Understanding the Role Fluidity of Stakeholders During Assistive Technology Research "In the Wild"

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ABSTRACT
Deploying novel technologies requires the coordinated efforts of the research team, research participants, and a variety of community members and project stakeholders. To ensure that the project is completed successfully, these disparate groups of people engage in articulation work, which is the meta-work that supports the use of collaborative systems. In this paper, we examine the articulation work surrounding the deployment of systems that have found limited long-term adoption: assistive technology. Specifically, we examine three research deployments of a collaborative game for children with autism. Analysis of the articulation work performed during these studies demonstrates how research deployments of technologies create conditions in which stakeholders must take on additional roles to make the deployment work. By understanding the articulation work surrounding deployment studies engendered in this role fluidity, we can improve both research design and the analysis of data emergent from these studies.

Author Keywords
Deployment; articulation work; collaboration; assistive technology; role fluidity; autism

ACM Classification Keywords
H.5.3 Group and Organization Interfaces *Computer supported cooperative work,* K.4.2 Social Issues *Assistive technologies for persons with disabilities*

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INTRODUCTION
Researchers focusing on the uptake and use of assistive technology "in the wild" have found limited long-term adoption, partly due to the complexity, required adaptations, and social acceptability of these systems [7,19,28]. To the degree that they are adopted at all [7], assistive technology use is surrounded by an additional factor—the need for support from others, often in the form of articulation work [26,35].

Articulation work is the meta-work surrounding collaborative technology systems to make them work [36], typically including a *"set of activities required to manage the distributed nature of cooperative work"* [36]. The articulation work of supporting users with disabilities requires their caregivers to engage with assistive technology as secondary users [14,18] and as "IT support" [5,7]. In research studies, this phenomenon can be even more profound, with the research team themselves doing additional work to support the deployment of a system and interacting with participants, their family members or teachers, and other community members. In considering research deployments as cooperative work, articulation work refers to the ways in which a wide variety of actors influence when, where, how, and who engages with a research system.

Although articulation work is well studied in collaborative work contexts (*e.g.,* [27,34]), it has not yet been examined in light of the deployment of assistive technologies as we do here. Field deployments have increasingly become central to assistive technology research, because they provide important data about the context within which an assistive system might be taken up. Field deployments "provide rich data about how closely a concept meets the target population's needs and how users accept, adopt, and appropriate a system in actual use over time" [29]. Given the challenges in adopting assistive technology, these approaches are promising for understanding the adaptation and appropriation processes around assistive technologies that might make their adoption possible. However, they are not without their own challenges. As researchers who have conducted numerous deployment studies previously [4,16,19,24,25,32] and written about their advantages [29], we find it essential to look critically at the work that surrounds this method and the ways in which such work might influence our findings. Specifically, we examine the articulation work surrounding the deployment of Zody, a collaborative assistive and therapeutic game for teaching social skills to children with autism.

Field deployments require researchers to accomplish a variety of types of articulation work, such as "adjusting the data collection, study plan, or other factors"[29]. Negotiating the terms of research projects evolves in practice. In this work, we highlight how the negotiated and competing roles each stakeholder group played impacted the practices and outcomes of the deployment studies, which in turn invoke important considerations for study design and analysis of resulting data.

In our reflection on three deployments of Zody, we saw substantial articulation work that is often overlooked as a critical part of assistive technology evaluation and adoption. We also observed the impact the surrounding articulation work (*i.e.,* teachers encouraging students to play together when students wanted to play alone) had on the children's experiences with the technology and on the results we saw from the deployments.

Deployment studies by their nature require substantial buy-in from community partners and other collaborators who are not professional researchers. However, what is interesting here is the way in which these same people—including the children—must take on different roles simultaneously to accomplish the work of running a smooth deployment study. Maintaining multiple simultaneous roles requires fluid transition from one role to another as the context of the setting shifts between research to the usual day-to-day activities. Therefore, we suggest a new concept, *role fluidity,* as a previously unconsidered form of *articulation work* that surrounds the work of a deployment study. For example, the children morph from students to research participants and back again with varying levels of rights, autonomy, and engagement in each of those roles to meet the demand of the current moment. Likewise, researchers move from scientific observers to technical support to instructor in the space of minutes to benefit the study. Role fluidity demonstrates that each stakeholder assumes the shape of the current role they are expected to be in a given moment or activity, shifting back to another role when the most immediate need changes.

