How Do We Assess Equity in Programming Pairs?

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Abstract: We comparatively apply methods for assessing equity to find ways that allow us to better interrogate, describe, and understand the construct's complexities. To do so, we replicate prior work assessing equity in programming pairs (Lewis & Shah, 2015; Shah, Lewis, & Caires, 2014) by creating distributions of coded (1) computer use, (2) turns of talk, and (3) questions and commands; furthermore, we build upon their application by (4) examining students' embodied interaction and social positioning. Using these four methods to analyze the discourse of a pair of students programming, we identified numerous examples of positioning shifts, and see how inequities could potentially emerge through discursive mechanisms. We then reflect on what each of these four different methods foreground, their strengths and shortcomings, including their sensitivity to time-scope and pedagogy, and triangulate the quantified and qualitative results.

Keywords: equity, collaborative learning, research methods, computer science

Introduction

Many researchers are investigating issues of equity in STEM contexts, in particular, equity within collaborative STEM learning environments, like group work. A place that has received particular attention recently is Computer Science (Margolis & Fisher, 2003; Margolis et. al, 2010). Computer science, and in particular programming, which typically uses a computer, presents a particular challenge in studying. The literature contains studies that use multiple methods encompassing multiple aspects to look at how and why equity can emerge in computer use (Cole, 1995; Lewis & Shah, 2015; Shah, Lewis, & Caires, 2014). In terms of methods, these studies account for distribution of computer use as well as types of talk (e.g. questions and commands). These papers all contrast two groups doing a computer task and discuss how their selected research measures show different facets of social dynamics being more or less equitable given the group. In addition, their conclusions are similar in they cite within group context as having the power to invalidate their methods: Cole (1995, p.73) concludes that "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 the interaction" and Shah, Lewis, and Caires (2014, p. 501) conclude that "it may be more useful to conceptualize equity as contextual." These studies highlight the need for a re-evaluation of how we study equity in computer science.

The studies cited above as well as others focus on a singular, monolithic definition of equity: Chizhik (2001) looked at how task characteristics (e.g. the number of solutions) affected the distribution of forms of participation and achievement on a test; Sullivan and Wilson (2015) looked at how positioning via "playful talk" affected status within the group, which has been shown to affect opportunities to learn. This is problematic because there are many aspects affecting and constituting equity and "these relationships [between aspects and facets of equity] turn out to be much more complex than one would expect" (Cole, 1995, p.68). So, we ask "what does equity mean in programming pairs?" To address this question we employ the methods presented in Lewis and Shah (2015) and Shah, Lewis, and Caires, (2014) because they specifically address Computer Science and include multiple measures of equity including quantitatively coding turns of talk, questions, and commands. However, we want to further elaborate on what equity means.

In an attempt to better inform how these research methods can account for the multiple aspects that affect and constitute equity, we turn to a well-cited definition for equity, which accounts for the multi-faceted nature of equity. Esmonde (2009, p.249) defines "equity as the fair distribution of opportunities to learn." She further breaks down this definition into two parts: (1) "opportunities to make sense of mathematical ideas and to participate in mathematical discourse practices" and (2) "students' opportunities to develop positive positional identities that place them as authoritative and competent members of the classroom community." We can map our selected methods onto Esmonde's definition by slightly modifying it. First, we are going to look at actualized engagement as supposed to "opportunities to learn" due to the difficulties associated with measuring an opportunity. For example, if a student is working in a group, and she does not engage in the activity, how can we differentiate whether she had the opportunity and chose not to take it, or whether she never had the opportunity in the first place, perhaps due to factors beyond our view? This complexity makes it very challenging to assess opportunity in classroom examples of group work. In addition, we divide Esmonde's first branch further into (1a) sense making and (1b) practicing disciplinary discourse to help differentiate these two observable facets of equity she is presenting. The resulting definition is mapped to our quantitative methods below. We first explain how we triangulate that this mapping is theoretically sound by using interaction level positioning to see what these quantitative indicators are capturing.

