

Children's Interactive Strategies around Digital Technology in a Collaborative Learning Environment

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Abstract: The current study examines how children develop different interactional strategies around digital technology as they get enculturated within a community of design learners. Using a comparative case study of a single case we discuss how a student progresses from individual to collective interactional strategies, over a period of time, as she collaborates around digital technology in a small design group. We then discuss the social affordances of technology and its importance in developing technology integration models.

Technology integration in collaborative learning

The introduction of screen-based technologies has led to improvements in developing both academic and 21st century skills and hence many schools have quickly adopted one computer per student initiatives in a classroom (Freeman et al., 2017; Swallow, 2017). However, the mere addition of technology in learning environments is not a sufficient condition to ensure improvements in learning outcomes, since technology presents trade-offs that interact with individual and group processes (Jeong & Hmelo-Silver, 2016; Kirkwood & Price, 2014; Lim & Chai, 2008). Our previous work suggests that digital technology affords different kinds of interactions in collaborative learning environment that are especially problematic in developing shared understanding among young children (Toprani, Yan, & Borge, 2016). These findings led us to further unpack the results on a time scale to understand if these processes are impacted by continued participation within a community of learners. Towards this goal, the current study aims at identifying the interactional strategies that students use around digital technology as a part of learning design, over a period of time, and subsequently analyzing their development within the larger culture of design practices.

Technology has been efficiently used to widen the scope of learning by providing more competent tools to learn with, however, it's potential to bring about a shift from traditional instructional approach to a student-centered instructional approach fostering higher-order thinking processes are preliminarily developed (Kirkwood & Price, 2014). There is a need for developing technology integration models that approach the process from a nested, systemic perspective where the role of technology is studied in relation to factors like curriculum, teaching pedagogies, learner's needs, and the learning goals (Veletsianos, 2016). We conceptualize collaboration as a nested process between individuals, small groups, and the larger classroom community. During this process participants are engaging in higher-order thinking: developing a joint understanding about the idea, collectively critiquing the idea, discussing alternative perspectives, evaluating its feasibility, and negotiating solutions so as to create new knowledge (Stahl, 2006). Studies that look at collaboration from a nested, knowledge-building perspective have found technology to have a more ambiguous and distributed impact on learning because of the interplay of a number of factors (Jeong & Hmelo-Silver, 2016; Toprani et al., 2016). Hence, in the current study we intend to explore *How student's strategies around digital technology change as they become a part of the community of design learners?* To take a systemic perspective, we explore these ideas in relation to one student's process of getting enculturated within the afterschool club over a period of two years. We view enculturation as a process that supports not only the acquisition of knowledge but also development of judgements around its application (Tishman, Jay, Perkins, 1993). We track the development of a student, "Catherine", who was a part of the afterschool club for more than two years (four semesters). We identify the collaborative strategies she developed around digital technology in relation to her continued participation at the club. The study is designed from the student's vantage point to understand technology's affordances within a sociotechnical system i.e. what the technology offers and how the students develop social processes to make use of it. We observe Catherine's interactional strategies over a period of two years, within the larger framework of the afterschool club's cultural practices to understand how her interactional strategies change.

Context and data selection

The current study is situated within an afterschool club, developed to promote design thinking among 8-12 years old students, in North East United States. The club is conducted weekly and each session is 75 minutes long where students work on design projects in teams of three or four. The goal of the club is to help students go through different design stages of questioning, planning, creating, and finally evaluating their design prototype against the initial client requirements. As a part of this project, Catherine, joined the club as a 4th grader and returned to the

club every semester starting Fall 2015, until Spring 2017 (i.e. four semesters). Her case provides a unique perspective to understand how student's collaborative strategies develop as they get enculturated through the club activities and experiences. Catherine, in her first semester was grouped with three other students of her age: Kathy, Eric, and Aron. They worked on creating a garden for a fictional client named Fred. In Spring 2017, Catherine was grouped with the same members Eric and Aron, and the fourth member was changed to Marcos. In this semester they were again creating a butterfly garden for Fred with a different set of requirements. In both the semesters students would create a Lego plan of their design and then recreate the same design in Minecraft, incorporating minor revisions.

We selected Catherine, because she has been in the club the longest without missing any semesters. We compared Catherine's collaborative strategies around digital technology across three semesters i.e. Fall 2015 (FA15) and Spring 2016 (SP16), when she was a novice to the design club's culture, and Spring 2017 (SP17), when she was enculturated in the design club based on her participation for four semesters. By systematically reviewing video data and curriculum plan we selected one comparable lesson for each of the three time points. Across the three semesters, we selected the first lesson when they started designing with digital technologies.

