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Hybrid discourse spaces: A mixed methods study of student engagement in U.S. science classrooms

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ABSTRACT

In this mixed methods study, we applied engagement and sociocultural (hybridity) frameworks to understand the nature of historically underserved students' participation in science discourse. We analyzed videos from seven U.S. urban middle school science classrooms to examine features of hybrid discourse spaces (where students' everyday and academic discourses are integrated) as students engaged in science talk. We also examined the relationships among instructional practices and science engagement ($N = 101$ students) using bifactor exploratory structural equation modeling (bESEM). Findings showed that science discourse occurred primarily in traditional spaces and was largely directed by the teacher. Within the smaller subset of hybrid spaces, small group discourse formats and shared or student-directed agency were more prevalent compared to traditional and everyday spaces. Qualitative themes displayed student agency, identities, and knowledge bases across lived worlds co-existing in hybrid discourse spaces. The bESEM showed that instructional practices associated with high quality and equity-focused instruction relate differentially to specific dimensions of engagement, demonstrating most consistent relationships with affective engagement. The variable representing funds of knowledge connections was only related to cognitive engagement. The integrated findings demonstrate the potential of hybrid discourse spaces for supporting equitable student engagement in science talk. Implications for practice and lines for future research are discussed.

1. Introduction

Vygotsky (1986) argued that talk is a sociocultural phenomenon crucial to learning; when a person turns their ideas into speech, they generate new understanding and meaning. Talk fosters science learning in many ways, such as facilitating collective sense-making about the processes underlying natural phenomena or supporting the critical evaluation of scientific claims based on evidence (Cavagnetto, Hand, & Norton-Meier, 2010; Colley & Windschitl, 2016. The literature also points to the centrality of classroom discourse for students' engagement, interest, and pursuit of science learning (Lemke, 1990, 2004; Murphy et al., 2018). Science discourse, specifically, is a term commonly used to refer to the rendering of science disciplines, which includes speech, written, and figural modes of representation (Gee, 2004; Lemke, 1990, 2004). Science talk (oral communication) is a more specific form of discourse that engages interpersonal processes associated with sharing and negotiating ideas with others (Cavagnetto et al., 2010; Ford & Wargo, 2012). A large body of research shows that science talk in classrooms is essential to support students' engagement in the epistemic, disciplinary practices associated with generating conceptual models and explanations that represent natural phenomena (Engle & Conant, 2002; Hogan, Nastasi, & Pressley, 1999; Murphy et al., 2018). Science discourse has also been the subject of several education reforms in the U.S.; many of the Next Generation Science Standards (NGSS) science practices (e.g., asking investigable questions) necessitate discourse processes related to disciplinary ideas and core scientific concepts (e.g., National K-12 Framework for Science Education; Lead, 2013; National Research Council (NRC), 2012).

Despite scholarly evidence and national reforms calling for discourse as a cornerstone of science education, student engagement in science talk remains elusive in Kindergarten to 12th grade (K12) classrooms (Berland & Reiser, 2011; Lee & Luykx, 2007; Windschitl, 2002). This is pronounced in U.S. urban education settings, where systemic inequities in access to high-quality science learning persist (Bae, DeBusk-Lane, Hayes, & Zhang, 2018; Gray, Hope, & Matthews, 2018; Maltese & Tai, 2011; Morgan, Farkas, Hillemeier, & Maczuga, 2016), and where students regularly learn science as a set of discrete, standardized set of facts to be memorized, absent of opportunities for agentic and meaningful co-

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construction of knowledge (Calabrese Barton & Tan, 2018; Lee & Luykx, 2007). Scholars further argue that to create access to high-quality science learning experiences for all students, Eurocentric systems and associated norms of schooling need to be re-imagined to include the diverse ways of knowing among students from historically marginalized groups (Bang & Medin, 2010; Brown, Reveles, & Kelly, 2005; Calabrese Barton & Tan, 2020; Gutiérrez, Baquedano-López, & Tejeda, 1999). This effort is imperative for diverse representation in science, technology, engineering, and mathematics (STEM) fields, which facilitates global scientific innovation and advancement (Association (AAAS), 1992; National Research Council (NRC), 2012).

In this mixed methods study, we explored the nature of middle school students' engagement in science discourse, focusing on science talk (oral communication) in hybrid discourse spaces (HDS). We draw from the concepts of hybridity (Moje et al., 2004) and students' funds of knowledge (Gutiérrez et al., 1999; Moll, Amanti, Neff, & Gonzalez, 1992) that highlight historically marginalized students' home and community resources as assets in classroom learning communities. Discourse spaces refer to what occurs during sense-making talk activities in which students are participating in science practices and knowledge building related to phenomena in the natural world (Lemke, 2004). Hybrid discourse spaces, more specifically, refer to classroom talk in which students' everyday (funds of knowledge) and academic (scientific) discourses are integrated (Gutiérrez et al., 1999, Moje et al., 2004). We also draw from engagement (Fredricks et al., 2004, 2016; Wang, Fredricks, Ye, Hofkens, & Linn, 2016) and complex systems frameworks to guide our investigation of the situational, interactive, and multilevel nature of students' engagement in science discourse (Hilpert & Marchand, 2018; Kaplan et al., 2020).

1.1. Review of literature and guiding frameworks

The study of student engagement in science discourse rarely fits neatly into one scholarly tradition but rather, benefits from drawing together socio-psychological and -cultural frames as well as mixed methodologies (see Bae et al., 2021 for a review). Such theoretically and methodologically pluralistic approaches are increasingly embraced in the educational psychology community. Scholars are calling for shifting goals of educational research designs to prioritize evidence regarding how context matters (Kaplan et al., 2020), adopting ontological frameworks that embrace non-linear, interaction dominant models (Hilpert & Marchand, 2018), and applying situative and/or critical frameworks to individual difference perspectives to better understand the multifaceted experiences of students from historically marginalized groups (DeCuir-Gunby, 2020; Eccles & Wigfield, 2020; Matthews & López, 2020; Nolen, 2020; Wigfield & Koenka, 2020). In this vein, we integrate engagement and hybrid discourse frameworks to explore how students' individual engagement in science is intertwined with and dependent on their learning environment, out-of-school experiences, and cultural identities. In the following section, we review related literature focusing primarily on studies conducted in U.S. urban education settings.

1.2. Engagement in science learning: A context forward approach

Engagement is a multidimensional construct that commonly represents the behavioral (e.g., being on-task, following rules), cognitive (e.g., mental effort, self-regulation), affective (e.g., excitement, enjoyment), and more recently, social (e.g., interaction with peers) ways students connect to learning tasks (Fredricks et al., 2004, 2016; Lawson & Lawson, 2013; Wang et al., 2016). Agentic engagement (i.e., volition to influence instruction and/or educational activities) is another dimension of engagement relevant to learning tasks that involve students' proactive interaction with others and their own work (e.g., offering suggestions, expressing preferences, Patall et al., 2019; Reeve, 2013). Additionally, Lawson and Lawson (2013) called for a socio-psychological conceptualization of student engagement that accounts for dynamic classroom, school, family, and community ecologies. Contemporary studies of student engagement have heeded this call, focusing on the social, cultural, and historical dimensions of engagement (Calabrese Barton, Tan, & Rivet, 2008; Gray, McElveen, Green, & Bryant, 2020), the context-specific and situational triggers of engagement (e.g., Cromley et al., 2020; Linnenbrink-Garcia, Rogat, & Koskey, 2011; Renninger & Bachrach, 2015; Ricca, Bowers, & Jordan, 2020; Ryu & Lombardi, 2015; Xie, Heddy, & Vongkulluksn, 2019), and the ecology of the micro (e.g., person, family) and macro (e.g., classroom, educational policies) factors that reciprocally influence students' engagement in science (Bae et al., 2018; Bae & Lai, 2020; Colley & Windschitl, 2016; Eccles, 2007; Fredricks, Parr, Amemiya, Wang, & Brauer, 2019).

Recent mixed methods studies underscore the context-bound and idiosyncratic nature of students' engagement in discourse and science learning. Ricca et al. (2020) applied the complex systems framework to examine emergent processes in collaborative group discourse among U.S. elementary students working on an engineering design project. Their analyses of talk turns at the individual and group levels of discourse showed that interactions among individual components were also represented at the group level (e.g., generating options, evaluating alternatives), indicating that activity at smaller (i.e. individual) scales correspond to collective activities (Ricca et al., 2020). In another mixed methods study of middle and high school students' engagement in U.S. urban schools, Fredricks et al. (2019) showed that the degree of students' engagement in school was contingent on a set of situational (e.g., feeling tired, not understanding the content), interpersonal (e.g., peer support, feeling heard by the teacher), as well as classroom and school structures (e.g., mastery goal structures, disciplinary harshness) factors.

1.3. Disciplinary engagement in scientific discourse: Inquiry-based and mastery approaches

High-quality instructional practices that support engagement in complex discourse processes are well-documented in the literature. Some of these include diverse questioning strategies that prompt students to elaborate, draw connections, and interrogate student-driven ideas (e.g., Chin & Osborne, 2008; Manz & Renga, 2017; Murphy et al., 2018) and limiting didactic initiate-respond-evaluate (IRE; Mehan, 1979) teacher-directed talk. Additionally, establishing discourse structures to build on students' ideas (e.g., construct and critique; Berland & Reiser, 2011; Ford, 2012; Sandoval & Reiser, 2004) and providing scaffolds to support students' engagement in productive inquiry grounded in evidence and reasoning (e.g., sentence stems, graphic organizers; Engle & Conant, 2002; Lombardi, Bailey, Bickel, & Burrell, 2018; McNeill & Pimentel, 2010) support student-driven talk.

A large body of literature also demonstrates that structured inquiry-based activities, in which students are actively exploring scientific phenomena around focused questions are fruitful contexts for facilitating disciplinary discourse (Hmelo-Silver, Duncan, & Chinn, 2007; Varelas, Becker, Luster, & Wenzel, 2002). An important feature of these inquiry activities is the presence of scaffolds to create optimally challenging tasks in which "students are cognitively engaged in sense-making, developing evidence-based explanations, and communicating their ideas" (Hmelo-Silver et al., 2007, p. 100). This deep (versus shallow) cognitive engagement through interactive dialoguing (e.g., arguing a claim in small groups) has been associated with more sophisticated content understanding and achievement (Chi & Wylie, 2014; Greene, 2015). These discourse activity structures also align with mastery approaches to science teaching and learning, which orient students towards developing competence in the knowledge and practices inherent to a specific discipline, rather than focusing on external (e.g., performance-oriented) goals such as avoiding failure or demonstrating competence (Ames, 1992; Bae et al., 2018; Lee, Hayes, Seitz, DiStefano, & O'Connor, 2016; Pintrich, 2000).

However, some scholars argue that even these high-quality (inquiry-based, mastery) opportunities for engagement in science discourse need to be critically examined for how dominant discursive conventions may be valued and upheld, and in turn, how the speech genres of racial/ethnic and linguistic marginalized groups may be excluded in science classrooms. Learning to participate in science talk often requires historically marginalized students to navigate different ways of thinking and acting across lived worlds, and at times, the cultural mismatch between mainstream science discourse and the native and cultural discourses of their home lives can maintain inequities in access to science learning (Brown et al., 2005; Calabrese Barton et al., 2008; Gutiérrez, 2008; Haverly, Calabrese Barton, Schwarz, & Braaten, 2020; Thompson, 2014). Therefore, we also draw from literature that focuses squarely on approaches aimed to encourage diverse forms of participation in science discourse.

1.4. The potential of hybrid discourse spaces: equitable engagement in scientific discourse

Hybridity is a useful theoretical frame to examine how teachers and students establish participation in learning spaces that can 1) serve as bridges between or scaffolds that link academic science content to students' everyday lives (Gutiérrez et al., 1999), 2) allow students to navigate across discourse communities (Lee, 1993), and/or 3) transform (destabilize, expand, reshape) academic and everyday knowledge and discourses (Moje, Collazo, Carrillo, & Marx, 2001, 2004). Core to this framework is the premise that students' funds of knowledge are valuable resources for learning, and thus should be valued and integrated in curricular content and practices (Calabrese Barton & Tan, 2009; Rodriguez, 2013). Funds of knowledge refer to historically rooted and culturally developed knowledge and skills that are fundamental to practice in students' households and communities (González & Moll, 2002; Moll et al., 1992). Positioning students as agents of their learning is also crucial to this aim; that is, treating students as meaningful contributors to the knowledge and practices of their classroom community (Haverly et al., 2020; Miller, Manz, Russ, Stroupe, & Berland, 2018; Stroupe, 2014). The importance of such asset-based pedagogies and cultural relevance in the curriculum has a long history in education research (e.g., Gutiérrez et al., 1999; Ladson-Billings, 1995) and is increasingly acknowledged in educational psychology (e.g., DeCuir-Gunby & Schutz, 2014; Fong, Alejandro, Krou, Segovia, & Johnston-Ashton, 2019; Graham, 2018; Gray et al., 2020; Kumar, Karabenick, Warnke, Hany, & Seay, 2019; Matthews & López, 2019; Schmidt, Kafkas, Maier, Shumow, & Kackar-Cam, 2019). We review the empirical evidence across these literature bases next, focusing on studies conducted in science classrooms.

