

On Planning the Canoeing of Rapids and Its Reasoning Processes

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Abstract: While planning has been at the center of influential debates on the nature of cognition and action, little research on planning has been done from a learning sciences perspective. We thus take up the empirical study of planning the canoeing of rapids and the reasoning processes that underlie that practice, as we seek to contribute to theorizing planning as a form of human activity. In an ethnographic approach, we followed the routines of a team of canoers and collected video records (with helmet cameras) of the full arc of the activity, from the collective, discursive construction of the plan through the entire rapids run. We find that any given plan provided resources for canoeing action, without exhaustively describing it. Knowledgeable performance in the rapids thus emerged from the planning process and, crucially, the historically constituted practices of the team and individuals' embodied knowledge and skills of canoeing.

Introduction

In the landmark volume *Plans and Situated Actions*, Lucy Suchman (1987) questioned some then-prevalent assumptions about the nature of knowledge and what it means to know in action. Suchman was writing at a time when models of knowing and learning drew heavily from computational metaphors, and her work on the nature of (human) planning sought to highlight the emergent, contingent, and adaptive character of reasoning and action (Suchman, 2003). Referring to whitewater canoeing as an example, Suchman (1987) wrote: "...in planning to run a series of rapids in a canoe, one is very likely to seat for a while above the falls and plan one's descent... A great deal of deliberation, discussion, simulation, and reconstruction may go into such a plan. But, however detailed, the plan stops short of getting your canoe through the falls" (pp. 52).

Rather than an indictment of plans and their utility, Suchman's canoeing example highlights the necessary incompleteness of any given plan, the contingencies of action, and thus the need for models of cognition to account for the complexities and fluid nature of cognition and action. In this regard, she suggested "a shift in the status of plans from mental *control structures* that universally precede and determine actions, to discursive *resources* produced and used within the course of certain forms of human activity" (Suchman, 2003; pp. 299, emphasis in the original).

Despite the profound reach of Suchman's work, however, to this day the canoeing and planning example stands as an imaginary case (Becker, 2014) or an illustrative case with no empirical evidence. Indeed, relatively little research on planning has been done from a learning sciences perspective (e.g., Roseberry, 2005). In this paper, then, we take up the empirical study of the nature of planning the canoeing of rapids and the reasoning processes that underlie that practice. Our main goal is to contribute to theorizing planning as a form of human activity and to add to the research base on basic cognitive processes. In this regard and in the spirit of ICLS 2020's theme of *interdisciplinarity*, we acknowledge the powerful impact that Lucy Suchman, a cultural anthropologist, has had on not only our field of the learning sciences (see the special issue of the *Journal of the Learning Sciences*, 12(2), 2003) but also with the adjacent areas of the cognitive sciences, human-computer interaction, and artificial intelligence. Alongside pioneering work from scholars in various other fields (Lave & Wenger, 1991; Scribner & Cole, 1981), Suchman's *Plans and Situated Actions* ushered in a productive debate on the role of communication, culture, interaction, and coordination in cognition and learning, and contributed in decisive ways to theory, method, and practice in the learning sciences.

A brief literature review

Suchman's imaginary case of canoeing planning has been widely employed in articulating situative perspectives on knowledge, learning, and action (e.g. Acord, 2010; Monk, 1998; Sharrock & Button, 2003; Solomon, 2007). When Suchman (1987) initially published *Plans and Situated Actions*, the case was presented as part of a general critique of then-dominant AI and computer-based paradigms of planning. In the classical AI paradigm (see Wilkins, 1988, for an overview), plans would output a series of primitive actions based on an initial set of conditions. These initial sets of conditions could include an initial "world" state, constraints, operators, and goals for the (automated) planner, and the paradigm did not generally account for changes in states over the course of planning and execution.

Suchman's ethnomethodological perspective (Garfinkel, 1967) emphasized how talk, communicative resources, intent, and background knowledge were all critical considerations in understanding human planning. The perspective demonstrated how the specificity of human planning would inevitably be inadequate in describing the totality of human behavior. For example, an everyday human activity such as flipping on a light switch (Allen, 1984) may employ a certain script, procedure, or heuristic drawing on the human's background knowledge (Clancey, 1997), but the final planning element employed to generate the final outcome is always contingent. Turning on the light could occur through flipping on a light switch, hitting the wall, or tightening the light bulb (Allen, 1984). The plan or reason for the action is left uncertain until the action has occurred.

