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Marginality in inquiry-based science learning contexts: the role of exclusion cascades

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ABSTRACT

Vygotskyan-inspired theories of learning have been applied in science education research, yet to more explicit attention to links between local social interactions and cultural-historical processes is needed advance critical theories of science learning. This microgenetic case study examined identity and motivation processes in a 7th grade inquiry science context with the goal of better historicizing these processes by describing the phenomenon of exclusion cascades in relation to two backgrounded cultural-historical processes, alienation and the social division of labor. Exclusion cascades highlighted the mutual constitution of competence and belonging. Implications are discussed with respect to challenging adaptationist ethos in science education.

Introduction

Recent years have seen a proliferation of empirical studies of small group and collaborative learning in a range of different disciplines and across levels of schooling, partially in response to advancements made in Vygotskyan-inspired sociocultural theories and neo-Vygotskyan sociohistorical theories that could be applied to human development and learning (e.g. Cole & Engeström, 2007; Lave & Wenger, 1991; Penuel & Wertsch, 1995; Rogoff, 1991; Wenger, 1999). As Penuel and Wertsch (1995) noted, developmental processes generally and the mental processes involved in learning are all socioculturally as well as historically situated in the works of Vygotsky; accordingly, that assumption has had major implications for education research writ large. Nonetheless, models vary in their emphasis on the attention given to each of these contexts of situatedness. In particular, the community of practice model is less explicit about the role of power (i.e., historical context) in defining whose participation is scaffolded, affirmed, and rewarded, as well as which forms of participation are recognized as legitimate. This results in imprecision regarding power's role as a *cultural-historical* rather than purely local phenomenon confined to the present moment (e.g., critique by Engeström, 2007). Further, the model insufficiently addresses what has been referred to as *adaptationism* in theorizing human development (i.e., Stetsenko, 2016), and therefore has limitations that may even inadvertently reproduce the dualisms the model aims to critique (see Stetsenko, 2016).

Accordingly, studies applying communities of practice to collaborative learning will involve some dehistoricizing and risk reinforcing an adaptationist ethos in their accounts of power's role in collaborative learning unless clarity is provided about the broader context in which communities of practice are situated. This critique extends to the authors' own previous work (Adams-Wiggins et al., 2020; Adams-Wiggins, 2020). In response to this problem, the present study was intended to better historicize group interactions with the goal of exploring how an adaptationist ethos might be challenged in studies of collaborative learning in the context of inquiry-based science curricula. The focal process was the development of marginal science identities in inquiry-based science

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environments. We relied on a backdrop of two concepts: manual/mental division of labor and alienation. We analyzed videorecorded observations of two collaborative groups in seventh grade inquiry-based science classrooms using a sociohistorical lens to understand how students construct meanings of their groupmates' motivation during inquiry tasks and construct identities in practice. While the present study was restricted in what could be analyzed, we hope to encourage further discussion of how those studying science education contexts can best challenge adaptationist tendencies in our own work.

Theoretical framework

Research on developmental processes tends to privilege analysis of one developmental domain, the ontogenetic domain, with the focus being individuals' lifespans, typically within a school year or a few school years such as the middle school transition or high school years. The present study embraces a sociohistorical lens and examines learners' identity processes in the science classroom as sociogenetic ones, i.e., processes originating in social activity and not meaningfully reducible to individual-level cognitive processes isolated from the sociohistorical context. In this perspective, psychological processes can be understood as operating across multiple domains of development, including the cultural-historical domain, which includes the microgenetic domain. We previously applied communities of practice theory has been applied to discipline-linked identity processes in science classrooms to describe how interactional histories reflect the construction of belonging in a community and competence in the community's practices over time, providing a small-scale history of the production of marginal identities (i.e., identities of marginal nonparticipation, identities of non-belonging and/or limited access to participation in relevant social practices) (Adams-Wiggins, 2020). Nonetheless, this was a microgenetic perspective that was presented with little articulation of connections to cultural-historical processes; these were analyses were limited to status legitimation, but still disconnected from relations of production and labor as part of the larger sociohistorical context. As noted by Williams (2016), schooling in a classed society is alienating, yet alienation in particular is underaddressed even in Vygotskyan scholarship. While a simultaneous analysis of microgenetic processes and the cultural-historical domain is beyond the scope of this paper, we bring the background concepts of manual/mental division of labor and alienation to historicize the focal microgenetic processes (i.e., the construction of marginal identities in the inquiry science contexts).

Competence and Belonging as Constituents of Marginality in Inquiry Science Learning Contexts

Drawing on Wenger's (1999) concept of marginal nonparticipation, marginality refers to the identity processes involved in an outbound trajectory away from a particular group – in this case middle school science inquiry groups, and science identity in general (Adams-Wiggins, 2020). As discussed in Adams-Wiggins et al. (2020), we argue that processes of marginality lie at the intersection of bids for competence and belonging. At this moment it is important to specify our conceptualization of competence and belonging, as distinct from other intrapsychic definitions in motivation research (i.e., Deci & Ryan, 2000). Whereas other researchers locate student competence and belonging as self-system processes that are optimized with the provision of teacher structure and involvement (e.g., Deci & Ryan, 2000), we positioned these constructs as always highly contextualized, much in line with situative motivation theory and its call for activity systems as the unit of analysis to understand students' motivational processes rather than maintaining the traditional reliance on self-report measures (Nolen et al., 2015); (Nolen, 2020). Group members' interactions constructed hierarchies of competence and belonging inside their group and how those processes related to centrality and marginality within the group, though instances of interactions undermining those hierarchies also surfaced. In the present paper, we further historicize the construction of competence and belonging within the cultural-historical domain of development by drawing upon the concepts of division of labor and alienation (Bowles & Gintis, 2011; Poulantzas, 2018; Williams, 2016). *Alienation* describes the experience in capitalism where workers are compelled to produce due to their lack of ownership over the productive process, have little say over how things will be produced, are placed in competition

for higher wages with their fellow human beings, and are assigned repetitive and boring tasks that do not lead to their own well-being or meet the needs of their own communities. While alienation is firstly discussed within paid work contexts as alienated labor (e.g., Sawyer & Gampa, 2020), alienation has also been referenced in the unpaid context of youths' schooling (e.g., Hascher & Hadjar, 2018; McDermott & Lave, 2006; Williams, 2016). We draw upon Poulantzas (2018), Bowles and Gintis (2011), and Williams (2011, 2016) perspectives to understand schooling as a vital part of capitalist social reproduction processes today and we therefore understand youths' experiences in school as contextualized in those processes. Of note, we share Williams (2011) reluctance to equate learning with "labor-in-capitalist-production" (p. 285) and situate marginality as operating within the very same capitalist social relations.