1.4.1. Connections to students' communities and real-world events

Studies show that HDS expand traditional classroom spaces (where only canonical scientific knowledge and practices are present) by inviting and valuing repertoires of knowing and communicating within marginalized communities. These can include intertextual connections between students' lived worlds and science ideas through storytelling, connections to the natural world, and analogies (Bang & Medin, 2010; Calabrese Barton & Tan, 2009; Moll et al., 1992). For example, when teaching about the atmosphere and weather, teachers have integrated students' experiences related to hurricanes in the Dominican Republic, or differences in air quality across neighborhoods (Calabrese Barton & Tan, 2009; Moje et al., 2001; Tan & Calabrese Barton, 2010). Relatedly, a study of Black and Latinx middle school students showed that STEM curricula with a communal emphasis (e.g., providing citizens with adequate housing options in a growing community) were positively related to behavioral engagement (Gray et al., 2020).

1.4.2. Connections to students' identities

Research also shows that student engagement in science discourse is not limited to the nature of the activity itself but also how students identify with the activity. In these studies, students' identities are conceptualized not as a static or constant characteristic, but as dynamic stories constructed by self and others rooted in culture, language, and actions (Gee, 1996, 2004). For example, in a study of elementary students engaging in scientific argumentation, Ryu and Lombardi (2015) used critical discourse analysis to demonstrate how socially situated identities (e.g., friendship composition in small groups), meanings and cultural models from home and school (e.g., car tuning and strengthening a helicopter model using LEGO blocks) combined to support an English Language Learner's ability to participate meaningfully in science talk with his peers. In another example, Thompson (2014) illustrated how high school girls were able to merge their science and out-of-school identities through conversations that centered science around a problem relevant to their communities (e.g., dangers of high caffeine intake among young pregnant mothers) and built a collective sense of agency through conversations that problematized the status quo in science.

1.4.3. Connections to students' diverse speech expressions

Finally, diverse speech expressions, where students use academic and everyday language to generate a deeper understanding of science ideas, have been documented in HDS. For example, Brown and Spang (2008) demonstrated language practices in an urban science classroom that paired students' everyday talk with scientific concepts and terms ("double-talk", p. 708), supporting their ability to develop a deeper conceptual understanding of canonical science concepts in the context of meaningful, shared classroom experiences. Similarly, Matthews and López (2019) showed that elementary teachers' critical consciousness (e.g., problematic assumptions of traditional curricula and normative practices that replicate inequitable power structures) played a significant role in the extent to which they integrated students' native language (i.e., Spanish) in their elementary classrooms. As illustrated here, scholars argue that the content of students' discussions should be prioritized over the grammatical structure of their speech (i.e., prioritizing students' ideas when expressed using everyday and/or home languages rather than correcting for the usage of Standard American English; Martinez, 2017).

Taken together, the objective of HDS is to invite students' home and cultural experiences, identities, and languages into disciplinary discourse to support meaningful and relevant opportunities for engagement in science talk.

2. Purpose of this study

The first aim of this mixed methods study was to identify and provide descriptions of HDS in science classrooms by systematically coding and thematically analyzing classroom videos in which teachers planned opportunities for students to engage in science talk. We provide detailed illustrations of the features (e.g., discourse formats, agency, interpersonal dynamics) of HDS. The second aim of this study was to examine the relationships among a comprehensive set of high-quality and equity-focused instructional practices and global, behavioral, cognitive, affective, and social dimensions of student engagement in science using bifactor exploratory structural equation modeling (bESEM). The following research questions guided this study:

1. What are the *key features* of HDS in middle school science classrooms? (qualitative)
2. What are the relationships among *high quality* (mastery and inquiry approaches, discourse moves) and *equity-oriented* (connections to students' funds of knowledge, building a sense of community) science instructional practices and specific dimensions of students' engagement (behavioral, cognitive, affective, and social) in science learning? (quantitative)
3. What are *high leverage practices and features of classroom environments* that support students' engagement in science discourse? (integrated)

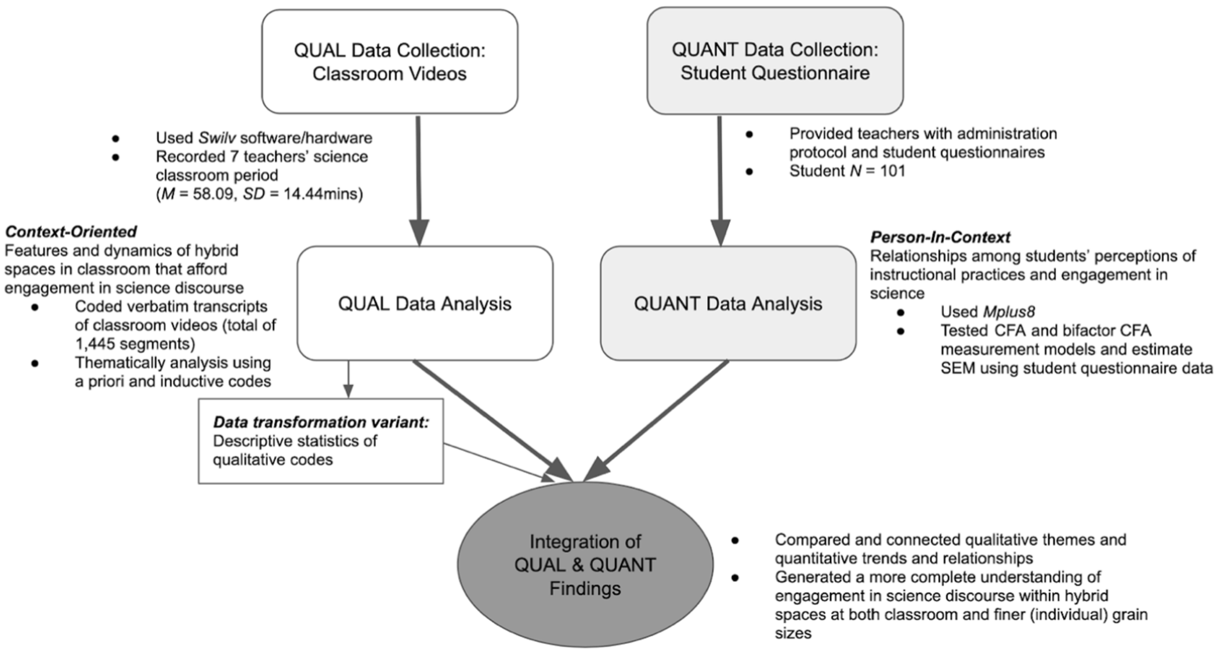

Fig. 1. Convergent mixed methods design.

Table 1
Description of participating teachers.

Teacher	Gender	Age	Race	Grade	Total # years teaching	District	Educational and professional history	Science Topics and Practices/ Discourse Activities
Mr. T	M	41	White	8	13	A	B.S. (Biology)	Chemical properties, Periodic table trends; Small group project and vocabulary worksheets/ Whole class science talk circle
Ms. R	F	44	Black	6	19	B	B.S. (Biology), Masters	Making observations and Inferences, Earth's atmosphere/ Whole class discussion
Ms. C	F	35	White	8	5	A	B.S. (Earth Science)	Designing controlled experiments, manipulating independent variables/Small group experiments
Ms. H	F	47	White	7	9	A	B.A. (Education)	Atomic and molecular structure/ Small group stations
Ms. L	F	39	Black	7	15	B	B.S. (Biology), Masters	Contributions of Black scientists/ Small group activity
Ms. E	F	n/a	Black	7	n/a	B	n/a	Structure of DNA/ Small group modeling activity
Ms. Y	F	29	Black	6	7	B	B.S. (Athletic Training), Masters	Seasons on Earth, rotation and revolution/ Whole class and small group discussions, small group lab

Note. School divisions A and B serve a student population who identify as male (51%, 50%), female (49%, 50%), and White (50%, 12%), Black (26%, 69%), Hispanic/ Latinx (16%, 15%), two or more races (5%, 2%), Asian/Pacific Islander (4%, 2%), and Native American (<1%, < 1%), respectively.

3. Methodology

3.1. Mixed methods design

A convergent mixed methods design was applied (Creswell & Plano Clark, 2018), in which qualitative and quantitative data were collected and analyzed concurrently. The qualitative strand also included a data transformation variant (Fig. 1). Three sets of findings from both strands were then integrated, including the qualitative themes of student engagement in HDS, classroom video code frequencies from the data transformation variant, and the quantitative relationships among instructional practices and dimensions of student engagement. We examined the degree of convergence (i.e., similarity), expansion (i.e., one set of findings providing additional information), and/or dissonance (i.e., two data sets contradicting one another) across these findings (Farmer, Elliott, & Eyles, 2006). There is also a multilevel aspect of this mixed methods design that included 1) a qualitative strand focused on the classroom level interpersonal dynamics and features of the learning environment (*context-oriented*), and 2) a quantitative strand at the individual level to explore the aggregate relationships among instructional practices and student engagement (*person-in-context*; McCrudden & Marchand, 2020; Sinatra, Heddy, & Lombardi, 2015).

3.2. Sample

For the quantitative bESEM strand of this study, data from a total of 101 middle school students (grades 6 to 8) from seven urban classrooms across six schools in two school divisions in the southeastern region of the U.S. were included (Kim, 2005; Kline, 2015). Students were recruited based on their teachers' consent to participate in a larger science education project. The sample represented a diverse student population, consisting of 51.5% female and 44.6% male, 15.8% White, 38.6% Black/African American, 17.8% Hispanic/Latinx, and 21.8% Mixed Race, 5% Asian/Pacific Islander, and 1.0% Native American. Students' mean age was 12.66 years old ($SD = 0.92$). For the qualitative strand of this study, we collected video recordings for an entire class period from a total of seven middle school teachers' classrooms. The sample of teachers (see Table 1) included one male and six females, with an average of 12.71 ($SD = 5.79$) years of teaching experience, who identified as Black/African American (62.5%) and White (37.5%). This study included two 6th grade, three 7th grade, and two 8th grade science classrooms.

3.3. Study procedures and context

Prior to data collection, we received approval to conduct the study from the university Institutional Review Board (HM20015115) and the research and assessment offices in the participating school divisions. Before any professional learning activities, we conducted classroom observations in late fall 2019 and early spring 2020. For the classroom observations, we asked teachers to select a classroom period where they were planning to implement a science lesson in which opportunities for student talk were intentionally planned ("*We are interested in videotaping a 50–60* min*. science lesson in which students have opportunities to talk with one another as they make sense of science ideas*"). We used this approach to ensure that the video collected represents typical science discourse in the observed classrooms (Fishman et al., 2017). Two trained research assistants attended each classroom observation to collect video data. Teachers were given a survey administration protocol by the research team and administered the paper-and-pencil questionnaire to their students in the spring of 2020. Notably all authors of this paper are active research members of this project, representing a faculty member, postdoctoral researcher, and doctoral students from different racial/ethnic (Asian, biracial White and Latinx, Black, and White American), educational (e.g., first generation college student), and professional backgrounds (research and teaching experiences in K12 and/or higher education settings). Since the summer of 2020, the team has been engaged in ongoing action research cycles with science teachers via a professional learning model called lesson study (Lewis, Perry, & Murata, 2006). This research-practice partnership is focused on creating high-quality and equitable opportunities for science discourse in urban middle school classrooms.

3.4. Data

3.4.1. Classroom video recordings

Classroom videos were collected using the *Swivl* technology, which includes a camera that captures a wide-angle view of the teacher and students then uploads the video to an online platform. The classroom teacher wore a wireless microphone that captured their voice during classroom discussions. Audio recorders were also placed on student tables to capture student voices. The audio was synced to the video. The videos captured a full classroom period and ranged from 38.97 to 77.98 min (M = 58.09, SD = 14.44) in length. Variation in the length of the videos was due to different bell schedules across schools.

3.4.2. Student questionnaire

Students first reported their demographic information (e.g., age, race/ethnicity, gender). Adaptations to existing questionnaire items included changing item wording to make constructs specific to science learning contexts and dropping items from existing scales to reduce survey fatigue (Gogol et al., 2014; Flake & Fried, 2020). Students rated each item on the questionnaire on a scale ranging from 1 (*Not true at all*) to 5 (*Very true*). Internal reliability and confirmatory factor analyses were conducted to establish the reliability of the factor structure of each scale prior to estimating the structural models (Kline, 2015).

