Equity Issues in Computer-Based Collaboration: Looking Beyond Surface Indicators

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Abstract

Student equity issues in small-group, computer-based design work carry all the same problems as other kinds of cooperative group work and some special problems related to the computer itself. This paper centers on the relationship between access to the computer mouse and other factors in group interaction in order to gain a fuller understanding of processes that may underlie inequities. This exploration is done in the context of two case studies from the Middle School Math through Applications Project (MMAP). Implications for classroom organization are discussed in terms of a theory that focuses on meaning-making rather than black-box structuring.

Keywords — Equity, cooperative learning, mathematics instruction, computer-assisted design.

1. Introduction

The use of the computer as a tool during cooperative group work has added some new dimensions to the problems of equity and status differences (Cohen, 1986). First, most of the questions about small group work are no simpler with the computer than without, and second, the computer's particular characteristics make some problems even more thorny. For example, we wonder how can we be sure all students are participating in an activity. When all students had access to a common set of manipulatives, we could at least look for hands-on behavior as a sign of participation. With the computer, we must sometimes depend on fleeting talk and focus of gaze as signs that a particular student has engaged with the task at hand. When we look at a group of students around a computer, it is hard to know if the student interacting most directly with the computer is also the student doing most of the thinking and problem solving.

If we assume that the person interacting most directly with the computer is also doing the lion's share of learning, inequitable access to the computer becomes much more serious than a lack of exposure to technology; it becomes a lack of exposure to the curriculum itself. This problem has not gone unnoticed and considerable research has been done in the cause of exploring devices that can help ameliorate problems of differential access to the computer. In particular, the widely-held assumption that males tend to dominate computer-based interactions has led researchers to explore the effects of the gender composition of small groups on the outcomes of group interactions.

For example, Lee analyzed same-gender and mixed-gender groups working with the program, *Where in the World is Carmen Sandiego.* The study found differences in such factors as the amount of task and procedure-related help given and received, based on the gender composition of the group (Lee, 1993). Other studies have found that the task itself can reverse the effects of group gender composition, with different effects found for a language-arts cloze task than for a LOGO programming task (Underwood & Jindal, 1994). Cohen, in a meta-analysis of non-technology based group work studies, claims that different rules apply depending on whether the task is well-structured or ill-structured(Cohen, 1994). Other research indicates that groups with the most ideal gender-structuring may still run afoul of equity problems due to idiosyncratic factors in group composition (Hoyles, Healy & Pozzi, 1994). This study found that initial interpersonal hostility in a group affected the way the group organized the work, which in turn affected the group's productivity and the roles each individual was able to play in the product.

Research such as that cited above may be able to help us to alleviate gender-related equity problems. However, such research has revealed the problem of organizing groups to promote equitable access to be quite complex, calling for different organizations depending on a large variety of interpersonal and task-related factors. This leaves teachers in a difficult analytical position when they actually try to set up groups in their classroom, because they must try to decide which of these factors apply to their own situa-

tion. As researchers, we have not provided enough underlying theory of group process to help teachers and students evaluate and improve their particular group process as it evolves. Instead, we have provided an ever-lengthening list of black-box rules.

In this paper, I hope to contribute to underlying theory by more closely examining the problem of differential access to computers. More precisely, this paper looks at access to the computer's mouse to see what the role of the mouse is in group interaction, using two case studies taken from the Middle School Math through Applications Project (MMAP). In MMAP, students use the computer as a tool for architectural design, working in small groups.

The MMAP cases serve as a good entry into the problem of mouse access because MMAP teachers, researchers, and students commonly center on the mouse as a signal of who is controlling design sessions on the computer. One teacher, for example, declared alternate days "boy's day" and "girl's day" on the mouse when she saw that most mice in the class were held by boys. Almost all our teachers encourage, remind, or admonish students to share use of the mouse. The students themselves also seem, to varying degrees, to attach some importance to who holds the mouse. They pull the mouse away from one another, complain when one of them monopolizes the mouse, and reach for the mouse almost automatically when they want to bring their ideas to reality on the computer.