Methods

Three lessons were analyzed using interaction analysis approach (Jordan & Henderson, 1995) to build a comparative case study (Glaser & Strauss, 1973) and shed light on how the collaborative interaction strategies changed across the three time points within the cultural practices of the club. The case studies were developed by analyzing talk among the group members with a focus on the strategies used by Catherine. We began by reviewing the lessons in their entirety and then gathering critical instances representing collaborative interactions among the team members. An instance was started when two or more members interacted with each other within the context of their design project and ended when the discussion was either terminated or interjected by the beginning of a new topic. We gathered 28 instances from FA15, 22 instances from SP16, and 24 instances from SP17 for further analysis of strategies. We then created Content Logs of these instances, followed by a detailed analysis of the transcripts in order to understand the strategies. These strategies were interpreted from the data by the first author, audited by the second author and then reviewed by the third author to look for biases and inconsistencies. The analysis draws from Ciolek and Kendon's (1980) and Streeck's (2013) work on spatial organization of talk and artifacts, facilitating collective learning processes.


Findings

The three cases presented below contrast between the interactional strategies used by Catherine when she had no exposure to the design club's culture and after she participated in the club for almost four semesters. The three cases present a trajectory of change from using individualistic interactional strategies, to using more inclusive and collective interactional strategies, as she got enculturated into the design club over a period of time.

FA15: Individualistic strategies around shared technology

When Catherine was a club novice, she largely controlled the arrangement of the artifacts. Catherine and Kathy, while collaborating together, shared a laptop and Catherine controlled access to the screen, while Kathy was left in a position of asking for access. Table 1 represents the spatial arrangement of artifacts and the position of the participants from the 11th lesson in FA15. In line 314 Kathy made a move to press some keys on the laptop and in 317, since her attempt failed, she tried to instruct Catherine of where she wanted to go in the shared Minecraft server. Although Catherine gave Kathy the autonomy to guide her in Minecraft, when Kathy asked her to focus on the fence instead of the biking trail, she redirected her attention to a decision Eric made earlier in the group about the fence, and continued working on the biking trail. The given instance and the arrangement of the artifacts

Table 1: Catherine's Individualistic Strategies around shared technology, FA15 (New participant)

	<p>314 Kathy: Can I control ((pressing some keys on the laptop)) 315 Cath: Ehh.. wait watch out Kathy 316 Cath: Tell me what to do because you are the one who 'tells me what to do' 317 Kathy: Go there, there, there 318 Cath: Should I just do the biking trail? 319 Kathy: We need umm more fence because we have a very skinny 320 Cath: Well Eric wants it to be that way so let's first ((continues doing the biking trail))</p>
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in the group provide evidence for Catherine's individualistic approach. All the artifacts were placed in her

transactional space (Ciolek & Kendon, 1980) i.e. space that was easily accessible to her and Kathy's entry into the space was controlled by her (315). Kathy and Eric's position made the spatial arrangement more problematic for collaboration because the three students had no shared transactional space, physically or virtually, to initiate a conversation. Although they were in a shared Minecraft server, they didn't know where the other person was and what they were doing. This kind of a spatial arrangement of the participants and the artifacts in the group creates a tension in the process of developing shared meaning (Streeck, 2013). This tension was verbalized towards the end of the lesson when Catherine, Kathy, and Eric got into an argument about having a magical fairyland in their design, which was added by Catherine without Eric's knowledge and Kathy's complete understanding of the idea.

SP16: Individualistic strategies around individual technology

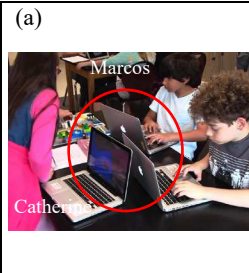
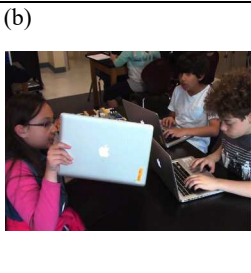
By SP16 Catherine had limited exposure to the club's culture and was still a novice, collaborating with the same group of students from FA15. In the 4th lesson of this semester, they were building a haunted house in Minecraft and they all had individual laptops to work on. Table 2 represents the spatial arrangement of artifacts and the position of the participants. In line 665 Catherine tried to control what Kathy could touch in Minecraft world, using her own laptop. Catherine asked Kathy if they should fill up a structure in Minecraft (669). When Kathy expressed that she liked it the way it was (670) Catherine disregarded her opinion and stated that it wasn't very important. She asked other team members if it belonged to their design (671) and later in the session deleted the structure. These interactional strategies, with individual laptops, continued to look similar to the FA15 strategies. The arrangement of the laptops and the position of the participants continued to be problematic for developing intersubjectivity (Ciolek & Kendon, 1980; Streeck, 2013). Kathy and Catherine's screen arrangement, and their spatial positioning provided them with no transactional space to reference what they were doing in Minecraft.

