MIDDLE SCHOOL STUDENTS' CONCEPTUALIZATION OF SCIENCE CLASSROOM BELONGING BETWEEN CURRICULAR CONTEXTS

by

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A Thesis

Submitted to the Faculty of Purdue University

In Partial Fulfillment of the Requirements for the degree of

Master of Science in Education

Department of Educational Studies

West Lafayette, Indiana

May 2019

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ACKNOWLEDGMENTS

This research was supported in part by the Spencer Foundation, Grant #10010522, to Principal Investigator Toni Kempler Rogat, Teaching, Learning, and Instructional Resources - 2016

Thank you to the research team who assisted in collecting the data used for this thesis: Dr. Toni Kempler Rogat, Dr. Karlyn Adams-Wiggins, Dongyao Tan, and Zachary Birch.

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TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

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Degree Received: May 2019
Title: Middle School Students' Conceptualization of Science Classroom Belonging Between Curricular Contexts.
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The purpose of this study was to examine belonging at classroom and academic domain levels, extending research that has primarily investigated general school and classroom-level belonging. This examination accounts for the context-specific, instructional, and domain experiences of students' belonging. More specifically, the goals of the research were to investigate the relations between belonging in science class with engagement, and to contrast students' perspectives of science classroom belonging in traditional compared to inquiry curricular contexts. Middle school students from traditional and inquiry science contexts completed self-reported measures of science classroom belonging and science engagement. Semi-structured interviews were conducted to evaluate students' experiences of belonging in science class. Science classroom belonging was correlated with science engagement, with students from inquiry contexts reporting higher belonging and engagement quality. In both contexts, students reported common social, academic and contextual sources of belonging, with additional emphasis on content-based and interpersonal interactions. In comparing justifications between contexts on the role of competence for experienced belonging, students in traditional contexts reflected on self-focused, intrapersonal competence, while students in inquiry contexts reflected on interpersonal forms of competence. Students' differentiated reports and conceptualization of belonging were related to contextual supports for involvement in authentic disciplinary practice and peer responsiveness.

Keywords: science inquiry, autonomy, science engagement, interpersonal

INTRODUCTION

Despite the United States' historical prominence in science, fewer individuals are entering the STEM workforce resulting in a need for additional STEM graduates (PCAST, 2012). However, before entering college, students' intentions to persist in science decreases, primarily during the middle school years (Archer et al., 2013; DeWitt et al., 2011; Vedder-Weiss & Fortus, 2011). In addition, science interest alone may not be sufficient to facilitate a desire to pursue science in the future (Bennett & Hogarth, 2009; Caleon & Subramaniam, 2008; Jenkins & Nelson, 2005). Instead, feeling included by peers and teachers in one's science classroom (i.e., science belonging) may provide critical motivational supports, encouraging students to meaningfully engage in science (Patrick, Ryan, & Kaplan, 2007; Roeser, Midgley, & Urdan, 1996).

Researchers have differentiated belonging at school and classroom levels with interpersonal and academic reasons as key sources of belonging. This research demonstrates positive relations between belonging and student achievement motivation and engagement (Patrick et al., 2007; Roeser et al., 1996; Walker & Greene, 2009). However, this research has maintained a focus on belonging in general, with limited consideration of belonging in an academic domain, such as science or science class. Examining belonging at the classroom and domain levels introduces a specific context with opportunities to experience specific teacher or instructional supports for belonging (e.g., task and participation structures; classroom climate) and/or domain membership, in this case, science class. Thus, students' experiences of science classroom belonging may influence their sustained motivation and high-quality science engagement, with implications for longer-term outcomes, such as intentions to sustain participation in the field of science. Additionally, unlike the co- and extra-curricular interactions

at the school-level, classrooms introduce practices and interactions unique to learning and curricular engagement. Finally, research has yet to examine the influence of curricular reforms, such as inquiry practices, on students' sense of belonging. Given the limited research on curricular contexts and domain-specific classroom belonging there is a need to give voice to students' own experiences and rationales for belonging in these learning contexts.

Toward this end, the current research used interviews and self-report surveys to investigate middle school students' science engagement and classroom belonging. It is hypothesized that positive relations between belonging and engagement will be sustained when examined at the science classroom level. Additionally, students will reference more classroom, curricular, and science specific reasons for belonging, expanding the field's understanding of how students experience classroom belonging.