Given the importance attached to mouse possession, the assumptions behind the actions of students and teachers bear closer examination. What happens when a child holds a computer mouse? Does the mouse mean power? What happens when a child who seems to be dominating work holds the mouse? What happens when a child who seems to be hardly participating holds the mouse? What happens when she never does? What does an inequitably-organized group look like? How can a teacher best help students to work equitably, given that she can only glimpse snapshots of their work sessions as she tries to keep up with all the groups in the class? By understanding more about group dynamics around a computer, we can learn more about group work in general, because the mouse serves as such a strong and outward marker. Since only one child at a time can hold it, it serves as a symbol of control over the group product, whether or not this control is real.

This paper examines the work of two student groups involved in a MMAP computer-based design project. It describes the relationship between who held the mouse and what happened in the group. These relationships turn out to be much more complex than one would expect given the assumptions about mouse possession and group control. After presenting the two cases, I'll discuss the implications of these cases for improving equity in mathematics classes that rely heavily on collaborative, computer-based work.

2. Case 1: Donald's Group

In the first case, Donald, Michella, Paul, and Mark are working together around the computer to make their first draft of an architectural design. The design is for a research station in Antarctica that will house four scientists for two years. We call this group "Donald's group" because Donald has a way of appearing to dominate work in the group he's in. He is proud of his computer skills and of his home computer. He happily engages in rivalries with anyone who disagrees with him, and he likes to win, but he always argues with a smile. I analyzed a video tape that was taken on a day when Donald had just been reprimanded for taking over group work. During the seven minute design session, Donald holds the mouse for almost 4 minutes (53% of the time), while the other three group members divide the remaining time. But part of the way through the session, the teacher visits the table and makes Donald give the mouse to another group member. The question is, did this intervention make the group more equitable?

Close analysis of this group's talk shows that the person with the mouse often has less impact on the design than other group members. As soon as one member takes the mouse, the others start shooting instructions at him or her. Mouse holders have all they can do just keeping up with this flurry of instructions. For example, consider the following piece of transcript from a part of the session where Donald has the mouse. Michella, Paul, and Mark are all using talk to guide Donald's use of the mouse as they create the design on the computer:

> Michella: OK, I want a door first, and then once you open it,
> Donald: A door?
> Michella: Yeah.
> Paul: A door, and then there's a hallway.
> Donald: In the middle?
> Paul: Yeah.
> Michella: Yeah. Wherever you want to put it.
> Donald: A door? In the middle? Of the hallway?
> Paul: Yeah.
> Paul: Not that small, not that small.
> Michella:[laughs]
> Paul: No. erase it.
> Donald: Why?
> Paul: Up more.
> Donald: Up more? No, this isn't the corner, this is a hallway.
> Mark: Stupid little house...
> Michella: So once we walk in it's a big old hallway.
> Paul: (?) kind of hallway.
> Michella: between all that hallway you can see
> Mark: a walk-in closet.

Michella: Be quiet!
Paul: (?) go straight.
Michella: And then you turn and you see,-
Paul: Keep going,
Michella: - you see the living room.
Teacher: (to whole class) You've got one minute left to just get done the basics.
Mark: Hurry up!
Donald: OK.
Mark: how many floors are we making?

Although Michella doesn't have the mouse, she is clearly having a great impact on the design. She is giving a verbal walking tour of the design she is picturing, and Donald is more or less drawing it on the computer. Others are also having their suggestions heard and used.

Soon after this, the teacher comes over and sees that Donald has the mouse. This results in a reprimand, especially because Donald has just been chastised for dominating the group's off-line work earlier in the class period. The following exchange takes place:

Teacher: Now why is Donald running this? Does Mark never get an opportunity too?
Mark: (?)
Teacher: Donald you get (?) away from the computer.
Donald: Paul said he didn't want to. (pushes the mouse toward Mark. Mark takes it and makes 3 wall sections.)
Teacher: Now wait a second you just pointed at Paul you didn't point at Mark. How bout Michella?
Mark: here you go.(Mark gives Michella the mouse).
Donald: Yeah, Michella!
Michella: (grins) I didn't -
Mark: I created my own house.
Teacher: Michella needs an opportunity also to be on the -
Michella: OK, so I want
Paul: The living room.
Teacher: So you go ahead and you make some decisions for them, cause they make a lot of decisions for you,
Michella: I make decisions!
Teacher: So go ahead for now,
Paul: Don't put a window there!
Teacher: So go ahead for now, and make some decisions for them.

