Navigating Connected Inquiry Learning with ScienceKit

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Abstract: New pervasive, social, and mobile technologies hold great potential for supporting young people's connections between interests, peer culture, and academic pursuits. Such connected learning experiences are critical for deep and engaged learning. However, efforts to identify and sustain ways to connect these experiences for learners remain elusive. In this study, we shed light on how we can initiate the process of connected learning through technology-realized and facilitator-based scaffolding of learners' interests, social interactions, and scientific inquiry pursuits. Specifically, we documented three cases of learners in an afterschool program called Kitchen Chemistry and their use of a social media app called ScienceKit. Analysis of ScienceKit data with facilitator interactions reveals a typology of learner paths across connected learning experiences. Furthermore, understanding typologies that best match each learner appears to be critical for helping learners to make connections across interest-driven and peer-supported scientific inquiry.

Keywords: connected learning, educational technology, social media, science inquiry

Introduction

Pervasive, social, and mobile technologies hold great potential to help young people connect their interests, peer culture, and academic pursuits (Ito et al., 2013). Such *connected learning* experiences are critical as research has shown that when learners deeply identify with a discipline, they engage more often (Ito et al., 2013), develop dispositions in those disciplines (Clegg & Kolodner, 2014), and begin to see themselves as empowered contributors to that discipline (Nasir, 2002). To date, immersive and social technologies (e.g., gaming systems, social media sites) that have fueled connected learning have mostly supported powerful learning outside of school and traditional academic disciplines (e.g., Squire, Ben DeVane, & Durga, 2009). Often, efforts to identify and sustain ways to connect these experiences to more formal academic endeavors remain an elusive enterprise (Ito et al., 2013). One key factor in helping forge links between learners' interests and their academics, has been finding ways to balance between offering them flexibility to explore their personal interests in socially relevant ways, while providing more structured scaffolding needed to support their procedural and conceptual understanding within a discipline (Clegg et al., 2012; Ito et al., 2013). Our research engages with the persistent question of how to design for such balance: *What technology-based and facilitator-supported interactions promote and strengthen the connections that learners make across spheres of connected learning experiences; specifically their procedural and conceptual understandings of a discipline, personal interests, and peer interactions?*

The study reported here is part of our larger design-based research initiative to promote connected learning experiences that we call *life-relevant science learning*, to help learners identify and explore the potential roles they can play in science and to help them find personally meaningful connections to science (Clegg & Kolodner, 2014). Specifically, we shed light on *how we can initiate the process of connected learning through technology-realized and facilitator-based scaffolding of learners' interests, social interactions, and scientific inquiry pursuits*. We examined learners' entries in a social media app called *ScienceKit* that we designed to promote life-relevant science inquiry and facilitate responsive, real-time inquiry scaffolding (Ahn et al., 2014). ScienceKit was specifically designed to help amplify learner dispositions. In previous studies, we found that ScienceKit enabled facilitators to notice learners' interactions and experiences that are often difficult to discern in the physical environment (Ahn et al., 2014). Through analysis of these entries, we sought to understand the role of ScienceKit and adult facilitation in influencing how learners navigated different spheres of connected learning. Our findings begin to articulate the types of scaffolding that are needed – which can come from different sources such as technology, peers, and educators – that promote connected learning experiences, particularly for learners from traditional school environments in which interests and peer culture are often de-emphasized or discouraged (Songer, 2006).

Background: Connected learning framework

Ito et al.'s (2013) connected learning framework guides our approach to scaffolding learners' experiences in life-relevant science learning environments. Connected learning describes a learning process that is driven by personal interests, encouraged with peer support, and helps learners connect their personal pursuits to formal academic and career possibilities (Ito et al., 2013). Interest-driven activities often lead to personal enjoyment, curiosity about unexpected gaps in knowledge, concern regarding a subject matter, and choices to pursue activities that help an individual solidify their identity, life goals, or self-improvement over a longer-term (Edelson & Joseph, 2004). Life-relevant learning seeks to connect academic pursuits, peer-support and personal interest through mindful guidance and scaffolding to maintain a learner's focus.