Cole (1995, p.71) states that "surface indicators alone, as convenient as they may be, cannot tell us at a glance whether a group is working well together." In order to get a better sense of group interactions, we extend Lewis and Shah's work (2015) by using the construct of positioning to examine discourse . Michaels et. al (2007, p.294) states that "all social relationships are in play in the accomplishment of deliberative discourse." Van Langenhove and Harre (1999, p.17) define "the act of positioning" as "the assignment of fluid 'parts' or 'roles' to speakers in the discursive construction of personal stories that make a person's actions intelligible and relatively determinate as social acts." Positioning in discourse could look like supporting an idea or critiquing an idea, which leads to the speaker being positioned as more knowledgeable or not. For example, a passing teacher may position a student towards the project by asking how it works. The student in turn could position him or her self away from the project by replying their partner built it so they do not know. In our study, we avoid presenting data about teacher and student interactions because of the intrinsic power dynamics between students and teachers in a classroom, making the positioning inherently inequitable. In addition to discursive positioning, we incorporate another facet to positioning: embodiment.

We apply the construct of embodied positioning used in math education (Leander, 2002; Dookie, 2014). Engle, Langer-Osuna, and McKinney de Royston (2014) present a framework that includes not only degree of intellectual authority and access to the conversational floor, but also degree of spatial privilege. Leander (2002, p. 193) also argues "that 2 key processes are active: narrating social 'scenes' through talk and producing embodied spaces." Embodiment is relevant to analyzing pair programming because pair programming typically involves a pair of people sharing a computer with a single mouse and keyboard; the person whose hands are on the keyboard and mouse has more power than the person who does not. By accounting for this embodied power via analysis of who has control of the computer at what points in time, we can better understand equity in the situation.

Using our two modifications of Esmonde's (2009) definition, we operationalize equity into three observable and quantifiable equity indicators that can provide an approximate measure of equity: Tool use, talk distribution, and question/command distribution. These indicators form the basis for a coding scheme (described below) that we use to analyze video recordings of students' discourse.

Our first equity indicator, tool use, ties back to the first part of our definition - sense making. Active computer use could indicate engagement with disciplinary ideas. While it is unlikely that computer use is the only way to engage with disciplinary ideas or that all computer use signals engagement in disciplinary ideas, the two are related. "Inequitable access to the computer becomes… a lack of exposure to the curriculum" (Cole, 1995, p.67) and computer use has been used previously as a metric in studies of equity in paired programming (Plonka et al, 2012). Theoretically, in an equitable pair, we would see a near equal distribution (50-50).

Our second equity indicator, talk distribution or "air time", ties back to the first part of our definition – practicing discourse. By measuring the distribution of student talk (Lewis & Shah, 2015; Shah, Lewis, & Caires, 2014) we can see indications of engagement with discourse practices. While it is unlikely that every turn of talk uttered by a student is engagement with discursive practices, we have a couple of reasons to believe that this metric, in our data, will still reflect an approximation of the ratio of discourse practices: (1) the students in our study have the same level of programming experience, so it is reasonable to assume that they engage in discursive practices at approximately the same rate and (2) "verbal matching within a group is a significant indicator of how well members of that group like one another" (Gonzales, Hancock, & Pennebaker, 2009, p.9), meaning that since the students presented below are very friendly towards one another, if one student starts or stops engaging in discursive practices then the other student will likely follow. If we then assume equitable collaboration, "the number of turns would be near equally distributed (i.e., 50-50)" (Shah, Lewis & Claires, 2014, p. 497).

Our third equity indicator, authority, ties back to the second part of our definition – authoritative and competent identities in the classroom. Commands and questions are of particular interest because they can indicate positioning. Questions generally give status to those being asked by positioning them as a relatively knowledgeable since "asking a partner a question can be seen as actively positioning that person as competent and, alternatively, not asking a partner a question can be seen as passively positioning that person as less competent " (Shah, Lewis, & Caires, 2014, p.499). Commands generally give status to the speaker, positioning them as relatively knowledgeable since "issuing many directive statements may indicate a lack of respect for the intellectual capacity of that individual to contribute" (Shah, Lewis, & Caires, 2014, p. 499). We use the word relative to indicate that when a speaker asks someone a question or commands the listener to do something, this positioning is not global, it is a relational shift between the speaker and listener. This position of knowledgeable is relative to the other person and only exists within the pair at that moment. We use coding to give us a rough idea of equity within the pair since one would assume about a 50-50 distribution of questions to each other to keep positioning equitable.