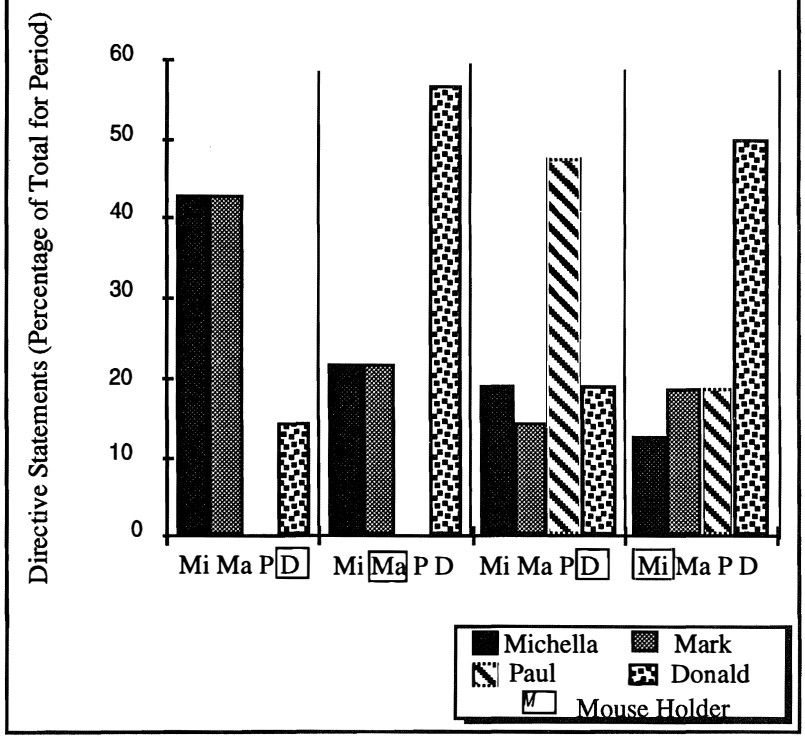
So the teacher has not only given Michella control of the mouse, but has encouraged her to take a dominant role in the design. But this turns out to be difficult, as Michella tries to balance the role of designer with the demands of using unfamiliar software.

Michella: (laughs) where's the door at?
Donald: Dooor, next to the bulldozer,
Michella: I see it.
Paul: You found it.
Donald: OK.
Michella: I hate this.
Michella clicks, and after a few seconds everyone laughs.
Michella: how do I erase it?
Donald: You sound like Mark! no, not Mark, but Martin.
Paul: This door, or this door?
Donald: Oh my goodness, (might be imitating Michella)
Mark: (?) none, bulldozer [The bulldozer is a tool for erasing]
Michella: I want..
Donald: bulldozer
Michella: It don't work.
Donald: Now get rid of those two doors.
Mark: Three doors.
Michella: I rather like them like that, shut up. [She goes to erase them anyway]
Paul: So are you putting number one or number two?
Michella: oh, why they ain't working?
Donald: You got to put the arrow part, you know the little tip, tip, tip, tip
Michella: No one does it!
Mark: bulldozer, it's on bulldozer.
Mark: You guys are on-
Donald: The-e-e-ere! (applauds)

Between the mechanics of the computer use and the suggestions of three group members, Michella is less able to have impact on the design than she was previously.

One measure of participation which seems valid for this session is the number of suggestions, commands, and ideas voiced by each member of the group. I'll use the term "directive statement" to refer to all of these. Figure 1 shows the number of directive statements made during each phase of the session, with the phases delimited by change in the holder of the mouse (or keyboard if it is the primary input device).

Figure 1: Directive Statements Versus Mouse Possession



Donald's use of directive statements drops considerably when he has the mouse, and rises again after he gives it up. Michella's total also drops when she gets the mouse. Also, as the above transcripts show, the level of her talk also changes. She spends more time on small details and less on conceptual design.

In this case, the teacher's intervention had precisely opposite its intended effect of putting Michella in charge and limiting Donald's impact on the design. Michella did try to resist letting the others take over, but the demands of running the computer were too great for her to be effective. Does this mean that a teacher shouldn't intervene in such a situation, or that the mouse is never an indicator of control? To provide more context for exploring these questions, I'll present an analysis of another group working in a different school on a similar task. This group is similar to Donald's group in that one boy tends to talk more and hold the mouse more than the other group members. Then I'll draw from both contexts to provide a framework for interpretation.