While some accounts suggest alienation is an inevitable result of technological advancements, we reject that argument along with Poulantzas (2018) and Bowles and Gintis (2011): alienation is not inevitable and instead is a result of the social relations inherent in a capitalist *social division of labor*. In a framing not unique to Poulantzas (2018), the working class is not the only group to experience alienation, although it is the class whose entire being is explicitly negated within the capitalist division of labor. Those in other classes are more likely to experience the division of labor as legitimate, partly due to the ideological socialization that occurs in schooling. For example, Bowles and Gintis (2011) argue that schools prepare youth for the world of wage labor and its corresponding hierarchical division of labor, contributing to alienation early in life. Further, Poulantzas (2018) notes that schools in capitalist societies primarily function to reproduce the mental/manual division of labor by dis-qualifying manual labor (i.e., working-class labor) and subordinating it, as mental labor involves rituals and cultural practices to be learned; it is characterized by monopolistic secrecy around that knowledge, thus enabling the division's reproduction. This manifests within and across schools, often producing racialized differences in which schools where youth of color are highly concentrated face strong socialization toward obedience in line with manual labor, as well as ability tracking inside schools in the U.S. (Bowles & Gintis, 2011). Recent scholarship by Rooks (2017) further elaborates the link between schooling and social reproduction in theorizing, noting the goals, content, classroom practices, and funding mechanisms are stratified in ways that make high levels of racial and economic segregation of schools profitable. Importantly, this is not simply a matter of "blue collar" versus "white collar" work, or even objective differences in intellectual ability, but rather a matter of educational assessment practices and subsequent educational credentials legitimating the process of sorting persons within a hierarchical division of labor by providing a meritocratic cover based on a "scientific" sorting process (Bowles & Gintis, 2011; Poulantzas, 2018). Further, "white collar" labor is stratified within itself via the mental/manual division of labor, as well (Poulantzas, 2018); this produces an increasingly alienated experience for even those outside the capitalist class who are aligned with mental labor (e.g. college-educated labor such as teachers and lower management) (Bowles & Gintis, 2011). The process of disqualifying and ideologically socializing youth in through curriculum reduced to vocational training, administering constant standardized testing, and applying harsh discipline also reproduces racialized forms of economic domination within U.S. schools (Rooks, 2017).

In sum, these two concepts (i.e., division of labor, alienation) help historicize discussions of learners' microgenetic identity processes in middle school inquiry-based science. Considering the highly overlapped relationship of competence and belonging in our historicized framework, we also expected competence and belonging to be co-evolving in peer interaction, rather than cleanly separate conceptually. This expectation is also supported by past research on academic and peer status hierarchies' functioning, in which the two are linked (Lloyd & Cohen, 1999) and recent situative theorizing of motivation as deeply intertwined with identity construction and power (Nolen et al., 2015). Our approach contrasts with sociocognitive approaches that omit the cultural-historical domain and prioritize the individual as the unit of analysis, as we rely on groups as our unit of analysis and accordingly frame marginal identities in the science classroom as inherently relational.

Method

Participants & context

Participants in the cases discussed here were two small groups from two seventh-grade inquiry science classrooms in the northeastern United States. The classrooms in this study were participating in a series of inquiry science units involving collaborative argumentation, modeling, and coordination of evidence with theories and models (Chinn et al., 2018; Rinehart et al., 2016). The school was an ethnically diverse high-performing middle school. During the time of data collection, students of color made up approximately 40% of the student body with Asian American students being the largest group at approximately 30% of all students of any racial/ethnic group, while African American students and Hispanic/Latino students each made up less than 10% of the student body. The school ranked in the top 5th of state middle schools on state standardized exam scores and approximately 15% of students eligible for free and reduced lunch. The neighborhood from which students enrolled had a median income above that of the whole state and within the second highest income quintile nationally. The current study is limited in that we did not have access to data about individual students' socioeconomic backgrounds (e.g. parents' occupations, parents' educational attainment, household income). We also only used students' self-reported racial/ethnic identification, which resulted in some missing data (e.g. Carson in Group C). While the majority of participating students reported their racial and ethnic identification, some did not report it and we did not attempt to classify those students in the absence of self-report data.

Procedures, sampling, & analyses

The two collaborative groups were selected from a larger dataset based on the video quality and observations were selected using operational construct sampling, as the two groups were intended to surface illustrative narratives that demonstrated interesting, rich social interactions relevant to the phenomenon of interest (Patton, 2015). Observations captured group activity and were transcribed before coding (See transcription conventions in Table 2). Based on group members' end-of-semester interviews in the larger study, these two groups were expected to vary sufficiently for examining the relative importance of belonging and competence to marginality in middle school inquiry science. Group F involved a group member, Ty, who was described as highly influential and highly competent by all groupmates. Ty was also observed during fieldwork being asked by his teacher to instruct his peers from the front the classroom. Conversely, Group C involved two group members, Carson and Greg, who were described as less influential and "goofing off" or "slacking" by their two interviewed groupmates. Group composition information is provided in Table 1. The video recorded observation length averaged approximately 17 minutes. Group members' peer ratings were obtained during the end of semester interviews (See Table 1). Interviewees were recruited from among students already consented into the larger study with teachers' assistance and only two members of each group of three to four students were made available for these interviews. In an exception to this limitation, the first author sought and able to secure permission to interview all four members of Group F prior to conducting any data analyses involving the larger dataset. This exception was sought because the first author noticed that no African American/Black students were eligible for interviews due to being largely absent from videorecorded groups and Shonyce of Group F had self-reported as African American/Black when students' individual demographic data were collected for the larger study.

Intensive qualitative case studies are one variation of the microgenetic approach (Chinn & Sherin, 2014). Here, two cases (i.e., Groups C & F) were embedded within the larger holistic case (i.e.,7th grade science classrooms implementing inquiry curricula). To carry out the case analysis, we applied Yin's (2003) descriptive case study strategies of pattern matching and cross-case synthesis. We expected competence and belonging to co-evolve in peer interaction, but we did not assume anything about the relative importance of each to marginality. The two groups were previously identified as involving a common outcome (i.e., extended periods of marginality for at least one group member) but with

Table 1. Student descriptive profiles by group.

Group	Name	Additional Information & Influence Rating
C	Luke*	Asian-American, Boy, Rated as 4 by Leesha. Pairwork partner was Leesha.
C	Carson	Not reported, Boy, Rated as 3 by Leesha and 2 or 3 by Luke. Pairwork partner was Greg.
C	Leesha*	Latina, Girl, Rated as 4 by Luke. Pairwork partner was Luke.
C	Greg	White, Boy, Rated as 2 or 3 by Luke and 3 by Leesha. Pairwork partner was Carson.
F	Paul*	Asian-American, Boy, Rated as 5 by Jivan, 4 by Ty, and 4 by Shonyce. Pairwork partner was Jivan.
F	Jivan*	Asian-American, Boy, Rated as 4 by Shonyce, 3 by Ty, and 4.5 by Paul. Pairwork partner was Paul.
F	Shonyce*	Black/African-American, Girl, Rated as 5 by Jivan, 4.5 by Paul, and 1 or 2 ("but sometimes she can reach a 4 or 5") by Ty. Pairwork partner was Ty.
F	Ty*	Asian-American, Boy, Rated as 5 by all group members. Pairwork partner was Shonyce.

Note: Table 1: Group members by group and perception of equity in group interactions. All student names are pseudonyms. Student pseudonyms with one asterisk are those who were interviewed. Students' ethnicities were self-reported via a checklist and students were able to select as few or as many ethnicities as they liked. Students' genders were self-reported using a binary checklist with male and female. No students in the present study checked more than one gender or left gender blank. Influence ratings were self-reported during end-of-semester interviews.

Table 2. Transcription conventions.