Table 2: Catherine's Individualistic Strategies around individual laptops, Spring 2016 (New participant)

	<p>665 Cath: Hey Kathy do not touch the chest. One good thing. Kathy where are you?</p> <p>666 Kathy: I am right here.</p> <p>667 Cath: I am coming.</p> <p>668 Cath: What's this?</p> <p>669 Cath: Should we fill it? Should we fill it?</p> <p>670 Kathy: Ohk.. Actually I like it.</p> <p>671 Cath: eh I think it's not important. I don't think it's important. Let's ask anybody if they built it.</p>
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SP17: Collective strategies around individual technology

Table 3. Catherine's Collective Strategies around Individual laptops, Spring 2017 (Experienced participant)

<div style="display: flex; justify-content: space-around;"> <div data-bbox="193 1379 443 1650"> <p>(a)</p>  </div> <div data-bbox="448 1379 699 1650"> <p>(b)</p>  </div> </div>	<p>330 Cath: Guys is this big enough ((fence she was building in Minecraft)) what I am building, is this big enough?</p> <p>331 Aron: No cover..cover the entire area that</p> <p>332 Marc: We have to leave the water there</p> <p>333 Aron: No too much water</p> <p>334 Marc: Until she finishes the fence</p> <p>335 Cath: Is this fine? How big it is so far?</p> <p>336 Marc: Where are you?</p> <p>337 Cath: Are we making it a square, or a rectangle?</p> <p>338 Marc: Rectangle. Ya that's pretty big. Outline the water</p>
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By SP17, Catherine had four semesters of experience at the design club and was working with other students with similar amount of experience. Catherine's interactions provided more opportunities for collective meaning making. Table 3 represents the spatial arrangement of artifacts and the position of the participants. In line 330, Catherine stopped half way through creating the fence that demarcated their building area in Minecraft, and asked Marcos and Aron if it looked alright to them. Initiating a discussion among the members, in line 331 and 338 Aron and Marcos respectively verbalized their alternative perspectives as a response to her question. Her follow-up questions (335, 337) gave all of them an opportunity to engage in collective information synthesis by trying to jointly understand the group's design and iterating on it (Borge, Ong, & Rose, 2018). These interactions in relation to the arrangement of the artifacts in the group provide evidence for Catherine's collective approach. Arranging the artifacts in the shared transactional space, giving every member equal opportunity to access them, is seen to

be favorable for collective interactions (Ciolek & Kendon, 1980). The transactional space was maintained in the virtual Minecraft environment by asking each other their locations, and physically turning their screens around to show what they were building (see picture b).

Discussion

The crucial change that emerged in the interactional strategies used by Catherine, from the instances analyzed across FA15, SP16, and SP17, was a shift from an individualistic interactional approach to a collective interactional approach while designing in her small-group. Collaboration is a social process of developing shared meaning within a small group (Stahl, 2006). Catherine's interactional strategies, mediated through the group's artifacts (digital technology in this case) played an important role in developing shared understanding among the members about their design projects. The existence of shared transactional space in SP17 ensured more efficient communication among the members compared to FA15 and SP16. This connects to Streeck's (2013) discussion of how intersubjectivity develops around embodied interactions between participants. The movement of artifacts contributes to the development of meaning making as the participants experience a single object together and build off of each other's experiences to expand on their ideas. As Catherine got enculturated in the design club, she manipulated the artifacts in ways that promoted collective interactions. Streeck (2013) considers these approaches as being central to the development of intersubjectivity, which in turn is influential in developing a shared understanding in collaborative teams (Stahl, 2006). Different technologies have different social affordances for supporting discourse-based learning and imbibing collaborative cultural practices among children (Kirschner et al., 2004; Toprani et al., 2016). This knowledge is crucial in orchestrating technology-enhanced learning environments to help designers and instructors integrate technology to benefit learning systemically, rather than influencing its parts (Prieto et al., 2011).

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