3. Case 2: Mitch's Group

The second case is taken from a group's first day using the ArchiTech software that serves as a design environment in some MMAP units. ArchiTech allows students to draw floor plans. and analyze them for characteristics such as cost and energy efficiency. One boy, Mitch, has been trained in the software, and his job is to help his group members, Darlene and Yuji, come up to speed in the software while the group works together to design a floor plan. He (along with all the other students who serve as trainers for their groups) has been told to help by facilitating group member's use of the software, not by doing everything for them.

Nonetheless, Mitch holds the mouse for eleven minutes during nineteen minute session. He also makes more directive statements than the others. He follows Donald's pattern of making fewer contributions to the design when holding the mouse, but only during the first half of the session. Darlene holds the mouse for only two minutes, with Yuji holds it for the remaining six minutes. Like Michella, Darlene has trouble making contributions to the design when she is holding the mouse. The next set of transcripts allow us to compare Darlene's role in the conversation when she is not holding the mouse to when she is holding the mouse.

In the first transcript segment below, Mitch is holding the mouse. Darlene suggests a bathtub and shows Mitch where it should be placed. Yuji joins in and directs Mitch about the size of the tub. The interaction continues similarly, with Darlene and Yuji directing Mitch's use of the mouse.

Darlene: Put a bathtub right there.(points)
Yuji: A big bathtub.
Mitch: A bathtub.
Mitch: How big do you want the bathtub?
Yuji: Big.
Mitch: Where?
Yuji: Right there.(points.)
Darlene: And then put a tiny little sink.
Mitch: Right here?
Yuji: Yeah.
Darlene: Yeah.
Mitch: Like that?
Yuji: A little bit bigger.
Yuji: Ah, that's good.
Darlene: Yeah put it, and then put a sink in.
Mitch: We have to make a door first
Darlene: Oh, yeah.
Mitch: The door 'll be right there?
Darlene: Yeah.
Mitch: OK?
Darlene: Yeah. and then put a sink up.
Yuji: No, door right here. door right here.
Mitch: In the corner?
Yuji: So it sits right here. Yeah.
Darlene: That would look funny, though, you walk in a corner, you go out of the corner?
Yuji: Yeah that's it.

Darlene has an active and directive role in this conversation. She suggests two design elements, a sink and a bathtub, which are taken up by the group and collaboratively incorporated. Now compare this to her role when holding the mouse. She takes on a much more subordinate role, while Mitch almost seems to be controlling the mouse verbally through Darlene.

Mitch: Now make a big humongous doorway, like a double door.
Darlene: OK, a door,
Mitch: Make a really big door.
Darlene: Where?
Mitch: Right there.
Mitch: Big door big door bigger bigger, down down down down.
Darlene: You want it to open like that?
Yuji: No. the other way. Rotate it.
Darlene: OK, now one more.
Yuji: Another door. Make it a double door.
Darlene: Another door? OK.

At this point Mitch takes the mouse again, which bodes well for Darlene's participation in the design. Altogether, she has more of the elements she suggests accepted into the design than either of the other two: Darlene has ten elements accepted, Yuji has nine, and Mitch has seven. In fact, this order is precisely opposite from the order of time on the mouse (Mitch, Yuji, and Darlene). In this group, the more time a child spent on the mouse, the less he or she had elements accepted into the design, as shown in Figure 2.

4. Two Cases: What We Can and Cannot Abstract

These cases are similar in that they highlight the kind of group interaction that commonly signals gender-related problems to most observers. Anyone walking around the classroom, especially a teacher who is familiar with the behavior patterns of particular students, would probably glance at either of our two groups and conclude that an assertive boy was dominating the group once again. The teacher actually drew such a conclusion in Case 1. The group in Case 2 also received a visit from the class's student teacher a little later in their interaction, in which the teacher admonished Mitch to share the mouse. The group proceeded to ignore his request and the student teacher moved on.

Yet, we have seen in both cases that our in-equitable situations were at worst more inequitable in technology access than in curriculum access, and at best barely qualifying as inequitable at all. The two girls in the case studies had the most access to the design task precisely at the points at which the group looked most inequitable: when the boy with a reputation for dominance held the mouse.