Now we can address our research question: How do different nominal indicators of equity differentially describe peer interactions? In this paper, we present the results gathered by applying these methods, we then reflect on what each of these methods foregrounds, their strengths and shortcomings, including their sensitivity to time-scope and pedagogy, and triangulate the quantified and qualitative results. We conclude by suggesting ways in which future would could more sensitively theorize about and assess equity in students' collaborative activity.

Methods

The data in this paper were collected in a New England high school's recently established makerspace, where we taught a single-semester elective course in digital making. The high school is highly diverse with 70% minority students and 58% of students coming from low-income families. The school's diversity is reflected in the 21 elective students (8 Haitian-Americans, 6 Hispanic, 2 African-Americans, 2 Asian-Americans and 3 other non-White students). The project captured approximately 260 hours of video, copies of student notebooks, pictures of artifacts, and the staff's daily field notes.

The data in *this* paper (a 35 minute segment of video) were collected when students had already completed one project and were working on their second project. The objective of this project was to make the makerspace "smart," where students were asked to use technology to make the space interactive in similar ways to home automation. Students were using BlockyTalky, a tangible networked tool kit used to build custom devices consisting of motors, sensors and LEGO pieces for structure. BlockyTalky devices can send messages over wireless networks to other units, to computers with music synthesizers and to Android apps created on MIT App Inventor.

In this paper, we present an episode of a pair of two sophomore girls. This pair was selected because from the outside, it was hard to tell whether the pair was inequitable or equitable. One girl did the vast majority of programming but the two girls seemed open to talking to one another. The traits of unequal tool use and openness to talk were widespread throughout the groups, making this pair representative of the groups in the class at different points in time, but not necessarily representative of the pair for the entire duration of the project.

In order to quantitatively assess how equitable a pair is, we use Shah and Lewis's scheme (Shah, Lewis & Claires, 2014; Lewis & Shah 2015) to quantify the students' relative distributions of computer time, talk, commands and questions. Computer time was attributed to the student who was actively using the keyboard or mouse. We then computed the ratio of computer time between the girls to arrive at a measure of equality. We also created transcripts for the selected episode, dividing them into turns, and tagging all turns containing a question or direct command. We counted the number of turns and tags for each girl and created a distribution of talk and talk type.

We also employ a more qualitative method, positioning, to investigate how these indicated inequities are created. To find instances of positioning, we consider each utterance and identify any positioning. In interpreting these utterances we code intentional positioning moves in the data (i.e. "I am going to program"), and tacit positioning (i.e. you are not programming). In the presentation of this coding below, we talk about positioning as authoritative or knowledgeable as positioning *up* and positioning as less authoritative or knowledgeable as *down*. In a few instances we also code positioning *towards* or *away* from the project itself, which is different in that it is positioning one as an owner or doer of the project. We make this distinction because positioning *towards* or *away* from the project is more likely to be in conjunction with embodied positioning. We also take note of embodied positioning by noting for each turn of talk who has control over the computer, paying close attention to transfers of possession and considering how it affects the meaning of the verbal positioning or vice versa.

Results

The pair of girls chose to address the teacher's inability to hear the bell within the woodshop because this problem had been causing students to be late for class. These two students attempted to make this "smart" bell by programming a BlockyTalky device with a sound sensor in the hall to sense the bell ringing, and then send a message to a second BlockyTalky device to have a synthesizer make noise in the room. This episode starts on a Friday afternoon, only a few days into starting the project. Sarah and Alice are sitting at a laptop at a table programming two BlockyTalky devices named Bruce and Eve.