Science Instructional Practices. Secondly, students reported their perceptions of their science teacher's science instructional practices. In the present study, the following five scales were used: (1) *Mastery approaches* (adapted from Midgley et al., 2000), related to instructional approaches that focus on supporting students' proficiency in science (6 items, α = 0.88, e.g., "My science teacher tells us mistakes are okay as long as we are learning from them"), (2) *Inquiry approaches* (adapted from Lee et al., 2016), related to instructional approaches that promote open-ended exploration of scientific ideas through disciplinary practices (6 items, α = 0.76, e.g., "My science teacher asks science questions that have more than one right answer.", "My science teacher asks us to use evidence to back up our science explanations."), (3) *Science discourse* (Bae et al., 2018), related to instructional approaches that focus on classroom discourse activities (5 items, α = 0.83, e.g., "My science teacher asks us to share and debate science ideas in small groups."), (4) *Funds of knowledge* (adapted from Dickson, Chun, & Fernandez, 2016; Kumar et al., 2019), related to instructional approaches that integrate students' home and everyday experiences, identities, and knowledge with science learning (5 items, α = 0.78, e.g., "My science teacher tells us about scientists in history who look like me."), and (5) *Community building* (adapted from Dickson et al., 2016), related to supporting students' sense of belonging in learning communities (5 items, α = 0.84, e.g., "My science teacher treats all students as important members of the classroom.").

Engagement Questionnaire. Student engagement was measured using an adapted version of a validated self-report scale specific to student engagement in science (Wang et al., 2016). The engagement questionnaire consisted of four subscales, including behavioral (3 items, α = 0.74, e.g., "I participate in my science class activities."), cognitive (3 items, α = 0.71, e.g., "I look over my science work and make sure it is done well."), affective (3 items, α = 0.90, e.g., "I have fun in my science class."), and social (3 items, α = 0.73, "I enjoy working with my classmates in science.") engagement.

3.4.3. Qualitative analyses

We conducted a thematic analysis of the qualitative classroom video data including a process of becoming familiar with the data (reading the transcript, segmenting, and incorporating field notes), coding transcript segments, and developing themes.

3.4.4. Familiarization

The classroom video recordings were transcribed verbatim and reviewed in conjunction with the video to document broad activity structures (e.g., a warm-up at the introduction of the main lesson) along an event map (Brown & Spang, 2008; Sandoval, Kawasaki, & Clark, 2020). We then organized the transcripts into a total of 1,445 unique segments for coding. We defined segments as a unit of talk organized around a specific purpose, marked by the end and start of a teacher's or student's talk turn, in which multiple talk turns can exist within a segment (see example segments in qualitative findings; e.g., Hogan et al., 1999; Murphy et al., 2018).

3.4.5. Coding

We coded the segments following a three-stage process using a codebook developed as part of a larger project focused on supporting scientific discourse in middle school classrooms. The development of the codebook involved a deductive approach informed by a systematic literature review of theory and extant literature related to scientific discourse in urban classrooms (Bae et al., 2021, see Appendix A) and a prior study of student engagement in science classrooms (Bae & Lai, 2020). A priori codes were applied to analyze macro features of the discourse segments systematically. Three types of *discourse spaces* were coded. The first was traditional discourse spaces characterized as segments in which only canonical science content and practices are acknowledged and valued. The next was HDS, which included both canonical scientific discourses as well as students' everyday discourses representing their funds of knowledge from the home, community, or cultural backgrounds (Calabrese Barton & Tan, 2020; Moje et al., 2001). Finally, we coded for everyday discourse spaces that did not include discourses related to science (e.g., a student asking for permission to go to the bathroom).

Within each of the discourse spaces, we also coded *discourse format* (whole class, small group, one-on-one/talk in pairs) and *agency* (teacher-directed, shared, student-directed). Discourse format refers to the configuration of students in a discourse segment (e.g., whole class discussion versus students talking in pairs, Sandoval et al., 2020). Agency

Table 2
Descriptive statistics of observed variables.

Variable	*M (SD)*	Min	Max	Skew	Kurtosis
1. Mastery	3.96 (0.83)	1.67	5.00	−0.65	−0.30
2. Inquiry	3.56 (0.71)	1.33	5.00	−0.28	−0.06
3. Discourse	3.71 (0.79)	1.60	5.00	−0.20	−0.43
4. Funds of Knowledge	2.62 (0.93)	1.00	5.00	0.32	−0.04
5. Community	3.76 (0.81)	1.80	5.00	−0.30	−0.73
6. Behavioral	3.75(0.65)	1.00	5.00	−0.84	3.05
7. Cognitive	4.15 (0.62)	2.33	5.00	−0.56	−0.13
8. Affective	3.52 (1.07)	1.00	5.00	−0.63	−0.10
9. Social	3.26 (0.97)	1.00	5.00	−0.55	−0.05

refers to the locus of authority within a particular talk segment (e.g., who is controlling the flow of discussion, making decisions about what ideas to pursue; Bandura, 2001; Ko & Krist, 2019; Patall et al., 2018; Reeve, 2012). When authority over the content and direction of the talk segment lay primarily with the teacher or with the student, the code 'teacher-directed' or 'student-directed' was applied, respectively. Similarly, when authority was shared (teacher and students negotiating authority and co-constructing knowledge), the talk segment was coded 'shared.' Finally, the codes related to HDS and students' engagement in discourse were grouped thematically to generate detailed descriptions of how students connect to science talk opportunities that bridge everyday and academic discourses (Huberman & Miles, 2002; Saldaña, 2014).

Four coders met weekly to discuss their code applications, and differences or discrepancies in code applications were resolved to develop a consensus. An example discrepancy related to whether talk segments in which everyday examples were integrated in science talk by the teacher should be coded as academic or hybrid, because the everyday component of these talk segments was potentially not always noticeably linked to students' everyday discourses. Because an objective judgment of the relevance of the everyday examples made by the teacher to students' out-of-school lives could not be made, the decision was made to consistently count these talk segments as hybrid. The first author double-coded all transcripts, and 80% to 98% interrater agreement was established between the first author and the second coder for discourse space, discourse format, and agency codes.

3.4.6. *Theme development*

The researchers met weekly to discuss emergent themes using a constant comparative method, in which coded talk segments across classrooms representing similar patterns were grouped into thematic clusters (Huberman & Miles, 2002; Saldaña, 2014). Specifically, talk segments coded as *hybrid* were examined in more depth and in relation to the discourse format, agency, and engagement codes to identify how activity structures, interpersonal dynamics, and students' connection to science discourse co-occurred in HDS. The three themes presented provide contextualized descriptions of key features of the classroom environment and interpersonal dynamics among teachers and students that relate to student engagement in HDS.

3.5. *Quantitative analyses*

3.5.1. *Data transformation variant*

We first tallied the frequencies of qualitative codes related to discourse space (traditional, everyday, hybrid) across classrooms and then the proportion (percentage) of each space was aggregated across classrooms. Within each traditional, everyday, and hybrid discourse space, the percentage of each discourse format (whole class, small group, or one-on-one) and agency (teacher-directed, shared, or student-directed) were calculated. These descriptive statistics provide information about classroom discourse structures that are important to consider when interpreting findings from the more in-depth qualitative analyses of the features of student engagement within HDS.

3.5.2. *Measurement models*

M*plus*8 (Muthén & Muthén, 1998–2017) was used to conduct the quantitative analyses, with maximum likelihood estimation with robust standard errors (MLR). Preliminary analyses included generating descriptive statistics (*M*, *SD*, correlations), as well as a series of confirmatory factor analyses (CFAs) for each of the five science instructional practices (one-factor models) and the four-factor engagement measurement model (see Tables 2-4). In each CFA tested, the latent variable was specified by the set of their conceptually corresponding items. Overall model fit was assessed using the cut-off criteria recommended by Hu and Bentler (1998, 1999) based on the following fit indices: Comparative Fit Index (CFI $\geq$ 0.90), the Tucker-Lewis Index (TLI $\geq$ 0.90), the Root Mean Square Error of Approximation (RMSEA $\leq$ 0.06), and the Standardized Root Mean Square Residual (SRMR $\leq$ 0.06).

An ESEM and a bESEM were estimated to assess the hierarchical, multidimensional factor structure of engagement (Ben-Eliyahu, Moore, Dorph, & Schunn, 2018; Wang et al., 2016). Specifically, we tested an ESEM in which all latent factors were specified by all items, with main loadings freely estimated through target rotation and all non-a-priori cross-loadings to be close to zero (Asparouhov & Muthén, 2009). To compare the ESEM against the CFA measurement model of engagement, we examined factor correlations (Morin et al., 2017). Because an ESEM approach provides more precise estimates of factor correlations when cross-loadings are present (Asparouhov, Muthén, & Morin, 2015), the ESEM is considered favorable over the CFA model if latent factor correlations are reduced. A bESEM was estimated, in which all engagement items were freely estimated for the global engagement factor, while the four specific engagement factors were specified as described in the ESEM. To compare the bESEM to the ESEM model, the factor loadings between the two models were compared (Morin et al., 2017). The presence of moderate factor loadings among the global engagement item loadings provides evidence of the hierarchical nature of engagement. Accounting for the global engagement factor aligns with contemporary conceptualizations of engagement as a hierarchical and multidimensional factor, for which recent studies have demonstrated empirical support (Bae & Lai, 2020; Ben-Eliyahu et al., 2018; Wang et al., 2016). Because the global engagement factor represents the variance common among the four dimensions, accounting for the global factor in the ESEM

Table 3
Correlations among observed variables.

Variable	1	2	3	4	5	6	7	8	9
1. Mastery	–								
2. Inquiry	0.54***	–							
3. Discourse	0.56***	0.57***	–						
4. Funds of Knowledge	0.26*	0.47***	0.33**	–					
5. Community	0.68***	0.64***	0.57***	0.47***	–				
6. Behavioral	0.48***	0.37***	0.36**	0.10	0.30*	–			
7. Cognitive	0.36***	0.20	0.35*	0.20	0.19	0.58***	–		
8. Affective	0.66***	0.33*	0.45***	0.17	0.51***	0.37***	0.47***	–	
9. Social	0.41***	0.18	0.17	-0.07	0.23*	0.27***	0.30*	0.43***	–

Note. *p <.05, **p <.01, ***p <.001.

Table 4
Goodness-of-fit indices for measurement models.

Measurement Models	χ^2	*df*	*p*-value	RMSEA	ΔRMSEA	CFI	ΔCFI	TLI	ΔTLI	SRMR
CFA										
Mastery	10.80	9	0.29	0.05	–	0.99	–	0.99	–	0.03
Inquiry	13.96	9	0.12	0.05	–	0.96	–	0.94	–	0.02
Discourse	2.21	4	0.70	< 0.001	–	1.00	–	1.00	–	0.05
Funds of Knowledge	4.34	4	0.36	0.03	–	0.99	–	0.99	–	0.03
Community	2.96	5	0.71	< 0.001	–	1.00	–	1.00	–	0.02
Engagement	165.87	48	< 0.001	0.15	–	0.68	–	0.57	–	0.10
ESEM and bESEM										
Engagement ESEM	45.34	24	0.005	0.09	-0.06	0.94	0.26	0.85	0.27	0.03
Engagement bESEM	36.86	16	0.002	0.06	- 0.04	0.95	0.001	0.89	0.05	0.02

provides a more precise estimate of the unique relationships among the instructional practices and each engagement dimension (Morin et al., 2017). We assessed model fit for the ESEM and bESEM models using the same criteria used for the CFA.

3.5.3. Structural model

The bESEM contained five latent variables representing science instructional approaches, including mastery, inquiry, integrating funds of knowledge, discourse opportunities, and community building, and four latent variables including behavioral, cognitive, affective, and social engagement, as well as a global engagement variable. Their respective questionnaire items specified each factor. The combined ESEM specified correlations among the five science instructional approaches, the four engagement dimensions, and global engagement factors. The five science instructional approaches were allowed to covary. Because the aim of this analysis was to understand the nature of students' engagement in science classrooms in relation to features of HDS, the instructional latent variables were specified to correlate with the engagement latent variables (specifying a bidirectional rather than predictive relationship; Schult & Sparfeldt, 2016). This quantitative analysis complements the qualitative strand by providing information at a finer grain size about the magnitude of the relationships among instructional practices in HDS and specific dimensions of students' engagement, teasing apart the unique relationships among these related but distinct constructs in a way that would be difficult using qualitative approaches alone.

Allowing the variables to correlate also aligns with the conceptualization of the interdependent, reciprocal nature of teacher instruction and students' engagement that we explored qualitatively. The ESEM was estimated with MLR estimation, and the same criteria for fit used for the measurement models were applied. To account for the nested structure of the data (students clustered within teachers), the *M*plus model type = COMPLEX option was used, which computes standard errors and chi-square tests of model fit that account for complex sampling features (Heck & Thomas, 2015). Statistical significance for the path coefficients was set at $p < .05$. The magnitude of the standardized beta coefficients was interpreted as follows: < 0.05 small, < 0.10 moderate, and < 0.25 large (Keith, 2019).