This paper contributes to discussions of both the deployment of novel technologies as a research method and articulation work as a practice surrounding assistive technology by explicitly examining the articulation work around the use of assistive technologies in field deployments. The concept of role fluidity extends our understanding of articulation work and highlights the importance of considering the impact of changing roles during research studies in the wild. A better understanding of role fluidity can lead us toward the goal of more robust research deployments and valid analysis of the research outcomes as well as deeper understanding of the ways in which assistive technology systems are often inherently collaborative.

RELATED WORK

This research touches on two important and overlapping areas, articulation work and collaborative games for children with autism. First, we provide an overview of research related to collaborative children's games designed to facilitate cooperation between users with autism during the use of a system. Then, we broadly discuss articulation work and related concepts around technologies that require collaboration to put or keep a system in use. We then relay challenges in articulation work to research practices.

Collaborative Games for Children with Autism

Collaboration is a common target behavior for children with autism because collaborative activities provide the opportunity to work on social interaction, comprised of understanding social norms, turn-taking, joint attention, etc. The children's social interaction skills can be supported by innovative technology leveraging mechanisms of collaborative technologies, such as supporting collocated users simultaneously using a single device. Several technology projects have addressed social relationship skills by developing tools for collaboration in which multiple students share the same device (*e.g.,* [3,13,14,17,23,30]). Touchscreens and other shared interactive surfaces "allow face-to-face interaction and multiple simultaneous inputs from individuals acting independently or as part of a group" [23], making them particularly compelling as platforms. Because of their inherently collaborative features, touchscreens have been used in research studies to teach a variety of social skills to children with autism. In particular, the high levels of structure that can be imparted using touchscreens have been shown to improve student performance in joint activities [13,17]. For example, Piper *et al.* developed and evaluated a tabletop system to support the teaching of turn-taking called SIDES [23]. By using a closed system in which behavior choices were prescribed and limited to a few options, clear visual directions, and consistent feedback, SIDES not only encouraged turn-taking during the game but improved social skills overall for participants. Although these large-screen projects are promising, at this time such hardware is not cost effective for most schools and clinics.

With the advent of the tablet and other mobile shared surfaces, smaller scale collaborative technologies are much more likely to be used beyond research settings. Additionally, these devices' small size might force children to become more comfortable with close physical proximity, a challenge for many students with autism. One such project, the Open Autism Project, focused on using multi-touch tablets to encourage social interactions "through creative, expressive, and collaborative activities" [18].

One way to scaffold children's collaborate play is through technology enforcement. Technology enforcement requires a certain action by children that demonstrates collaboration before enabling certain features. Examples of technology enforcement include the requirement to play using cooperative gestures before making progress, such as requiring two people to be in a photo before enabling the camera button. The developers of Incloodle , a camera taking application, found that requiring two faces be in the same picture frame before enabling the camera button helped children play with one another if they needed scaffolding. Additionally, previous studies have found that children wanted more enforcement from technical systems [3] and performed better than with human enforcement . However, the articulation work that went into the research study to create such productive deployments around assistive technologies for collaboration remains unstudied.

Articulation Work

When working on a project with multiple stakeholders, division of labor and clear articulation of the rights for each stakeholder limit the kind of natural imbalances that can emerge on teams with different levels of power and prestige [35]. When considering the composition of deployment teams—particularly those that include children and people with disabilities—these issues of power, prestige, and preconceived notions of competency for the other stakeholders [20] become even more central. Tensions emerge around the provenance of ideas, the distribution of effort, and conflicting values. "Articulation work" enables teams to overcome these challenges, but does so through the addition of overhead [27] in the form of analysis of the culture and politics of the work [34].

Coordination among stakeholders to make collaborative work successful results in patterns in articulation work that have often been described in binary groupings (i.e., local and global levels; inter and intra organization level; formal or *ad hoc*; routine or non-routine [1]). In the Abraham and Reddy inter- and intra-departmental coordination model, decisions at the global level (i.e., administration decides to go live with a new technology) may prove to be disruptive at the local level (i.e., staff is not yet trained on the tools). Decisions made by one party to "temporarily solve" an issue can result in further problems and "re-coordination of activities" for the other department [1]. These inter departmental conflicts or "cross boundary breakdowns" have bearing on innovative technology deployments in the wild as research activities are shared across organizations and stakeholders. In this work, we see articulation work carried out between stakeholder groups, but within each stakeholder who takes an additional role created by the work of participating in research.