From the quantified perspective, the pair looks inequitable (Figure 1). Computer time was distributed 16% to 84% in Sarah's favor (N = 12:48 minutes). Overall talk distribution was 37% to 63% in Sarah's favor (N=316 turns). Commands were distributed 53% to 47% for Alice and Sarah respectively (N=17 turns). Questions asked were distributed 58% to 42% for Alice and Sarah respectively (N=50 turns). Our coding of these data is marked using boxes around the transcript in the qualitative findings section below with the following notation: coded as command and coded as question. Tool use, including computer time, is described within the analysis following the transcript.

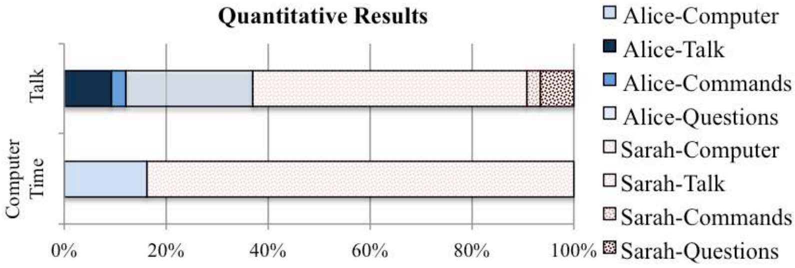

Figure 1: Computer and Talk Distribution by Student

We now have an indication of how equitable the pair was. The pair appears to be inequitable in the measures of computer use and turns of talk, but equitable in the measures of commands given and questions asked. In theory, the dynamics of positioning we see in the qualitative analysis should approximately match the proportions above. It then follows that if we see Sarah making moves to keep tool usage or a lack of Alice making bids to use the tools, a similar yet less extreme dynamic should be seen with air time, and an almost equal distribution of moves to position oneself as knowledgeable – these indicators are good approximations of actual positioning. If not, we would need to question whether these indicators are a reasonable construct to apply in this context.

We start the qualitative analysis about 24 minutes into the episode where we see a transition from talking to active programming on the computer. This piece of the episode was chosen due to the lack of programming in the first 20 minutes and the fact that teacher interactions were minimal in this piece of the episode. While most of our methods would work on student discourse without tool use, our aim is to present all of the indicators in conjunction with the qualitative analysis and we cannot study the effect of positioning on tool use when there is no tool use.

[23:39] S: Wait, stop.

[23:42] A: That was fun

[23:43] S: As you can tell, I didn't program it to do any kind of actual sound. I just did a bunch of random buttons.

[23:56] S: Hold on a second, stop stop.

The transcript above is presented based on time stamps, not turns of talk as defined in the methods section, so when trying to understand this coding, each line needs to be dissected into turns. For example, [23:43] has two turns of talk within the single time stamp.

Our equity indicators in this snippet show Sarah dominating through computer use, more turns of talk and multiple commands. This matches the qualitative analysis where we see Sarah positions Alice away by commanding her to stop pressing the buttons multiple times ([23:39], [23:43]). Sarah explains to Alice that she programmed the device to make random noises when triggered, emphasizing the randomness with a gesture. Looking at embodied positioning, Sarah is on the computer for most of it ([23:39]- [23:43.]). At the beginning,

Figure 2: (a)Left - Alice reaches across table to touch phone
(b) Right – Sarah motions to Alice to stop pressing button on phone

Alice reaches over to touch the phone in front of Sarah (Figure 2a) then Sarah relocates the phone in front of Alice ([23:39]) before making an embodied move in conjunction with her command ([23:56], Figure 2b). By reaching out to prevent Alice from touching the phone it emphasizes Sarah's authority. In isolation, these few turns could be misleading, but as part of the whole episode we see how this temporarily lop-sided interaction leads to skewing the equity indicators of commands.

[24:08] A: Hey, did you want me to make an actual beat?

[24:11] S: If you want to. I was just going to go ahead and [inaudible]

[24:14] A: Alright, well that sucks.