Only a small number of studies have attempted to examine both human planning and the plan's eventual execution. These studies have focused on planning in contexts such as hospital wards, schools (Markee & Kunitz, 2013; Rogoff, Topping, Baker-Sennett, & Lacasa, 2002; Rosebery, 2005), orienteering (Murakoshi, 1997), and street navigation (Hölscher, Tenbrink, & Wiener, 2011). For instance, Rosebery (2005) demonstrated how school lesson planning falls quite short of being able to capture the day-to-day contextualized responses of school children while at the same time still serving as a useful resource for the teacher. Bardram and Hansen (2010) presented a perspective on "continuous planning" with "plans and execution... entangled in a complex coordination puzzle" (p. 340). More relevant work to our goals, Murakoshi's (1997) study of orienteering developed a taxonomy of planning elements, such as directives, places, conditional sentences, and delimiters.

Theoretical framework

We take a broadly socio-cultural perspective (Lave & Wenger, 1991) to studying plans as "discursive resources produced and used within the course of" (Suchman, 2003, pp. 299) the ongoing activities of a group/community. Rather than studying a lone canoer, then, we investigate a community of canoers' collective, discursive construction of a plan for running rapids and how such a plan is then manifested in the action that it seeks to structure. In doing so, we take it that knowing and learning the canoeing of rapids reside (in important ways) in the practices of the community, as well as their historically sedimented knowledge of the rivers they traverse.

At the same time, by participating in the practices of the group, individual canoers learn how to paddle canoes and develop increasingly sophisticated embodied skills of maneuvering and steering (Barsalou, 1999). They also learn the specific disciplinary aspects of canoeing rivers and rapids (e.g., recognizing river features), as well as the rapid planning and running routines of the community.

Finally, in line with an interactionist perspective on knowing and learning (Jordan & Henderson, 1995), we take it that knowledgeable performances are produced in the moment-by-moment interactions between participants in a setting. Implicit in this view is the idea that cognitive activity is distributed among participants and "things" in a setting, rather than the strict property of individuals (Greeno & Engeström, 2014). In our canoeing case, for example, this means we attend to various mechanisms and resources that both communities and individuals deploy to coordinate their activity (Goodwin, 2011).

Methods

Data for this work come from a larger study of the River Team (a pseudonym, hereby "the Team")—a community of predominately undergraduate students who canoes the rivers of Texas and conducts water quality monitoring activities. The community is housed in and affiliated with a major University in southwest United States (US), and the data the Team collects is entered in a state-wide citizen science database utilized by the state's regulatory environmental board. Most Team trips have between 10 to 12 members. Although a couple of team members paddle kayaks or stand up paddle boards, most use a wooden 16-foot canoe that can sit two canoe partners.

The first author was a member of the Team for four years, and he acted as a participant-observer throughout the study. He collected ethnographic data (Hammersley & Atkinson, 1995) on the Team's activities, in and off the rivers, from February 2016 to February 2019. Targeted river running data collection occurred from September 2016 to January 2017, and 12.4 hours of video data were captured alongside several pages of field notes, video logs, and analytical notes. Video records were made by two GoPro cameras installed on canoeing partners' helmets.

For this paper, we focus on records of the Team scouting various rapids, the planning processes that ensued, and finally the subsequent execution of the plan. Accordingly, in our analysis we look at the moment-to-moment, fine-grained details of the Team's discursive construction of planning and attempt to match plan elements to the actions observed during rapid running. We treated the records by first watching and logging all the footage of the Team's river trips. Selected episodes were then transcribed and annotated using conventions adapted from Jordan and Henderson (1995):

...	A pause of 1s or shorter	Caps	EMPHATIC talk
::	Extended vowel sound (e.g., No::)	[Beginning of overlapping talk
(())	Authors' comments	Unint	Unintelligible talk

Analysis and results

Out of a rich and large dataset, we select two episodes of canoeing rapids which, taken together, characterize the basics of planning for and running rapids and the reasoning processes cutting throughout.

Read-and-run: Knowledgeable action without planning

We begin by examining an episode that did not involve a formal planning phase, yet the Team still performed knowledgeably. In doing so, we highlight the various structuring resources (Lave, 1988) that undergird the Team's practice of rapid running as a whole and which therefore shape the Team's rapid running planning. As we will see later, such resources are taken and shared by all members of the Team's community.