4. Results

4.1. Qualitative (and quantitative data transformation variant) results

The findings from the qualitative strand answered research question 1: What are the *key features of HDS* in middle school science classrooms?

4.1.1. Nature of Hybrid Discourse Spaces in science classrooms

The distribution of the three discourse spaces across a total of 1,445 coded segments showed that traditional spaces were the most common (M = 71.88%, SD = 10.79%), followed by hybrid (M = 19.88%, SD = 11.28%), then everyday (M = 8.24%, SD = 3.40%) discourse spaces. Notably, the small group discourse format was most prominent in HDS (53.58%), whereas traditional discourse spaces were characterized by similar distributions of whole class (36.29%) and small group (38.72%) formats. On the other hand, everyday discourse spaces were characterized by similar distributions of small group (40.33%) and one-on-one (41.66%) formats. The distribution of agency (teacher-directed, shared, and student-directed) within the traditional, hybrid, and everyday discourse spaces showed that teacher-directed agency was most common across all three. This was particularly the case in traditional discourse spaces (79.60%) but also present in high proportions in hybrid (61.73%) and everyday (69.49%) discourse spaces. The opposite pattern was observed in terms of student-directed agency, which was found most frequently in HDS (26.54%), followed by everyday (22.89%), then traditional (16.35%) discourse spaces. Similarly, shared agency between the teacher and students occurred most frequently in HDS (11.73%) compared to everyday (7.62%) and traditional (4.05%) discourse spaces.

The segments coded as HDS were examined in more depth to explore the content of the talk and the interpersonal dynamics among teacher and student as they relate to student engagement. Qualitative themes regarding features of HDS showed that 1) shared and student-directed agency interacts with discourse format, 2) positioning science against the backdrop of socio-cultural and -historical events support the development of narratives about the discipline, and 3) both teachers and students participate in diverse speech expressions that represent multiple identities and lived worlds.

4.1.2. Shared and student-directed agency across discourse formats

A noteworthy trend was that instances of shared and student-directed agency were most frequent in HDS. Additionally, small group discourse formats, such as students working in stations, were most prevalent in HDS, where the ownership of discussing and sense-making (agency) was more likely to be placed between student-to-student. The following case illustrates how agency and discourse format interact in science talk activities. In the first half of Mr. T's class, where students were sitting in their assigned seats and completing a worksheet on the elements in a periodic table (atomic mass and number), the teacher was predominately asserting agency, whereby the teacher directed the flow of talk through didactic initiate-respond-evaluate patterns. In these talk segments, students recalled content ideas to questions posted by the teacher [*behavioral engagement*]:

Mr. T (initiates): "How many electrons does it take to make a bond?"
Student (responds): "Two."
Mr. T (evaluates): "So these two electrons are shared."

In contrast, when the discourse format transitioned to a Socratic seminar-style science talk circle format, several student-directed and shared agency instances were observed. Here, students demonstrated excitement and interest [*affective, social engagement*]. The shift in agency from teacher-directed to shared was noted at the onset of the discussion as follows:

Student: "I feel like I'm in a conference."
Mr. T: "Is this the head of the joint chief of staff here? President meets with his advisors all sitting around the table."

Further evidence of shared and student-directed agency was observed in the dialogic patterns of discussion, in which students elaborated on each other's ideas to collectively generate possible consequences of exposure to toxins [*cognitive, social, agentic engagement*]. For example, when Mr. T made a claim about the presence of lead and mercury in the water from science lab sinks, a student exerted agency by asking the teacher for evidence ("How do you know?").

Students in Ms. Y's class also demonstrated student-directed agency in a whole-class discussion by spontaneously posing questions that shifted or extended the flow of discussion [*cognitive, agentic engagement*]:

Ms. Y: "The Earth is tilted on its axis and it revolves around the sun."
S1: "Even if the Earth is tilted, why don't we feel it?"
Ms. Y: "The Earth is so big. I live on a hill at my house, but I don't feel like I'm tilted all day because it's so big."
S1: "How big is it?"

Other instances of student-initiated questions were observed in the HDS of Ms. Y.'s science classroom (e.g., "In Brazil and Australia, when it's July here and it's July over there, it's winter? They have hot Christmases?").

Segments of shared agency were commonly observed in small groups as students conducted hands-on science activities. For example, students demonstrated agency when they had opportunities to select how they wanted to represent the arrangement of elements on a periodic table (e.g., drawing parallels between increasing atomic number and radius to the increasing average salary of professional athletes in different sports), what variable they wanted to manipulate in a controlled experiment (e.g., the slope of a ramp), or what materials they wanted to select to build a model of DNA [*social, cognitive engagement*].

In small groups, there were also several instances of students holding each other accountable for staying on task and resolving ambiguities within the group [*social, behavioral engagement*]: S1: "Wait, I'm supposed to be working. What am I doing? What am I doing? I just messed this completely up. See? This is what happens when we get off the subject." We observed further evidence of student agency in small groups when Ms. Y checked in on a small group, and one student responded, "We're doing great, figured out how to do it now…I realized that I thought it was winter and spring but this time, it's summer and fall. Then it's going to be winter and then it's going to be spring. [*cognitive, affective, social engagement*]".

Finally, in HDS, teachers also explicitly redistributed agency to their students. For example, Ms. L positioned herself as a learner, stating to her student, "So Ms. L forgets sometimes…You gotta be patient with me. I'm a work in progress." Statements such as this challenged traditional classroom expert (i.e., teacher) and novice (i.e., student) hierarchies and signaled a classroom environment in which agency is shared across participants.

4.1.3. Connections to the socio-cultural and -historical context of science topics and students' out-of-school lives

Explicit links between science and historical events emerged as a unique feature of HDS. This approach to integrating the stories of science and scientists stands in stark contrast to traditional, didactic ways of learning science as a collection of facts to be memorized. It also extends reform-based approaches to science teaching in that the socio-cultural and -historical significance of the content students are learning about is centered in relation to disciplinary knowledge and practices.

For example, Ms. L's students completed an activity in which they created a poster of Black scientists to display in the classroom. In small groups, students researched the scientific contributions of Black scientists and incorporated historical information from their social studies class [*social, cognitive engagement*]. During these activities, Ms. L prompted students to consider major events surrounding their selected scientist's career (e.g., asking "What major things did she live through?" regarding Katherine Johnson's contributions to the first and subsequent NASA space flights of U.S. crews). She also prompted students to consider the importance of representation and inclusivity in making scientific advancements, asking questions such as, "Why do you think it's important to learn about African American scientists?" to which a student replied, "There's not a lot of African American scientists in the world." Similarly, when teaching about atomic structure and chemical reactions, Mr. T connected these concepts to mutations in DNA. He used events from World War II (e.g., atomic bomb dropped in Hiroshima) to provide historical context for the scientific phenomena examined in class (e.g., mutations from exposure to radioactive elements).

Teachers also invited students' out-of-school knowledge and experiences into the science learning activities. In Ms. R's class, students were asked to differentiate observations from inferences (a scientific practice that appears in the state standards) during a whole-class discussion. She used a series of photographs that represented scenes familiar to students, such as Black families in church attire, building architecture common in urban neighborhoods, and hairstyles from different eras. Students actively shared observations and inferences based on out-of-school experiences and built upon each other's ideas based on shared lived worlds [*cognitive, social engagement*]: S1: "The Barbie doll's clothes…and the flowers on the clothes they wear.", S2: "And their hair." These observations and inferences (S: "I think that back in the day everybody used to wear, like church clothes.") were also acknowledged and affirmed by the teacher (Ms R.: "Alright, so S's observation is that these are church clothes...the kind of clothes that you would wear when you go to a church service").

Ms. R also incorporated popular culture in her classroom management routines. For example, an established choral response that showed to be effective for redirecting students' attention back to the teacher [*behavioral engagement*] was calling out the name of the American rapper, to which students responded with an adapted title of one of his songs (Ms. R: "Tupac.", Students: "All eyes on you."). Similarly, in a discussion about how the tilt of the earth's axis relates to different seasons in the northern and southern hemispheres, Ms. Y made links to real-world implications (e.g., "It's December and it's winter in the northern hemisphere, what does it feel like in Brazil?"). Students responded to these opportunities by asking for clarification ("Where is Brazil?") and building on each other's ideas as they made sense of what season and the temperature it would be in different parts of the Earth (S1: "That's winter.", S2: "It'll be warm." [*social, cognitive engagement*].) These cases illustrate how teachers create HDS for student engagement in discourse by drawing links across science ideas, students' lived worlds, and broader social, cultural, and/or historical contexts.

4.1.4. Co-participation in the use of students' languages and expressions of in-and-out of school discursive identities

The languages that students bring to science classroom discourses reflect their identities, including social positioning and membership in a particular community of speakers (Brown & Spang, 2008; Gee, 1996). In many cases, teachers themselves engaged in code-switching (i.e., the fluid use of multiple languages and dialects, Nilep, 2006) when in dialogue with their students, affirming their students' ways of knowing, talking, and interacting in science classrooms. A notable linguistic marker of HDS was the presence of multiple dialects, including American Standard English (ASE, the dominant way of speaking in mainstream classrooms, Hollie, 2001; Smitherman, 1986) and non-ASE (i.e., dialects with linguistic patterns or terminology that varies from ASE; Hudley & Mallinson, 2017). For instance, teachers' whole-class instruction was typically expressed in ASE, whereas smaller group interactions often reiterated this formal language into everyday language to connect everyday and scientific discourses. For example, as Ms. Y checked in with students, she facilitated their understanding of seasons by using both scientific language, "Where does the north end of the Earth's axis lean towards this time of year?" and everyday language, "It's just asking towards or away from the sun." This prompted students to consider how to translate their everyday ways of expressing their emerging science understanding into scientific terms [*cognitive engagement*]: S1: "I thought I had to put it in degrees. Now, I understand." S2: "How do I say this in a full sentence?".

Hybrid discourse spaces were also characterized by using terms of endearment or nicknames amongst students and/or between the teacher and students (e.g., "Yes baby, what did you say?", "How many y'all have?"). For example, as she was walking around the class, Ms. H checked in with a Black, male student using both ASE and non-ASE:

> Ms. E: "Your mom get your report?"
> Student: "She was like, the 'needs improvements' need to come up." [*social engagement*]
> Ms. E: "How many 'needs improvement' do you have? One?"
> Student: "Three."
> Ms. E: "Oh, that's not bad! You just..You gotta improve. You improvin' in my class."

This segment illustrates how the teacher is bringing into the classroom the students' home life (mother's engagement in student's academic performance), out-of-school identity (son), and engaging in the student's ways of speaking with his family members [*social, affective engagement*].

We also observed code-switching in high frequencies in small-group activities. Several instances of student-to-student talk observed in HDS illustrated agentic speech acts in which students were incorporating academic and everyday or youth speech genres to signal peer-to-peer relationship dynamics (Varelas et al., 2002). For example, as they were building models of DNA, a student mixed academic and youth genres as she attempted to get her peers on task (e.g., S1: "If I keep my cool, you can keep yours. This is teamwork. We've got to do this", S2: "He lookin' like, "Bruh!" [*affective, social engagement*]). As illustrated in these examples, the presence of diverse speech genres and languages invoked multiple identities that represented students' membership to racial/ethnic, in- and out-of-school social, and cultural groups (Brown et al., 2005). The presence of these discursive identities expressed by both teachers and students represent an acceptance of the diverse language practices in science classrooms.

4.2. Quantitative results

Findings from the quantitative strand answered research question 2: What are the relationships among *high-quality* and *equity-oriented* science instructional practices and specific dimensions of students' engagement in science learning?

Specifically, a close look at the parameter estimates, including factor loadings and correlations for the CFA and ESEM solutions, indicated theoretical conformity for the four-factor model (Morin et al., 2017). The factor loadings for both the CFA ($\gamma = 0.38$ to 0.90) and the ESEM ($\gamma = 0.17$ to 1.02) indicated that the four dimensions of engagement were well-defined (Table S1). Notably, standardized factor loadings greater than 1 can occur due to moderate correlations among observed variables (Deegan, 1978; Jöreskog, 1999). Further, evidence that the factors were more clearly differentiated in the ESEM was shown, based on lower factor correlations in the ESEM ($r = 0.06$ to 0.34) compared to the CFA ($r = 0.28$ to 0.96). When the ESEM was compared with the bESEM solution, results showed that the bESEM demonstrated superior fit based on generally strong and positive factor loadings on the global engagement factor across all items ($\gamma = 0.06$ to 0.81, Table S2). Additionally, results showed generally moderate factor loadings across the specific engagement factors, indicating that all four engagement factors retained specificity. There were a couple of exceptions in which item-to-factor loading was reduced, indicating that the global factor expressed a majority of the variability in that item (cognitive item 2 γ = -0.05, behavioral item 2 γ = -0.02, behavioral item 3 γ = -0.10). Overall, findings are in line with results of bESEMs in prior studies (Bae & DeBusk-Lane, 2019; Wang et al., 2016). Thus, in the final structural model, engagement was specified as a multidimensional construct consisting of a global factor and four specific engagement factors.