Notation	Meaning	Example
T	Teacher speaking	T: Alright, let's go over this.
Bracketed Name	Name replaced with pseudonym in transcript	[Carson]'s
Bracketed Action	Non-verbal action embedded in turn	*[pauses]*
Parentheses	Target of speaker's turn or description of non-verbal tone taken during turn	*(to Jivan)*
Italicized Turn	Turn containing only non-verbal actions; loose transcription of conceptually irrelevant talk occurring during off-task conversation	*Shonyce leans back and sighs.*
Backslashes	Beginning of interruption/crosstalk	Greg: No! I was almost done!//
Inaudible	Non-transcribable portion of audio	Jivan: [*inaudible*] heard it.

contrasting group dynamics. The research team previously developed a coding scheme to describe actions within groups that increase or decrease marginality for a given group member, but these codes largely did not historicize power in the cultural-historical domain (See Tables 3-4). Thus, we extended the existing coding scheme by analyzing higher-order themes relevant to manual/mental division of labor and alienation. The higher-order analysis is the focus of the results section presented in this paper.

Results

In this section, we highlight exemplar interactions from two collaborative groups from classrooms where inquiry-based science curriculum units were being enacted. First, we present an overview of observed groups with vignettes summarizing the temporal sequence of events for each group's observation. These vignettes also highlight the relationships between individual group members that inform all group talk reported in this paper. Second, we discuss themes cutting across the two groups, including an introduction of the concept of exclusion cascades. Finally, we present exemplars from the two groups.

Overview of groups: group C and group F

Group C – Luke, Leesha, Carson, & Greg. The group's assigned task during this observation focused on the function of cell nuclei and required students to evaluate evidence quality and draft rationales to

Table 3. Marginality relevant interactions - decreasing marginality.

Modality	Code	Description
Material	Bringing In	Improving student access by another student or materials changing physical position
Spatial	Moving In	Student relocates in workspace to gain access group activity
Non-Verbal	Moving In	Instances in which a group member's body posture, gesture, or facial expression changes to communicate readiness to participate in group activity and/or symbolically move closer to the conversational space
	Bringing In	Using gestures, facial expressions, or other non-verbal expression communicate perceived competence or belonging in the group; this code can be applied during on-task or off-task periods
	Asserting Boundaries	Defending against an intrusion upon personal space or personal belongings
	Social Body Language	Gestures, facial expressions or other non-verbal expressions indicating enjoyment, enthusiasm, excitement, or satisfaction during off-task periods
Speech	Other-Advocating – Social	Sticking up for a groupmate who is being criticized; intervening when a groupmate's sense of belonging is being attacked; this code applies to situations where off-task topics are the focus
Discursive	Other Advocating – Academic	Promoting contributions of a groupmate in need of an advocate; Creating opportunities for others in the group to be seen as competent in response to group dismissal; Re-presenting another's intellectual contributions to be heard by the group when another group member has been ignored or dismissed; this code does not apply in situations where off-task topics are the focus, but can refer to socially-oriented facets of on-task activity
	Assertiveness	A student states how they would like to be treated by group members, either during on-task or off-task periods, thereby setting their terms for social interaction in the group; the case for applying this code is strengthened when it is a response to another group member's exclusive or disrespectful behavior
	Backing Off	Comments that go back on one's previous dominating/excluding act; apologizing for participating in exclusionary or dominating discursive acts; this code may be applied in response to others' self-advocating/assertiveness
	Helping	Offering a groupmate help on an academic task
	Advocating Inclusive Group Structures	Comments that invoke or express the desire for egalitarian group norms and practices; affirming the value of group members' contributions; affirming the importance of all group members' success; expressing a sense of investment in groupmates' learning and/or sense of belonging
	Self-Advocating	Creating opportunities for one to be seen as competent in the group in response to being ignored or dismissed by the group; Re-presenting one's intellectual contributions to be heard by the group when one has been ignored or dismissed; this code does not apply in situations where off-task topics are the focus of discussion, but can refer to socially-oriented facets of on-task activity
	Social Approach	Instances when a more marginal group member makes an attempt to connect with their groupmates through off-task conversation; this code does not apply to all off-task conversation initiation; in this code, the person who initiates conversation is both actor and target
	Social Inclusion	Code should be applied when positive, social off-task conversation with a more marginal group member is occurring; Code should be applied with a higher intensity when a central group member initiates speaking with a marginalized group member in off-task conversation.
	Soliciting Widespread Participation	Code should be applied when comments solicit widespread participation; Comments that seek to include all group members, or specifically seek the contribution of marginalized group members

Note: Table 3: Indicators of decreasing marginality by modality. Codes with infrequent occurrence were omitted from this table.

support their conclusions. The observation opened with Greg immediately being pulled away from the group by the teacher to discuss missed work due to a prior absence. Greg and Carson were seated as a pair, but with Greg's removal by the teacher, Carson instead sat directly behind and in the middle of Leesha and Luke who were sharing a laptop. Interactions within the group remained tense upon Greg's return, as Leesha and Luke largely worked together while explicitly refusing to work with Greg and Carson. Throughout, Greg and Carson invoked humor to reengage Leesha and Luke, though this mostly resulted in rejections and expressions of frustration from Leesha and Luke.

Group F – Paul, Ty, Jivan, & Shonyce. The group's assigned task during this observation involved generating a model of natural selection by looking at models from specific species discussed in previous lessons. The observation of Group F opened with Jivan and Paul seated as pair partners on

Table 4. Marginality relevant interactions - increasing marginality.

Modality	Code	Description
Material Spatial	Disconnection from Group Interactions	One's physical position changes to exit group interactions
	Deference	Spatially yielding to more central group members in accessing task tools
	Blocked Position	Moving task tools or one's body to obstruct groupmate's access
	Spatial Dominance	Moving spatially to become the hub of activity, communicating the primacy of own individual preferences relative to groupmates
Non-Verbal	Ignoring	Non-response to groupmate's verbal or nonverbal communication
	Disengaged Body Language	Non-verbal expressions indicating passivity or withdrawal
	Pushing Out Body Language	Non-verbal expressions communicating groupmate's limited competent or belonging
	Selective Eye Contact	Shift in gaze to target a subset of groupmates
	Selective Inclusion	Violating intended whole-group focus of the task, pursuing dyadic or triadic interaction
Speech Discursive	Peer Social Exclusion	Disrespectful or aggressive comments unrelated to the task, questioning groupmate's belonging in the peer group
	Deference	Verbally reinforcing a central groupmate's ideas without rationale; using turn order that prioritizes central group member(s); complying with central groupmates' instruction
	Discursive Dominance	Verbally asserting one's own primacy and centrality to group activity; directives stated in a coercive tone; use of sarcastic, condescending, or disrespectful tone
	Mistakes as Incompetence	Verbally indicating that errors indicate incompetence
	Punishing Perceived Unseriousness	Justifying exclusion through perceived off-task behavior, lack of seriousness, lack of focus/attention, or past history of being in trouble with the teacher
	Self-Deprecation	Verbally describing oneself as incompetent or not belonging
	Sounding Scientific	Using tone of seriousness, objectivity, and certainty about one's ideas to bolster authority of one's ideas or undermine groupmate's authority

Table 4: Indicators of increasing marginality by modality. Codes with infrequent occurrence were omitted from this table.

one side of the table, while Ty and Shonyce were seated as pair partners on the other side of the table. Early in the observation Paul held a loosely off-task conversation with a student outside the group, while Ty attempted to join; the entire observation involved occasional off-task discussions inside the group. On multiple occasions, Paul called for the group's attention, directed the group's movement through the task, and announced what the group's final answers should be. Talk turns were rarely directed to Shonyce and she also mostly listened to what her groupmates said, rarely asserting her own perspective. Interactions between Shonyce and Ty were mixed, with her advocating for the group to listen to him at one point, but later hitting him with a pencil. She hit him with a pencil after an extended exchange in which all three of her groupmates made unsolicited comments about her eyebrows.