As HCI researchers, we must acknowledge the articulation work that goes into creating, using, and researching technology [27]. Articulation work affects the research process. Similar challenges in organizations regarding both within and between group dynamics occur in research processes, yet not always delineated in the same way such as by differences in stakeholder group. Dachtera *et al.* (2104) found that different perspectives across research collaborators are not necessarily a "simply academic vs. industry dichotomy," but rather tensions that take rise from individual stakeholder group attitudes toward a research approach and differing research interests or expectations toward the research project [6]. Negotiated terms of project management occur more formally at the onset of a partnership, as a first order of business—"first order articulation work" [36]. First order articulation work here refers to "the planning and coordinating of who will be doing what, when, where and how etc., before the actual project begins [36].

Although many tensions can be addressed through first order articulation work, other challenges arise at the point the collaborative technology is put into use—called second order articulation work [36]. This work consists of handling missed responsibilities, re-delegation of unfinished jobs and all the crucial moves during the project that are necessary so that the project doesn't break down, or managing situations when technology does break down, as well as how the uptake of a collaborative technology differs in the wild form the expected trajectory.

Understanding how researchers navigate the challenges presented once a technology is put into place is essential to understanding the context of adaptation and adoption as well as ensuring that the inherent influence of researcher -led articulation work is accounted for in our research findings. As part of the research team, researchers have a variety of paths they can take in understanding their place in their work, such as: introspection, inter-subjective reflection, mutual collaboration, social critique, and discursive deconstruction [12]. Here, we provide details of our path by reflecting on the articulation work across three deployments.

We explored the articulation work of each stakeholder group (including the research team) around the use of Zody, an iPad application that encourages collaboration and social interaction between children with autism. In our work, not only were the children enlisted to cooperate during the collaborative play activity; children were also actors in the articulation work that occurred around deployment. As children were the intended primary users of the system, their needs and wants were in conversation with the roles of the other stakeholders and researchers, resulting in a negotiated deployment configured to multiple stakeholders' needs. Furthermore, the teachers and therapists negotiated the conditions under which the fieldwork was conducted, to meet the aims of research as well as the needs of their classrooms. Echoing the "dual nature" of articulation work that occurs at both local and global levels [1,11], we build on prior work by focusing on the articulation work of three different stakeholder groups (*i.e.,* researchers, teachers, children) during three different deployments to illuminate field deployments' complexities in the wild and the challenges that occur during the process, thus impacting the results. We ask: 1) How do multiple stakeholder negotiate field deployments, and 2) How do deployments create a need for role fluidity?

STUDY SETTINGS AND METHODS

Over the course of one year, we deployed Zody at three sites with 49 children and 12 adult caregivers. In this section, we describe the three sites of deployment, technology deployed, methods of setting up and conducting the three deployments, and our approach for analyzing the dynamic, context-specific articulation work that we observed. We describe the reflection on articulation work observed during these studies and demonstrate how this work indicates the need for and presence of role fluidity in the deployment of technological systems.

Collaborative Tech: Zody Experimental System

Zody is a prototype collaborative iPad game that supports cooperation in real time. The goals of this game design were to support collaboration and cooperation, and to demonstrate the development of better social reciprocity, social communication, and problem-solving through relationship-based interventions [33].

Several combinations of cooperative gestures support two players engaging in an action to realize a shared goal.

Zody employs different two-player "cooperative gestures," through which the system interprets the gestures of more than one user as contributing to a single, combined command" [21]. In this tablet game, cooperation and collaboration are supported through mechanics, such as simultaneous finger presses, differing player roles, or encouraging discussion to support social interactions. This structure created a role for each player as well as, recommending that players work together. The Zody game notably focuses on co-located players, making a video game social in face-to-face space. Additionally, the game provides options for cooperative play that are predictable (game mechanics provide options instead of a teacher prompting the same behavior) in a preferred modality (video game). The researcher selected the technology because collaborative play is a frequent target skill for children with autism, and an iPad game is a preferred mode of play.

Site Descriptions

The same version of Zody was used across three unrelated field sites. Each site provided a unique research setting, with different personnel. The first and last authors were involved in the design of each empirical study. At each site, use of the Zody game varied substantially, providing a diverse dataset through which to understand articulation work and its role in deployment studies (see Table 1).