Belonging

Sense of belonging is a basic psychological need to be accepted by the people in one's environment (Baumeister & Leary, 1995; Goodenow, 1993b). Typically considered a social dimension, belonging captures an individual's interpersonal relationships. In educational settings, belonging is a student's perception of how they fit into a school (i.e., school belonging) or classroom (i.e., classroom belonging) (Anderman & Freeman, 2004; Goodenow, 1993b, 1993a). When students experience belonging within their educational environments, they report greater motivation and engagement (Good, Rattan, & Dweck, 2012; Patrick, Kaplan, & Ryan, 2011; Roeser et al., 1996).

Belonging at the school level is related to several beneficial outcomes, including students' motivational beliefs, such as self-efficacy (Freeman, Anderman, & Jensen, 2007; Walker & Greene, 2009), task value (Anderman, 2003), and mastery goal endorsement

(Anderman & Anderman, 1999; Walker & Greene, 2009), that predict academic performance (Anderman & Anderman, 1999; Freeman et al., 2007; Wallace, Ye, McHugh, & Chhuon, 2012). Additionally, school belonging is related to student engagement ranging from involvement in school (Astin, 1999; Finn, 1989) to engaging in academic tasks (Finn, 1989; Voelkl, 1997).

Researchers have also investigated students' sources of their school belonging using interviews. Findings from qualitative research on school belonging identify two main categories of students' differentiations of belonging: interpersonal and academic forms of belonging. Interpersonal forms of belonging captures interactions between a student and individuals in the school. Academic forms of belonging capture perceptions of the rigor, shared values, support, and opportunities provided by the school (Green, Emery, Sanders, & Anderman, 2016; Nichols, 2008). Nichols (2008) examined the impact of a transition between schools on middle school students' sense of belonging. Thematic analyses from the belonging interviews identified students' reported *Location of Belonging,* which included interpersonal (friends, adults, mixed), school level (amenities, size), and learning and academic variables (academic performance, support). Additionally, Green, Emery, Sanders, and Anderman (2016) examined middle and high school students' sense of belonging in their STEM schools using semi-structured interviews. Similarly, their findings highlighted the distinction students made between *social belonging,* attributed to interpersonal relationships with peers and teachers, and *academic belonging,* attributed to an alignment with students' academic needs (e.g. rigor of class offerings, shared academic interests). These qualitative studies on school belonging help conceptualize students' distinction of interpersonal and academic reasons for belonging.

Classroom belonging

Belonging has also been examined related to classrooms. Goodenow (1993) defined classroom belonging as:

> Students' sense of being accepted, valued, included, and encouraged by others (teacher and peers) in the academic classroom setting and of feeling oneself to be an important part of the life and activity of the class. [Extending beyond] liking or warmth, classroom belonging involves support and respect for personal autonomy and for the student as an individual (p. 80).

Classroom belonging influences students' expectancy of success (Goodenow, 1993a), self-efficacy (Zumbrunn, McKim, Buhs, & Hawley, 2014), intrinsic value (Freeman et al., 2007; Goodenow, 1993a; Zumbrunn et al., 2014), and academic performance (Goodenow, 1993a; Zumbrunn et al., 2014).

A benefit of examining belonging at the classroom level is the shift in class offerings during adolescence. In American education systems, classroom belonging becomes more differentiated during the adolescent years due to the shift from enrollment in one elementary classroom to classrooms varied by subject (Goodenow, 1993a; Midgely, Middleton, Gheen, & Kumar, 2002). From this time forward, adolescents' perception of classroom belonging is likely to fluctuate between classes because classrooms may depict varied academic, social, and motivational contexts (Goodenow, 1993a) . With the increase in subjects of classes an adolescent can report belonging to, assessing the intersection of students' classroom belonging with the subject of the classroom is crucial beginning in the middle levels.