Exclusion cascades

The most salient pattern across both groups was that in many instances, competence and belonging operated as mutually constitutive at the moment-to-moment level and in ways that exceed single interactional turns, in what we term *exclusion cascades*. Exclusion cascades are series of peer interactions inside the group that produce a marginal position for a given group member. Exclusion cascades involve a chain of speech acts, nonverbal acts, or movement of people or objects within the physical space that are not meaningfully reducible to a smaller grain size when discussing marginality as a socially constructed identity in the science classroom; microexclusions and moves to legitimate status hierarchies occur within these cascades. Some single acts examined in isolation may show limited conceptual connection to marginality, but within the chain of events those acts play clearer roles for constructing a group member as incompetent in science and/or not belonging in the peer group. Further, like status negotiation, these cascades operate within broader sociohistorical contexts, and therefore are not detached from processes like alienation and the social division of labor. Exclusion cascades cannot be understood separate from broader cultural-historical processes. The

connections between the microgenetic process of exclusion and cultural-historical processes of alienation and a social division of labor give the concept of marginal nonparticipation greater grounding in the material realities that produce durable forms of marginalization that extend beyond schools.

In our first illustrative example of an exclusion cascade, Shonyce, a member of Group F's low perceived competence and low belonging compounded her marginal position. Below, Group F's Shonyce not only had limited opportunities to participate in on-task activities, she also became subject to criticisms of her appearance during an off-task period:

Turn & Speaker

(1) Paul: Can you move your ears? I can't.
(2) Jivan (to Shonyce): Oh, you have a unibrow.
(3) *Ty and Paul are teasing Shonyce, telling her she has a unibrow and motioning to their own foreheads.*
(4) Shonyce (terse tone): Stop it.
(5) Paul: A lot of people do.
(6) Ty: [continues rubbing forehead between eyes] Unibrow! . . . Unibrow.
(7) Paul: Small hairs right here.
(8) *Shonyce glares at Ty and slams her pen down at the floor between them.*
(9) Jivan: You have a unibrow too.
(10) Paul: You really do. We're not lying.
(11) *Jivan throws something under the table in Ty's direction.*
(12) Jivan: No, she doesn't.
(13) Paul: Yes, she does. She has, like, small hairs. A lot of people do.
(14) Shonyce (to Paul): I would stab you but I can't reach you.
(15) Jivan (referring back to the task): Okay, let's think of one more. We only need one more.

Here, Jivan initiated the exchange by commenting on Shonyce's eyebrows, with Ty and Paul immediately joining in to comment, as well. Shonyce pushed back verbally throughout the exchange and finally Jivan backtracked his comments. Nonetheless, the exclusion cascade already was in full swing, which allowed Paul to make one more comment before Shonyce voiced her frustrations as a desire to stab Paul with her pencil.

Contradictory struggles against the manual/mental division of labor (group F)

While the classroom and school broadly rewarded demonstrations of competence and mastery, and the curriculum promoted co-construction of understanding, this was complicated by students' ability to reshape norms during student-led activity. Three students in Group F struggled against a team member, Ty, who treated teammates as subordinates to be managed. This phenomenon was primarily reflected in frequent resistance to Ty's participation both on and off task. While Ty's groupmates described him as having high academic status and field observations of classroom activity corroborated their perceptions of Ty, Ty often faced resistance to his attempts at participation. That resistance involved an antagonistic set of interactions with Jivan and Shonyce. Conversely, Shonyce was described by Ty as not offering much to the group, while Paul and Jivan described her as having the least influential role in the group. In a contradiction, the group's low receptivity to Shonyce's on-task contributions and tendency to sideline her during off-task periods reproduced the ideology associated with the manual/mental division of labor by legitimizing it. Shonyce discussed her own comfort with sharing ideas in the group in terms of feeling happy to get right answers because "I felt smart, I felt like I was smart like the others," suggesting that her limited opportunities to contribute to on-task activity

informed her alienation. She was required to participate, yet her perspective was systematically omitted from decisions about *how* the group would do its tasks and considerations of her well-being and development (in the form of learning, sense of competence, and sense of belonging) were disregarded.

In Ty's case, the groupmates constructed an exclusion cascade by playing off one another to successfully challenge his supervisory position and secure their own access to participation and influence. Importantly, despite Ty's enactment of dominating managerial relations, Ty did not actually possess the economic and political role of a workplace manager. Instead, Group F remained in the role of students in a relatively economically advantaged school. Below, Ty expressed frustration when his groupmates accepted a contribution from Jivan, but discredited Ty's own previously stated, similar contribution:

Turn & Speaker

(1) Paul: No, there's two of them. Two, like two types of heads //
(2) Jivan: Wait, does the population vary in that one?
(3) Paul: Yeah. Ty: Two//
(4) Jivan: If the population varies // Ty: That's what I said!
(5) Jivan: No, you didn't talk about that.
(6) Paul: You were talking about genes and stuff like that. *(laughs)*
(7) Jivan: *[inaudible]* heard it. Population varies.
(8) Ty: I said, two types of genes are present
(9) Paul: Yeah, yeah, two types of genes are present in both of them.
(10) Ty: That's what I said, it's the same //
(11) Paul (to Ty): We're talking about population. //
(12) Jivan: // Yeah //
(13) Paul: //Not genes.
(14) *Paul, Shonyce, and Ty laugh*
(15) Shonyce: Y'all tease each other back and forth.
(16) Ty: *(To Jivan)* Oh, yeah, I'm not the one who said oxygen.
(17) Shonyce: See, that's what I'm talking about.

Here, Ty's contributions were explained away while Jivan was welcomed to present a similar idea. Paul and Jivan both contributed to positioning Ty's contribution as justifiably ignorable, blocking him from ownership of the ideas.

Similarly, during off-task episodes, Ty faced resistance to his attempts to join group activity, namely from Paul. In the excerpt below, when group members and students from a nearby group began discussing Pokémon in relation to the unit's focus on evolution, Paul changed the topic of discussion, pushing Ty out of the conversation and out of meaningful or satisfying activity. Shonyce, too, was on the margins of this off-task episode, but she played a role in Ty's exclusion cascade:

Turn & Speaker

(1) *Students around the classroom abruptly become talkative. Paul talks animatedly about Pokémon to a student outside the group as Ty attempt to join in, but Paul talks around him to the student outside the group.*
(2) Paul: Got that Charmander. There's that Charizard.
(3) Ty: (stares at Paul) No, there's Char//

(4) *Ty is interrupted by student outside the group, Ty turns around to discuss Pokémon with a student seated behind him, continuing to correct the student's listing of Pokémon evolutionary sequence. Paul interjects, mentioning a different Pokémon evolutionary sequence (Pikachu).*

(5) Ty: *(turning back to Paul)* No, no, no. *(Pointing pencil in the air, gesturing with each name)* It's Pichu, Pikachu, Raichu.

