# When Figured Worlds Fracture: A Collaborative Environment Splintered by a Non-Collaborative Tool

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**Abstract:** This proposal explores how the design of tools and activities influences the developing collaborative community of elementary school students in an informal learning environment. In particular, we focus on how a shift in activity and tools actively disrupts the students' collaborative work by changing from a widely visible tool that can be distributed and shared to an insular tool that is designed for a single user and constrains information sharing. We argue that tools can create fractures in some groups as participants struggle to gain access to information the tool provides in alignment with goals of informal activities. We conclude with design recommendations for tools intended for use in a collaborative environment.

## Introduction

Productive collaborative learning and the utilization of technology as a tool for developing conceptual understanding and promoting student engagement are considered crucial components of our teaching and learning environments. Emerging within these environments are varying forms of technology such as robots, coding apps, and microcontrollers, which have been found to positively impact students' interest, motivation, skills, and knowledge within STEM disciplines (e.g., Kazakoff & Bers, 2012; Nugent et al., 2014), as well as collaboration among group members (e.g., Kafai & Vasudevan, 2015). Yet, the design and implementation of the tools involved can have a negative impact on students' learning and collaboration (e.g., Simpson, Bannister, & Matthews, 2017; Law et al., 2017). In this proposal, we describe how a forming community of students gets wildly disrupted by the introduction of a tool that is *insular* - that is, designed for only one student to use, and difficult for other students to even see. This has implications for community development, communication between students (which slows down the entire group), and the overall learning potential. As such, following the Design Strand's call for papers, this proposal is a *critique of what exists now* as well as *a vision of what could be*. This proposal also addresses Law and colleagues (2017) call for the "analysis of social interaction and collaboration of dyad and group practices" that can "systematically inform the design, testing, and refinement of CSCL environments and practices" (p. 6).

## Theoretical grounding

Holland, Lachicotte, Skinner, and Cain (1998) defined figured worlds as "a socially and culturally constructed realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others" (p. 52). Thus, characters and actors in a figured world have some idea of how others should act and behave as events unfold. Using this lens, artifacts, tools, events, discourses, signs, and people are attributed meaning by individuals within a socially constructed figured world that may differ from how individuals outside the figured world interpret their meaning (e.g., Urrieta, 2007). Additionally, differences in meaning may also exist among individuals within a given figured world; highlighting ways in which issues of power and status are negotiated and contested (Holland & Leander, 2004).

Of importance in this study, Jurow (2005) noted that "artifacts play an important role in figured worlds because they can serve as *pivots* (Vygotsky, 1978), which shift the frame of an activity" (p. 39, italics original) and the figured worlds within which participants are immersed. Following Kamberelis, Dimitriadis, and Welker (2018), "We imagine each figured world as dynamic and self-organizing, and we view the boundaries between figured worlds as blurry and fluid" (p. 693). We view collaboration as similarly blurry and fluid, viewing it as "the ebb and flow of communication and its continued integration into future interaction" (Evans et al., 2011, p. 259), with a particular emphasis on how the tools, as pivots, influence the ebb and flow. In this proposal, we focus particularly on the artifacts of *tools*, and how those tools can contribute simultaneously to constructing and deconstructing a figured world. In particular, a figured world - with its attendant meanings attributed by individuals - that emerges around a collaborative activity with an open and shared tool; yet, splintered by the introduction of another tool that is insular.

## Methods and analysis

Evidence for the findings reported on in this paper draws from a larger study of three elementary school classes (one 3rd grade, one 4th grade, and one 5th grade) in an intermediate public school (i.e., Grades 3-5) located in the northeast region of the United States. The school included a "TinkerLab" space for students to engage in STEM-related making activities as part of their curriculum, and students from the identified classes participated in three days of activities during free periods. These activities were created and initiated by the TinkerLab teacher. Specific to this paper, our participants were six 5th grade students completing one STEM-related making activity. The students were first tasked with creating a masking tape path on the floor for a small robot, Dash, programmed using the app Blockly, to move along (hereafter called Phase 1). The group was then tasked with programming Dash to move along a masking tape path constructed by another group (hereafter called Phase 2). The activity lasted approximately 22 minutes. Data was collected using a stand-alone camera to capture the group as a whole, as well as three GoPro cameras worn on the chest of three of the students. The use of the GoPro cameras was intentional as it allowed us to capture three student views of the same activity.