Peer-support provides a means for connecting learners' interests to scientific inquiry. With networked and mobile technologies, peer-support has expanded from face-to-face interactions among similar-aged learners to also include learners over vast distances and asynchronous communication (Clegg et al., 2013; Ellison, Steinfield, & Lampe, 2007; Kreijns, Kirschner, & Jochems, 2003). These networks differ from prior peer-supports by offering persistent records, searchability, replicability, and an increased reach for communication (boyd, 2009). Such features are valuable tools that afford learners with opportunities to engage in authentic, collaborative inquiry that mirrors scientific practice (Ketelhut, Nelson, Clarke, & Dede, 2010). Social media tools offer personally relevant modes of communication, allowing learners a way to express themselves through a variety of means via new media (e.g., music, photos) (Greenhow & Robelia, 2009).

The academic sphere of learning consists of more traditional disciplinary learning venues such as academic studies, civic engagement, and career opportunities (Ito et al., 2013). We situate scientific inquiry as an academic sphere of learning as inquiry is shaped by standards-based frameworks such as the Next Generation Science Standards (NGSS) (NRC, 2012; NSTA, 2012). Scientific inquiry involves asking questions about the world, searching to understand what is known, recognizing the gaps in one's understanding, and investigating to answer remaining questions (e.g., Clegg & Kolodner, 2014). We can readily design and observe rote steps to scientific inquiry in which a learner follows a predictable series of steps, such as question and answer prompts (which we refer to as algorithmic inquiry). However, science learning environments that focus solely on rote practices can create situations in which learners can become detached or unmotivated to learn the more complex forms of inquiry (Chinn & Malhotra, 2002).

The connected learning framework aspires to weave together these three spheres of learning. However, our understanding remains limited regarding the ways in which we can initiate and strengthen learners' abilities to connect their experiences across these spheres. For example, helping a learner move from a personal interest to a deeper disciplinary practice is a complex process. The converse situation is also difficult in many established academic contexts, where learners may not perceive science as interesting or personally relevant (Chinn & Malhotra, 2002). The result is a rift between academic, interest-driven, and peer supported experiences, which could then pose challenges for researchers and practitioners who help learners engage in connected learning experiences. While Ito et al. (2013) focus on systemic challenges to promoting connected learning (e.g., socio-economic inequalities), we investigate the practical applications of connected learning to identify challenges that arise on a day-to-day basis and ways to address them. We seek to discover ways in which software-realized and facilitator-based scaffolding can help learners navigate effectively across their personal interests, peer interactions, and academically oriented scientific inquiry. Therefore, our study aims to uncover how the artifacts learners captured (e.g., images, video, drawings) through the use of a social media tool (ScienceKit) can inform our understanding of how they connect their personal interests and academically oriented spheres of learning, and shed light on the barriers they may face in this process. When helping learners engage in life-relevant science learning, we must take any rifts across these spheres into account and help learners forge new connections to mitigate them.

Methods

Design approach

We enact Ito et al.'s (2013) connected learning framework by linking children's interests in cooking and eating to scientific inquiry in a social context with peers and adults who share their interests. Learners in our study participated in the Kitchen Chemistry (KC) life-relevant science learning program, an after-school or summer camp program where children learn science and scientific inquiry skills through making and perfecting dishes (Clegg et al., 2012). In KC, learners use the ScienceKit social media iOS™ app that enables learners to capture moments of interest in their daily lives (e.g., cooking) with multi-media (e.g., photos, drawings, videos, and text) and connect them to science inquiry by making claims, posing questions, and designing experiments (Ahn et al., 2014). These learner-created entries are then shared amongst all learners to support social interaction. For this study, we analyzed learner generated data gathered in the ScienceKit iPad™ app (Figure 1).

We collected ScienceKit data over three consecutive days (~ 4.5 hours each day) in a weeklong implementation of the KC program that was run in a summer camp serving a lower socioeconomic status (SES) public elementary school. Seven learners (9-11 years old) participated in the camp. Seven researchers and one science teacher served as facilitators in the environment. Including our entire research team as facilitators in the environment ensured full participation of researchers in our design-based research process (Barab & Squire, 2004) and approximated our inclusive, future vision of integrating community volunteers in such programs. We gathered the ScienceKit entry data primarily from learner-created entries, though for some entries facilitators supported data input (e.g., if the learner's hands were full due to cooking activities).