Table 5
Parameter estimates for bifactor ESEM model.

Variables	Behavioral	Cognitive	Affective	Social	Global
Mastery	0.38^{**}	0.02	0.53^{***}	0.41^{***}	0.42
Inquiry	0.39^{**}	0.006	0.25*	0.25*	0.08
Discourse	0.33^{**}	0.06	0.34^{**}	0.16	0.16
Funds of Knowledge	0.09	0.22*	0.38	0.01	0.06
Community	0.16	0.17	0.65^{***}	0.16	0.18

Note. *$p < 0.05$, $^{**}p < 0.01$ $^{***}p < 0.001$.

4.2.1. Bifactor ESEM

In the bESEM, all five latent science instruction variables (mastery, inquiry, discourse, funds of knowledge, and community) were specified to correlate with the four engagement dimensions (behavioral, cognitive, affective, and social) and the global engagement factor (Figure S1). This model showed adequate fit (x2 = 846.24, p <.0021, RMSEA = 0.06, CFI = 0.89, TLI = 0.90, SRMR = 0.05). All parameter estimates are presented in Table 5. Results showed that mastery-oriented instruction was positively and significantly related to behavioral engagement (r = 0.38, p = .004), affective engagement (r = 0.53, p <.001), and social engagement (r = 0.41, p < .001). Inquiry approaches were positively and significantly related to behavioral engagement (r = 0.39, p = .009), affective engagement (r = 0.25, p = .03), and social engagement (r = 0.25, p = .04). Discourse opportunities were positively and significantly related to behavioral engagement (r = 0.33, p =.001) and affective engagement (r = 0.34, p < .001). Funds of knowledge were positively and significantly related to cognitive engagement (r = 0.22, p = .04). Finally, community building was positively and significantly related to affective engagement (r = 0.65, p < .001). In summary, results of statistically significant relationships showed that all science instructional practices (except for funds of knowledge) were related to affective engagement. Mastery approaches, discourse opportunities, and inquiry approaches were moderately related to behavioral engagement. Only mastery and inquiry approaches were moderately related to social engagement. Finally, the funds of knowledge variable was statistically significantly related only to cognitive engagement.

4.2.2. Integrated results

Findings from the integrated (combined qualitative and quantitative) findings answered research question 3: What are *high leverage practices and features of classroom environments* that support students' engagement in science discourse?

The integrated findings provide a fuller picture of the nature of student engagement in science at different grain sizes, including more general patterns of relationships related to classroom structures and instructional practices (quantitative results including code frequencies and the bESEM), and more situation-specific examples of student engagement in HDS (qualitative themes and case illustrations from classroom observations). From the bESEM results, we see consistent positive, statistically significant relationships between high quality and equity-focused instructional practices (mastery, inquiry, discourse, community) and engagement dimensions, including affective engagement, and to a lesser extent, behavioral and social engagement. The qualitative findings show how these relationships manifest in real-time, such as the momentary nature of students' affective responses (e.g., excitement, interest) within HDS, where personal connections (e.g., birthdays, popular music) and socio-historical connections (e.g., contributions of Black scientists, atomic bombing of Hiroshima) are discussed in relation to science topics. Similarly, the quantitative relationship between equity-focused instruction and behavioral engagement is illustrated in the qualitative cases, such as a teacher establishing a choral response routine using the name and song of a famous rapper.

Finally, the quantitative code distributions highlight the broader structures (e.g., small group versus whole class discourse formats) and interpersonal dynamics (e.g., teacher-directed vs. shared agency) of student engagement in science discourse. Quantitative code counts showed that HDS had the highest frequencies of student-directed and shared agency (e.g., both students and teachers initiating questions to drive discussions) as well as the small group discourse opportunities. Qualitatively, we see that within these HDS, students are invited to express their in and out-of-school identities (e.g., code-switching between ASE and non-ASE) and drive the direction of their science learning (e.g., initiating unprompted questions to elaborate on science ideas) as they engage in science discourse.

5. Discussion

In this study, we focused on student engagement in science discourse, focusing on HDS. Findings contribute to contemporary work in educational psychology that aims to integrate sociocultural and individual difference frameworks to understand learning in context. We also applied mixed methods to capture science discourse at different grain sizes. Finally, the integrated findings extend a largely ethnographic literature base on hybrid spaces by presenting broader quantitative relationships in addition to in-depth qualitative illustrations of student engagement in discourse across seven middle school classrooms. We systematically coded science talk segments to show how agency and discourse formats are distributed within traditional, hybrid, and everyday discourse spaces. Notably, the results from this data transformation variant showed that small group formats, as well as student-directed and shared agency, were most common in HDS. Together with our detailed case illustrations, our findings advance efforts to identify more generalizable principles that support equitable access to science discourse in urban classrooms. The integrated findings demonstrate the potential of HDS for expanding the boundaries of traditional classroom norms and practices to invite students' diverse ways of knowing.

We also extend the literature by demonstrating how a comprehensive (high-quality and equity-focused) set of science instructional practices relates to four engagement dimensions. This is the first study to our knowledge that has examined such relationships using the bifactor engagement model, which accounts for the shared variance across the four engagement dimensions through a global factor, thus more precisely isolating the unique relationships to each engagement dimension. Results showed a consistent, positive relationship between instructional practices (mastery, inquiry, discourse, and community building) and affective engagement, whereas the nature of the relationship with other engagement dimensions (behavioral, cognitive, and social) varied. The implications of our findings for theory and practice as well as directions for future research are discussed next.

5.1. *Discourse spaces in science classrooms*

The literature on HDS underscores the importance of involving historically marginalized students as agentic participants in talk activities and integrating students' funds of knowledge in the standard curriculum for deeper engagement and learning (Calabrese Barton & Tan, 2009; González & Moll, 2002). The qualitative themes and case illustrations presented in this study showed that HDS were characterized by the *presence* of students' funds of knowledge, where momentary (typically two to three talk turns in length) *links* or *bridges* were made to the science content (e.g., connection to TV shows, everyday and historical events), and/or where students *navigated* between discourse communities (e.g., mixing youth and cultural genres of speech while sharing scientific ideas in small groups; Lemke, 1990, 2004; Varelas et al., 2002). We argue that the presence of these instances of HDS are not trivial as they present spaces of possibility that move towards a classroom culture in which students are positioned as rightful participants with knowledge and experiences that are valuable for learning science. For example, the expressions of students' discursive identities qualitatively documented in the HDS, including both teachers' and students' use of speech genres and languages that signal membership to diverse social and cultural groups, indicates a culturally affirming classroom environment (Brown et al., 2005; Calabrese Barton et al., 2013; Gutiérrez et al., 1999). In HDS, students are positioned as valued members of the learning community; their diverse ways of knowing, doing, and talking in science activities are legitimized as assets to the learning process rather than in conflict with dominant ways of speaking and engaging in science (Brown et al., 2005; Martinez, 2017; Thompson, 2014). Based on supporting evidence that HDS support equitable participation in science discourse, we argue that the exploration to understand even the nascent nature of these spaces documented in this study is important.

It is also worth discussing that most of the classroom segments coded in our study were characterized as *traditional*. Results showed that HDS made up approximately 20% (and traditional spaces approximately 72%) of all coded classroom video data. This finding indicates that there is much room for not only a better understanding of the nature of HDS in science but also how teachers and administrators can be supported to create and maintain hybrid learning environments. Relatedly, teacher-directed agency was most prominent across all three classroom discourse spaces (making up approximately 60%, 70%, and 80% of hybrid, everyday, and traditional discourse spac`es, respectively). Thus, control over the flow of discourse was predominantly in the teachers' locus of control, even in HDS. There are several well-documented explanations for the limited hybrid talk episodes and the high frequency of teacher-directed agency documented in this study. Past studies show that teachers sometimes reproduce their K-12 experiences of didactic teaching and learning and often have reservations about relinquishing authority in classroom discussions. These trends are due to a confluence of factors (e.g., unpredictability, lack of opportunities to experiment with student-centered discourse moves; Braaten & Sheth, 2017; Windschitl, 2019).

Importantly, our findings also showed that the nature of teacher-directed talk segments represented a variety of discourse moves, ranging from more didactic (e.g., initiate-respond-evaluate) to more dialogic (e.g., probing students to elaborate on their ideas). Thus, although we contend that there is room to create more opportunities for shared and student-directed agency in science classrooms, we also recognize that teacher-directed talk can play an important role in facilitating student engagement in science discourse (e.g., Manz & Renga, 2017; Murphy et al., 2018). Scholars also argue that unless classroom environments consistently allow students to actively participate in the knowledge-building process, students are not likely to recognize and take up opportunities to enact agency when they arise (Miller et al., 2018). Examining opportunity structures in relation to student agency over time warrants future study.

Finally, it is important to understand that teachers' ability to create HDS operate within organizations, and structural barriers in low-income schools may hinder this effort. Prominent examples include the accountability pressures that limit teachers' instructional autonomy, particularly in terms of allowing students to direct the flow of a lesson in a way that may diverge from memorizing science content aligned to high-stakes standardized assessments (e.g., Haverly et al., 2020; Hayes & Trexler, 2016; Ko & Krist, 2019). In many ways, the classroom norms and practices of HDS go "against the cultural grain" of schooling (Hammer, 1997, p. 520). Despite these barriers, our study documents and describes how teachers structured and facilitated science talk in hybrid spaces. The implications of these findings are discussed next.

5.2. Implications for practice and directions for future research: Creating hybrid discourse spaces in science classrooms

The integrated findings in our study begin to address the gaps in the literature regarding ways to facilitate student engagement in HDS. One of these includes facilitating open-ended discourse activities in small-group formats (which were most common in HDS) that likely facilitate the distribution of agency by creating an activity structure that encourages students to take responsibility for the learning process and co-construct knowledge with peers (Linnenbrink-Garcia et al., 2011; Ricca et al., 2020). Relatedly, asking questions emerged as an effective discourse move for supporting shared agency in HDS. These included using open-ended questions to elicit student ideas across lived worlds, asking follow-up questions to extend students' train of thought and prompting them to elaborate on initial ideas, and creating a classroom culture that allowed for discussion prompted by spontaneous questions raised by students. These findings align with research on the importance of using multiple questioning approaches for supporting equitable engagement in science talk (e.g., Chin & Osborne, 2008; Murphy et al., 2018).

Another notable strategy that emerged from the qualitative findings was explicitly drawing cross-curricular connections between science ideas and historical events to support the development of *narratives* about *who* participates in science and why science is relevant in students' lives. Supporting students in developing science narratives, such as researching stories of Black scientists in which historically marginalized students can see themselves as members of the science community is a powerful approach to countering mainstream notions of who belongs in science (Calabrese Barton & Tan, 2018; Morgan et al., 2016; Rosebery, Warren, & Tucker-Raymond, 2016; Thompson, 2014).

Although there is growing acknowledgment of the importance of integrating students' diverse funds of knowledge in the science curriculum, translating these goals to practice is complex and information to guide this approach to teaching is lacking. Additional work is needed to understand how to *build upon* and *maintain* HDS in science classrooms. As discussed above, we see that there is room to shift the classroom discourse norms away from teacher-directed talk to increase student agentic engagement (Patall et al., 2019; Reeve, 2013), where students are taking ownership of making connections between everyday and science ideas, as well as shared agency (Miller et al., 2018; Stroupe, 2014), where students are co-constructing knowledge through discourse. What is less understood is *when* and *how* to productively integrate students' funds of knowledge in science discourse activities that moves beyond using students' out-of-school ideas and experiences as superficial hooks and towards meaningful connections that deepen students' understanding of scientific phenomena (Calabrese Barton & Tan, 2009; Haverly et al., 2020; Moje et al., 2004).

It is important also to note that to truly achieve hybrid learning environments in which historically marginalized students' diverse identities, languages, and experiences are centered, teachers need to be aware of how historicized structures and relations of power and position manifest in classrooms. That is, "…an understanding of power that is key in developing an analysis of funds of knowledge pedagogical contributions is that power and agency exist not only in the ability to act with purpose on one's behalf but also in the acts themselves and in being able to communicate the possibility (or even threat) of action…" (Rodriguez, 2013, p. 103). For example, Matthews and López (2019) showed that teachers' critical awareness is an important antecedent to whether they integrate students' home language in their teaching of core subjects. It is worth noting that four of the classrooms examined in this study were taught by Black female teachers in an urban school district that serves a predominantly Black student population, and three of the classrooms were taught by White teachers (one male, two females) in a school district that serves a more racially diverse student population. The racial/ethnic makeup of teachers and students within the classrooms may have influenced our findings. For example, a recent review of teacher-student relationships showed that having a co-racial or co-ethnic teacher was associated with less frequent disruptive behavior ratings (for Black and Latinx students) and greater academic achievement among Black students (Redding, 2019). We recognize that teachers' identities, racial and ethnic backgrounds, cultural values, and critical consciousness influence their approaches to science discourse, as well as their confidence and ability to leverage their students' diverse funds of knowledge. Exploring how these factors may explain variations in how teachers facilitate science discourse in HDS warrants further study.