Although researchers have yet to examine middle school students' conceptualization of classroom and domain belonging, research has been conducted with college students' sense of

classroom belonging. For example, Zumbrunn, McKim, Buhs, and Hawley (2014) examined how college students' perceptions of support and belonging within their educational psychology class related to their motivation, engagement, and achievement. Students attributed their belonging to interpersonal relationships, primarily with classmates but also with their instructors. Specifically, students attributed belonging to feelings of being valued (e.g., acknowledgement of effort and competence), respected (e.g., acceptance), similar to (e.g., shared thoughts and opinions), and comfortable with peers (e.g., due to nice classmates). Similarly, in reference to instructors, students attributed belonging to instructors' investment in (e.g., willingness to work with student), respect for (e.g., attentive listening), tone setting (e.g., playing music), availability (e.g., office hours), approachability, and encouragement of group interaction. Students also spoke of placing a similar value on the course and the teacher education program as their peers. Students with lower self-reported belonging also mentioned academic differences and dissimilar task value as a reason for their lack of belonging, such as a lack of responsiveness and not being a teacher education major, respectively. For all students, their sense of classroom belonging was attributed to their interpersonal feeling of acceptance and support by classmates and instructors.

Research on classroom belonging has seldom isolated the role of domain-specific belonging (see Goodenow, 1993a and Good et al., 2012 for exceptions). As mentioned above, Zumbrunn et. al. (2014) examined college students' sense of belonging in an educational psychology class. Although their examination of belonging was at the classroom level, the affordances of the educational psychology course subject and curricular features for students' belonging was not a variable in the study. While the authors reported students' *general* classroom belonging, there remained an opportunity to specify the disciplinary affordances that may have facilitated students' *educational psychology* belonging.

Closely related to domain-specific classroom belonging is a newer construct of belonging to an academic domain. Belonging to an academic domain involves, “one’s personal belief that one is an accepted member of an academic community whose presence and contributions are valued” (p. 701, (Good et al., 2012). Although not restricted to a specific classroom, Good, Rattan, and Dweck (2012) measured math belonging, taking up previous calls to examine the influence of a specific subject or domain on students’ sense of belonging (Goodenow, 1993a). The present study extends previous research on classroom belonging (Zumbrunn et al., 2014) and sense of academic belonging (Good et al., 2012) by accounting for the disciplinary affordances and middle school students’ voiced justifications of science classroom belonging.

Influence of Science Curricular Contexts

Examining classroom belonging in a specific subject (science) presents an opportunity to extend and further specify the classroom belonging construct by accounting for the specific content and disciplinary practices of science. In particular, when comparing belonging experienced in traditional classrooms to those in which inquiry practices are more central, additional academic sources may be available.

Traditional science instruction is influenced by science reforms of the early 21st century. Learning goals in traditional contexts tend to focus on acquiring science content knowledge and participating in science activities. In most traditional contexts, the teacher provides content knowledge to students, who then apply their acquired knowledge during science experimentation and activities, with a primary focus on following procedures (National Research Council, 2007b).

Recent advancements in science education focus on using empirical study and evidence to reform science learning. In particular, science education researchers recommend inquiry-based

science approaches to learning in line with current reform efforts (Krajcik et al., 1998; National Research Council, 2007b; NGSS Lead States, 2013), with some features having potential implications for experiencing belonging. Inquiry-based science instruction forefronts students' firsthand experiences of science and often includes the incorporation of collaborative inquiry through pair, group, and whole class work. This recommendation for collaboration has relevance for the interpersonal sources of belonging due to the increased opportunities to interact with and experience membership with the individuals in one's classroom. Further, inquiry-based science integrates the practice of argumentation, which provides support for collaboration through the discussion of scientific evidence using evidence-based rationales (Lead States, 2013). When students learn to engage in effective argumentation where they support their claims with evidence, as is characteristic of inquiry instruction, students may sense increased belonging due to a feeling that their ideas are valued and respected by their classmates. Both collective inquiry and argumentation are unique affordances of classes integrating inquiry practices, where students are accountable for knowledge construction. Here, what distinguishes inquiry instruction is the integration of reform-based instructional practices. Despite strong theoretical support for inquiry practices, implementation varies due to enactment challenges (Furtak & Kunter, 2012; NRC, 2012). The variance in implementation of inquiry practices is what supports a continuum of curricular contexts opposed to a clear dichotomy between all traditional and all inquiry contexts. Nevertheless, the heightened student agency afforded within inquiry classroom contexts have potential for enriching students' science classroom belonging due to the increased opportunities for social interaction about science content.