Figure 1. A) ScienceKit allows for posting photos, videos, drawings, and associated text. B) Learners and facilitators can then see everyone's posts on a global timeline. C) Learners used ScienceKit it a variety of situations (e.g., drawing together, recording events from afar).

Context and data collection

On the first day of KC, we explained to learners that they would ultimately conduct their own investigations as chefs, investigators and scientists to perfect a dish of their choosing. We shared our collective goal to connect their personal cooking interests to science learning. Each day we encouraged them to ask and explore questions in which they were personally interested. We also focused on helping learners use ScienceKit to express their interests and explore their inquiry questions. The first two days of the program were *semi-structured days* in which facilitators provided inquiry questions and helped learners to carry out cooking investigations. On the first day, learners made observations of four batches of brownies and hypothesized about the ingredient or procedure that was changed among the variations. After a discussion of how the number of eggs was varied in each batch of brownies, learners carried out an experiment investigating oil and water miscibility using eggs as an emulsifying agent. The second day's investigations focused on baking cookies with different leavening agents to understand how leavening agents react and the role their reactions play in making cookies. This day concluded with the learners developing their own interest-driven inquiry plan to be conducted on the third and fourth days. Throughout the program, learners used ScienceKit to document their experiences, ask new questions, collect data, and make claims. Learners also used ScienceKit to capture playful, fun, or social moments in the program. For this study, we did not evaluate ScienceKit data on the fourth day as much since the final day was focused more on presentations of their findings to parents and the local school community.

We used methods consistent with a comparative case study (Merriam 1998) on this single implementation of KC. We compared three cases of learners (Juan, Larielle and Aziza, Noah) to examine how connected learning took place in KC through the use of ScienceKit. We collected data from various sources (multiple video perspectives of the learning activities and context, researcher field notes, learner reflections and interviews). For this study, our focus was on analysis of learners' ScienceKit entries. We unpacked the interaction moments that learners captured in ScienceKit themselves to illuminate our understanding of how the children made connections across the spheres of peer-oriented, interest-driven, and academically oriented learning experiences. As such, we analyzed learners' ScienceKit entries using qualitative coding methods (Strauss & Corbin, 2007). We coded each learners' entries for interest, peer-culture, and inquiry attributes. Interest-driven contributions refer to entries that related to or described learners' hobbies, curiosities, or excitement (Edelson & Joseph, 2004). Similarly, peer-culture entries are posts that displayed learners peer interactions (e.g., selfies with one another, interviewing peers) or that reflected common peer practices (e.g., when learners appeared to be imitating pop culture references, language, or inside jokes they had observed of their peers' previous entries in ScienceKit). Finally, we used Chinn & Malhotra's (2002) framework for scientific inquiry to identify scientific practices learners exhibited in their ScienceKit entries. Interest, peer-culture, and inquiry codes were not mutually exclusive. Drawing on Ito's (2013) vision of connected learning, it was our hope that learners' entries would reflect overlaps in these codes. Coding for each entry also accounted for relevant meta-data (e.g., time the entry was posted, who made the entry, what media if any did the entry use). Next, we conducted an axial coding pass where we identified high-level themes of the ways that learners' interests, peer interactions, and inquiry came together (or remained disparate) in their use of ScienceKit over-time. We also examined how these connections or disconnections were influenced by the ScienceKit app and adult facilitation.

Results

We detail several vignettes of learners' experiences that reflect three distinct paths across interest-powered, academically oriented, and peer-supported connected learning spheres. Our discussion then highlights our analysis of the ways in which facilitator-based and software-realized scaffolding influenced connected learning experiences.

