expect the framework development to be an iterative process, with many possible framings and designs (Boyatzis, 1998). I plan to recruit three to five individuals for each workshop, possibly arranging multi-session series based on availability and interest. The workshops will likely take place online unless all participants are located in the same geographic area, and I have conducted design sessions online previously (Pitt, Hock, et al., 2021).

Over the course of two to three hours per session, co-designers will be invited to discuss the initial ideas I have developed and work together to refine and improve the framework. Drawing on my previous experience with co-design work (as discussed in Chapters 4 and 5), I will work to ensure all participants are able to voice their design ideas and collaborate. These additional insights will serve both as a form of in-depth member checking and as a PD session to more directly involve the stakeholders in this work (Birt et al., 2016; Stake, 1995), building the validity of the framework and the research.

There are also further studies related to this work such as framework implementation and surveys that I discuss in the next chapter as part of the future work for this dissertation as a whole.

Chapter 8 Discussion & Conclusion

In this final chapter, I bring the components together so that we can all exit gracefully. First, I will discuss some connecting threads across the studies, then cover limitations and future work. After that, we move to broader implications and then conclude.

8.1 Connecting threads

In this dissertation we move from *reflection-in-action* to *reflection-on-action* to considering the end and the potential forms it takes (Schön, 1987). I might call that *reflection-on-**future**-action* or *reflection-on-**potential**-action* or perhaps simply *reflection-on-endings.* To get to the end of the story, we must start at the beginning. In Chapter 4, the focus is on the current state of relationships and community groups, the snapshot of the interactions and intersections of ecosystems, communities attempting to learn each other's languages (Bronfenbrenner, 1977; Lave & Wenger, 1991). Roles and identity and ownership within projects are complex and shifting, as are the relationships between the community members and researchers in the design spaces (Yip et al., 2017). From these studies, we found that relationships can and do change over time, but current PD practices may not be enough to create equitable experiences. While design processes may never truly be equal, there are ways to understand the dynamics inherent in projects and shift them towards are more equitable outcome.

In Chapter 5, I explore more of the time dimension, in addition to the role of the technology and impacts of implementation on the existing system. This work explores the opportunities and challenges of long-term work, as well as the considerations for technology design research in communities, and how there are a number of barriers to sustaining it. Alongside the project ecosystem we also consider the ecosystems of the individuals involved in the project, such as the youth (Pitt, Bell, et al., 2021). Through this work at the science center, we identified key sociotechnical, sociocultural, and technical challenges, which helped us understand the infrastructural burdens such projects can have on the communities in which they exist. We connected the potential impacts of the badge project not only to the youth and the science center, but also the broader ecosystem in which the project existed, noting how the negative or positive perceptions of the technology could have significant impacts on long-term sustainability.

When contemplating complex dynamics and how multiple individuals and their communities intersect and bounce off of each other, I always return to Bronfenbrenner's (1977) ecosystem model, shown in Figure 10 with the chronosystem time dimension added, from (Santrock, 2008). If we picture the time dimension as continuing down, as a long wire or stream of water, permeable but still distinct, what might it look like as it intersects with the ecosystems of others over time? Consider the branching and merging of a river, with each rivulet and aspect of the stream a different individual, merging and splitting and moving across time. And each of those rivulet tubes represents an individual ecosystem, like in Figure 10. Each collision or merging of the water is like encountering a new person or community and changes the individual's

ecosystem in some way. A group might flow through time together as a single river for a while, but eventually spilt off into their own paths.