5.3. Student engagement in science discourse: Individual, instructional, and classroom dynamics

The findings from our bESEM show that both high quality and equity-focused instructional practices were related to multiple dimensions of student engagement. In this study, these included orienting students to pursue understanding and persist through challenges during science learning activities (i.e., mastery orientation; Ames, 1992; Elliot, 1999; Pintrich, 2000), creating opportunities to participate in open-ended explorations of scientific phenomena (e.g., inquiry approaches; Engle & Conant, 2002; Hogan et al., 1999), implementing a variety of discourse moves (e.g., asking questions to elicit student ideas; Manz & Renga, 2017; Murphy et al., 2018), connecting students' out-of-school experiences to science (e.g., funds of knowledge connections; González & Moll, 2002), and building a peer learning community (Estrada, Woodcock, Hernandez, & Schultz, 2011; Xu, Solanki, McPartlan, & Sato, 2018). Additionally, our findings specific to the four dimensions of engagement (behavioral, cognitive, affective, and social) adds to the growing body of research showing that student engagement is not only multidimensional, but that the engagement dimensions co-occur in response to dynamic classroom events (Bae & Lai, 2020; Sinatra et al., 2015; Wang & Eccles, 2012).

At the individual level, the positive relationships between students' perceptions of the high-quality and equity-focused instructional practices and students' engagement can be explained by mechanisms related to autonomy-supportive practices and students' sense of belongingness. The high-quality instructional practices examined in our study, including mastery orientation and inquiry-based approaches, meet students' need for autonomy (i.e., sense of control over their learning) by providing choices, integrating students' interests, and being responsive to students' questions are associated with student engagement or meaningful connections to tasks (e.g., Patall et al., 2018; Reeve & Shin, 2020; Skinner, Furrer, Marchand, & Kindermann, 2008). The equity-focused instructional practices examined in this study, including community building, likely tap students' sense of relatedness or belongingness, which are associated with engaged learning behaviors such as persistence on tasks and prosocial academic interactions (Gray et al., 2018; Zumbrunn, McKim, Buhs, & Hawley, 2014).

This study extends previous work by demonstrating that, by and large, high-quality and equity-focused instructional practices demonstrate a consistent moderate to strong relationship to affective engagement, which is characterized by students' emotional connection to learning. In this study, affective engagement asked students to report on their positive-activated emotional engagement (e.g., being excited, having fun) in their science classroom. This link is important, based on findings from past studies that have shown that positive-activated emotions in learning (compared to positive-deactivated emotions such as being calm, or negative-activated such as being annoyed) is associated with openness to learning and a strong connection to the learning task and in turn, higher academic performance (Ben-Eliyahu & Linnenbrink-Garcia, 2013; Pekrun, Elliot, & Maier, 2009). Further, researchers have argued that instruction focused too narrowly on behavioral engagement (e.g., management strategies) without attention to students' affective experiences does not have lasting effects on students' meaningful participation in learning activities (Pianta, Hamre, & Allen, 2012; Skinner et al., 2008). Our findings contribute to the growing body of work indicating that particularly for students who have historically been marginalized in science, it is important to create spaces that are affectively and socially engaging (Estrada et al., 2011; Linnenbrink-Garcia et al., 2011; Xu et al., 2018).

Finally, future research is needed to better understand possible explanatory mechanisms for the mixed patterns of quantitative relationships identified in this study between the instructional practices and other engagement dimensions (behavioral, cognitive, and social). For example, why mastery, inquiry, and discourse-focused practices related to behavioral and social engagement and why the link between funds of knowledge was only related to cognitive engagement are questions that remain to be answered.

5.4. Implications for practice and directions for future research: Teasing apart how instructional strategies differentially relate to student engagement

Our qualitative findings provide some possible starting points for future work by illustrating what these high quality and equity-focused instructional practices 'look like' in terms of discrete teacher instructional moves in the classroom and the situational nature of students' engagement as responses to these opportunities. The instructional approaches identified in HDS, such as teachers anchoring open-ended discussions in real-world phenomena (e.g., presenting the dangers of drinking water from the classroom sink; inquiry approach) and placing students in small group activities to collaborate on hands-on tasks (e.g., building models of DNA; building student learning communities) were commonly associated with momentary student expressions of enjoyment and excitement (affective engagement).

The statistically significant relationship between the funds of knowledge variable and cognitive engagement is also of particular interest. In this study, the items measuring cognitive engagement asked students to report on their level of effort (e.g., "keep trying", "work hard"). It is possible that when students see themselves in the science curriculum (e.g., are exposed to scientists that look like them) and/or make personally relevant connections (e.g., connect science to personal interests and hobbies), they are motivated to put forward more effort towards persisting on challenging science tasks. Further research is needed to examine this possibility.

Finally, given the emergence of student agency as a notable feature of HDS in our qualitative findings, future work may consider adding agentic engagement as a fifth dimension to the latest four-part engagement framework (Fredricks et al., 2016; Wang et al., 2016). To date, studies examining one or more of the four engagement dimensions included in our study (behavioral, cognitive, affective, and social) are largely separate from studies examining agentic engagement, which focuses on individual students' proactive contribution and control of the flow of instruction (e.g., Bandura, 2001; Patall et al., 2019; Reeve, 2013). Further, in line with contemporary efforts to understand student engagement in context, the study of epistemic agency, which underscores the collective negotiation of power and authority within learning communities, is needed (Ko & Krist, 2019; Miller et al., 2018; Stroupe, 2014). This examination of intrapersonal and interpersonal agentic behaviors will support a better understanding of why and how students engage in classroom discourse.

6. Limitations

There are limitations to this study that we would like to acknowledge. First, the qualitative data were limited to one lesson from seven urban classrooms serving a predominantly Black and Latinx student population; thus, findings may not generalize to all student populations. Notably, the literature on students' funds of knowledge originates from the work of Moll et al. (1992), who aimed to understand how forms of knowledge that arose from working class Mexican students' homes and communities could serve as assets in mainstream educational settings. Additionally, much of this early ethnographic work was conducted in students' homes (e.g., (Moll et al., 1992), whereas our study was conducted in a formal education setting. As researchers increasingly apply the literature on hybrid spaces and students' funds of knowledge to other subgroups of historically marginalized students, it is important to account for the idiosyncrasies across diverse racial/ethnic and cultural backgrounds of students. For example, although classrooms included in this study fall under common characterizations of 'urban education', we acknowledge that there is wide variability in urban schools that is influenced by a confluence of cultural, geographic, socio-historical, political, and geographic factors (Green, 2015; Milner, 2015; Welsh & Swain, 2020). Thus, our findings regarding students' funds of knowledge and dynamics of HDS in middle school classrooms located in the southeastern region of the United States do not necessarily generalize to all urban settings.

Second, the cross-sectional nature of our data limits our ability to capture the day-to-day variation in science discourse that is inherent to classroom teaching and learning. Relatedly, it is important to consider that creating an equitable science classroom environment takes time; examining the progression of teachers' equity-focused discourse approaches and classroom dynamics across multiple lessons is an important line for future study. Third, we had a relatively small quantitative sample size because of the disruption to data collection related to the COVID-19 pandemic and subsequent school closures in early spring of 2020. Our mixed methods approach that include verbatim transcription and analysis of classroom videos coupled with the bESEM attenuates some of these limitations. The integrated findings provide an understanding of science discourse and student engagement at multiple levels and grain sizes (classroom dynamics, student experiences) as well as general patterns (students' perceptions of science instruction and engagement representative of the academic year) and idiosyncratic (cases of situational engagement) aspects of classroom spaces that would be difficult to capture with purely qualitative or even large-scale quantitative approaches. Future research is needed to examine whether the quantitative relationships between science instructional strategies and specific engagement dimensions identified in this study replicate in larger samples.

7. Conclusion

The premise of this study was that traditional classroom norms and practices may be insufficient to address goals to make science accessible and optimally engaging for historically underserved students. A primary aim of this study was to understand features of HDS in which academic and students' everyday discourses are brought together. Our integrated findings demonstrate unique quantitative relationships between high-quality and equity-focused instructional practices and four engagement dimensions, demonstrating most consistent relationships with affective engagement, whereas the variable representing funds of knowledge connections was only related to cognitive engagement. We also present qualitative illustrations of how these relationships manifest in science HDS. Findings point to ways that science teachers can continue to create and sustain HDS for science discourse, including shifting agency for knowledge construction to students, and strengthening the connection between science content and students' funds of knowledge to promote engagement.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Table A1
Qualitative a priori codes and descriptions.

Code	Description
Discourse space (knowledge(s) that is/are present)	
Traditional	Only canonical science content and practices are present. *Example:* T: Chlorine gains one, so it fills its electron shell and becomes full. But sodium has lost an electron. S: Chlorine gains one. T: So will it become positive or will it become negative? S: Negative.
Hybrid	Both canonical science and content and knowledge and practices from students' home, community, and/or cultural backgrounds are present. *Example:* S1: Even though the Earth is tilted, why don't we feel it? S2: It's called gravity. T: The Earth is so big. I live on a hill at my house, but I don't feel like I'm tilted all day because it's so big. S1: How big is it?
Everyday	Topics discussed are not related to any science ideas or practices. *Example:* T: What's wrong? Have to go to the bathroom? S: Can I get some water?
Discourse format (configuration of students participating in talk)	
One-on-One	Student-to-Student or Teacher-to-Student talk in pairs.
Small Group	Talk is occurring within groups of approximately 3 to 6 students.
Whole Class	All students in the classroom and the teacher are participating in the talk activity.
Agency (locus of control; authority over the content and direction of talk)	
Teacher-directed	The teacher is directing the content and flow of the conversation or discussion. *Example:* T: Can someone raise their hand, tell me what is DNA? Deoxyribonucleic acid, but what is it? Where is it located? S: In the nucleus. T: In the nucleus, exactly right. Now, can somebody raise their hand and tell me…what does it look like?
Student-directed	The student is directing the content and flow of the conversation or discussion. *Example:* S1: We could do purple as the Cs. Pink can be the Gs. Yellow… you already got it. Green could be adenine. Blue will by thymine. S2: Remember that. Write it down so we can. S1: I've got an idea, how about we use white.
Shared	Both teacher and student(s) is/are directing the content and flow of the conversation or discussion. *Example:* S: This thing right here has more bumps and is more rough, and this is more a smooth surface right here. And you see less friction on this surface than this surface right here. T: What about the ball? Did you make any observations about the surface texture of the ball? Is it completely smooth? S: Ah yes, definitely because if you had a completely smooth ball, it would probably go faster than this one.

Data availability

Data will be made available on request.

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Appendix A

See Table A1.

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cedpsych.2022.102108.

References

American Association for the Advancement of Science (AAAS). (1992). AAAS* 93: Science and education for the future: Boston * 11-16 February 1993: Pre-Meeting Program. *Science, 258*(5087), 1511-1528. 10.1126/science.258.5087.1511.

Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology, 84*(3), 261.

Asparouhov, T., & Muthén, B. (2009). Exploratory structural equation modeling. *Structural Equation Modeling: A Multidisciplinary Journal, 16*(3), 397–438.

Asparouhov, T., Muthén, B., & Morin, A. J. (2015). Bayesian structural equation modeling with cross-loadings and residual covariances: Comments on Stromeyer et al. *Journal of Management*, *41*(6), 1561–1577. 10.1177/0149206315591075.

Bae, C., & DeBusk-Lane, M. (2019). Engagement profiles in middle school: Implications for motivation and achievement in science. *Learning and Individual Differences, 74*, 101753. https://doi.org/10.1016/j.lindif.2019.101753

Bae, C. L., DeBusk-Lane, M., Hayes, K. N., & Zhang, F. (2018). Opportunities to Participate (OtP) in Science: Examining differences longitudinally and across socioeconomically diverse schools. *Research in Science Education, 1-22*. https://doi.org/10.1007/s11165-018-9797-5

Bae, C. L., & Lai, M. (2020). Opportunities to Participate (OtP) in science learning and student engagement: A mixed methods study. *Journal of Educational Psychology, 112*(6), 1128–1153. https://psycnet.apa.org/record/2019-54277-001.