Inquiry to interest and peer support

Our first vignette highlights a learner who made diverse attempts to engage in inquiry and peer interactions, but did not make many connections between these spheres of connected learning. On the first day of KC, Juan, a rising 4th grader in KC, was very energetic during his group's investigation of ways to mix oil and water using eggs as an emulsifier. His attempts to find a correct "answer" for how the ingredients interacted were illustrated in his ScienceKit video entries, which detailed his thought processes, hypotheses, and observations. For instance, Juan stated, "My hypothesis was sort of right, but I think you have to shake [the oil and water to get them to mix]." When a facilitator asked Juan to observe the bottles again to allow the oil and water to sit for a while to see if they were indeed mixed, Juan stated in a ScienceKit video that "You're starting to see the yellow come back. Oh come on, I was wrong!" While looking over the investigation procedures, Juan noticed that we were going to add an egg to the oil and water mixture, and wondered aloud, "If an egg would float on [the oil and water]". Juan then quickly changed his question to ask whether a baby elephant would float on the oil and water. When facilitators tried to connect to his interest in baby elephants to a movie or television show with baby elephants, Juan ended the conversation and his ScienceKit entry stating "Ah, yeah, that's all I got for now."

Juan did show some interest and connection to peer groups, but did not fully engage these interests and peer groups in his KC inquiry experiences with ScienceKit. For instance, he attempted to connect with fellow learner Allen by referring to an earlier comment Allen made in ScienceKit about a "cookie monster" as the learners were baking cookies to explore various leavening agents. Juan related to Allen's post by making his own post about a "cookie master." However, Juan's outreach to his peers did not result in an exchange between learners in ScienceKit. While Juan continued to use ScienceKit on the second day to create inquiry-related posts, his posts did not reflect algorithmic inquiry as they had on the first day of KC. Instead, Juan continued to make posts connected to what he found interesting at the moment, such as stating his drawing of a cookie was a "cool cookie". However, he did not connect to interests he may have had external to KC. By the third day, Juan drastically reduced his use of ScienceKit, resulting in only 5 posts compared to the first day's 27 posts.

Analysis of Juan

Juan's use of ScienceKit suggests that it was difficult for him to connect an academic focus to his pre-existing interests or peer-groups. Initially, Juan was actively engaged in the scientific inquiry process, as seen when he stated factual observations and engaged in algorithmic scientific inquiry during the pre-planned investigations. He also playfully expressed himself during inquiry projects and when using ScienceKit in general. However, it was difficult for facilitators to uncover what Juan's personal interests were, and how they might be connected to inquiry. Without apparent connections between his academic pursuits, interests, or peer interactions, facilitators' scaffolding within ScienceKit largely focused on Juan's inquiry practice as it was an area that he seemed to be more willing to share with facilitators. Effectively, Juan's ScienceKit use focused mostly on engaging in pre-planned scientific inquiry. We suspect this may be because Juan missed the introduction to interest-driven inquiry on the first day. Missing this key discussion, coupled with the more rote academic practices and culture that he was familiar with in a more traditional classroom, may have impacted Juan's willingness to share his interests and connect his peer interactions to inquiry. *Our analysis of Juan's case suggests that learners' interests may not initially be apparent, thus making it difficult for facilitators to connect their interests to inquiry and peer-oriented experiences*.

Peer-culture to interest

Our next vignette describes two learners, Larielle and Aziza, friends who initially used ScienceKit to navigate from peer-interactions to interest-driven inquiry before facing challenges with their peer-oriented inquiry. On the first day of KC, a fellow learner, Demarco, started taking photos of other learners during a whole group discussion. Larielle and Aziza quickly imitated Demarco's posts during the meeting, taking photos of facilitators and peers. Such peer-oriented posts were common from Larielle and Aziza throughout KC, whether it was during social time or formal inquiry activities. The girls also often shared ScienceKit on one iPad™ for inquiry tasks. As a result, their inquiry tasks were increasingly distributed on Larielle's ScienceKit account.

During inquiry-based tasks, Larielle and Aziza often created videos in ScienceKit by interviewing one another about what they were doing in KC. For instance, one interview occurred over the course of two ScienceKit videos for a total length of 20 minutes. Aziza recorded the inquiry and interviews throughout the entries. Both learners were focused on strengthening their group identity while using ScienceKit. For instance, they started the video by stating, "Welcome to table #4, people. Here is [Larielle] and here is our friend here" when introducing Larielle and the facilitator at the table. Aziza then reviewed the four different brownies they were investigating, asking her partner questions such as, "So [Larielle], […] how is brownie #1 looking?" Both girls crafted their video as an interactive, interview-like dialogue on the brownies and measurement tools. Midway through the video, the facilitator helped scaffold the inquiry by prompting them with questions such as asking them to compare two brownie variations. Eventually, Larielle and Aziza even started making predictions about how the brownies were made both with help from the facilitator and independently.