Does this mean that we should restructure all small groups so that assertive boys hold the mouse? Of course not. In MMAP, we have also observed groups that fit the pattern of our expectations quite well: the person holding the mouse actually *was* shutting other group members out of the design task. The point to be draw from these examples is that surface indicators alone, as convenient as they may be, cannot tell us at a glance whether a group is working well together, and that interventions based on these indicators may have effects precisely opposite to what we intend, as in Case 1, or no effect at all, as in the student teacher's visit to the Case 2 group.

5. Conclusion

Whatever role the mouse plays in group dynamics, it is certainly not a reliable indicator of control over group collaboration. This is true for both kinds of control usually noted in research: task management and control over the design itself. The person who held the mouse most did not in any important sense control either task management or design features. In fact, the very notion of control becomes difficult or impossible to pin down when complex group interactions are examined closely. We might just as well ask who is in control in a bumper-car ride– the answer would be everyone and no one. Suggestions made may or may not be accepted, and design elements accepted may or

may not be suggested aloud. Ideas, once suggested, can grow and take shape as the group tries to draw them, moving far from the original idea. Certainly the computer is a partner in the collaboration, since students often have to think of alternatives when their ideas can't be represented properly on the comp uter.

Still, what is one to do with the fact that Darlene and Michella both had less access to the computer than the rest of their group? There are two potential problems. First, will these girls develop computer skills? And second, do they perceive the mouse as a signal of control, and thus feel disempowered?

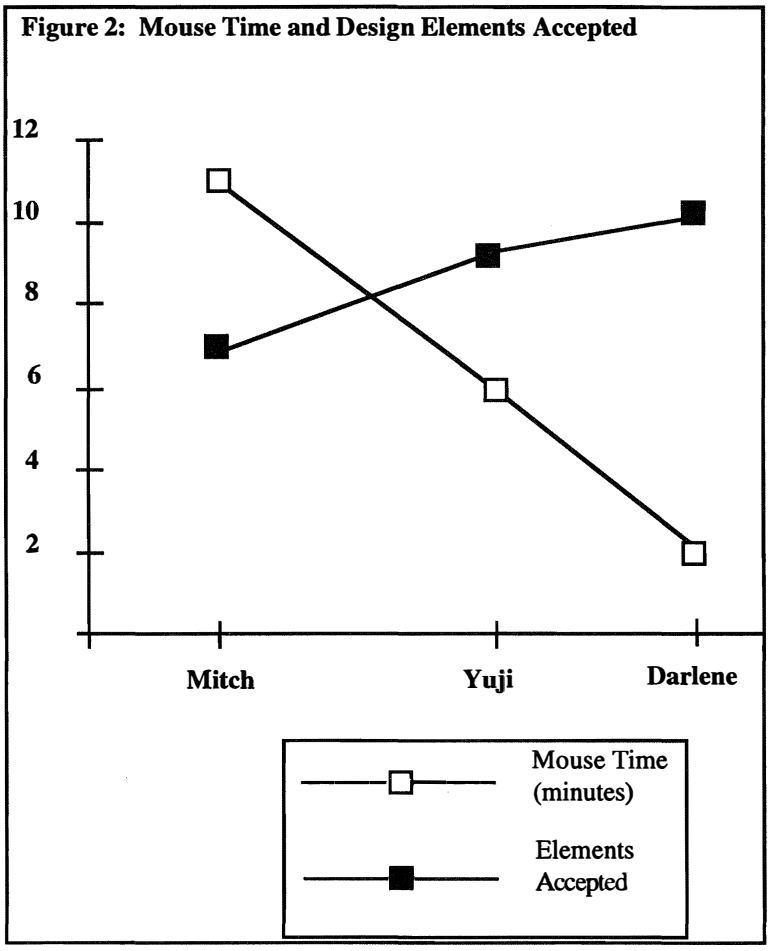
In Darlene's case, she was able to function quite well on the computer when the boys were not around. On one day she completed an entire design on her own, and showed the results off to a friend. Our observations in many groups subsequent to this suggest that whenever students are fairly involved in the design, they pick up computer skills by watching and can come fully "up to speed" with a little time for exploration.