Public School

Zody was first deployed at a special day class in a US public school, with children with mild to moderate learning

Site	Users	N	Facilitators and Materials	Procedure
Public School	Children ages 8-12; All participants had educational and parent-reported medical diagnoses of Autism-Spectrum Disorder (ASD).	8	• 1 Special Education Classroom Teacher • 2 School Psychologists/Research assistants • 1 Researcher • 3 dedicated iPads • 3 dedicated Lego sets • 3 cameras	• Facilitation of the deployment by researcher/school consultant; coordinated with the teacher and school psychologists • Introduction of Zody Game and Study orientation to students • Partner assignment of students • 4 Weeks of collaborative play (alternating weeks between iPad game and Lego build sets for 3 times a week for 10 minutes) • Participant pairs played with Zody a total of six, 10-minute sessions with data collection and video recording. • 30 minutes of free play time during orientation to the study
Private Summer School	Children ages 6-9, All participants had educational and parent-reported medical diagnoses of Autism-Spectrum Disorder (ASD) and/or ADHD.	35	• 1 School Director (oversight) • 1 School Psychologist (oversight) • 4 Staff members with teaching credentials training • 1 Researcher	• Facilitation of the deployment by researcher and director of summer school • Introduction of game to staff and children • Researcher downloaded iPad on 50 school devices • Free use during 3 weeks of summer school activities • Researcher invited to observe 10 minutes per grade once a week
Private Summer Camp	Children ages 6-12; All participants had educational and parent-reported medical diagnoses of Autism-Spectrum Disorder (ASD).	6	• 1 camp leader • 6 Staff members with behavioral training • 1 Researcher • 1 camera	• Facilitation of the deployment by researcher and leader of a 3 week summer camp • Researcher downloaded game on 10 camp devices • Video recording of Probing • Free use during 3 weeks of summer camp • Researcher present daily for 1 hour

Table 1. The site, users, facilitators, and procedure for each of the three deployments of Zody.

challenges and autism. The self-contained special education classroom activities were based on the individual education plans of its current students. Instruction was provided across individual, small group, and whole group activities. Eight children, ages 8-12, consented to play together with an assigned partner for 10 minutes three times a week across four weeks. In this study, iPad play was compared across the randomly assigned pairs to building Lego play sets, which occurred during alternating weeks.

Private School

The second site was a private, university-affiliated special school for children with learning and behavioral challenges (namely autism and ADHD) for first through fifth grade. The school's behavioral approach promotes self-awareness and self-control by providing explicit rewards for self-monitoring and for maintaining expected behaviors. The study was conducted during the summer school session. The summer program was run as a typical school day, with blocks of academics and social skill practice as well as recess and breaks. Thirty-five children, ages 6 to 9, were provided the option to play at break time across 3 weeks, if they earned "good behavior" points.

Summer Camp

The third site was a summer camp for children with autism. As a summer camp was primarily focused on social skills, this camp provided another type of opportunity to explore the use of Zody in a less academic, yet therapeutic, setting. Participants attended the full day camp for fifteen days. During a typical day at the summer camp, campers would rotate through thirty-minute group activities aimed at playing together (*e.g.,* field games such as kickball, relay races, balloon toss, dancing, water play, and indoor games like board games, Legos, cars, arts and crafts). Therapists prompt social skills such as initiating, maintaining, and ending activities smoothly between campers, and supported conversation between campers. Six campers, ages 6 of 12, consented to participate in technology probes with a partner during one of the daily free choice play breaks.

During deployments, we collected substantial observational data, logs, self-report or teacher reports to examine outcomes related to socialization and collaborative play. Results of in game use from the first study appear in [4]. However, when we analyzed the data across these studies collectively, we found evidence of a large amount of articulation work worthy of additional reflection.

Analysis

In this section, we describe our reflective approach for applying articulation work to understand the processes and practices surrounding three deployment studies. Here, we describe both the first and second order articulation work observed across the three deployment studies.

To begin our analysis, the first and last authors first reviewed interviews, videos, evaluation questions, and field notes from each deployment individually and discussed them in relation to each project alone. Based on preliminary results from this analysis, the first author then crafted a detailed description of each study and its results to serve as common ground for the rest of the research team. She then collected and combined the empirical data and shared these along with the site summaries with the remainder of the research team.

The entire team then reviewed and analyzed the data using constant comparative technique to identify patterns in the data [9] and view in comparison to existing articulation concepts, resulting in evidence of the planning and coordination of the deployment (first order articulation work), how breakdowns of both the technology and processes were handled (second order articulation work) [27,34] and a previously unconsidered strategy--role fluidity.