On the second day, Larielle and Aziza worked with their science teacher from the previous year, Ms. Smith. One of the facilitators directed the interview and ScienceKit in each of their interview-style videos on this day. Thus Aziza, who had been operating ScienceKit for the group on the first day, was not able to direct the camera on her specific interests. The content of the interview also changed when the facilitator conducted the interview. The group used ScienceKit as they made observations of three variations of cookies made with different leaveners. When asked whether they thought all groups were measuring the size of the cookie dough once it had been placed on the baking sheet, Aziza stated "kinda". However, when the facilitator prompted her for clarification, she revised her answer to "well, I think they are doing the same." Aziza then shifted to asking the facilitators questions such as "are we going to bake these?" and "how you think the cookies going to turn out?" The facilitators answered these questions, which redirected the focus of the inquiry back to the facilitator rather than Larielle and Aziza. This exchange reflected a marked reduction in the amount of peer-interaction that was visible in the girls' ScienceKit interactions during the second day of inquiry sessions Their subsequent entries also became more passive as Larielle and Aziza often propped the iPad™ on a bookshelf with ScienceKit recording "hands-free" video of their interactions rather than using it for peer interviews.

Analysis of Larielle and Aziza

Our analysis of this vignette suggests that social learning technologies can have a positive impact on learners' ability to connect with their peer-groups while engaging in scientific inquiry. With Larielle and Aziza, the practice of interviewing connected their peer-group to interest-driven inquiry. When the facilitator prompted the child interviewer with questions, s/he was able to help the learners use ScienceKit to reflect on the inquiry-based aspects of their experiment. However, once the facilitator more actively assumed the interviewer role to encourage specific lines of inquiry, Larielle and Aziza began to use ScienceKit more passively. Larielle and Aziza seemed to lose interest in the immediate inquiry when they were no longer conducting interviews as a peer-group. *This change in usage seems to suggest that facilitator-provided scaffolding could unintentionally steer learners away from peer-supported inquiry and decrease engagement with the learning technology.* We suspect that working with their teacher may have also impacted the power dynamics of Larielle and Aziza's group compared to the first day, reinforcing an emphasis on academically oriented inquiry. Moreover, as the learners became less actively engaged with the inquiry process, they also seemed to become less engaged with ScienceKit. We hypothesize that ScienceKit was no longer part of Larielle and Aziza's peer-group, resulting in Larielle and Aziza recording less of their interests while using ScienceKit as a peer-group.

Interest to inquiry

A third path we observed involved facilitators who focused on navigating learners toward the academic sphere while scaffolding interest-driven inquiry. During the first day of the program, learners were frequently prompted to draw upon personal curiosity to ask new inquiry questions during planned inquiry activities as well as during downtime. One such example of spontaneous, interest-driven inquiry occurred during breakfast on the first day. As learners were acclimating to ScienceKit, they carried their iPads™ to the breakfast table. One learner, Noah, snapped a photo of strawberries on the table and made the ScienceKit entry, "Some [strawberries] probably got more care than others. Some are bigger than others." In a later post, Noah posed a question about whether milk had sugar as an ingredient, using a photo of a milk-carton with attached meta-text. Noah then began to explore the questions he posted by reviewing the ingredients lists (or "nutrition") on the wrappers of his breakfast foods (e.g., milk, cereal). As other learners began to see Noah's posts in ScienceKit, they began to post their own similar questions.

Noah's other entries on the first day of KC also reflected a focus on interest-driven inquiry (rather than peer support). He would often go into great detail when exploring the semi-structured inquiry projects, such as when he commented "How much they each rose [brownie #4] 1 inch, [brownie #2] 1 inch, [brownie #1] 1 inch, [brownie #3] half inch" or when he stated "Maybe [the brownie variation labeled] B3 needed to be in the oven long enough to rise higher. B3 is shorter than the rest." While Noah did not document his peer-oriented inquiries as much as others, he did post many factual observations and shared important algorithmic inquiry.