Bae, C. L., Mills, D., Zhang, F., Sealy, M., Cabrera, L., & Sea, M. (2021). A systematic review of scientific discourse in urban K12 classrooms: Accounting for individual, collective, and contextual factors. *Review of Educational Research, 91*(6), 831–877. https://doi.org/10.3102/00346543211042415

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology, 52*(1), 1–26.

Bang, M., & Medin, D. (2010). Cultural processes in science education: Supporting the navigation of multiple epistemologies. *Science Education, 94*(6), 1008–1026. https://doi.org/10.1002/sce.20392

Ben-Eliyahu, A., & Linnenbrink-Garcia, L. (2013). Extending self-regulated learning to include self-regulated emotion strategies. *Motivation and Emotion, 37*(3), 558–573.

Ben-Eliyahu, A., Moore, D., Dorph, R., & Schunn, C. D. (2018). Investigating the multidimensionality of engagement: Affective, behavioral, and cognitive engagement across science activities and contexts. *Contemporary Educational Psychology, 53*, 87–105.

Berland, L. K., & Reiser, B. J. (2011). Classroom communities' adaptations of the practice of scientific argumentation. *Science Education, 95*(2), 191–216.

Braaten, M., & Sheth, M. (2017). Tensions teaching science for equity: Lessons learned from the case of Ms. *Dawson. Science Education, 101*(1), 134–164. https://doi.org/10.1002/sce.21254

Brown, B. A., Reveles, J. M., & Kelly, G. J. (2005). Scientific literacy and discursive identity: A theoretical framework for understanding science learning. *Science Education, 89*(5), 779–802.

Brown, B. A., & Spang, E. (2008). Double talk: Synthesizing everyday and science language in the classroom. *Science Education, 92*(4), 708–732.

Calabrese Barton, A., Tan, E., & Rivet, A. (2008). Creating hybrid spaces for engaging school science among urban middle school girls. *American Educational Research Journal, 45*(1), 68–103. https://doi.org/10.3102/0002831207308641

Calabrese Barton, A., & Tan, E. (2009). Funds of knowledge and discourses and hybrid space. *Journal of Research in Science Teaching, 46*(1), 50–73. https://doi.org/10.1002/tea.20269

Calabrese Barton, A., Kang, H., Tan, E., O'Neill, T. B., Bautista-Guerra, J., & Brecklin, C. (2013). Crafting a future in science: Tracing middle school girls' identity work over time and space. *American Educational Research Journal, 50*(1), 37–75.

Calabrese Barton, A., & Tan, E. (2018). A longitudinal study of equity-oriented STEM-rich making among youth from historically marginalized communities. *American Educational Research Journal, 55*(4), 761–800.

Calabrese Barton, A., & Tan, E. (2020). Beyond equity as inclusion: A framework of "rightful presence" for guiding justice-oriented studies in teaching and learning. *Educational Researcher, 49*(6), 433–440.

Cavagnetto, A., Hand, B. M., & Norton-Meier, L. (2010). The nature of elementary student science discourse in the context of the science writing heuristic approach. *International Journal of Science Education, 32*(4), 427–449.

Chi, M. T., & Wylie, R. (2014). The ICAP framework: Linking cognitive engagement to active learning outcomes. *Educational Psychologist, 49*(4), 219–243.

Chin, C., & Osborne, J. (2008). Students' questions: A potential resource for teaching and learning science. *Studies in Science Education, 44*(1), 1–39.

Colley, C., & Windschitl, M. (2016). Rigor in elementary science students' discourse: The role of responsiveness and supportive conditions for talk. *Science Education, 100*(6), 1009–1038.

Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE Publications.

Cromley, J. G., Perez, T., Kaplan, A., Dai, T., Mara, K., & Balsai, M. J. (2020). Combined cognitive–motivational modules delivered via an LMS increase undergraduate biology grades. *Technology, Mind, and Behavior, 1*(2). https://doi.org/10.1037/tmb0000020

DeCuir-Gunby, J. T., & Schutz, P. A. (2014). Researching race within educational psychology contexts. *Educational Psychologist, 49*(4), 244–260.

DeCuir-Gunby, J. T. (2020). Using critical race mixed methodology to explore the experiences of African Americans in education. *Educational Psychologist, 55*(4), 244–255.

Deegan, J. (1978). On the occurrence of standardized regression coefficients greater than one. *Educational and Psychological Measurement, 38*(4), 873–888. https://doi.org/10.1177/001316447803800404

Dickson, G. L., Chun, H., & Fernandez, I. T. (2016). The development and initial validation of the student measure of culturally responsive teaching. *Assessment for Effective Intervention, 41*(3), 141–154.

Eccles, J. S. (2007). Families, schools, and developing achievement-related motivations and engagement. In J. E. Grusec, & P. D. Hastings (Eds.), *Handbook of socialization: Theory and research* (pp. 665–691). The Guilford Press.

Eccles, J. S., & Wigfield, A. (2020). From expectancy-value theory to situated expectancy-value theory: A developmental, social cognitive, and sociocultural perspective on motivation. *Contemporary Educational Psychology, 61*, Article 101859.

Elliot, A. J. (1999). Approach and avoidance motivation and achievement goals. *Educational Psychologist, 34*(3), 169–189.

Engle, R. A., & Conant, F. R. (2002). Guiding principles for fostering productive disciplinary engagement: Explaining an emergent argument in a community of learners classroom. *Cognition and Instruction, 20*(4), 399–483.

Estrada, M., Woodcock, A., Hernandez, P. R., & Schultz, P. W. (2011). Toward a model of social influence that explains minority student integration into the scientific community. *Journal of Educational Psychology, 103*(1), 206.

Farmer, T., Elliott, S., & Eyles, J. (2006). Developing and implementing a triangulation protocol for qualitative health research. *Qualitative Health Research, 16*(3), 377–394.

Fishman, E. J., Borko, H., Osborne, J., Gomez, F., Rafanelli, S., Reigh, E., et al. (2017). A practice-based professional development program to support scientific argumentation from evidence in the elementary classroom. *Journal of Science Teacher Education, 28*(3), 222–249.

Flake, J. K., & Fried, E. I. (2020). Measurement schmeasurement: Questionable measurement practices and how to avoid them. *Advances in Methods and Practices in Psychological Science, 3*(4), 456–465. https://doi.org/10.1177/2515245920952393

Ford, M. J. (2012). A dialogic account of sense-making in scientific argumentation and reasoning. *Cognition and Instruction, 30*(3), 207–245.

Ford, M. J., & Wargo, B. M. (2012). Dialogic framing of scientific content for conceptual and epistemic understanding. *Science Education, 96*(3), 369–391.

Fong, C. J., Alejandro, A. J., Krou, M. R., Segovia, J., & Johnston-Ashton, K. (2019). Ya'at'eeh: Race-reimaged belongingness factors, academic outcomes, and goal pursuits among Indigenous community college students. *Contemporary Educational Psychology, 59*, Article 101805.

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research, 74*(1), 59–109.

Fredricks, J. A., Wang, M. T., Linn, J. S., Hofkens, T. L., Sung, H., Parr, A., et al. (2016). Using qualitative methods to develop a survey measure of math and science engagement. *Learning and Instruction, 43*, 5–15.

Fredricks, J. A., Parr, A. K., Amemiya, J. L., Wang, M. T., & Brauer, S. (2019). What matters for urban adolescents' engagement and disengagement in school: A mixed-methods study. *Journal of Adolescent Research, 34*(5), 491–527.

Gee, J. P. (1996). *Social linguistics and literacies: Ideology in discourses* ((2nd ed.).). Taylor & Francis.

Gee, J. P. (2004). Learning Language as a Matter of Learning Social Languages within Discourses. In M. Hawkins (Ed.), *Language learning and teacher education: A sociocultural approach* (pp. 13-32). Multilingual Matters. 10.21832/9781853597657-004.

Gogol, K., Brunner, M., Goetz, T., Martin, R., Ugen, S., Keller, U., et al. (2014). "My questionnaire is too long!" The assessments of motivational-affective constructs with three-item and single-item measures. *Contemporary Educational Psychology, 39*(3), 188–205. https://doi.org/10.1016/j.cedpsych.2014.04.002

González, N., & Moll, L. C. (2002). Cruzando el puente: Building bridges to funds of knowledge. *Educational Policy, 16*(4), 623–641.

Graham, S. (2018). Race/ethnicity and social adjustment of adolescents: How (not if) school diversity matters. *Educational Psychologist, 53*(2), 64–77.

Gray, D. L., Hope, E. C., & Matthews, J. S. (2018). Black and belonging at school: A case for interpersonal, instructional, and institutional opportunity structures. *Educational Psychologist, 53*(2), 97–113.

Gray, D. L., McElveen, T. L., Green, B. P., & Bryant, L. H. (2020). Engaging Black and Latinx students through communal learning opportunities: A relevance intervention for middle schoolers in STEM elective classrooms. *Contemporary Educational Psychology, 60*, Article 101833.

Green, T. L. (2015). Places of inequality, places of possibility: Mapping "opportunity in geography" across urban school-communities. *The Urban Review, 47*(4), 717–741.

Greene, B. A. (2015). Measuring cognitive engagement with self-report scales: Reflections from over 20 years of research. *Educational Psychologist, 50*(1), 14–30.

Gutiérrez, K. D., Baquedano-López, P., & Tejeda, C. (1999). Rethinking diversity: Hybridity and hybrid language practices in the third space. *Mind, Culture, and Activity, 6*(4), 286–303.

Hammer, D. (1997). Discovery learning and discovery teaching. *Cognition and Instruction, 15*(4), 485–529.

Haverly, C., Calabrese Barton, A., Schwarz, C. V., & Braaten, M. (2020). "Making space": How novice teachers create opportunities for equitable sense-making in elementary science. *Journal of Teacher Education, 71*(1), 63–79.

Hayes, K. N., & Trexler, C. J. (2016). Testing predictors of instructional practice in elementary science education: The significant role of accountability. *Science Education, 100*(2), 266–289.

Heck, R. H., & Thomas, S. L. (2015). *An introduction to multilevel modeling techniques: MLM and SEM approaches using Mplus* (3rd ed.). Routledge. 10.4324/9781315746494.

Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and achievement in problem-based and inquiry learning: a response to Kirschner, Sweller, and Clark. *Educational Psychologist*, *42*(2), 99-107.

Hilpert, J. C., & Marchand, G. C. (2018). Complex systems research in educational psychology: Aligning theory and method. *Educational Psychologist, 53*(3), 185–202.

Hogan, K., Nastasi, B. K., & Pressley, M. (1999). Discourse patterns and collaborative scientific reasoning in peer and teacher-guided discussions. *Cognition and Instruction, 17*(4), 379–432.

Hollie, S. (2001). Acknowledging the language of African American students: Instructional strategies. *The English Journal, 90*(4), 54–59.

Hu, L. T., & Bentler, P. M. (1998). Fit indices in covariance structure modeling: Sensitivity to under parameterized model misspecification. *Psychological Methods, 3*(4), 424.

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1–55.

Huberman, M., & Miles, M. B. (2002). *The qualitative researcher's companion*. SAGE.

Hudley, A. H. C., & Mallinson, C. (2017). "It's worth our time": A model of culturally and linguistically supportive professional development for K-12 STEM educators. *Cultural Studies of Science Education, 12*(3), 637–660.

Jöreskog, K. G. (1999). *How large can a standardized coefficient be* [Unpublished report]. *Scientific Software International.*

Kaplan, A., Cromley, J., Perez, T., Dai, T., Mara, K., & Balsai, M. (2020). The role of context in educational RCT findings: A call to redefine "Evidence-based practice". *Educational Researcher, 49*(4), 285–288.

Keith, T. Z. (2019). *Multiple regression and beyond: An introduction to multiple regression and structural equation modeling* (3rd ed.). Routledge. 10.4324/9781315162348.

Kim, K. H. (2005). The relation among fit indexes, power, and sample size in structural equation modeling. *Structural Equation Modeling, 12*(3), 368–390.

Kline, R. B. (2015). *Principles and practice of structural equation modeling.* Guilford Publications.

Ko, M. L. M., & Krist, C. (2019). Opening up curricula to redistribute epistemic agency: A framework for supporting science teaching. *Science Education, 103*(4), 979–1010.

Kumar, R., Karabenick, S. A., Warnke, J. H., Hany, S., & Seay, N. (2019). Culturally inclusive and responsive curricular learning environments (CIRCLEs): An exploratory sequential mixed-methods approach. *Contemporary Educational Psychology, 57*, 87–105.

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal, 32*(3), 465–491.

Lawson, M. A., & Lawson, H. A. (2013). New conceptual frameworks for student engagement research, policy, and practice. *Review of Educational Research, 83*(3), 432–479.

Lee, C. D. (1993). *Signifying as a scaffold for literary interpretation: The pedagogical implications of an African American discourse genre*. National Council of Teachers of English.