(6) Paul: Yeah, Raichu.

(7) Ty: I remember, it's, uh, Charmander//

(8) Paul: //*(Interrupting Ty)* That's it. *(Flexing hand outward toward Ty for emphasis)* Stop it. *(laughs)*

(9) Ty: Why do you always forget that one?

(10) Paul: I have a book of it, I have like 350!

(11) Ty: Well, I have like 420. *(Leans forward, shaking hands and head simultaneously)* Ohhhh!

(12) Shonyce: *(imitates Ty's gesture and voice)* Oh! Laughs.

(13) *Group talks off task, largely inaudibly. Class bell rings.*

(14) Paul: Which model was it?

Here, Paul abruptly halted Ty's ability to participate by wielding his own influence to change the topic of discussion after Ty one-upped him. Shonyce participated in the exchange, imitating Ty's gestures and intonation before laughing.

Ty appeared particularly interested in achieving belonging in the group and even began to infuse an unserious tone in his on-task interactions with the group. Paul was the primary actor through which Ty sought inclusion. Yet, this was only partially successful: while his groupmates continued interacting with him and laughed, they did so in a dismissive and aggressive way. In the following exchange, Paul and Shonyce both called Ty's comment "stupid." In Shonyce's case, she regularly received corrections in the absence of other constructive feedback or recognition, had her bids for redirecting group activity circumvented, and even faced blatant ignoring despite sitting face-to-face in a small group setting. In each case, the exclusion was a product of multiple group members and multiple acts in concert (i.e. an exclusion cascade):

Turn & Speaker

(1) Paul: Selective pressure?

(2) Jivan: That's what I already said.

(3) Paul: (to Jivan) Yo, Ji, you wrote that already?

(4) Jivan: Yeah.

(5) Paul: Let's write selective pressure.

(6) Ty (looking up from paper to look at Jivan): Yo, dude, you're supposed to follow with us. No, I'm the one who told you, but you've got to write it down.

(7) Paul: Just write, "selective pressure"

(8) Ty: (Looking at Paul) What? Yeah, but with what? We're still on 9.

(9) Paul: Just write, "selective pressure"

(10) Jivan: We already said that.

(11) Paul: Where?

(12) Jivan: Look, right there. I didn't write it.

(13) Paul: (To Jivan, pointing) You did!

(14) Jivan: Well, I did, that's why I'm so ahead of you guys.

(15) *Students talking over each other.*

(16) Shonyce: Write what?

(17) Jivan *(to Shonyce)*: Selective pressure.

(18) Paul: Um, both have animals.

(19) Jivan: *Laughs* Oh, yeah.

(20) Paul: Yeah, both have animals. [The teacher] just told you that *(laughs)*.

(21) Shonyce: That's stupid! It isn't the same animal!

(22) Paul: Still, some type of species. They both have a type of species.

(23) *All write in packets*.

(24) Shonyce: Each model has animals in it.

(25) Paul: *(Talking at the same time as Jivan)* Okay, 12, um //

(26) Jivan: *(Talking at the same time as Paul, to Shonyce)* No, "species" sounds better, "animals" sounds childish. Cause, if you actually know the science lab, it would be a reptile.

(27) Ty: *(Talking over Jivan in response to Paul)*//Oh, I know, I know. Um. *(Pauses)* The environment was changed by humans.

(28) Jivan: (To Ty) Huh!?

(29) Paul: No, not always. The//

(30) Jivan: //No. They were invasive.

(31) Ty: //No, they were changed by humans.

(32) Paul: No, but, the humans probably didn't leave them there.

(33) Ty: (exasperated, emphasizing each word) Yes, they did.

(34) Jivan: //No, they could've been an invasive species.

(35) Paul: Yeah, they probably//

(36) Ty: //*(Condescending tone, tilting head while staring at Paul)* Then how did they get there?

(37) Jivan: *(Annoyed tone)* I don't know. How did a ball python get to the Everglades!?

(38) Paul: They learned the backstroke! *(laughs)*

(39) Ty: Noooo they don't *(laughing)*

(40) Paul: Okay, fine, both are brought by humans somewhat? Cause they both say so?

(41) *Ty and Jivan both say "Yes".*

(42) Ty: So, so, this was caused by humans. Environmental change was caused by humans.

(43) Shonyce: Environment what?

(44) Paul: Okay, and 13.

(45) Shonyce: Caused by what? Environment *(pauses)*

(46) Jivan: *(To Shonyce)* Caused by humans. No, write environment change.

This dynamic reemerged later in the observation, as well. In the following excerpt, Ty offered a superficial response to the question of what similarities existed between two models. This time, Paul laughed along, but nonetheless dismissed the idea. Ty's peer group level exclusion also was reflected in the group's support for Shonyce hitting him with a pencil. Further, when Shonyce offered on-task contributions, she was in one instance spoken over by her off-task groupmates and in another instance quickly dismissed by her on-task groupmates:

Turn & Speaker

(1) T: Okay, a couple more minutes on that.

(2) Ty: Okay. I know. There are animals that die. Paul and Ty laugh.

(3) Shonyce: (Reaches hand out toward Paul, talking with serious tone) Reproduction, I was gonna say about the offspring part//

(4) Ty: // There are animals that die. Let's write that.

(5) Paul: Animals die every day, man.

(6) Shonyce: (Leaning toward Ty, watching him write) Ty, don't put that!

(7) Jivan: (Leaning toward Paul) But does it show that in the model? No, it doesn't show it in the model.

(8) Paul (sarcastic tone): Each model has five boxes. Done!

(9) Shonyce: Oh my god, no!

(10) Ty: No, no, no, this one has four.

(11) Shonyce: Each one has five. Oh, dang, they do all have five!

(12) Paul: It's in the same layout, too. Small, small, small, big, big, small, small, small, big.

(13) Shonyce: You've got a point there. But I'm not gonna write that.

(14) Jivan: Wait, can I see the snake one? Oh, they both have keys.

(15) Shonyce: Oh, they both have predators! Because//

(16) Jivan: //We already said that.

(17) Paul: //We said environmental change//

(18) Jivan://Yeah.

(19) Ty (to Shonyce): They're technically not predators.

(20) Paul: Pollution's not a predator! It's um, it's like a cause.

(21) Ty: Like birds. And also the, the//

(22) Shonyce leans back and sighs.

(23) Paul: //Wait, one's a dominant and a recessive trait.

(24) Ty: That's what I was saying.

(25) Shonyce begins to snap a pencil at Ty's hand to hit him. Paul and Jivan watch.

(26) Shonyce: I can't do it right.

(27) Paul gestures with his hands, showing Shonyce how to hit Ty with the pencil harder. Ty winces and shrinks back into his chair as Shonyce follows Paul's directions and hits Ty's hand.

(28) Ty: Noo! Ow! [Laughs] Hit me in the thumb! When you hit me in the knuckle, that's not okay. That's not okay.

(29) Shonyce: I'm sorry, Ty. (Laughing)//

(30) T: How many people need a little more time?

(31) Paul and Shonyce raise their hands.

(32) Paul: We need more.

(33) Shonyce: Yeah, we need more.

(34) Ty: No, we finished.

(35) Jivan: We finished!

(36) Shonyce: No, we don't have a 13!