Engagement

Contextualizing belonging to science and science instructional contexts may provide benefits for students' engagement in science. Engagement is a multi-faceted construct encompassing behavioral, cognitive, emotional, and social dimensions characterizing students' learning experiences (Fredricks, Blumenfeld, & Paris, 2004; Fredricks, Wang, et al., 2016). *Behavioral engagement* is students' participation while learning. Examples range from simple forms, such as paying attention, completing school work, and following written and unwritten classroom rules, to more invested forms, such as participating in class discussions, expending effort, and persisting through challenge (Finn & Zimmer, 2012). *Emotional engagement* refers to students' reactions, both positive and negative, to the classroom environment. This includes students' affective reactions to teachers, classmates and academic activities. *Cognitive engagement* captures students' thoughtful and effortful investment in comprehending complex ideas and mastering difficult skills. This can include making connections and applications between differing types of knowledge to more metacognitive forms such as planning and monitoring learning.

The social relationship and community focus of belonging warrants the examination of an interpersonal dimension of engagement. Engagement researchers have recently extended the engagement construct to include a social dimension (Finn & Zimmer, 2012; Linnenbrink-Garcia, Rogat, & Koskey, 2011). *Social engagement* is students' interactions with peers, which includes prosocial behaviors and the quality of interactions with peers during instruction (Finn & Zimmer, 2012; Fredricks, Wang, et al., 2016; Linnenbrink-Garcia et al., 2011). Examples include sharing ideas and materials, helping (giving and receiving), building on others' ideas, and discussion (see also Rimm-Kaufman, Baroody, Larsen, Curby, & Abry, 2015).

Researchers seeking to address the leaky STEM pipeline often see engagement as a viable construct due to its malleability in response to context, which makes it a prime target for interventions (Appleton, Christenson, & Furlong, 2008; Fredricks, Filsecker, & Lawson, 2016). Additionally, engagement is linked to a number of beneficial learning outcomes, including academic achievement (Furrer & Skinner, 2003) and in-depth learning (Nystrand & Gamoran, 1991). By identifying robust predictors of engagement, researchers and educators can target interventions to enhance students' science engagement.

Current study

The purpose of this study was to examine middle school students' science classroom belonging and engagement. The call to increase middle school-aged students' intent to pursue science careers can be informed by an exploration of the role of belonging for students' science engagement. Although previous research has highlighted the benefits of belonging for motivation and engagement outcomes, this research has focused on the school level with few studies focused on the role of belonging in a specific classroom's domain context (i.e., science class). Thus, the current study aimed to extend classroom belonging literature by elaborating students' experiences of belonging in a subject-specific classroom (Goodenow, 1993a, 1993b). In doing so, students' sources of belonging can be further differentiated as contextualized in specific classrooms and subjects. The current study also explored how the contrasting curriculum features from traditional relative to inquiry science classrooms may differentially relate to fostering belonging. Toward this end, interviews were conducted with middle school students in both traditional and inquiry classrooms regarding their voiced experiences and sources of belonging.

Given the extension to a new context (middle school science classrooms), the aim was to first confirm the relations between belonging and engagement outcomes established in past

research which involved administering self-report surveys to middle school students. Prior research shows that belonging predicts behavioral and emotional engagement (Furrer & Skinner, 2003), therefore, it was hypothesized that belonging would be related to all four dimensions of engagement (behavioral, cognitive, emotional, and social). Taken together, the current study will address the following research questions:

Research Question 1. To what locations and justifications do middle school students attribute their science classroom belonging?

Research Question 2. How does the instructional context (i.e., inquiry versus traditional) relate to students' experiences of science classroom belonging?

Research question 3. Is middle school students' self-reported science classroom belonging related to science engagement?

METHODS

This study used a mixed methods approach to understand middle school students' sense of classroom belonging and its relationship with science engagement. Quantitative methodology included student surveys and qualitative methodology included coding and analysis of interviews. This study is part of a larger study exploring students' conceptualization of personal mastery goals.

Participants and Context

Participants included 309 middle school students in seventh grade from five science teachers' classrooms in the United States. All but one of the schools were predominately White with similar representation of male and female students (see Table 1). Classrooms selected include two traditional classrooms in two midwestern schools and three inquiry classrooms in two eastern schools. Five teachers (2 traditional teachers, 3 inquiry teachers) and their students with consent participated in the study. Of the 309 students who completed surveys, 75 were interviewed; however, audio recordings were only retained for 73 interviews for this study (n = 29 traditional classrooms, n = 44 inquiry classrooms).