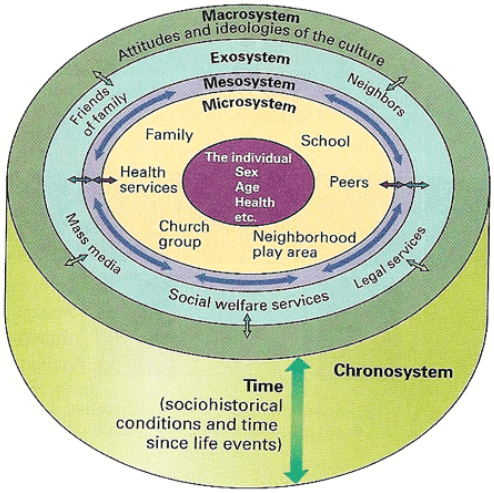

Figure 10 - Bronfenbrenner's ecosystem/ecology model, from Santrock (2008)

In Chapter 6, we examine the branching of that river, the ways in which the lives of the community members and the community as a whole shifted and changed during and after the course of the project, as well as their feelings and opinions on the ending process. We can also consider the flow of information throughout the sociotechnical systems designed and implemented in these projects, the information ecology at hand that exists within the mesosystem of the individual as well as across the multiple ecosystems in their communal existence (Bronfenbrenner, 1977; Star & Ruhleder, 1996). Understanding how people in these community-partnered projects experienced the ending of their involvement as well as what they desire in an ending process provided strong empirical evidence of a need for further understanding and design of a clear and mutually beneficial ending process.

Drawing on those previous study chapters and their findings, Chapter 7 then focuses on the empirical data combined with the literature of Chapter 2 to propose a scaffolding framework for ending projects justly and well, drawing on a variety of theoretical perspectives and also presenting a theoretical positioning for endings as a potential design space and crucial component of the design research process. This framework strives to encourage reflection but also action, pragmatic and practical applications of the theoretical construct of endings as explored through this work.

8.2 Limitations

As discussed in the individual chapters, the studies presented here have some limitations given the qualitative nature of the methods. However, given the in-depth relational nature of the work, I found the methodology to be appropriate and consistent with my theoretical perspective. As

discussed in Chapter 6, case studies have limits to their generalizability, but I have used a number of measures to establish validity.

Much of this work is based solely on two research projects, and as I discuss in 8.3 Future Work below, it is my goal to see this expanded and revised for broader applicability. The samples, while appropriate for case studies and interview studies of this nature, are not as geographically and otherwise diverse as might be useful for generalizability. Additionally, the type of projects focused on—two long-term community-partnered informal learning projects that involve the participatory design of sociotechnical systems, funded by the NSF—is quite narrow.

The fact that this final study and framework development was conducted and designed by a single author is also a significant limitation, though member checking was employed. As discussed in 8.3, I plan to address this with further iteration and exploration of the concepts and design.

Pandemic Impacts

Much of this work was also influenced by the COVID-19 pandemic. Both focal projects had their trajectories significantly shifted by this event and I would be remiss not to acknowledge the potential effects on the findings. It is impossible to know the full impact of the abrupt endings in these projects. Additionally, the pandemic created a gap between the ending of the projects and the final interviews, as the chaotic and complex pandemic environment made developing, coordinating, and contacting participants difficult. Traumatic experiences also have effects on memory, and between the delay and the pandemic, it is possible that participants did not remember all of their experiences. However, I took steps to help participants recall their experiences and many of them were able to recount their participation in detail. As for the pandemic impacts, sometimes endings are unexpected, and that is something to be considered when designing for the end. Like I discussed in Chapter 7 when delineating types of endings, it is best to be prepared, but maintain an awareness that research with communities out in the world always holds a level of uncertainty that cannot be fully countered, even by meticulous planning.

8.3 Future Work

While several studies are present in this dissertation, there is still substantial work that could be done to better understand the ending of projects. I am particularly interested in the iteration, revision, and testing of the framework, which I hope will engage with broader communities of academics both within my home disciplines and outside of them, as well as community groups. I want to engage in further interdisciplinary conversations, as I am sure there are more ideas and perspectives that I have yet to explore. While I am looking into avenues for funding further research in this area, I believe that researchers could incorporate the framework and findings discussed in this work to the benefit of their partner communities and the work. Another possible application is that granting agencies might use some of the principles and actionable processes I put forth in the framework to update their proposal requirements, requiring at least some

discussion of how the research team plans to end the project (or if they don't plan to, what they will do instead) in a mutually beneficial and equitable manner for the community that they're partnering with.