FINDINGS

Across these three sites, the first order articulation work to set up the studies resulted in three distinct research study designs. In this section, we present the first order articulation work that reveals the shaping of these arrangements. Secondly we discuss how formal roles negotiated at the outset (first order articulation work) morph, change, and conflict during the implementation of the study (secondary articulation work)—resulting in the need to move fluidly among dynamic roles. These roles shifted because of the different conceptualizations each stakeholder group had around the purpose of the technology and the need to incorporate the researcher's conceptualization into their behavior during specific research tasks.

First Order Articulation Work

Across the sites, the formal work of making the initial contact with sites began similarly. Either the first or last author had previous communications with the director at each field site, facilitating an initial email to gauge potential interest in a new project. Each director then invited the researchers to provide a staff orientation to the project. The study design evolved across each site as the use of the technology was negotiated. For example, the public school site agreed to a four-week quasi experiment (see[4] for in-game results) that included the support of three researcher facilitators and research materials *(i.e.,* lead research and two school psychologists all employed by the district) to implement the study procedures; the private school site requested that researcher upload the iPad game and visit the site for brief check ins; and the camp welcomed the researcher to probe daily during free play. Participant selection also varied. In the public school setting, consented participants were randomly assigned to a partner by the lead researcher whereas in the private school, the teachers permitted the children's play the game only if they turn points and picked a partner, and at the camp, after consenting, the therapists identified pairings of campers to put together. Lastly, the coordination of technology use was discussed before deployment and varied from only being used in the presence of the researcher in the public school setting to earned use at the private schools where the teachers decided it should be earned for collaborative use during a play break, finally to the camp where the game was available during the multiple free break times and partners where suggested by staff during the times the researcher was present. Data collection methods varied. In the public school setting, two researchers set up video cameras collecting minute-by-minute data that was also used by the staff for the student assessment. At the private school, staff permitted the collecting field notes reflecting 10 minutes per week drop in visits to observe, meet with teachers, and at the end of three weeks, and survey the teachers. Lastly, at the campsite, the lead researcher video recorded and collected field notes and made observations during the time allotted for technology probes at camp.

Second Order Articulation Work

Second order articulation work consists of handling missed responsibilities, re-delegation of unfinished jobs and all the necessary moves during the project that are necessary so that the project doesn't break down, or managing situations when technology does break down. By analyzing three research deployments of the same technology, we can see not only the wide variety of study designs form first order articulation work but also a nuanced type of second order articulation work. In particular, these findings highlight a new kind of second order articulation work—role fluidity—that results from the necessity for people to occupy multiple roles in support of a single research deployment. Acknowledging and understanding this type of articulation work is essential for complete assessment of outcomes of deployment studies.

Resolving Tensions through Role Fluidity

The second order articulation work surrounding these deployments had the incidental effect of creating a secondary role for many of the stakeholders. The deployment created unaddressed work, unexpected tasks, or tensions around different conceptualizations of the system that required stakeholders to move fluidly from their regular work to the work created by the research. In this section, we describe some of the most common dual roles and the resolutions of these roles in practice.

Teacher Becomes Research Facilitator

Teachers served as community partners in the research alongside their primary roles as instructors, who work to maintain positive and productive educational environments. A "paradox of participation"--when researchers seek a collaborative experience yet can not escape that they are the driving force behind the work [2]—occurred in the case of the private school where the school's mission was to provide highly individualized and systematic instruction and earned rewards yet the research task was to explore collaborative play. The mis-match in mission created by the deployment created tension that is apparent in the comment from a first grade teacher who said *"not all of my kids got the game loaded on the iPad (there were technical problems) which I think was a big reason why the game didn't catch onto much in our class."* The technical challenges he describes were related to his concern that adding a new game might impact the existing software on the iPads for his class, as relayed to the researcher later through the school psychologist. However, in the interests of maintaining the relationship and the collaboration, in the interview he described these as technical challenges. In other words, in his role as a teacher he gave priority to the existing classroom setup but in his role as a research collaborator he reported the problem as technical.

Similar tensions occurred in the public-school study—which was by far the most structured of the three studies in its design—the teacher reported promising the children they could complete the Lego set after the study ended. Here the teacher reconciled the desire of her students to keep playing with the researcher's request to keep the materials separate until the study was completed. There is some limited evidence to suggest she also allowed the children to play with the Legos between sessions during the study. However, she did not share this directly with the research team; the reports came from the children. These stories potentially indicate how she not only moved fluidly between the roles but also may have actively altered the study design and reported potentially inaccurate study data in the interests of satisfying her goals as both a teacher and a research collaborator. The lack of explicit knowledge about this from her also provides insight into the fine line that researchers must walk between gathering important contextual information and potentially offending research partners.