In the mode of river running shown here, canoers do not stop to formally plan out a course of action for traversing a rapid. Instead, as Team members describe it, they attempt to *read and run* the rapid simultaneously. When reading and running a rapid, canoers will quickly (visually) scan for river features in the emergent path and respond accordingly.

The episode took place on the Guadalupe River in Texas. It was October 2016, and the water flow was lower than usual, which exposed more rocks and objects that paddlers had to avoid. Multiple small rapids had also formed, and the Team decided they could read-and-run their way through them.

We pick up the action when Samantha and Stanley, our focal canoe partners for that trip, were approaching one of the small rapids at the beginning of the run. Samantha sat in the front of the canoe (the bow), while Stanley sat in the back (the stern). As the canoe in front of them began to enter the rapid (Figure 1.a). Samantha turned back to face Stanley and asked (00:11) "you good?," to which Stanley replied "yeah." Immediately after, the canoe behind Stanley (Figure 1.b) told them to (00:12) "go ahead."







Figure 1. (a) Samantha's view of the canoe ahead, as it entered the small rapid; (b) Line of canoes behind Samantha and Stanley.

While this exchange is very brief, it illustrates some crucial resources for canoeing rapids that reside in the practices of the Team. To begin, Samantha and Stanley's exchanges highlight the interactional resources that canoe partners constitute for one another (Goodwin, 2011). Throughout the run, partners rely on each other's reading and assessments of the river and coordinate their actions through talk to steer their canoes.

In addition, the Team relies on inter-canoe communication and coordination to further structure rapid running, here observed in two ways. First, canoes may inter-communicate to guarantee continued flow of entrance into the rapid, as when the canoe behind Stanley and Samantha directed them to "go ahead" and enter the rapid. Second, and immediately related, when approaching the rapids Team canoes form roughly in a line of equally spaced canoes (Figure 1.b), thus guaranteeing orderly and paced entrance into the rapid. Individual canoes thus constitute mutual resources for maintaining good conditions for rapid running, and equal spacing between canoers ensures continual feedback about the conditions ahead.

Twenty-six seconds after their "go ahead," Samantha and Stanley entered the fast moving rapid:

1	00:38	Samantha:	Sleeper ((a rock covered in water, circled)) in the middle ((begins drawing left)).	
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2	00:39	Stanley:	Okay... OH SHOOT ((canoe hits sleeper, circled)).	
3	00:41	Stanley:	((Unint)) I'm sorry.	
4	00:44	Samantha:	You're good.	
5	00:46	Stanley:	Okay. We're going to go:: straight ahead ((arrow shown)).	
6	00:47	Samantha:	Okay.	
7	00:49		((Samantha and Stanley exit the rapid safely)).	
8	00:54	Samantha:	((Turning to Stanley)) Nice.	

On turn 1, we see that immediately upon entering the rapids, Samantha called out a potential *hazard* in the form of a “sleeper”—a submerged rock, in canoeing lingo. Hazards refer to river features that pose dangers to canoers and thus should be avoided; as we will see, they are important elements in the discursive, collective construction of plans. A second later (turn 2), Stanley acknowledged the presence of the sleeper, but they hit it anyway—an illustration that bumps are a common occurrence in the practice. In light of the bump, on turns 3 and 4 Stanley and Samantha then reiterated to each other that they were proceeding well.

Two seconds later (turn 5), Stanley spelled out a *line* that they were to follow: “to go:: straight ahead.” Lines describe a path or direction down the river, and they are another type of element that anchors the discursive construction of plans. Indeed, when formally planning to run a series of rapids, Team canoers will spend most of their time imagining possible lines of descent for the complete extent of the run.

Finally, in the remaining five seconds of the run, Samantha and Stanley successfully cleared the rapid, though they did not exchange any further communications. At the end (turn 8), Samantha’s statement “Nice” seemed to function as a positive *evaluative* comment of their collective performance.

In sum, this episode of reading-and-running rapids reveals much about the nature of *running* rapids (action) and, by implication, the nature of planning for that task. Specifically, our analysis reveals various resources that structure knowledgeable action through the rapids, including: (1) knowledge of whitewater canoeing, specifically canoers’ ability to identify (read) river features; (2) individuals’ embodied skills for quickly maneuvering the canoe; (3) the interactionally achieved coordination of steering between canoe partners; (4) the coordination of activity between and across all canoes in the Team. Knowledge of these resources are taken as shared by members of the community when working out plans for rapids, as we will see next.