I would also like to see or conduct broader studies of the ending process, using surveys and other methods to allow for increased participation, as the current studies are limited to specific contexts. Ideally, this would be an international study, or at the very least on the national level, gathering information about funding, communities, approaches, and more. There is also a lot of available data on the school system or organizational level that could be used to explore the impacts of different ending processes at a larger grain size. I would also like to see if this work could be applied to additional contexts in technology research, beyond the informal educational technology contexts discussed here. I encourage other scholars to build on this work, or even push back on it, alter it, and incorporate it into other frameworks, perspectives, or paradigms. One of my goals with this dissertation is to be in conversation with the broader academic community.

There is also the theoretical and methodological angle of meta-design, the design of design research, and how what we use as our research methods can be further used for designing the structure of the project itself. I think that this has the potential for incorporating marginalized and non-dominant ways of knowing by moving away from focusing solely on the most common Western-dominated approaches to research and design and bringing in other approaches (Escobar, 2018). However, this will face difficulties as introducing shifts in processes is notoriously difficult as I discuss in Chapter 5. I am particularly intrigued by this avenue of research.

Coming back to the discussions in Chapter 1 around moving fast and breaking things, as well as AI harms in the workplace and communities, I look to the potential of this work in mitigating AI related harms and issues, such as privacy and ownership. What could practitioners and researchers of AI and machine learning do in their projects to consider what happens with their models and data when the active portion of the project is over? I know conversations surrounding AI ethics are ongoing, as multiple independent research organizations, governments, companies, and others all argue and battle for control over how to best use the technology and whether or not the systems are violating current law. There could be more focus on the longer-term impacts and how best to mitigate potential harms on a community level. Thus, I believe that there are a multitude of ways to extend on the current work, whether through further academic explorations of the concepts or direct application of the framework.

8.4 Broader Implications

Currently, community infrastructuring and service work – key to strong project endings, as previously discussed – are not particularly rewarded in academia, particularly for early career researchers (Penuel & Gallagher, 2017). These early career researchers and graduate students

may want to work towards justice in community research, but are on shaky ground themselves, on tenuous funding and driven by the job market. These researchers may have power in their research projects but not in the larger academic system. A conundrum indeed. This may be why, in part, that a large percentage of graduate students struggle with mental health issues (Forrester, 2021). These mental health issues also create strain and cognitive load, further contributing to the cognitive load of early career researchers (Murguía Burton & Cao, 2022). Hence, I feel that developing frameworks and approaches like the ones discussed in this dissertation are an important component of alleviating that strain.

Through the framework I have designed, I hope to spark conversations surrounding the ecological and relational considerations in ending long-term projects, as well as encourage technology-oriented fields to engage in more interdisciplinary conversations surrounding their work. As we have seen throughout this dissertation, sociotechnical systems serve as potential connectors but also dividers, especially those that are introduced to communities without infrastructural and other support, crumbling when the researchers depart (Simpson, 2005). Considering the ending here is key, as we need to confront the idea that the technology may have to depart along with the researchers to minimize the burdens and harms on the community.

We also come back to the modern digital divide, where there are still vast areas without broadband service, and youth who are familiar with cell phones but perhaps not how technologies function or how to remain safe online (Chatlani et al., 2023; Logler et al., 2020). As touched on in 8.3 with regards to AI, technologies have the potential to amplify existing issues, such as television and film writers and actors being underpaid and now threatened with being replaced with generative tools (The SAG-AFTRA TV/Theatrical Negotiating Committee, 2023; Toyama, 2015). With these considerations, we can further explore the importance of acknowledging the potential long-term impacts of technology interventions, and the commitments we make to the communities with whom we partner.

From an information science perspective, this dissertation not only focuses on the design and implementation of sociotechnical systems, but also the flow of information in the ecology of the project, whether through digital channels or face to face (Star & Ruhleder, 1996). Information flows to different individuals and communities, being interpreted and transformed through the process. Understanding this flow of information and how to ensure that everyone receives the information they need in the modality that they need it is part of the framework that I have developed, as many times community participants are omitted from the final audience in terms of the findings (Denzin & Giardina, 2016).