(37) Paul: (Flapping hand at Ty) Well, you wrote something stupid!

(38) Ty: It's obvious. (smiles)

(39) Shonyce: Me and Paul don't have a 13, but//

(40) Paul: (sarcastic tone) // "Animals die". That's so smart, Ty, so smart //

(41) Shonyce: //And then he wrote something that is stupid. He wrote that "it continues on for many generations".

Finally, in the below excerpt, Ty pursued belonging through self-deprecation in a discussion about gym class. Shonyce similarly self-deprecated, but to a lesser degree as she invoked her parent's athletic skill in the same moment. Here, Ty extensively mocked his own basketball skills in order to be part of off-task interactions with his group, but nonetheless still faced dismissiveness and ignoring. Ty also faced a putdown colored with a joking tone from Jivan, but the meaning of this otherwise joking comment is best understood within an exclusion cascade that involved ignoring and selective eye contact:

Turn & Speaker

(1) *Ty and Shonyce try to write on each other's papers following Shonyce taking Ty's pencil. Group has off-task talk about basketball in gym class.*

(2) Paul (to Jivan): Oh, you've been outside, playing with the ball, and//

(3) Jivan: // no, we played full court basketball. It was like 1, 2, 3, 4…I had dream 3's everyday. I had like 7 points.

(4) Shonyce: I'm awful at basketball.

(5) Ty: (turning to Paul, smiling) I'm gonna score zero. Dude, dude//

(6) Shonyce: //But it's fine cause my dad was great at basketball.

(7) Paul: (Looking at Shonyce) I love basketball.

(8) Ty: (to Paul, Paul looks around the classroom as Ty speaks) I suck at taking long shots and I suck at layup shots.

(9) Paul: (Looking at Jivan) I can get layups once in a while. I can get like, two-thirds.

(10) Ty (Waving hands enthusiastically toward Paul): No, no, Paul//

(11) Paul: (Looking at Jivan) //Depending on what type.

(12) *T calls class for class's attention.*

(13) Ty: (to Paul) This is me doing layups (gestures mimicking a layup) Ah, I missed (laughs).

(14) *Paul turns to face front of the classroom.*

(15) Jivan: (mocking tone) Ty, you're shitty. *Turns to face front of the classroom.*

(16) *Ty's facial expression turns serious and he turns to the front of the classroom. T calls class to whole class instruction.*

In the face of Paul's relative higher belonging in the peer group, Ty's high competence in the science academic content was insufficient to ensure his access to participation opportunities. This bounding of Ty's influence was co-constructed, not something unilaterally executed by a single group member. Jivan, Paul, and Shonyce's actions played off of one another to produce the cumulative effect of Ty resorting to sarcasm and deference to stay part of group activity, but this strategy seemed to have limited success. In a similar fashion, Shonyce's participation was curtailed, but in her case this was primarily on the basis of exclusion from on-task discussion and shutting down her attempts to contribute.

Contradictions in alienating manual labor & stratifying mental labor (group C)

Group C's interactions heavily foregrounded students' own reproduction of the manual/mental division of labor's corresponding political relations and supporting meritocratic ideology. Yet, some students weaponized the stratified character of the manual/mental division to ensure their safety from membership in the lowest stratum of mental labor. These interactions primarily manifested inside each of the two pairs within the group: Carson and Greg who held low perceived competence and Leesha and Luke who held high perceived competence. Both Carson and Greg, more marginal group members, relied on peer group connection and joking with Leesha and Luke to maintain belonging in the group and thereby ensure they would receive help on the assigned tasks. However, this belonging-based norm of help-giving was challenged by Leesha specifically and Luke to a lesser degree, as they called Carson and Greg's contributions and seriousness about the work into question. This was reflected in exclusion cascades coming from both directions, with Carson sometimes benefitting and Leesha retaliating in frustration against Carson and especially Greg. For example, Greg relied on humor as a social approach tactic to maintain connection to group activity. Here, Greg had difficulty operating the task tools and hyperbolized his struggle to get attention and assistance from Leesha and Luke:

Turn & Speaker

(1) Greg: What the wazz?!

(2) *Leesha laughs at Greg's exclamation.*

(3) Greg: How do you go back?

(4) Luke: (*to Greg*) You just use the arrow keys.

(5) Greg: Did you just say 'arrow please'?

(6) Luke: (*with emphasis*) Arrow keys.
(7) Greg: (*joking tone*) Aeroplane?
(8) *Luke smiles and shakes his head. Greg, Leesha, and Luke continue working.*

This excerpt illustrates Greg's bid for acknowledgment through humor in Line 1, where he took a joking tone to express confusion. His bid was met with laughter and smiling from Leesha, followed by instrumental support from Luke. This kind of positive peer interactions associated with social belonging can impact access to ongoing group interaction and the task itself. Yet, Leesha and Luke's receptivity was limited to brief acknowledgments through laughs, brief affirmation of on-task activity through helping, and brief non-verbal acts to disconnect from Greg's attempt at continuing the off-task exchange. In the exchange below, Greg's lack of belonging also became grounds for Leesha's dismissal of his need to access task tools:

Turn & Speaker

(1) *Leesha takes the laptop from Greg's workplace.*
(2) Greg: No! I was almost done!//
(3) Leesha: //*(laughing)* Sorry, I need to see something.
(4) Greg: *(to Leesha)* You snazz bag.
(5) *Leesha ignores Greg's comment and works using the laptop.*

Despite some receptivity to Greg and Carson's joking approach to group activity, both Carson and Greg eventually completely lost access to on-task activity in what appeared to be retaliation primarily from Leesha for low perceived competence as evidenced in repeated failure to make on-task contributions. In this case, the exclusion cascade swept both Carson and Greg into their own separate group within the group, illustrating how the construction of competence implicit in inquiry tasks indeed places a limit on the extent that belonging in the peer group can inform inclusion in the collaborative group. In the following excerpt, invocation of the peer group did not protect Carson from exclusion. Leesha read written instructions aloud to the group. While the group continued a task that required evaluation of evidence quality, a conflict arose over the mode of interaction that groups were supposed to take: while the students' printed packets instructed them to work individually, the teacher had instructed students to work as groups. Leesha read the instructions aloud and rejected Carson attempt to operate as a whole group. Importantly, Leesha nonetheless interacted with Luke during a task she had characterized as an individual one moments earlier:

Turn & Speaker

(1) Carson: *(quietly, to Leesha)* Could you reread that?
(2) Leesha: laughs *(to Carson)* You can read it, it's not that hard. Okay, we have to do this individually, so go away.
(3) Carson: *(reading aloud to himself, mumbling voice)* Individually answer the question: how good or bad is Evidence 1? //
(4) Leesha: *(to Luke)* // How good or bad is it? //
(5) Carson: // Write the reason for your answer, and write someone who might disagree with you. Okay.
(6) Leesha: *(to Luke)* Do you – is it good or bad?
(7) Luke: I think it's good.
(8) Carson: I think it's, I think it might be good.
(9) Leesha: I think it's good. Or is it?
(10) *Leesha reaches in front of Carson to move the laptop closer to her view.*
(11) Carson: Can we move this computer so I can write? Or is it?

(12) Leesha: (to herself) Maybe, ah, yeah. Carson: How do you open this? Jeez. *(appears to be referring to mechanical pencil Carson is holding in his hand)* How do you open this?