281 Rapid: Scouting and running a rapid

We now consider an episode that illustrates the full arc of planning for and running rapids. The 281 Rapid is so named for its location right next the US Highway 281 bridge over the Guadalupe River in Spring Branch, Texas. The episode took place a few hours after the read-and-run case considered above, and thus it provides some continuity of context for analysis. The 281 rapid is not inherently difficult nor long, but it contains a major drop and shallow areas that can trap a canoe. Due to these potential dangers, the Team decided to scout and plan their run for the rapid.

Scouting and planning for a rapid

The Team parked their canoes upstream and river-left of the rapid (Figure 2). From there, they walked alongside the river bank to the end of the rapid—a place from which they could observe the run in its full extent. Usually, Team planning for running rapids is led by the trip leader, and the emergent plan is then further elaborated by canoeing pairs/partners. In this particular case, however, Mateo (the trip leader) decided to delegate the planning entirely to the group. The Team then self-assembled and planned their own lines through the rapid. Canoeing

partners discussed possible lines to take through the rapid, and they constructed their lines working backwards from the end of the rapid to the start. The end of the rapid (or *end state*; Wilkins, 1988) is an important planning element central to any Team canoeing plan. Here, the desired end state was a small and calm rocky beach river-left and downstream of the rapid (see Figure 2). Partners also other consulted with other team members in search of ideas for possible *lines* to reach the desired end state.

After 8.5 minutes, however, Stanley and Samantha had not reached a decision on which line to take. As such, they chose to watch Aaron paddle through the rapid by himself and to use his run as an empirical case to build their plan with. Aaron entered the rapid with a stand up paddle board and took a line towards river-right and over the *drop* (Figure 2) safely. The drop thus provided Stanley and Samantha with a potential *target*—that is, a river feature that canoers want to aim towards and eventually “hit.” In the analytical vocabulary we develop here, *targets* and *hazards* are kinds of *landmarks*, which are elements that anchor the discursive construction of *lines* of descent and other aspects of plans.

Having seen Aaron paddle through the rapid successfully on river-right, Samantha asked Stanley (09:04) “Do you want to do it that way?” to which Stanley immediately replied “Yeah.” Taking Aaron’s line meant staying river-right and going right over the drop. The two firmly agreed on this, and both started slowly walking back towards their canoes. Samantha then paused and continued to discuss which lines other team members were taking, while Stanley went ahead and waited at the canoes.

After some 10 minutes, Samantha met with Stanley at their canoe, and Samantha brought up the plan again (19:08): “So: I was looking at the right line again, and the only thing I can foresee possibly happening is...umm. So, you know that drop, right? We’re going where Aaron was, that little divot. If we go into that at an angle, and we get stuck. Like if the tip of my thing ((front part of the canoe)) drops down, and there’s a little bit of air between our boat, then we’ll flip.”



Previously, we saw Samantha and Stanley agreed on the right-line and to go right over the *targeted* drop. However, now Samantha brought up the possibility that going over the drop could be a *hazard* and could cause the boat to flip. However, she did not discard the previous plan and proceeded to state (20:01): “If we were to do that, we would need enough power, and we would both need to lean in. Lean downstream ((leans forward with her body)). That will move the boat down. But other than that, that’s the only risk that I see.”

Here, Samantha specified the plan and her envisioned line further, and she did this in two ways. First, she discussed a *mode* of river-running where both canoers would have to generate “enough power” to make it through the drop. A mode is a planning element that regulates how the rapids (or segment thereof) should be approached and run. Second, Samantha provided a *technique* for ensuring that the canoe would make it down the drop by “lean((ing)) downstream.” Techniques are planning elements consisting of relatively specific, routinized, culturally shared packages of actions. The technique here is to both lean in while also generating enough power.

Samantha ended her planning considerations by asking Stanley (20:20) “How do you feel? Do you want to do the right-line?” to which he replied “I’m ready. For sure, for sure.” This ended the formal planning phase, which lasted a total of 22 minutes. Samantha and Stanley then waited for the rest of the team to get ready.

Running 281 Rapid

After four minutes waiting, Samantha and Stanley decided to go ahead and run the rapid first. They got into their canoe and took some time to rehearse their plan once again:

9	25:00	Samantha:	Don’t forget, get on your knees ((places knees against the canoe, shown)) And:: we’ll lean in when we go in down that drop.	
10	25:12	Stanley:	So lots of power and we’re going to the right of the cliff, I mean to the right side of the cliff ((introduces new planning element, discussed below)).	
11	25:16	Samantha:	We’re not going to the far-right side ((gestures left, shown)) We’re going to where Aaron was.	
12	25:17	Stanley:	Yeah okay.	
13	25:22	Samantha:	Yeah make the call as you see it.	
14	25:23	Stanley	I’m sorry, not right. The left. Like where Aaron was. Okay.	