Thus, it is my hope that this work has implications not only for HCI, information science, and the learning sciences, but also for further interdisciplinary work, research design, and the structure of academic projects more broadly. Many fields engage in work with communities, and I challenge

researchers, including myself, to engage interdisciplinarily and take steps to make their work more just and end well, whatever that means for the communities in which they do their work.

8.5 Contributions and Conclusion

Throughout this dissertation I have explored the multi-disciplinary area of community-partnered technology design projects, particularly focusing on the design of informal learning technologies. Through qualitative research using case studies and interviews, I have explored the roles, relationships, and identities of community members; the challenges, opportunities, and trade-offs of implementing technological interventions in communities over the long term; and how community members perceive and understand the ending of these community projects. From these studies, I have developed a preliminary framework drawing on democratizing and value-oriented design perspectives to support the design of research projects that end justly and well.

Through these studies and this design work, I make the following academic contributions as part of this dissertation:

1. I contribute empirical insights on the development and changes within relationships and power dynamics throughout the course of a community-based educational technology design project; the challenges, obstacles, and opportunities at the conclusion of a project life cycle; and the different ways *ending a project* occurs, whether for an individual or on a larger scale.
2. I contribute theoretical insights drawing on the learning sciences, value sensitive design, and other fields to develop a more comprehensive approach to ending community-based technology research projects, as well as the different meanings of *ending* such projects, to create a better understanding of and definition for *ending* in design research.
3. Finally, I contribute a theoretically grounded methodological framework for designing projects involving long-term technology development with community groups that assists researchers in planning for and incorporating the ending of the project, derived from the findings in the previous contributions.

This manuscript brings together research focusing on the ways in which researchers in community-partnered technology projects can strive to understand and improve their relationships with and within the communities they work, particularly regarding how to sustain and *end* projects. Through this work and the contributions therein, I have provided support for the following thesis:

> *Understanding the role of community relationships in the life cycle of community-based projects can support the development of best practices for ending projects, creating a healthier and more just research ecosystem.*

While there is still much work to be done in shaping a more just research ecosystem, this work provides actionable recommendations, as well as empirical findings and interdisciplinary theoretical perspectives to move towards this goal.

The sun sets, the credits roll, the book comes to an inevitable end. It is my hope that this dissertation sparks conversations within various fields as well as among communities that partner with research teams. This is *an* end, but not *the* end, as there is always more to do and discover.

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Appendices

Appendix A.
Dissertation Studies Summary Table

Research Questions	Studies	Summary of findings	Contributions
RQ1: What factors in the project ecosystem affect the development of relationships and roles in and amongst community groups? How do these relationships change over time? (And how does this impact the progress and conclusion of the project?)	**Pitt & Davis 2017 (power dynamics in projects)** *Yip et al. 2017 (relationships between youth and adults in design)* *Clegg et al. 2023 (adult roles and changes over time)*	• Co-designers were highly attuned to power hierarchies • Each group brings specific culture and vocabulary that must be communicated • Long-term development of rapport reduced distance but did not eliminate it	• Empirical contribution: factors influencing the dynamics of projects involving teens in the development of technology • Empirical contribution: understanding of the change in dynamics, roles, and dispositions between groups over time
RQ2: What are the core opportunities, challenges, and trade-offs in sustaining or concluding longer-term research implementations, particularly focusing on community- partnered research?	**Pitt et al. 2019 (long-term implementations)** with Pitt et al. 2018 (*youth training and ownership/agency)* *Pitt et al. 2018 (external perspectives on implementations)*	• There were technical, sociotechnical, and sociocultural challenges to long-term badge implementation, and the relationships with the various groups were key to successful sustainment • Aiding youth in training each other on the system increased feelings of ownership and empowerment.	• Empirical contribution from external industry and academic perspectives and long-term implementation study on challenges, opportunities, and trade-offs • Empirical contribution from youth training study on youth empowerment through giving responsibility
RQ3: What do researchers and communities need to better support and facilitate their involvement in community research that ends equitably?	Final study: Retrospective case studies (cross-case) of projects via interviews with networks of community members, development of framework.	• Infrastructure is easily disrupted • Emotions regarding the ending of projects are complex and nuanced • Desire for more openness, sharing, and communication • The many meanings of ending in community-based projects	• Empirical contribution from case study interviews on support and facilitation • Theoretical contribution on ending as a design space and perspectives on ending • Methods contribution of framework