Thus, in field deployments of assistive technology, collaborative research teams must identify choices that the other stakeholders may make related to their primary roles, how these could potentially affect the research, and consider how to balance these. Additionally, safe spaces must be engendered to ensure that discussion of these choices is open and honest.

Student Becomes Research Participant

One might imagine that the research participants themselves, especially when children, do not particularly engage in work to make the deployment study work. However, our analysis indicates that users and research participants do in fact engage in second order articulation work during the study if not first order leading up to it. Specifically, in our case, children juggle the roles of research participant and young student. The research participants in the study were aware of the researcher's intention to observe their behavior in order to understand how children collaborate while playing the game so they behaved in they way the think the researcher expected. For example, a researcher asked participants at the public school to describe who began the play.

Figure 1: Photos of one summer camper showing the other camper how to use the cooperative gestures built into the iPad game.

Researcher: Who started playing?

Jesus[1] (age 10): You

Researcher: Right. After I said "start," then what happened?

Jesus: And then we build.

- Observational Notes from the Public School Study

Here the researcher is trying to delineate the start of play *after* her indication that playtime could begin. She is asking the participants to describe who—of the two of them—began playing first and why. Jesus makes a point to answer the researcher's question literally that the researchers cannot ignore her impact on their play. Next, Jesus described how he played with Legos beyond the researcher's gaze. We found these roles—participant and student—elicited different play behaviors as evidenced by his commented: *"before Miss (researcher's name) told us to build the cars, we used to build our own little gadgets*." His comment provides insight into the difference in their private versus prescribed play.

Perhaps the most apparent articulation work by the children is visible when they need to communicate the need to work together during the study. For example, when a camper missed the first day group orientation meeting, he quickly became confused about the collaborative game and his partner's insistence that they play together (see Figure 1). In responding to the question, "How did you like the game?" Brian, age 12, from the summer camp claimed:

"I didn't really like it, it didn't really fit my interest. It's kind of hard to figure out how to play. Well, my partner is kind of hard to cooperate (with). When it's moving that fast, It's hard to cooperate with him. Then [he] just got frustrated and [he] walked away stomping. He kept on saying 'just keep on playing.'"

In Brian's case, the work to smooth out his experience started with the child coaching him and then involved the researcher backtracking to explain the game mechanics during the session while the therapist assisted his partner in returning to play.

While playing a game with a friend might be enjoyable to many children this age, developing improved social skills was an explicit goal for each of the children in this study. Notably, this goal is not necessarily one the children share with those who set the goal for them. Thus, the children often asked to play by themselves, for example Jack said *"I just played by myself because it's more fun, but easier to (win) with two people. I think it's more fun alone because I get to control the mover, and throw".*

Another child from the public school study, Juan, also became frustrated with the collaborative activity. He occasionally left the table and walked to the other side of the room. On one occasion, he walked toward the door and the research assistant/school psychologist directed him to come back into the room. His partner explained at the end of the study that he left the table because he didn't want to throw the iPad. Here we see the children doing articulation work to maintain their participation in the study, as Tasha, age 9 said:

"*Nobody wants to play alone in Zody. We don't want someone to walk away...They don't want to throw the iPad. They'll damage it. He wanted to play alone. You need partner to play together*."

A common observation at the public school site, where game play was reserved to the research session, was the negotiation to gain first access to the iPad. At this site, the negotiation to participate in the research is not so hidden as the children tug for the iPad as if vying for ownership of the iPad--just before the session begins, to be the one who choses which mini-game and role to play at the to start of the session. Research staff also engaged in articulation work around this issue as we discussed outside of the sessions to resolve how to address this behavior and concluded that the device would be placed between the pairs on the table and no further intervention would occur, as seen in Figure 2.

[1] All names are pseudonyms

Figure 2: Two students from public school negotiated ownership once the staff releases the iPad for their joint use during the session.

Thus, we saw a variety of ways the children did articulation work to maintain their participation and collaboration in the study. The students engaged in hidden work to maintain their role as research participants. Their effort provides insight into alternative uses of the technology that may be more natural in the school context and more likely to persist in that context beyond a research study. This finding has implications for how any data regarding the tool's efficacy are interpreted, given that the student's engagement with the technology can shift based on what role that are playing at the moment of observation.