Curricular context

Traditional teachers were selected from a network of middle school science teachers in the midwestern United States. Traditional teachers had participated in professional development related to integrating experiences with phenomena, while continuing to draw on science texts and curricular materials provided by their school districts. Instruction characteristic of traditional classrooms consisted of students completing experiments and assignments as aligned with

teacher models and instruction. Classroom observations confirmed that traditional instruction focused on students' recall and rehearsal of science content, with less emphasis on student explanation or developing science skills. Inquiry teachers were identified based on their previous completion of a professional development opportunity on inquiry instruction. As part of a previous research project, inquiry teachers had participated in provided professional development with accompanying access to inquiry curriculum aimed at encouraging students' participation in scientific reasoning by developing explanatory models and participating in argumentation practices. Teachers from inquiry contexts facilitated lessons contextualized in authentic problems, with lessons emphasizing students' explanation of key unit concepts and revision based on evidence.

Measures

Survey

Participants completed a survey packet measuring their classroom belonging (Goodenow, 1993b) and science engagement (Fredricks, Wang, et al., 2016) (see Appendix A for items). All items were rated on a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

***Classroom belonging*.** Goodenow's (1993b) 18-item Psychological Sense of School Membership scale was used to measure students' belonging ratings. Classroom belonging, as captured in this scale, involved feeling included, valued, and respected in one's school. Given the current aim of examining belonging in science class, the scale was adapted to measure students' sense of *science classroom* belonging (e.g. I feel like a real part of this class.). Additionally, items that referred to general teachers/staff in the school were removed as the focus of this study was on how students perceive their classroom. Thus, the final scale included six items (α = .81).

Science Engagement. A survey on math and science engagement (Fredricks, Wang, et al., 2016) was adapted to measure students' science engagement. It contained 20 items measuring four dimensions of engagement: behavioral, cognitive, emotional, and social. Each subscale contained five items. Items were adapted to capture students' *science engagement* (e.g., I look forward to science class).

The behavioral engagement subscale measured effort, persistence, and on-task activity when participating in science. Examples of items include "I put effort into learning science" and "I do other things when I am supposed to be paying attention" (reverse coded). The emotional engagement subscale measured positive and negative affect towards science class. Examples of items include "I enjoy learning new things in science class" and "I often feel frustrated in science class" (reverse coded). The cognitive engagement subscale measured students' investment in learning and use of metacognitive strategies. Examples of items include "I try to understand my mistakes when I get something wrong" and "When work is hard, I only study the easy parts" (reverse coded). The social engagement subscale measured students' interactions with peers in science class. Examples of items include "I try to work with other classmates who can help me in science" and "When working with others, I don't share my ideas" (reverse coded). The four engagement subscales were combined to form a single science engagement scale (α = .87), effectively measuring science engagement as a meta-construct (Fredricks, Wang, et al., 2016).

Interview

A semi-structured interview protocol elicited students' perceptions of their science classroom belonging. The questions developed for this study solicit specific examples, experiences of inclusion, and sources of science belonging (see Appendix B for interview

protocol). The science classroom belonging interview was part of a larger study evaluating students' situated conceptualizations of mastery goals.

Procedures

Consent and assent documents were distributed to all students in classrooms of the teachers who volunteered to participate in the study. Students who returned both forms received an incentive (e.g. pencil, prepackaged pastry, etc.). During selected class periods, all students who provided consent and assent completed the survey items. A researcher read each item aloud and students marked ratings on their survey packet. Survey completion took approximately 25-minutes.

As part of the procedures of the larger study, interviewed students were purposefully sampled based on percentile splits (top, middle, and lowest 33% of ratings) of self-reported achievement goals, by class period, to identify students endorsing low, moderate, and high mastery and performance goal endorsement (see Table 2). Teachers also recommended students who were talkative or would feel more comfortable talking with the research team. Interviewees were audio recorded in a private room in the school where interviews were being conducted concurrently by the project team. Each interview was approximately 30-minutes in duration. Of the 75 students interviewed, audio-recording was unavailable for two interviews. Thus, a total of 73 interviews were transcribed and analyzed.

Data Analysis

Quantitative analysis

Descriptive statistics via SPSS were used to characterize sample means and standard deviations for science classroom belonging and science engagement. Correlations examined the

relationship between science belonging and engagement for positive relationships, as expected from previous research.