Appendix B.
Logic Model for Final Study

Research Questions	**Method/ Participants**	**Strategies/ Instruments (interview questions, other data)**	**Analysis**	**Contributions**
RQ3: What do researchers and communities need to better **support and facilitate** their involvement in community research that **ends equitably?** • Additional support for: • RQ1: Factors in relationships / change over time • RQ2: Core opportunities, challenges, and trade-offs	Two case studies of long-term community-partnered projects involving participants from the following categories, 6-8 participants per case (12-16 total), ideally involved when the project concluded: • Staff (teachers, librarians, supervisors) • Parents • Principal investigators • Research assistants • Evaluators/grants administrators	Interviews with participants from each case, triangulated with archival data (publications, grant applications, demographic information, etc.)	1. Triangulation of interviews with supporting data (*Appendix C*). 2. Qualitative coding of interviews with a combination of inductive and deductive coding, drawing on previous work themes and the interview protocol, as well as emergent themes. 3. Development of a framework from the themes to organize them into actionable guidelines. 4. Member checks and follow-ups to ensure accuracy and validity of findings.	• Contribution: Empirical exploration of project dynamics over time from the perspective of key groups • Contribution: Implications for theory around ways of ending and ending as a design space, drawing on VSD and PD as well as other fields • Contribution: Methodological framework with theoretical grounding

Appendix C.
Data Sources for Triangulation of Case Studies

Project	**Data Sources**
Science Everywhere	• Previous papers: (Ahn et al., 2012, 2014, 2018; Bonsignore et al., 2014; Cabrera et al., 2018; Clegg et al., 2023; Mills et al., 2018, 2019; Yip et al., 2016) • NSF Reports • Video annotations and brain dumps • Correspondence • Meeting notes • Interviews with key individuals (archival and new) • Design artifacts • Additional documents from second site
Digital Badges for STEM Education	• Previous papers: (A. Bell & Davis, 2016; K. Davis et al., 2018; K. Davis & Klein, 2015; K. Davis & Singh, 2015; Pitt, Bell, & Davis, 2018; Pitt, Bell, et al., 2021; Pitt, Bell, Strickman, et al., 2018; Pitt et al., 2019; Pitt & Davis, 2017) • NSF Reports • Design session memos • Correspondence • Meeting notes • Interviews with key individuals (archival and new) • Design artifacts • Technical documentation • Logic model

Appendix D.

Interview Protocol (Main Version) - End of Projects Interview Protocol v.2.2

Preamble

Hello! Thank you so much for agreeing to participate in this study. Today we'll be talking about your experiences with [Project name] and how you felt about the project and the process of being involved overall. There are no right or wrong answers, and I want to know your opinions as they will help me understand how the project progressed as well as how things can be improved for this type of project in the future. If at any point you don't want to answer a question, feel free to skip it. You can end the interview at any time. If you need further clarification, please ask. This interview will be recorded and transcribed but will remain anonymous for any publications or presentations from this research project. Do you have any questions before we begin?

Okay, I will begin recording now. *[Turn on auto transcription and cloud recording.]*

Interview Protocol

Larger question area	**Interview questions (will be adjusted for different participants)**	**Notes**
Intro questions	1) Could you state your name for the recording? 2) When were you involved in [Project name]? a) How many years? b) From when to when? 3) How did you first get involved in [Project Name]? a) Researcher: How was it developed? b) Participants: How did you hear about it? c) What made you decide to get involved?/What drove you to do this project? 4) How would you describe the overall goals/point of [Project name]? a) *Participants: Do you remember how you thought of the project when it was first explained to you?* b) Was this clear to you?	