Evaluator Becomes Community Collaborator

Lastly, researchers also must balance between the role of community research partner and unbiased evaluator of the technology, which presents its own ethical challenges [22]. Juggling these multiple roles created tension around the conceptualization of the system, ultimately impacting how the system was used to meet each goal. We found in the environment of a research study, researchers also may have variable priorities. How do they present the project to each site? How do they appeal to all stakeholders? A fun game is more likely to score well on user satisfaction measures, to collect happy, publishable quotes from the children during interviews, and so on. At the same time, effectiveness of an intervention is fundamental to publishing research, as there exists well-documented bias against studies that publish negative results [10,31].

Perhaps unsurprisingly, when faced with a game, children tend to want the game to be fun regardless of any therapeutic purpose. At the same time, teachers and other caregivers are more likely to hope for therapeutic effectiveness. Here the researchers vacillate between portraying Zody as a game and teaching tool as she addresses teachers and students simultaneously. Students are increasingly savvy to the "chocolate-covered broccoli" of the educational game industry. For example, in the private school, upon first introducing the game to the students, one asked: *"Is this an educational game or a fun game?"* To which the researcher replied, "*both, I hope*." This exchange highlights the tension the researcher felt when describing the same piece of technology to students and teachers. Here the researcher plays three roles: partner to the teacher, researcher, and fun-game-bringer for the children.

In summary, the articulation work that surrounds deployments may lead us to overestimate the appeal of our research systems. Unconscious bias can seep in when community partners are heavily invested in the relationship and in the outcomes of the study. This is not to say that we should seek to eliminate this type of bias or change these engagements. Deployment studies are often the only way to see certain phenomena and understand the impacts of the designs in practice. However, recognizing and incorporating this kind of work into our analysis can give us a clearer picture of the practices and outcomes we observe.

DISCUSSION

Articulation work has been used to consider global and local [1,11] or intra and inter-organization, formal and *ad hoc*, routine and non-routine [1] work surrounding collaborative technologies. In this research, we build on these concepts to understand the articulation work that surrounds research deployments and uses of assistive technologies. The work we observed in these deployments goes beyond that which has been previously described. In this work, stakeholders actively and fluidly shift and manage multiple roles in response to and in support of this additional work, a concept we term *role fluidity*. By explicitly engaging with this articulation work surrounding deployments, we can see how formal roles negotiated at the outset (first order articulation work) morph, change, and conflict during the implementation of the study (secondary articulation work)—resulting in the need to move fluidly among dynamic roles.

Role fluidity highlights how stakeholders manage the demands of the research with day-to-day life. Uncovering role fluidity, as early in the process as possible, could result in understanding a greater diversity of needs per stakeholder and prepare not only for the work of the deployment but also for a more complete analysis of the results. Thus exploring the benefits of the technology per each role; how the benefit changes in the presence of other stakeholders; may reveal how the immediate needs may conflict with research activities. Lastly, we discuss how these conflicts are resolved or what trade-offs are made to have a deployment be successful.

Multi-Role Probing Regarding Perceived Benefits

One inherent challenge to conducting community-based research projects, such as deployment studies, is the limited knowledge the researchers may have of the context they are entering and the community partners may have of research procedures. Thus, the various team members may greatly struggle to predict what roles they may undertake and subsequently what activities they may undertake within those roles.

By explicitly engaging role fluidity early, research teams can turn this second order work into pre-emptive first order work.

For example, team members might read case studies of similar past projects and the roles undertaken. Alternately, they may brainstorm together or individually all the possible roles that might be expected on this project. Once a set of roles is established, even if incomplete, the research team can then explore scenarios and explicitly probe responses by role. This allows the stakeholders to move between possible roles in relation to hypothetical scenarios before the project fully begins.

By no means do we imagine that moving some of the work we observed during deployment to the planning stage would eliminate all of the challenges of deployment studies and the articulation work that surrounds them. Rather, this kind of effort is most likely to make for a space for discussion, reflection, and analysis. Similarly, during the study itself, parallel role-playing scenarios may shed light on the context of use and provide key empirical data. For example, in our work, to probe the relationship of the experiences to different roles, we might have asked the children to answer questions specifically thinking of themselves as a child or peer, a student, and as a research participant. This kind of approach has been used with child design teams to empower children to see themselves as "designers" rather than "children" or "research participants"[8]. By making explicit that which is currently fluid and implicit, we could uncover key empirical and design research considerations. However, more work is needed to understand the potential for this kind of approach.