(13) Luke: *[inaudible]* and then you pour it like this.

(14) Carson: So, I could just pour it all out, right? I'm not going to.

(15) *Greg moves from his standing position between Leesha and Carson, and approaches Leesha's work space, where the laptop is located.*

(16) Leesha: Greg, go away!! *Leesha throws Greg's packet of papers across the table to his seat, facing her.*

(17) Greg: I need to do this!

(18) Carson: Well, don't be touching people's *[pauses mid-sentence]//*

(19) Leesha: //Here, since you weren't here, you use the laptop to look through the evidence //

(20) *Leesha places the laptop in front of Greg.*

(21) Greg: // Okay.

Here, the exclusion cascade began with Leesha's avoidance of working with Carson, moved toward reifying Carson as an incompetent collaborator by invoking a double standard enabling Leesha to work with Luke, and escalated to Leesha's explicit hostility toward Greg and Carson both as the two continued rejecting the individual work mode. Leesha used the instructions as a tool to justify Carson's exclusion, while ignoring the instructions in order to collaborate with Luke on the task. This juxtaposition highlights Leesha's desire to work with Luke because she perceived him as having high academic competence, as well as her desire to exclude Carson because she perceived him as having low academic competence. Greg's position in the group was even more marginal than Carson's. Whereas Leesha, Carson, and Luke were seated in chairs facing the task tools (i.e., laptop), Greg stood behind Leesha and Carson in attempts to participate, reflecting his limited influence over spatial organization of group activity. When Greg attempted to move in spatially for increased access to the task space, he was unsuccessful, as was exemplified by Leesha's reaction to Greg's spatial bid ("Greg, go away!"). Finally, the excerpt also illustrated Carson's reinforcement of Greg's marginality when Carson framed the physical workspace as unable to accommodate Greg's on-task engagement in Line 19.

In sum, Group C's interactions reveal that while social belonging might sustain interaction for a time, it has limitations on its utility when there is an inquiry task at hand requiring on-task contributions, as competence is also being constructed during these periods. Regardless of Greg's attempts to socially connect with group members at various points, he was gradually pushed out of group activity and was eventually left to work alone.

Discussion

The present study aimed to better historicize marginal identities in inquiry science contexts and pursued this aim by illustrating the phenomenon of exclusion cascades which exist within the broader cultural-historical realities of alienation and the social division of labor in a classed society. Through an analysis of small group activity using classroom video, we identified a series of peer interactions termed exclusion cascades that produced marginal positions for group members. The presence of exclusion cascades suggests a mutually constitutive relationship between the construction of competence and construction of belonging in which the two inform one another's evolution during group activity, extending previous work highlighting how competence is constructed in social interaction in the classroom by highlighting peer interactions' role (Gresalfi et al., 2009); Engle et al., 2014), aligning with previous research on status hierarchies indicating that students can use popularity and peer group hierarchies to blunt the impact of academic status differences (Lloyd & Cohen, 1999). These results also contribute to the nascent situative perspective in motivation research, as the situative perspective conceptualizes motivational processes with persons and contexts not being split in the analysis, thus allowing group as a unit of analysis to surface as important in its own right (Nolen et al., 2015; Nolen, 2020). The results here highlight how learners co-constructed their interactional context in ways that

pushed some to the margins of group activity. Peers' co-construction of the context thus should be considered in discussions of how inequities are reproduced in science classrooms. While the results illustrate two constructs most often studied as individual-level cognitive processes (i.e. competence and belonging) also operating at the group level, they also highlight the role of histories of social interaction (Esmonde et al., 2011) and suggest connections to longer-standing histories at the societal level.

None of these processes can be fully understood and remediated without understanding the cultural-historical domain's role: capitalist manual/mental labor ideology contextualizes schooling writ large and it is under-addressed in science education reforms; yet, a theory of schooling in capitalist societies would suggest this omission is probable short of targeted intervention. For example, in the absence of an explicit curricular goal of ending oppressive social relations, the forms of resistance most readily available were still limited in their ability to replace dominating social relations with a radically democratic alternative. Shonyce was left with one-off retaliation against Ty as a strategy. In Group F, Resistance to Ty's tendencies alongside acceptance of Paul's less aggressive but nonetheless managerial approach may be better understood as struggle for reproduction, rather than providing much clarity about what a challenge to the social division of labor would look like for students in a science classroom. Similarly, any reasons Carson and Greg had for their approach were unable to be discussed, as self-management within schools that serve capitalist social reproduction remained the unstated starting point for meaning making in the classroom. Further critical science education research involving inquiry-based curricula should explore ways alienation and the ideology associated with the social division of labor can emerge, primarily to identify points of intervention in the wake of reforms. Some areas for investigation and intervention include individualist ideologies regarding learning and achievement that persist beyond introduction of communities of learners, promotion competition between youth, the tendency to valorize youth who self-regulate without need for direct supervision (in line with mental labor's stratification), and the tendency to stigmatize youth who insufficiently comply with these norms of self-management and competition.

We raise the question of how a concept like science identity as a form of identity-in-practice should be further theorized with respect to longer timescales that include prospects for postsecondary education and employment. The findings presented here suggest important distinctions between engaging in scientific practices as a student and occupying the position of scientist as a relation of production (and social reproduction) (See Archer et al., 2010; Barzilai & Chinn, 2018 for relevant discussions of distinctions within science education). Accordingly, how does stratification of *labor* via manual/mental division of labor ideology and the stratification of access to more prestigious institutions of education en route to labor inform longer-term forms of marginality typically referred to as marginalization and oppression? How might researchers' failure to address the aforementioned question also contribute to the "monopolization and secrecy of knowledge" associated with the mental side of the division of labor in the broader society, in a direct contribution to capitalist social reproduction (Poulantzas, 2018, p. 240)? We propose that rejecting adaptationism requires further engagement with these distinctions.

Finally, the present study should be understood in light of some limitations. First, while peer interaction during collaboration periods was the focus here, the present study did not address the role of teacher practice or broader school cultural norms for informing the interactions discussed here. Past research related to equity-oriented interventions in small group learning suggests and important role for teachers in promoting an inclusive group climate (Cohen et al., 1999). Future research should consider the role of teacher practices. Second, the present study is descriptive and cannot identify the cause behind marginality-producing peer interactions in collaboration. For example, the present study did not include students' interactional histories prior to the semester-long curriculum implementation and the implementation occurred during the second half of the school year. Past interactional histories likely informed how easily students navigated interactions with one another and may have also informed how quickly students resorted to exclusionary tactics. Further, considering early adolescent learners' struggles with the requirements of argumentation and collaboration, future research should

examine whether exclusion is used as a maladaptive coping mechanism for handling frustrations with challenge. This should include examinations of what reasons learners give for exclusionary behaviors, triangulating data from observational studies with targeted interviews of group members to explain the impact of specific interactions among group members on group members' self-perceptions and construction of identities. Third, the present study did not include participants' individual socio-economic data, nor did students mention this information in group talk; accordingly any class divisions within the school are not identifiable and are not accounted for here. Future research should collect individual-level data related to social class to permit clarity regarding class relations inside a given school and among specific students. Fourth, the present study did not permit inclusion of all group members in interviews and relied heavily on triangulation of students' self-reports with observational data. While future research should continue to apply a triangulation approach, researchers should attempt to interview as many members of a group as possible and also modify recruitment procedures if teacher-supported recruitment results in insufficient representation of students based on demographic groupings.