Starting on turn 9, Samantha again stressed out the importance of “lean((ing)) in” (a technique they had discussed during planning) when going “down that drop,” and the need to “get on your knees” to correctly do so. Stanley followed up by acknowledging the mode required to run the drop, “so lots of power” (turn 10), as previously agreed. However, still on turn 10, Stanley appeared unsure where the drop was and tried to refer to it by the placement of the “cliff.” This was the first mention of the *cliff* landmark, and it seemed Stanley was referring to a set of rocks to the left the drop (cliff marked on Figure 2). On turn 11, Samantha then clarified that the line did *not* go through the far-right side, but where “Aaron was” (turn 11, dashed line on Figure 2). Samantha then decided it was up to Stanley to “make the call” about where they will be positioned above the drop (turn 13). Upon hearing this, Stanley agreed with Samantha about the placement of the drop (turn 14), and they started paddling downstream.

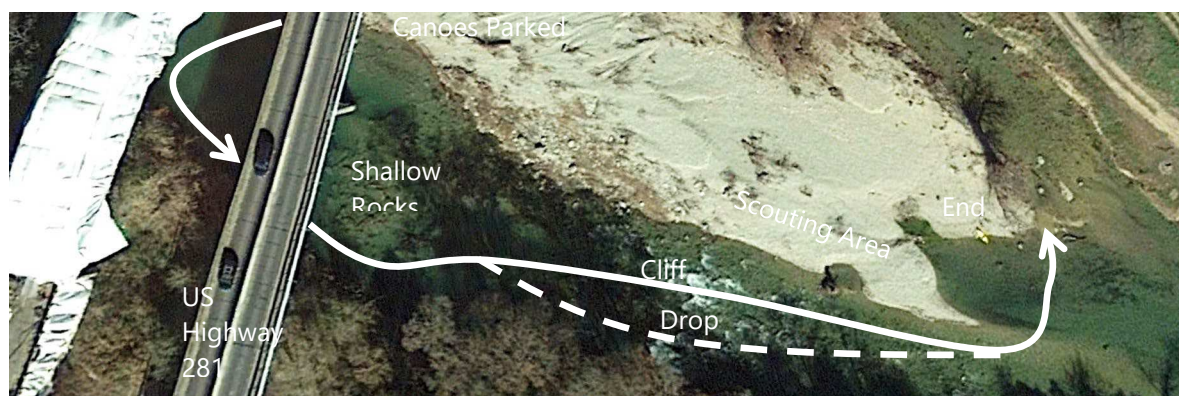






Figure 2. Annotated Google Maps Satellite Image of 281 Rapid. Solid line is the path of the actual rapid run. Dashed line is the path of the planned run.

Once moving, Stanley and Samantha took some time to paddle towards and under the highway bridge. They then approached an unplanned-for set of shallow rocks (see Figure 2), and had to decide on the fly whether to go the left or right; Stanley eventually called out (26:07) “we’re going to go the right.” After they passed the shallow rocks, they began entering the fast-moving part of the rapid:

15	26:30	Samantha:	Okay, I’m just going to start paddling forward. Make sure you steer us into the right direction.	
16	26:35	Stanley:	Is this uh:: Is this the right spot? Right? Yeah.	
17	26:38	Samantha:	Uh, sure?	
18	26:39	Stanley:	Straight ahead? [Okay.	
19	26:41	Samantha:	[Yeah we’ll figure it out I guess.	

For 11 seconds, then, Stanley and Samantha were somewhat disoriented, unsure of their placement within the rapid (turns 15-19). They decided to paddle forward and guess where to head (turns 18-19), which is surprising given the time they spent scouting and planning for the rapid. Four seconds later:

20	26:45	Stanley:	Okay. To the left of this sleeper ((circled)).	
21	26:46	Samantha:	((Starts drawing left)) Yep.	
22	26:47	Stanley:	No no, we’ll go to the right. NEVERMIND LEFT. Sorry.	
23	26:51	Samantha:	((Both enter the rapid and pass left of the sleeper, circled)) I’m just going to paddle forward.	