On the second day of KC facilitators encouraged learners to capture as much of their cooking experiments as possible using ScienceKit. Likewise, we observed that Noah's ScienceKit posts increased. However, his posts on Day 2 consisted mostly of photos or videos of what they were doing in the program (e.g., mixing ingredients) as opposed to inquiry-based reasoning about the experiences he was capturing (e.g., making claims, asking questions). While Noah still created posts that displayed his inquiry-based reasoning practices, the amount of such posts were relatively the same as in the previous day (4 posts showing algorithmic inquiry compared to 5). Additionally, Noah's Day 2 posts consistently lacked visible peer-interactions or connections with others in the group. When Noah was given the opportunity and support by facilitators to create his own inquiry, he did derive his inquiry question from personal interest. Noah's own investigation involved exploring variations of his mom's meatloaf recipe so that he could later share his results with her. Noah continued to carefully document his inquiry-based process the next day (e.g., with posts describing the consistency of the various meatloaf recipes prior to cooking).

Analysis of Noah

Throughout the KC program, Noah consistently demonstrated his ability to engage in interest-driven inquiry, from the questions during breakfast on the first day to engaging in a more complex inquiry when conducting his meatloaf investigation. However, Noah did not connect his inquiry to peer-groups in KC. Scaffolding on Day 2 may have influenced Noah's use of ScienceKit to focus more on the academic sphere instead of finding ways to encourage a connection to peer-groups that happened serendipitously during breakfast on the first day, when he seeded questions to his fellow learners. Facilitators also noted that Noah was a more introverted learner, which may have affected the number of peer-oriented ScienceKit posts that he made. Based on the ways in which Noah's questions propagated to his peers early on in the KC program, it may have been helpful to acknowledge Noah's ability to create new interest-driven inquiry topics and encourage him to engage more with peer-groups (e.g., helping fellow learners to create more complex inquiry) to further his connected learning experiences.

Note that the context of KC activities may have influenced the type of ScienceKit entries that Noah made. During Day 1, instead of cooking, learners made observations and claims about pre-baked brownie variations. During Day 2, learners were actively engaged in experiment processes (e.g., measuring and mixing ingredients), with less time to make observations and claims about their results. On Day 3, learners engaged in their own interest-driven inquiries. Day 3's data for Noah reflects the strongest connection between academically oriented and interest-powered spheres, as he was deeply invested in a cooking investigation to recreate and improve upon his mother's meatloaf recipe. Using Noah's strong interest and ability to create inquiries from those interests came close to complex scientific inquiry, but lacked peer-support. His case suggests that *connecting less socially prone learners to others may be challenging, but simply exposing their inquiry practices to others may facilitate social exchanges.*

Discussion

Our analysis of a practical application of Ito et al.'s (2013) connected learning framework underscores the importance of being attuned to the interactions and influences that learners, facilitators, and technological tools exert within in a connected learning context. While social learning technologies can help minimize disconnects between interest-driven and peer-supported spheres for learners, the gaps between these spheres and learners' academic pursuits, remain non-trivial to traverse. A key take-away from this analysis is that ScienceKit afforded us a rich data channel to help identify, follow, and strengthen learners' connections across academically oriented, interest-driven, and peer-supported spheres of influence. The findings from our study underscore the ways in which social media-based tools and associated learner data illuminate our understanding of the paths that learners can follow across academically oriented, peer supported, and interest-powered contexts. Importantly, these data also shed light on potential barriers and missed opportunities that researchers and practitioners can use to initiate and strengthen connections across the interrelated, but often disconnected, spheres. For example, our analysis of Noah revealed that he had a fairly high degree of personal interest in inquiry (e.g., unprompted observations about strawberries, ingredients in milk, designing new variations on his mother's meatloaf recipe). Facilitator efforts to reinforce his knowledge of academically oriented scientific procedures (measuring, mixing, comparing) seemed to be beneficial. However, facilitators could have taken advantage of the data in Noah's ScienceKit stream to quickly connect the academically oriented, process-based artifacts he created on Day 2 to his personal interests (seen on Day 1). Furthermore, facilitators could have devised opportunities for Noah to showcase his personally relevant meatloaf investigation with peers, thereby strengthening the peer-supported sphere of his connected learning network.