Qualitative codebook development

A coding protocol was developed using both a top-down and bottom-up approach (Ritchie, Spencer, Bryman, & Burgess, 1994). Initially, codes were informed by a theoretical review of belonging. Nichols' (2008) coding scheme for students' sense of school belonging was utilized as the foundation for developing the qualitative coding framework. The primary codes for *Presence of Belonging* (i.e., whether students feel they belong) and *Location of Belonging* (i.e., who students attribute their belonging to) were used for the current study. The current study focused on how *Locations of Belonging* are interrelated, so the original General Location of Belonging subcode was excluded and any one response could receive multiple *Location* codes. The primary codes adapted from Nichols' framework for *Locations* of belonging included interpersonal locations for Peers and Teacher. Further, given the focus on examining belonging at the science classroom level, a final location of Domain was added to capture students' attribution of belonging to science or the science classroom.

Given the aim to differentiate students' Justifications of Belonging (i.e., sources and reasons for belonging), a Justifications coding category was developed drawing from definitions of belonging in previous research. Specifically, primary codes for Community, Pedagogy, and Respect were adapted for use. *Community* captured students' feelings of inclusion, membership, shared values, and the classroom climate. *Pedagogy* included the influence of teacher characteristics for belonging and was expanded to include the hypothesized science classroom influences, such as classroom activities and science disciplinary practices. *Respect* included

treatment toward the reporting student, such as the extent to which classmates or teachers valued them as an individual and appreciated their contributions (see Table 3).

Codebook adaptations. Using a bottom-up approach to analysis, a subset of the interview sample (n = 8) was used to initially assess, develop, and elaborate the coding framework for use within this new context. Although the above coding framework was supported, this process revealed the need for two additional codes relevant to students' report of self-competence. Thus, a Location code for Intrapersonal-Self (i.e., attributing belonging to personal characteristics and self-perceptions) and a Justification code for Competence (i.e, indicators of knowledge) were added (see Table 3). The remaining interviews were coded in Nvivo using the finalized coding framework. Each student's response to an interview prompt was coded as a segment and assigned a relevant code.

Following the primary codes elaboration with this sample, sub-codes were developed for each Justification's primary code based on patterns within the sample's range of responses. For example, a pattern within the Community primary code was a subcode accounting for the role of the Classroom Climate as facilitating belonging, such as personal characteristics of peers/teacher (e.g. nice, supportive), similar goals/motivations with classmates, or freedom to speak without judgement. Although a set of these sub-codes are consistent with belonging definitions employed in previous studies, other subcodes introduce new differentiations. The identification of these novel sub-codes both elaborate the Justifications coding category and serve as a primary finding from analyses of belonging in science classrooms. These new sub-codes are designated in italics in Table 4 and are detailed below:

- **Community-contributing ideas**: Discussing/sharing ideas, working together, distributing work

- **Competence-high self-competence/-efficacy**: Student's perception of their own high knowledge or abilities
- **Competence-low self-competence/-efficacy**: Student's perception of their own low knowledge or abilities
- **Competence-prior knowledge**: Pre-existing knowledge/experience with the topic
- **Competence-similar relative competence**: Student's perception that their competence is similar to their classmates
- **Pedagogy-science practices**: Belonging experienced during or facilitated by the disciplinary practices or activities of science (e.g. argumentation, labs, experiments).
- **Respect-Challenging/Questioning Ideas**: Significance of peers taking time to critique or ask questions about student's contributions

All interview responses (N = 73) were coded using this final coding framework.

Analysis and expansion. Content analysis was used to interpret coded interview responses (Krippendorff, 2013) and occurred in two phases. The initial analytic phase focused on students' reported belonging as aligned or aligned extensions of extant belonging literature. In this analytic phase, a subset of students was purposefully selected from both curricular contexts who rated themselves on the belonging survey as experiencing the lowest (bottom 33% from 0-3.6, n = 29, 15 traditional, 15 inquiry) and highest sense of belonging (top 33% from 4.3-5.0, n = 20, 5 traditional, 15 inquiry). Students were then classified by their curriculum to determine whether differences existed in students' *Justifications* of belonging based on their classroom curriculum structure (n = 20 traditional classroom students, n = 30 inquiry classroom students). Of these 50 students, one student with low belonging ratings from the traditional sample did not

have belonging responses and was excluded. Thus, the total number of students examined in this analysis was 49.