We analyzed the video data using interaction analysis methods (Jordan & Henderson, 1995). Collectively, we silently watched each video in 2- to 4-minute portions, then discussed what we observed, citing evidence from the data. We further discussed our interpretations, understandings and subjectivities regarding what we observed, which were often grounded in prior scholarship and our experiences as researchers. The latter allowed us to "see" the data from different perspectives (e.g., embodied cognition; Hall & Nemirovsky, 2012). Through our meetings, we "stumbled" upon instances of phenomenon as we experienced "situations of breakdown, surprise, bewilderment, or wonder" (Brinkman, 2014, p. 722). In this short paper, we focus on the use of three tools and the student interactions around them: a roll of tape, an iPad,[1] and a measuring tape.

## Results

In Phase 1, Olive[2] immediately reached for the tape and positioned herself as experienced in similar activities saying, "I've done Odyssey of the Mind." Other participants handed Olive the tape and Olive began creating a single, non-linear track. Other students suggested ways the tape path could be made more difficult for the robot to traverse, such as including short, jagged tape lengths (i.e., sharp angles). When the teacher gave a five-minute warning, members bustled about with urgency. Olive shared physical ownership of the tape, passing it to group members. Students tore off sections of tape and passed them out. Group members used the tape sections to build on to both ends of the existing tape path.

The tape served as a tool with affordances that the group members drew upon. First, the tool was fully visible at all times. Students could see at a glance who had the tool and what was being done with it. Second, the tool was shareable. Olive could give sections of tape to other students to place on the track. Third, the group's activity and movement towards the final goal of creating a tape path that would be difficult for Dash to traverse for the other team was always visible to each group member. This visibility provided opportunities for all members to evaluate progress toward the goal, and decide whether and how they should contribute. As Phase 1 concluded, the group appeared to be working together collaboratively toward accomplishing this final goal.

In Phase 2, four new tools were introduced: a measuring tape to identify lengths of the path created by the other team; a pencil to mark the path with section measurements; an iPad; and Dash, the robot. As noted above, we focus solely on the measuring tape and the iPad in this analysis, and view Dash as an extension of the iPad, rather than a tool in its own right. After the measuring tape was handed to the group, students passed it around before Olive was given and took ownership of the tape.

> Harry: [giving the tape to Olive] "She's the smart one."
>
> Olive: [taking the tape] "I do Odyssey of the Mind."
>
> Simon: "Just give it to her, and make her do all the work."

Group members crouched near the track and helped Olive measure sections of the tape path to prepare for programming Dash using measures of lengths of the path and turns in degrees. The collaborative mood from Phase 1 seems poised to continue.

The teacher then called for two group members to get the iPad and Dash. Harry, Simon, and Ben rushed toward the teacher. Ben took the iPad from the teacher, and Harry and Simon tried and failed to take it from him. Back at the group, Harry again tried to take the iPad from Ben saying, "Give it, give it" (see Figure 1, left). Timothy stepped toward the pair and took the iPad. Ben continued to vie for the iPad, resorting to grabbing (see Figure 1, middle). Group mates clustered around Timothy (see Figure 1, right).

Figure 1. Physical attempts to take the iPad (left and middle); clustering around the iPad (right).

Students appeared to cluster around Timothy for three purposes. First, students wanted to see what was happening on the iPad. As the tool is insular, there was no other way to gain access to visual information projected on the iPad screen beyond students moving their bodies close to it. Second, students wanted to touch the iPad when they think Timothy is incorrectly programming Dash for the measured path. Third, students positioned themselves in attempts to take the iPad.