RQ#1: How does the interviewee understand the project ecosystem, their role in it, and the power structures that exist?	5) When you think about your role or position in the project, how would you describe it to yourself? To others? a) Do you feel like this was clearly defined? 6) Could you describe the structure of the project for me? a) Who are the main groups involved? b) Who are the main people involved? c) Could you draw a diagram or describe a visual of how you see the project working? 7) Was someone in charge of the project? [Probe?] a) Who would you say is in charge of the project, if anyone? b) Do you think there is a hierarchy? c) If so, where do you see yourself in it? *8)* Where do ideas in the project come from? *a)* How does information travel in the project? *b)* What communications have you received and how?	

RQ#1: How does the interviewee feel about their role over time and connections to the project?	9) Do you think your role in the project has changed over time? a) How do you feel that it has/hasn't? b) Did you wish it had/hadn't? c) What would the ideal role have been? 10) Which aspects of the project do you feel most connected with? a) Are there aspects that felt disconnected from you or the project overall? b) Are there aspects you wanted to connect with more? 11) How would you define the relationships you have with different aspects of the project structure that you described earlier?	
RQ#1: How does the interviewee view the other members of the research ecosystem?	12) Who did you interact with most throughout the course of the study? a) Was it one main person or multiple people? b) *What was your relationship with that person like?* 13) Who did you consider key to the study procedures and activities? a) *When you described the hierarchy earlier, who were the key players?* b) *What was your relationship with those people like?*	

RQ#2: How did the interviewee prepare for, navigate, and process the end of the project?	14) Did you know that the project or your participation in it would end? a) *When did you know?* b) *When were you told or notified?* c) *Who did you receive this information from?* 15) How far in advance did you know the project would end? a) *What preparations were made for the ending of the project*? b) How did the COVID-19 pandemic affect this process [if not mentioned]? 16) How did you feel when you first learned that the project would end? a) How do you feel about it now? 17) [mostly researchers] Were you involved in the ending of the project in any way? a) Did you do any preparation for the ending of the project? 18) What would you have done differently (in regards to the project ending or other processes) given the option? a) What would you have wanted others to do differently? b) What preparations would you have wanted? 19) Do you consider the ending of a project to be an important aspect of the overall planning process? a) *Looking back to the beginning of your involvement, was the end of the project of importance/concern?*	

RQ#2: What are the potential broader impacts of this project or initiative? What are the opportunities and benefits?	20) Were project findings shared with the community and the public? a) *Did you hear about the publications or presentations made about this project?* 21) Do you believe that the project had significant impacts and implications for the community or world? a) Why/why not? b) What are they? What would have helped? 22) Would you have liked to know more about this project? a) *Is there an additional way you would have liked to have participated?*	
RQ#3: What do members of the community want from a research partnership?	23) Going into this project, what did you want to get out of this partnership? a) What did you hope would happen? 24) What would be your ideal outcomes from this research partnership? a) *What did you hope to achieve by being involved?* b) *What did you want for your community?*	
RQ#3 – **Researcher**: What are the main goals of researchers involved in a research partnership?	25) What were your research goals going into the study? 26) Did your research goals shift throughout the course of the study?	

RQ#3: What does the interviewee consider to be the most important practical considerations in the process of ending a research project?	27) If you were to re-do this process, what would you do differently in respect to ending the study? a) *Are there any changes you would have made earlier?* 28) What advice would you give to another researcher or community member who wanted to engage or participate in this type of work? a) Would you participate in another project of this type in the future?	
RQ#3: What did the interviewee get from the project vs. what they wanted to get out of the project?	29) What did you (personally) get out of your participation in this project? a) *Do you feel like the project was an equitable experience overall?* b) *Did it feel like certain people got more benefits out of the project?* 30) Was this different from what you wanted to get out of this project? 31) Reflecting on this experience, is there anything you want the researchers (or future researchers) to know about working with communities in this way? 32) Is there anything else you'd like to share about your involvement in this project?	

Post interview/wrap-up
Thank you so much for participating in this research. Your input is incredibly valuable as I'm working to improve the community partnered project research process, particularly the ending of these types of projects. I will be in touch with your gift card shortly. Would it be okay to follow up with you to confirm that I'm interpreting your answers correctly or if I need any additional information? Do you have any questions for me?

Thank you again for your time.