Detecting conflict between and within roles

Additionally, seeking to understand the immediate needs of the teacher as well as the long-term goals of the research project could reveal conflicts. For example in the case of installing the game at the private school, being asked not to install it for some as an indicator there's a conflict between an immediate benefit of the tool and the long-term goal of the project. While problem solving through these "technical difficulties" this is a point for the researcher to be reflective bout each role each stakeholder is playing. Although it's difficult for teachers to change research put into motion by an administrator and an outsider, there could be opportunities to conduct different activities that would better suit the teacher's needs—for example having students do a one-time probe on a designed iPad and asking students and teachers to give "tester" feedback. This brief activity may minimize the need to for a teacher to take on additional roles.

Reflecting on researchers' multiple roles as trade offs

Researchers must reflect on their own immediate needs as community partners and longer-range needs as professionals that impact the trade-offs made in the final study design. For example, in this work, the lead author traded off exploring how long students might naturally engage with the game by meeting the need of the sites to have a well-rationalized recommendation for the amount of playing time desired by the researcher (*e.g.,* set at an estimated the minimal viable duration of 10 minutes). By acting as a community partner, we relay on our past experience in the field of special education that has yielded an understanding of the balancing act required in school settings. To meet the special education mandated services with this new research activity—a not yet proven intervention—decisions must be made based on the sites' needs rather than the researchers needs. For example, a researcher may be interested in pursuing a particular type of game play that is at odds with how end-users play the game when the researcher leaves the room. This change in behavior could lead researchers to explore what constitutes failure for different stakeholders.

Role fluidity requires reflection on the roles of multiple stakeholders as well as the need to account for different stages of deployment to understand the long-term impact that this technology can serve in the wild. This, ultimately, may lead to development iterations to inform software that can also support these *differing* roles and movement among them.

In deployment studies, researchers count on positive results, and though we try to maintain our objectivity in data collection, we often hope for positive results to serve as a foundation to build upon. At the same time, both the researchers and the community members with whom we have partnered for the deployment can be heavily invested in making the relationship work. In contrast to many other types of field work, deployments are interventions that require explicit action from multiple actors [29], and as seen in this work, a variety of articulation work and movement among roles to make deployment work.

Role Fluidity, part of the invisible work of deployment studies could possibly bias results by enabling interactions that would not occur without this extra work in the absence of a research study. Thus, failing to take into account these variables can lead to misinformed interpretations. For example, "the game was not played because of technical issues" could be easily dismissed as a common problem with technology deployment or it could reveal a tension the teacher was experiencing that indeed would be experienced even with more robust technologies. Encountering a "technical difficulty" could be a polite way for a teacher to maintain participation in the research even when they do not want to add the additional tasks to their existing program. We cannot fully consider the impact of role fluidity without explicitly making it visible and considering it in our analyses. Therefore, developing strong rapport with stakeholders, or establishing connections early and postulating how fluid one's role will be may reveal the hidden tensions of a study in the wild.

No particular study design will satisfy the tensions between all roles in one setting. Indeed, many tensions may not be identifiable prior to deployment and can be seen only through the articulation work that emerges around the study. Therefore, researchers engaged in deployment studies, particularly around assistive technologies, should be proactive in reporting how roles change amongst stakeholders with respect to their specific deployment. Collectively, we can then contribute to the body of knowledge around deployments as a method as well as articulation work as a concept for collaborative technology engagements. Furthermore, we as a community can differentiate tensions amongst different types of settings, relationship strength, and the design of both technologies and the studies we use to evaluate them.

CONCLUSION

This paper is a first step toward a larger discussion of the need for deep and explicit consideration for competing roles and expectations of each stakeholder during deployment studies. The work of deploying research technologies—including the work done by participants—should be considered in the design of deployment studies. In particular, a more fluid concept of stakeholder roles allows researchers to better account for the changing power dynamics inherent to research studies, even those that are heavily community based and participatory [15].

This work expands the considerations for articulation work to include the concept of *role fluidity as articulation work,* an emergent concern surrounding the introduction of research technologies. Further, we contribute to the methodological discussions surrounding deployment studies as an approach to understanding design and technological innovation by pointing out the need to consider articulation work in the design, implementation, and analysis of research studies.

Regardless of the final research design, consideration for the articulation work by participants embedded in that design and in the deployment of the technology should make for ethical, reliable, and productive scholarly practice. Allocating time and resources to account for articulation work could create a smoother road to technology adoption after the research phase. In the future, researchers in the wild should deeply consider the additional roles and potential conflicts created by their presence in the wild.

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