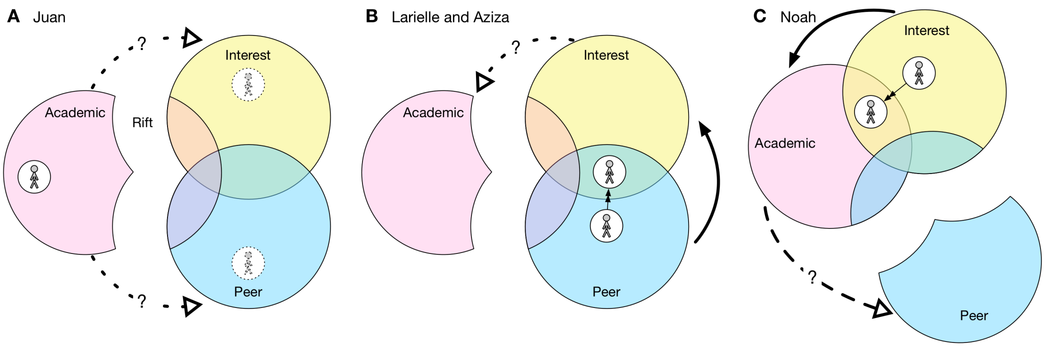

Figure 2. This figure depicts situative learner practice based on Ito et al.'s connected learning framework, (2013) and potential difficulties encountered by different learners. Though similar in shape, it is not intended to be two dimensional or representative of a Venn diagram. A) Juan's interests and peer-support were difficult to connect to his focus on academic activities. B) Larielle and Aziza's path moved from peer support to interests but transition to formal academic inquiry were challenging. C) Scaffolding helped Noah to create interest driven inquiry but did not help him connect to peer-support groups with his inquiries.

Another key take-away is that the ScienceKit data, coupled with analysis of facilitator-learner interactions, revealed the beginnings of a typology of learner paths across connected learning experiences specific to Kitchen Chemistry. Our analysis has revealed a variety of possible paths that learners may take as they develop more comprehensively connected learning experiences (Figure 2). It appears that not only can there be a rift between the academic sphere and the interest and peer-support spheres as previously described, but there might also be a similar gap separating peer-support for learners such as Noah (Figure 2C). Understanding what typology best matches each learner could be critical for helping learners engage in using a new learning technology for interest-driven and peer-supported scientific inquiry, specifically in connected learning contexts such as Kitchen Chemistry. Researchers could use such a typology to evaluate the efforts of learners to effectively engage in connected learning. The typology might also inform new designs for connected learning experiences themselves. Both of these findings contribute to our understanding of individual learner paths within connected learning experiences, and suggest design implications for strengthening the ways in which learners traverse across the spheres of connected learning.

Overall, our analysis points to the potential of more complex social tools and focused reflection of educators to ascertain learners' natural orientations within academic, peer-oriented, and interest-driven spheres and to make decisions about how to direct them toward more connected learning. For example, during the Day 1 activity, the scientific inquiry practices that we foregrounded were making observations and proposing claims about experiment results. Facilitators asked the learners to examine four batches of brownies and to try to determine what ingredient might have been varied to cause any differences in physical characteristics, such as texture, taste, density, color. The learners were explicitly asked to engage in academically oriented inquiry. During the next 2 days, KC activities required more active engagement by learners in the actual cooking process. Learners captured these activities both because they wanted to and because they were encouraged to do so. We believe it is difficult to tease apart whether facilitators directed learners or whether learners wanted to capture everything. With reflective practice (Schön, 1983) facilitators and technology designers should also reflect on the logical intent and purpose of actions. Facilitators may have needed more time and better tools (in ScienceKit) to review and reflect on the media captured during these activities to connect procedural practices to inquiry-based practices. Future work can focus on developing social inquiry technologies to make such learner interest and peer-interactions in the current science camp setting as well as community contexts easier for facilitators to recognize in real-time. Additionally, research into social inquiry technologies should support more adaptable scaffolding to help learners navigate connected learning paths, thus empowering learners to connect to their interests and peer-groups.

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