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No potential conflict of interest was reported by the authors.

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Compliance with Ethical Standards

Adams-Wiggins and Dancis declare that they have no conflicts of interest. All procedures performed in the study were in accordance with the ethical standards of the Portland State University and the U.S. Federal Policy for the Protection of Human Subjects. Informed consent was obtained from all participants included in the study, through both parental consent and child assent.

References

Adams-Wiggins, K. R. (2020). Whose meanings belong?: Marginality and the role of microexclusions in middle school inquiry science. *Learning, Culture and Social Interaction*, *24*, 100353. https://doi.org/10.1016/j.lcsi.2019.100353

Adams-Wiggins, K. R., Myers, M. N., & Dancis, J. S. (2020). Negotiating status hierarchies in middle school inquiry science: Implications for marginal non-participation. *Instructional Science*, *48*(4), 427–451. https://doi.org/10.1007/s11251-020-09514-5

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2010). "Doing" science versus "being" a scientist: Examining 10/11-year-old schoolchildren's constructions of science through the lens of identity. *Science Education*, *94*(4), 617–639. https://doi.org/10.1002/sce.20399

Barzilai, S., & Chinn, C. A. (2018). On the goals of epistemic education: Promoting apt epistemic performance. *Journal of the Learning Sciences*, *27*(3), 353–389. https://doi.org/10.1080/10508406.2017.1392968

Bowles, S., & Gintis, H. (2011). *Schooling in capitalist America: Educational reform and the contradictions of economic life*. Haymarket Books.

Chinn, C. A., Duncan, R. G., & Rinehart, R. W. (2018). Epistemic design: Design to promote transferable epistemic growth in the PRACCIS project. In E. Manalo, Y. Uesaka, & C. A. Chinn (Eds.), *Promoting spontaneous use of learning and reasoning strategies: Theory, research, and practice for effective transfer*. Routledge. https://doi.org/10.4324/9781315564029-16

Chinn, C. A., & Sherin, B. L. (2014). Microgenetic Methods. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences (2nd ed.*, pp. 171–190). Cambridge University Press; Cambridge Core. https://doi.org/10.1017/CBO9781139519526.012

Cohen, E. G., Lotan, R. A., Scarloss, B. A., & Arellano, A. R. (1999). Complex instruction: Equity in cooperative learning classrooms. *Theory into Practice*, *38*(2), 80–86. https://doi.org/10.1080/00405849909543836

Cole, M., & Engeström, Y. (2007). Cultural-historical approaches to designing for development. In J. Valsiner & A. Rosa (Eds.), *The Cambridge handbook of sociocultural psychology* (pp. 484–507). Cambridge University Press. https://doi.org/10.1017/CBO9780511611162.026

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, *11*(4), 227–268. https://doi.org/10.1207/S15327965PLI1104_01

Engeström, Y. (2007). From communities of practice to mycorrhizae. In J. Hughes, N. Jewson, & L. Unwin (Eds.), *Communities of practice* (pp. 51–64). Routledge. https://doi.org/10.4324/NOE0415364737

Engle, R. A., Langer-Osuna, J. M., & Royston, M. M. D. (2014). Toward a model of influence in persuasive discussions: Negotiating quality, authority, privilege, and access within a student-led argument. *Journal of the Learning Sciences*, *23*(2), 245–268. https://doi.org/10.1080/10508406.2014.883979

Esmonde, I., Takeuchi, M., & Radakovic, N. (2011). Getting unstuck: Learning and histories of engagement in classrooms. *Mind, Culture, and Activity*, *18*(3), 237–256. https://doi.org/10.1080/10749031003790128

Gresalfi, M., Martin, T., Hand, V., & Greeno, J. (2009). Constructing competence: An analysis of student participation in the activity systems of mathematics classrooms. *Educational Studies in Mathematics*, *70*(1), 49–70. https://doi.org/10.1007/s10649-008-9141-5

Hascher, T., & Hadjar, A. (2018). School alienation – Theoretical approaches and educational research. *Educational Research*, *60*(2), 171–188. https://doi.org/10.1080/00131881.2018.1443021

Lave, J., & Wenger, E. (1991). *Situated learning: legitimate peripheral participation*. Cambridge University Press.

Lloyd, P., & Cohen, E. G. (1999). Peer status in the middle school: A natural treatment for unequal participation. *Social Psychology of Education*, *3*(3), 193–214. https://doi.org/10.1023/A:1009609126635

McDermott, R., & Lave, J. (2006). Estranged labor learning. In M. Elhammoumi, N. Duarte, & P. Sawchuk (Eds.), *CriticAl perspectives on activity: Explorations across education, work, and everyday life* (pp. 89–122). Cambridge University Press. https://doi.org/10.1017/CBO9780511509568.007

Nolen, S. B. (2020). Challenging research norms in educational psychology. *Educational Psychologist*, *55*(4), 267–272. https://doi.org/10.1080/00461520.2020.1810043

Nolen, S. B., Horn, I. S., & Ward, C. J. (2015). Situating motivation. *Educational Psychologist*, *50*(3), 234–247. https://doi.org/10.1080/00461520.2015.1075399

Patton, M. Q. (2015). *Qualitative research & evaluation methods: IntegraTing theory and practice (4th ed., vol. 1–1)*. Sage.

Penuel, W. R., & Wertsch, J. V. (1995). Vygotsky and identity formation: A sociocultural approach. *Educational Psychologist*, *30*(2), 83–92. https://doi.org/10.1207/s15326985ep3002_5

Poulantzas, N. (2018). *Classes in contemporary capitalism*. Verso Books.

Rinehart, R. W., Duncan, R. G., Chinn, C. A., Atkins, T. A., & DiBenedetti, J. (2016). Critical design decisions for successful model-based inquiry in science classrooms. *International Journal of Designs for Learning*, *7*(2). https://doi.org/10.14434/ijdl.v7i2.20137

Rogoff, B. (1991). *Apprenticeship in thinking: Cognitive development in social context*. Oxford Univ. Press.

Rooks, N. M. (2017). *Cutting school: Privatization, segregation, and the end of public education*. The New Press.

Sawyer, J. E., & Gampa, A. (2020). Work alienation and its gravediggers: Social class, class consciousness, and activism. *Journal of Social and Political Psychology*, *8*(1), 198–219. https://doi.org/10.5964/jspp.v8i1.1132

Stetsenko, A. (2016). *The transformative mind: Expanding vygotsky's approach to development and education*. Cambridge University Press. https://doi.org/10.1017/9780511843044

Wenger, E. (1999). *Communities of practice: Learning, meaning, and identity*. Cambridge University Press.

Williams, J. (2011). Toward a political economic theory of education: Use and exchange values of enhanced labor power. *Mind, Culture, and Activity*, *18*(3), 276–292. https://doi.org/10.1080/10749031003605854

Williams, J. (2016). Alienation in mathematics education: Critique and development of neo-vygotskian perspectives. *Educational Studies in Mathematics*, *92*(1), 59–74. https://doi.org/10.1007/s10649-015-9659-2

Yin, R. K. (2003). *Case study research: Design and methods*. SAGE.