The second problem is more disturbing. Darlene did apparently feel that her role in the design was less than the boys' role. In her group presentation (two months after the session analyzed) she said the boys did all the work and she and another girl sat in the back and made suggestions. However, the fact that Darlene had less time on the mouse and the fact that she felt that she had less impact on the design are twin symptoms of the general disempowerment of girls in math class (Koehler, 1990). This problem is so pervasive that mandating mouse control, even if it did actually help the mouse holder control the design, wouldn't erase the general inequities.

What we can do, however, is to help students become more conscious of what good group collaboration is, and what they should expect from other group members and for themselves. If students are encouraged to work out compromises and to find their own productive role in the group process, then they are much more prepared to become productive members of collaborative adult work groups than if we try to engineer solutions for them by telling them who should hold the mouse and what role they should play in the design process.

Cole (1995) sheds some light on why surface level structuring may have the unpredictable effects explored in this paper. That study traced the development of meanings for participants in small

Figure 2: Mouse Time and Design Elements Accepted



group computer based design work. It found that every aspect of the group's interaction, from academic content to social roles, developed meanings through the process of group interaction. These meanings came from places as varied as interactions with teachers, long-practiced social roles, and roles copied from other participants within and outside the working group, as well as from previous academic and non-academic experiences brought to the group. All of these factors became influential when a participant injected them into the public forum, creating a pool of meaningful concepts and behaviors that others could draw out, modify, and reinsert into the public pool. In this way meanings became increasingly elaborated and sophisticated for participants.

Thus, a behavior such as mouse possession will never have an unambiguous meaning. Not only does the behavior differ in meaning from group to group, but it differs within the same group over the course of the group's interaction. That is, the mouse serves as a symbol of group control when one or more of the participants use it that way. In the same group, the mouse can serve as a symbol of subordination when the participants treat the mouse holder as subordinate to group instructions. In short, the way the mouse gets used in a group has much more to do with the interpersonal meanings brought to the group and developed during interaction than it does with whatever properties are inherent in the mouse, (e.g., the fact that only one person holds it or that the holder has most direct access to the computer).

In Donald's group, the mouse did not even begin to become a symbol of group control until the teacher explicitly gave it that meaning. In fact, Donald was deliberately playing a subordinate role by holding the mouse and volunteering to follow the other participant's instructions. When the teacher came over and told Michella to take control by taking the mouse, Michella at first protested that she was active in the design process ("I make decisions!"). But she did take the mouse, and found that the teacher's interaction with the group was not enough to overcome the pattern of behavior that had already become established in the group's organization. That is, she and the other participants continued treating the mouse holder as the one who implements other's instructions, just as they had when Donald held the mouse. Over time, as everyone acquired more facility with the computer program, it is quite possible that the meaning of mouse possession might have changed again for the group, depending on such factors as how the social interaction played out, what happened to the group's design when they showed it to the class, and how much particular participants felt that they had impacted the design.

In Mitch's group, the meaning attached to mouse possession was even more ambiguous. During the initial interaction, an organization developed in which each member of the group claimed a room to draw. The person who claimed the room also expected to hold the mouse during the drawing of that room. Yet this organization was in some conflict with a pattern that came about because Mitch had been the participant who learned how to use the program first. In the first part of the interaction, he took on the role of running the program while others gave suggestions, and this pattern also became part of the group's interaction. When Darlene took the mouse and found it much harder than before to continue to design "her" room, she relinquished the mouse to Mitch, choosing the role of room designer over the role of mouse holder when the two came into conflict.

It is easy to see how, with the number of factors that impact the meaning of the mouse, that simple one-time teacher structuring might not have the expected impact. Teachers must build meanings the same way as any other participant in group interaction, by inserting them into the public pool, often multiple times, until they are taken up by other participants. In (Cole, 1995), teachers *were* able to influence complex behavior patterns in groups, but only after they had emphasized and demonstrated the pattern themselves many times and only after the pattern was taken up by other participants and molded to fit existing interactional factors.

Thus we must ask ourselves two questions in considering equity in computer-based interactions: First, what behavior patterns we are really trying to build, and second, how can we place these behaviors in the public forum so that they are most available to be taken up by students? Since sharing the mouse is just a symbol of the behavior of working cooperatively, we should think about how to raise awareness of what it means to work cooperatively. This way that students can evaluate and remedy their own group processes in ways that correspond to the behaviors and concepts that make sense in their own groups.

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