Our equity indicators in this snippet show almost equal distributions, as Sarah stops using the computer, allowing Alice to start using it, there are almost equal turns of talk and only a single question. This almost matches the qualitative analysis where we see Alice volunteers and then starts programming an actual beat ([24:08]) – though in terms of disciplinary content this is arguably a peripheral part of the programming project. Additionally, Sarah positions Alice's contribution as minimal ("If you want to"), positioning Alice down. Sarah starts this snippet on the computer but Alice's question ([24:08]) leads her to move away from the computer and leave the table while Alice get's a chance to program ([24:14]). Shortly after, Alice finishes programming and asks Sarah for help uploading her code to the BlockyTalky. Notice how drastically different the equitability of the pair is between the two presented snippets – in a matter of seconds we go from Sarah dominated to almost equitable just because of where these turns of talk were grouped.

[26:06] A: How did you upload it?

[26:13] A: This is the old one still

[26:19] S: Upload ....

[26:28] S: Stop hitting it for a second. That was really weird. Okay. We'll leave it at that.
Okay. Now we just need the sound sensor

[26:50] S: Oh you changed the sound

[26:53] S: Please stop because [inaudible] over load the program.

Our equity indicators in this snippet show Sarah dominating the pair again, as Sarah takes over the computer, dominates turns of talk and issues two commands – exacerbated by Alice asking a question. This almost matches the qualitative analysis where we see Sarah returns to the table and to the embodied position of computer user after Alice positions her as knowledgeable by asking a question ([26:06]). Alice presses the start button on the phone ([26:13]) and notes the lack of difference – a meaningful contribution not picked up by the indicators - and Sarah responds by showing Alice the upload button ([26:19]). While this enables Alice to contribute, Sarah continues to use the computer, not returning it to Alice. Sarah then proceeds to once again command Alice to stop pressing the button, emphasized by a less drastic gesture than illustrated in Figure 2b ([26:28]). Alice starts repeatedly pressing the button enthusiastically once her new tune starts coming out of the synthesizer ([26:50]). Sarah issues another command, gesturing by touching the phone ([26:53]). This interaction positions Alice further away from the project. Sarah's comment about Alice's contribution is a little hard to interpret since there is no value statement in it ([26:50]) – she is simply stating that she observed Alice's contribution. It could be argued that she accepts the modification and thus positions Alice up since Sarah does not change the modification.

[27:00] S: We need a sound sensor or a sensor that senses sound, okay

[27:03] A: Sound sensor? What do you mean? Something that picks up sound?

[27:05] S: Yeah. But I think it's already doing that.

[27:09] A: Go on the phone. The phone screen then get the music one and drag it over

[27:17] S: Hmm?

[27:17] A: Go on the phone

[27:19] S: No, this is for Bruce

[27:20] A: Oh

[27:21] S: Then Bruce to that

[27:27] A: Don't we need two phones then?

Our equity indicators in this snippet are hard to interpret by themselves - during this whole snippet, Sarah is using the computer, but neither girl dominates turns or types of talk. Turning to the qualitative analysis where we see Sarah maintains her position as knowledgeable by making a statement and having Alice ask clarifying questions ([27:00] - [27:03]). Sarah clarifies what she means by the sound sensor, resulting in Alice being positioned down. Alice, in return, positions herself up by starting to direct Sarah to program a sound sensor using the App Inventor ([27:09]), making gestures in the air of where to go on the screen. Sarah clarifies that the sound sensor is for the BlockyTalky Bruce, adding emphasis by touching the device with her left hand, not the phone ([27:19]). However, Alice does not seem to understand, positioning Sarah up yet again by asking if they need two phones ([27:27]). Sarah ignores the final question from this snippet so Alice asks her again.

Almost all of the commands and questions position the speaker and listener as theorized with exception of the final command in this snippet, which due to Sarah's rejection of Alice's positioning ([27:19]) results in an overall downward positioning for Alice. This error within the equity indicator construct, however, seems to be the exception, not the rule. When looking at other instances of commands in this episode, we notice this is the only instance of a command resulting in the speaker ultimately being positioned down.

> [27:49] A: Don't we need two phones then to transmit it?
>
> [27:50] S: No. Because if this hears sound, it will set off Eve. If someone looks at the time and realizes the time they hit E-they hit the button and it sends a message to Eve
>
> [28:01] A: Okay
>
> [28:12] S: Sound sensor port 1, yes. But what do we do with the sound sensor?