Lee, C. S., Hayes, K. N., Seitz, J. C., DiStefano, R., & O'Connor, D. (2016). Examining motivational structures that differentially predict engagement and achievement in middle school science. *International Journal of Science Education, 38*(2), 192–215.

Lee, O., & Luykx, A. (2007). Science education and student diversity: Race/ethnicity, language, culture, and socioeconomic status. In S. K. Abell, & N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 171–197). Routledge.

Lemke, J. L. (1990). *Talking science: Language, learning, and values*. Ablex Publishing Corporation.

Lemke, J. L. (2004). The literacies of science. In I. E. W. Saul (Ed.), *Crossing borders in literacy and science instruction: Perspectives on Theory and Practice* (pp. 33–47). International Reading Association/National Science Teachers Association.

Lewis, C., Perry, R., & Murata, A. (2006). How should research contribute to instructional improvement? The case of lesson study. *Educational Researcher, 35*(3), 3–14.

Linnenbrink-Garcia, L., Rogat, T. K., & Koskey, K. L. (2011). Affect and engagement during small group instruction. *Contemporary Educational Psychology, 36*(1), 13–24.

Lombardi, D., Bailey, J. M., Bickel, E. S., & Burrell, S. (2018). Scaffolding scientific thinking: Students' evaluations and judgments during Earth science knowledge construction. *Contemporary Educational Psychology, 54*, 184–198. https://doi.org/10.1016/j.cedpsych.2018.06.008

Maltese, A. V., & Tai, R. H. (2011). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among US students. *Science Education, 95*(5), 877–907.

Manz, E., & Renga, I. P. (2017). Understanding how teachers guide evidence construction conversations. *Science Education, 101*(4), 584–615.

Martinez, D. C. (2017). Emerging critical meta-awareness among Black and Latina/o youth during corrective feedback practices in urban English language arts classrooms. *Urban Education, 52*(5), 637–666.

Matthews, J. S., & López, F. (2019). Speaking their language: The role of cultural content integration and heritage language for academic achievement among Latino children. *Contemporary Educational Psychology, 57*, 72–86.

Matthews, J. S., & López, F. (2020). Race-reimaging educational psychology research: Investigating constructs through the lens of race and culture. *Contemporary Educational Psychology, 61*, Article 101878. https://doi.org/10.1016/j.cedpsych.2020.101878

McCrudden, M. T., & Marchand, G. (2020). Multilevel mixed methods research and educational psychology. *Educational Psychologist, 55*(4), 197–207.

McNeill, K. L., & Pimentel, D. S. (2010). Scientific discourse in three urban classrooms: The role of the teacher in engaging high school students in argumentation. *Science Education, 94*(2), 203–229.
Mehan, H. (1979). *Learning lessons: Social organization in the classroom*. Harvard University Press.
Midgley, C., Maehr, M. L., Hruda, L. Z., Anderman, E., Anderman, L., Freeman, K. E., et al. (2000). *Manual for the patterns of adaptive learning scales*. University of Michigan.
Miller, E., Manz, E., Russ, R., Stroupe, D., & Berland, L. (2018). Addressing the epistemic elephant in the room: Epistemic agency and the next generation science standards. *Journal of Research in Science Teaching, 55*(7), 1053–1075.
Milner, H. R. (2015). *Rac(e)ing to class: Confronting poverty and race in schools and classrooms*. Harvard Education Press.
Moje, E. B., Collazo, T., Carrillo, R., & Marx, R. W. (2001). "Maestro, what is 'quality'?": Language, literacy, and discourse in project-based science. *Journal of Research in Science Teaching, 38*(4), 469–498.
Moje, E. B., Ciechanowski, K. M., Kramer, K., Ellis, L., Carrillo, R., & Collazo, T. (2004). Working toward third space in content area literacy: An examination of everyday funds of knowledge and discourse. *Reading Research Quarterly, 39*(1), 38–70.
Moll, L. C., Amanti, C., Neff, D., & Gonzalez, N. (1992). Funds of knowledge for teaching: Using a qualitative approach to connect homes and classrooms. *Theory Into Practice, 31*(2), 132–141.
Morin, A. J., Boudrias, J. S., Marsh, H. W., McInerney, D. M., Dagenais-Desmarais, V., Madore, I., et al. (2017). Complementary variable-and person-centered approaches to the dimensionality of psychometric constructs: Application to psychological wellbeing at work. *Journal of Business and Psychology, 32*(4), 395–419.
Morgan, P. L., Farkas, G., Hillemeier, M. M., & Maczuga, S. (2016). Science achievement gaps begin very early, persist, and are largely explained by modifiable factors. *Educational Researcher, 45*(1), 18–35. https://doi.org/10.3102/0013189X16633182
Murphy, P. K., Greene, J. A., Allen, E., Baszczewski, S., Swearingen, A., Wei, L., et al. (2018). Fostering high school students' conceptual understanding and argumentation performance in science through Quality Talk discussions. *Science Education, 102*(6), 1239–1264.
Muthén, L. K., & Muthén, B. (1998-2017). *Mplus user's guide: Statistical analysis with latent variables, user's guide.* Muthén & Muthén.
National Research Council (NRC). (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. National Academies Press.
NGSS Lead States. (2013). *Next generation science standards: For states, by states*. National Academies Press. 10.17226/18290.
Nilep, C. (2006). "Code switching" in sociocultural linguistics. *Colorado research in linguistics, 19.* 10.25810/hnq4-jv62.
Nolen, S. B. (2020). A situative turn in the conversation on motivation theories. *Contemporary Educational Psychology, 101866*. https://doi.org/10.1016/j.cedpsych.2020.101866
Patall, E. A., Steingut, R. R., Vasquez, A. C., Trimble, S. S., Pituch, K. A., & Freeman, J. L. (2018). Daily autonomy supporting or thwarting and students' motivation and engagement in the high school science classroom. *Journal of Educational Psychology, 110*(2), 269–288. https://doi.org/10.1037/edu0000214
Patall, E. A., Pituch, K. A., Steingut, R. R., Vasquez, A. C., Yates, N., & Kennedy, A. A. (2019). Agency and high school science students' motivation, engagement, and classroom support experiences. *Journal of Applied Developmental Psychology, 62*, 77–92.
Pekrun, R., Elliot, A. J., & Maier, M. A. (2009). Achievement goals and achievement emotions: Testing a model of their joint relations with academic performance. *Journal of Educational Psychology, 101*(1), 115–135. https://doi.org/10.1037/a0013383
Pianta, R. C., Hamre, B. K., & Allen, J. P. (2012). Teacher-student relationships and engagement: Conceptualizing, measuring, and improving the capacity of classroom interactions. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 365-386). Springer. 10.1007/978-1-4614-2018-7_17.
Pintrich, P. R. (2000). An achievement goal theory perspective on issues in motivation terminology, theory, and research. *Contemporary Educational Psychology, 25*(1), 92–104.
Redding, C. (2019). A teacher like me: A review of the effect of student–teacher racial/ethnic matching on teacher perceptions of students and student academic and behavioral outcomes. *Review of Educational Research, 89*(4), 499–535.
Reeve, J. (2012). A self-determination theory perspective on student engagement. In S. Christenson, A. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 149–172). Springer.
Reeve, J. (2013). How students create motivationally supportive learning environments for themselves: The concept of agentic engagement. *Journal of Educational Psychology, 105*(3), 579–595. https://doi.org/10.1037/a0032690
Reeve, J., & Shin, S. H. (2020). How teachers can support students' agentic engagement. *Theory Into Practice, 59*(2), 150–161. https://doi.org/10.1080/00405841.2019.1702451
Renninger, K. A., & Bachrach, J. E. (2015). Studying triggers for interest and engagement using observational methods. *Educational Psychologist, 50*(1), 58–69.
Ricca, B. P., Bowers, N., & Jordan, M. E. (2020). Seeking emergence through temporal analysis of collaborative-group discourse: A complex-systems approach. *The Journal of Experimental Education, 88*(3), 431–447.
Rodriguez, G. M. (2013). Power and agency in education: Exploring the pedagogical dimensions of funds of knowledge. *Review of Research in Education, 37*(1), 87–120.
Rosebery, A. S., Warren, B., & Tucker-Raymond, E. (2016). Developing interpretive power in science teaching. *Journal of Research in Science Teaching, 53*(10), 1571–1600.
Ryu, S., & Lombardi, D. (2015). Coding classroom interactions for collective and individual engagement. *Educational Psychologist, 50*(1), 70–83.
Saldaña, J. (2014). Coding and analysis strategies. *The Oxford Handbook of Qualitative Research*, 581–605.
Sandoval, W. A., & Reiser, B. J. (2004). Explanation-driven inquiry: Integrating conceptual and epistemic scaffolds for scientific inquiry. *Science Education, 88*(3), 345–372.
Sandoval, W. A., Kawasaki, J., & Clark, H. F. (2020). Characterizing science classroom discourse across scales. *Research in Science Education, 51*(1), 35–49. https://doi.org/10.1007/s11165-020-09953-7
Schmidt, J. A., Kafkas, S. S., Maier, K. S., Shumow, L., & Kackar-Cam, H. Z. (2019). Why are we learning this? Using mixed methods to understand teachers' relevance statements and how they shape middle school students' perceptions of science utility. *Contemporary Educational Psychology, 57*, 9–31.
Schult, J., & Sparfeldt, J. R. (2016). Do non-g factors of cognitive ability tests align with specific academic achievements? A combined bifactor modeling approach. *Intelligence, 59*, 96–102.
Sinatra, G. M., Heddy, B. C., & Lombardi, D. (2015). The challenges of defining and measuring student engagement in science. *Educational Psychologist, 50*(1), 1–13.
Skinner, E., Furrer, C., Marchand, G., & Kindermann, T. (2008). Engagement and disaffection in the classroom: Part of a larger motivational dynamic? *Journal of Educational Psychology, 100*(4), 765–781. https://doi.org/10.1037/a0012840
Smitherman, G. (1986). *Talkin and Testifyin: The Language of Black America*. Wayne State University Press.
Stroupe, D. (2014). Examining classroom science practice communities: How teachers and students negotiate epistemic agency and learn science-as-practice. *Science Education, 98*(3), 487–516.
Tan, E., & Calabrese Barton, A. (2010). Transforming science learning and student participation in sixth grade science: A case study of a low-income, urban, racial minority classroom. *Equity & Excellence in Education, 43*(1), 38–55.
Thompson, J. (2014). Engaging girls' sociohistorical identities in science. *Journal of the Learning Sciences, 23*(3), 392–446. https://doi.org/10.1080/10508406.2014.888351
Varelas, M., Becker, J., Luster, B., & Wenzel, S. (2002). When genres meet: Inquiry into a sixth-grade urban science class. *Journal of Research in Science Teaching, 39*(7), 579–605.
Vygotsky, L. S. (1986). *Thought and language* (Revised ed.). Massachusetts Institute of Technology.
Wang, M. T., & Eccles, J. S. (2012). Social support matters: Longitudinal effects of social support on three dimensions of school engagement from middle to high school. *Child Development, 83*(3), 877–895.
Wang, M. T., Fredricks, J. A., Ye, F., Hofkens, T. L., & Linn, J. S. (2016). The math and science engagement scales: Scale development, validation, and psychometric properties. *Learning and Instruction, 43*, 16–26.
Welsh, R. O., & Swain, W. A. (2020). (Re) Defining urban education: A conceptual review and empirical exploration of the definition of urban education. *Educational Researcher, 49*(2), 90–100.
Wigfield, A., & Koenka, A. C. (2020). Where do we go from here in academic motivation theory and research? Some reflections and recommendations for future work. *Contemporary Educational Psychology, 61*, Article 101872. https://doi.org/10.1016/j.cedpsych.2020.101872
Windschitl, M. (2002). Framing constructivism in practice as the negotiation of dilemmas: An analysis of the conceptual, pedagogical, cultural, and political challenges facing teachers. *Review of Educational Research, 72*(2), 131–175.
Windschitl, M. (2019). Disciplinary literacy versus doing school. *Journal of Adolescent & Adult Literacy, 63*(1), 7–13.
Xie, K., Heddy, B. C., & Vongkulluksn, V. W. (2019). Examining engagement in context using experience-sampling method with mobile technology. *Contemporary Educational Psychology, 59*, Article 101788. https://doi.org/10.1016/j.cedpsych.2019.101788
Xu, D., Solanki, S., McPartlan, P., & Sato, B. (2018). EASEing students into college: The impact of multidimensional support for underprepared students. *Educational Researcher, 47*(7), 435–450.
Zumbrunn, S., McKim, C., Buhs, E., & Hawley, L. R. (2014). Support, belonging, motivation, and engagement in the college classroom: A mixed-method study. *Instructional Science, 42*(5), 661–684. https://doi.org/10.1007/s11251-014-9310-0