24	26:56	Stanley:	We're good. We're good. Paddling. Paddling hard ((to hit the targeted drop, circled, but they miss it and pass to the left)).	
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After a temporary disorientation, Stanley and Samantha found themselves facing an unplanned-for sleeper (hazard) at the start of the rapid, and Stanley decided to go left of it (turn 20). Samantha agreed immediately (turn 21), but then Stanley seemed to change his mind (turn 23). Ultimately, they went left of the sleeper, entered the rapid (turn 23), and aimed at the drop (a planned-for target), but they missed it entirely and went by its left (turn 24). After they did so, Stanley sarcastically stated “That’s one way to do it!” and laughed. They continued and parked the canoe on the left river bank (Figure 2); the end state they had originally envisioned.

So, what do we learn regarding the nature of planning for and running rapids? In the collective, discursive construction of a plan of descent, canoe partners exchange various ideas about possible lines of descent, and they consult with other Team members as well. When imagining and projecting such lines, canoers attend to river features (drops, sleepers, and others) that discipline their perception of what constitutes hazards, targets, and landmarks (Stevens & Hall, 1998) and continuously refine their lines through and around these features. Planning may also address other elements of canoeing rapids, such as explicit descriptions of the mode (e.g., fast, powerful, slow and steady) for running parts of the rapid and techniques for carrying out the mode (e.g., leaning in).

During the rapid run, we saw that some plan elements were manifested in canoers’ talk and/or paddling, such as when Stanley and Samantha explicitly aimed at the drop that they had planned to target, or when they discussed their current “spot” (turn 16) or positioning within the rapid. We take it that these instances are evidence that the plan indeed served as a resource for structuring canoeing action, as Suchman (2003) would have it. And yet, contingencies of action also led the canoers to deviate from their plan and much of their performance relied on their individual abilities to read the rapids, embodied skills of canoeing (Barsalou, 1999), and interactionally achieved coordination of steering (Goodwin, 2011).

Discussion and conclusion

We have considered the practice of planning for and running rapids and the cognitive processes that undergird it. To uncover how canoers reason about and with the plan, we purposefully chose to empirically investigate how planning unfolds in the activities of a community of canoers and their routine practices, rather than the lone canoer example that has fueled researchers’ imagination. Doing so afforded us a window into the discursive construction of plans and allowed us to trace how the plan materialized itself in the action of canoeing dyads during rapid run.

As we have seen, reasoning while planning revolved around canoers “reading out” river features that were consequential for their rapid runs (e.g., *hazards* and other *landmarks*) and discursively weaving such features into plan elements that anchor imagined lines of descent. Planning was thus carried out to produce resources—not as prescriptions—for action. In other words, canoers never specified plans to be complete in any way, but rather assumed substantive reading-and-running would be necessary during the actual descent. This pattern has repeated throughout our data.

In line with these observations, during rapid running, reasoning with the plan seemed to involve canoers recalling some of the plan elements generated earlier, as means to informing decisions (e.g., where to paddle next) and action (e.g., *mode* of paddling). However, not all plan elements appeared during action, and their envisioned line of descent was only partially fulfilled. As in the case of the 281 rapid, then, a significant portion of canoers’ knowledgeable performance resulted from their reading and running abilities, their embodied skills of paddling, and (importantly) their use of each other as interactional partners (Goodwin, 2011) in steering the canoe.

At the same time, knowledgeable planning and canoeing action were distributed across actors in the Team, including individuals, groups, and community. Significantly, the practice of collective team planning ensured canoers access to resources for crafting lines of descent that took them safely down the rapids. Similarly, during rapid runs, communication and coordination across Team canoes ensured adequate conditions

Finally, as we reflect on planning as a kind of activity, as Suchman (2003) suggested, planning for canoeing rapids represents a very specific regime of planning—for example, in its tolerance for “mistakes” during action (e.g., bumps and plan deviations) and its plan “incompleteness.” As contrasting cases, the creation and use of flight plans (Hutchins, 1995) and lessons plans (Rosebery, 2005) draw on a different set of planning elements and procedures, and probably recruit very different reasoning processes. As learning scientists compare planning across contexts and practices, we advance our understanding of (the pervasive) planning activity and its reasoning processes in two ways: (1) providing a preliminary vocabulary of planning structures and subsequent action, and (2) showing initial sketches of how both knowledge and interaction underlie and organize human activity.

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