Our equity indicators in this snippet are also hard to interpret by themselves, distributed similarly to the previous snippet. Turning to the qualitative analysis where we see Alice reiterates her question ([27:49]) and Sarah replies ([27:50]). Sarah, who is on the computer with the exception of this ([27:50]), not only fully explains the flow of execution so Alice knows how the project works, but stops using the computer to touch each object she references as she walks through it. Alice replies "Okay" but sits back in her chair so she cannot see the computer screen and starts looking towards the back of the room. Unlike the last snippet where this mixture of indicators shook out to be about equitable, we see Alice unengaged and leave Sarah to dominate the project. This is an interesting case of where the indicators – despite having similar quantities – mean different things. Sarah continues by positioning Alice up by starting off the next step of the project saying "we" as supposed to "I" ([28:12]) and asking Alice about what to do with the sound sensor.

In Figure 3, the lines represent the ratio from the start of the episode to that turn of talk. The lines climb as measures are coded as Sarah, and the lines go down as measures are coded for Alice. As these are cumulative sums of the codes, they start to level off to indicate an average ratio. Looking at where these indicators level off the emerging averages even for the subset of the total coded set show the same trends discovered by coding the whole episode.

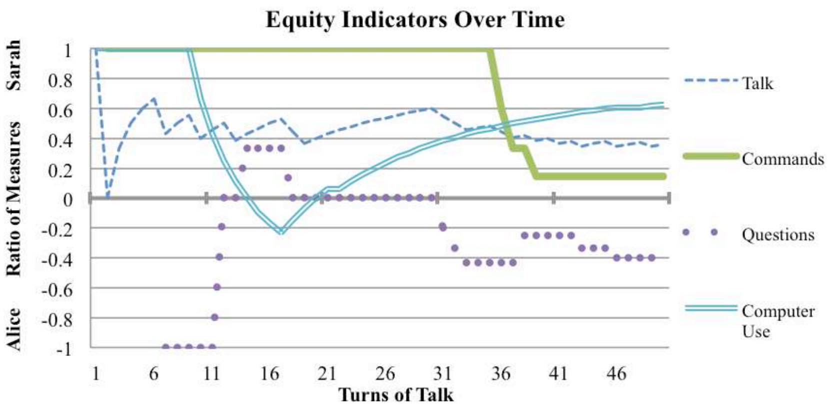

Figure 3: Equity indicators in favor of each student over the presented transcript

Discussion

We discuss the four measures of equity in terms of what each measure lets us see, the strengths and weaknesses of each measure, and agreement between each of the measures.

We investigated how the girls' *tool use* would help us quantify engagement with disciplinary ideas. Overall, we see a disparity between computer use, Sarah using it actively for 84% of the time. While one of this measure's strengths is that it can pick up embodied moves, like Alice and Sarah reaching for/starting to use unoccupied tools with no verbal indications, and that it aligns with the dialogue when present, we do notice that in this learning environment, there are more tools than just the computer. In addition, in learning environments such as in Shah and Lewis's study, where students are in a paradigm where keyboard use is forced to be equal, this measure would be an artificial indicator– meaning that this measure is sensitive to the structure of the activity. Finally, in contexts such as this where there are multiple tools and multiple ways to interact with computer science skills, this measure would struggle to mirror reality without being modified to account for this change. Most notably, every time the girls test the bell, they both can *hear* the test since sounds are being played – making it extremely difficult for one student to try to prevent the other from participating in testing. As researchers experiment with different pedagogical models or technological tools for learning computing, the structures embedded in these models could have large impacts on the quantitative measures used in this study, without necessarily impacting overall equity in a collaboration. Developing ways to triangulate between multiple ways of assessing equity, as we do in this paper, may help to ameliorate over- or under-estimation of equity that single methods might cause.

We investigated how the girls' *distribution of talk* would help us quantify practicing disciplinary discourse. The two girls enacted a dialogue with lots of back and forth in the form of typical conversation turn taking. This dynamic results in about equal turns of talk and could be held as standard and the deviations from this as being where the power shifts occur. While we do see engagement with disciplinary ideas happening discursively, this measure has no way of differentiating between an engagement with a disciplinary idea and a non-disciplinary utterance like "Okay, let's see."