Perspectives across the three group members illustrate differences of activity in Phase 2 in contrast with Phase 1. As new tools were introduced, the cohesion of the group with a common goal in Phase 1 fractured. The measuring tape was primarily considered the purview of Olive, but the importance of the measuring tape was overshadowed by the interactions and conflicts that emerged around the iPad. In particular, the budding "collaborative" group splintered into two separate communities when the iPad is introduced. Olive led the measurement of the tape path with one other student following her and helping by orienting the tape on the path, while no leader emerged from the four students vying for control of the iPad. Instead students physically maneuvered to see the iPad or take possession. Each time a student took possession of the iPad, he covered the screen with his body, blocking visual access to the others. In addition, verbal contributions of other students, in an attempt to effect the programming of Dash, were largely ignored by the iPad controller because such contributions were often accompanied by attempts to take possession of the iPad. Competition for control of the iPad slowed the progress of the group toward the goal of programming Dash to traverse the path. Students prioritized their individual efforts to gain control of the iPad over negotiating suggestions to meet the activity goal of programming Dash to traverse the tape path. One example of the prioritizing of individual goals over the activity goal occurred when Harry managed to take possession of the iPad. In an effort to explore how the coding steps were aligned with Dash's movements, Harry adjusted lines of code Simon had written. Simon immediately asserted "You messed it up," referring to Harry's movement of code Simon had written. Simon took the iPad back from Harry, and physically protecting the screen from Harry, attempted to "fix" the code.

Competition for control of the iPad often interfered with communication of linear measures needed to program Dash's movements. Olive and her student helper could not see the iPad screen, so in rare moments when measurements were requested by the iPad controller, Olive had only the masking tape path as a referent. As a consequence, she often provided measurements for the section of the path she was measuring, rather than the section of the path that was being programmed. Without shared context in the form of access to the code and to the measurement of the path, the collaboration from Phase 1 devolved into goals for each of the groups, namely measuring the path and controlling the iPad.

## Discussion and conclusion

We had initially begun this investigation to look at mathematical play in informal robotics environments, but the introduction of the iPad in the second round of the activity contributed to the splintering of a single figured world into two; therefore, causing rifts that made mathematical play impossible. There was also a fundamental design breakdown that contributed to the splintering of the mathematics within that context (e.g., angle and length measurements). Here, the iPad served as a pivotal tool in that the meaning and importance ascribed to the iPad by individual members of the group led to a deconstruction in the socially negotiated and constructed figured world in Phase 1 of the activity as students vied for power and control of the iPad. This deconstruction seemed to shape the subsequent construction of two figured worlds - one around the iPad and one around the measuring tape - that were not in accordance with one another and led to students within this context *working alone together* as opposed to *working together alone* toward meeting some defined goal.

Our findings raise questions as to the use of a single, desirable technological tool in promoting an environment of collaborative problem solving and growth as learners within a group as the iPad - as an insular tool - may limit access of visibility and use of the activity. One obvious (and only partial) solution would be requiring that every student or pair of students gets a turn with the iPad, which may stand in contrast to informal learning environments in which collaboration is a social and voluntary form of engagement. Alongside this issue of formalizing an informal environment, such a solution still does not solve the issue of information distribution within the group (e.g., Olive giving a length measurement for the incorrect strip of tape, because she cannot see what strip the iPad holder is asking about). Richer possibilities include displaying the iPad on a larger screen so everyone in a group can follow along and provide just-in-time input (reducing the insularity of the tool), decrease the number of students in a group, and require all measurements be completed before gaining access to the iPad. Each of these possibilities would increase the likelihood of a shared figured world for the group, even as they change the emphasis on developing a figured world predicated upon informal activity.

However, we envision a change in the design of the tools that goes beyond merely reducing insularity or formalizing otherwise informal contexts. In particular, what if coding apps such as Blockly could be controlled by more than one iPad (e.g., angle, distance, "go") in a shared, synchronous virtual space? Such a design would create three separate programming tools that must be used in concert to accomplish the overall goal, such that using the three iPads collaboratively (alongside the information with the measuring tape and pencil) would be required to maneuver Dash. In particular, we consider that such a design would support collaborative informal learning environments beyond the current design, and render it less likely that the figured world splinters partway through the activity.

## Endnotes

(1) We viewed Dash as an extension of the iPad, and will explicate in our presentation how we developed that view.
(2) All student names are pseudonyms.

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