Despite the weaknesses in both this measure of talk and the measure of computer use, we see that on a larger scale, both of these measures are in agreement that Sarah engaged in more disciplinary knowledge building – both through activity and discourse. Looking at the transcript and video, we would agree with this characterization of the pair. Since both girls seemed to engage in disciplinary content when talking and using the computer at the same rate, these measures reflect researcher perceptions of the data. However, both of these measures are sensitive to differences. For example if someone is a much slower typist, or if the style which someone speaks, for example Sarah, is choppier than Alice, resulting in more but shorter turns of talk, these measures might be artificially inflated.

We claimed *commands issued and questions asked* would help us quantify authoritative and competent identities in the classroom. Overall both of these measures indicated equity of authority. This makes sense given that throughout the episode there were numerous examples of authority being shifted between the two girls. The salient positioning mechanisms that used commands and questions have been mentioned above – commands, asking for tool use, monologues and questions. This also makes sense given that causing inequities in the other measures requires a power shift. In terms of weaknesses, there were a couple of instances where Sarah used "I" or "we" to describe working on the project, which caused power shifts that are not accounted for by the indicator.

We claimed *positioning* would help us triangulate the other coding schemes. To get an idea for a larger scope with this method, we attempt to distill trends in the codes seen throughout the episode to compare them to the quantified indicators. First, a lot of the discourse around the tools, even the phone that was not included in the computer use code, was power moves by Sarah who was actively using the computer or commanding Alice to stop using the phone to test. This trend of inequity in tool use is reflected in the quantified measure. Second, looking at talk distribution, we see that Sarah occupies the conversational floor for the majority of the time, expressing more disciplinary thoughts than Alice. This trend of inequity is reflected in the quantified measure. Third, we see almost constant shifting in authority between Alice and Sarah, without any long periods of time being dominated by one girl's authority. This trend of relative equity is reflected in the quantified measure.

One major weakness of models from current literature, which look at change over time, is their drastic sensitivity to *scope* – or the amount of time the method is applied over. For example, one difference between the positioning analysis presented above and the one presented by Shah and Lewis (2015) is scope is instead of a dozen of turns of talk that are supposed to characterize the pair's interaction as a whole, we present multiple minutes of transcript. There are many ways to slice the data into a small series of turns, however, because of how fluid these measures are, the picture captured in those series looks drastically different depending on where you select them (Figure 3). The cumulative coding over time is rather messy though they start to level out over time. This variability within the measures means that applying these measures to short pieces of data will result in unreliable and not necessarily valid findings. In the same vein, analyses that only show small snippets of the data hide a lot of the complexity and overall trends. This indicates that we need a theory and methods that reflect the time-course of real-world phenomena.

Conclusion

Equity is a complex construct. This research illuminates the need for theories and analytical methods that better engage with these complexities. This analysis reflects results from methods from the literature, and adds support to the claim that the quantifiable metrics serve as a proxy for the different facets of equity we investigated. There are many other forces, including socio-cultural processes that can empower some students and disempower others, that while we did not wade into them, we hope future efforts to put this work in conversation with critical and structural frameworks for equity could further advance the field. We also highlight the pedagogical and technological sensitivities within the methods of the literature, meaning that quantitative methods need to be adapted to the context that they are applied in. Because of the variance in how measures can quantify interactions, researchers must be careful to select equity measures that are appropriate to the contexts that they are studying, as well as to explain their processes for selecting those measures. We argue that the scope of data used needs to not only be carefully considered to avoid selection bias, but justified in these studies, possibly through quantitative analyses, due to the sensitivity of qualitative methods to local maximums and minimums illustrated in selected clips. Lastly, we urge researchers to define and present the type of equity they are prioritizing when we talk about designing and implementing equitable learning environments to help increase clarity in the field. Ultimately we are left with the question: how would someone go about convincingly evaluating equity within a pair?

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