When examining Justifications of Belonging, analyses focused on the alignment or extension of responses with conceptualizations of belonging (see Table 5). Specifically, *aligned* responses were consistent with existing belonging literature given voiced experiences of acceptance, comfort, fit, inclusion, positive affect, respect, support, value, and liking (e.g. friendships, crushes). Belonging researchers acknowledge interpersonal sources of belonging, but these conceptualizations have been constrained by examination in traditional educational contexts or at the school-level (Green, Emery, Sanders, & Anderman, 2016; Nichols, 2008; Zumbrunn et al., 2014). The current study extends this interpersonal nature of belonging with *aligned extensions* that further contextualize interpersonal forms of belonging when examined in inquiry contexts at the classroom level. Additionally, a designation of *no belonging* included students who stated they did not belong in their science classrooms for reasons aligned with literature on experiences of low belonging.

Comparatively, there were also responses that were *misaligned* with extant literature due to their intrapersonal sources and focus on students' own characteristics that made them feel they belonged. Although this intrapersonal source is counter to the fields' conceptualization of belonging, it was included in analyses because students voiced them as contributors to and evidence of their belonging. Each student's responses were rated as aligned, aligned-extension, misaligned, or no belonging. Ratings were mutually inclusive meaning that a student's full response could receive any combination of alignment codes.

The final analytic phase contrasted student-reported belonging to evaluate whether frequency, Justifications of belonging, or alignment differed between curricular contexts (i.e.,

inquiry, traditional). To do this, high-level summaries of the key themes and meanings evidenced in each student's Justifications were generated describing subcodes. The summaries were then organized by instructional context and frequencies were calculated to examine the prevalence of subcodes within each context. Finally, for subcodes that were sufficiently frequent to showcase a meaningful pattern of the sample (n = 5 or more), subcode alignment was examined to determine whether differences in alignment existed between contexts.

RESULTS

Students' reported science belonging and engagement

Quantitative analyses sought to confirm the relationship between students' reports of science classroom belonging and science engagement. Students' science classroom belonging ratings were significantly related to their reported science engagement, $r(302) = 0.46$, $p < .001$. Moreover, students from inquiry contexts reported higher ratings of belonging ($M = 3.91$, $SD = 0.82$) than students from traditional contexts ($M = 3.52$, SD = 0.85), $t(302) = -3.154$, $p < .002$. Similarly, students from inquiry contexts reported significantly higher science engagement ($M = 4.05$, $SD = 0.53$) than students from traditional contexts ($M = 3.59$, $SD = 0.61$), $t(307) = -5.647$, $p < .001$. Students' interview responses may explain the differences in belonging ratings between curricular contexts.

Students' conceptualizations of science classroom belonging

The first aim of the qualitative analyses was to determine to what students attribute their belonging. The primary pattern of responses was grounded in academic reasons (opposed to purely interpersonal reasons), as students experienced belonging related to learning, class activities, and/or course content. Within this larger pattern, the majority of responses reference Peers as a Location. Generally, students spoke of belonging attributed to Peers as supporting a sense of community and respect. Additionally, students spoke of belonging attributed to the teacher ($n = 12$) as being respectful, expressing care for students, validating knowledge or correctness, and instructional moves. A secondary pattern involved students describing interpersonal reasons for belonging without an explicit connection to academic interactions (e.g., being able to make people laugh, having class with their friends). These primary and secondary

patterns of responses suggest that while interpersonal interactions are important, students' sense of science classroom belonging is mostly facilitated by academic interactions, both inter- and intra-personal.

A subset of the sample (8% of the sample, $n = 4$), reported they felt they did not belong (i.e., no belonging). All instances were in reference to Peers and a lack of Community. For example, a student spoke of classmates being "judgmental (S468-T[1])," while another referenced "divisions" based on social or peer hierarchies (S409-I).

Our second research question examined whether students' Justifications for their science classroom belonging varied between curricular settings. Many of the frequent Justifications were consistent between contexts and aligned with belonging literature. However, some aligned responses were extensions due to the disciplinary and classroom affordances.

Alignments

Aligned responses included 10 subcodes: Community-Class Climate, Community-Friendships, Community-Helping, Community-Inclusion, Community-Participation, Community-Positive affect, Pedagogy-Instructional practices, Pedagogy-Teacher Characteristics, Respect-Attentive Listening, and Respect-Valuing Ideas (see Table 5). These responses were consistent with existing belonging literature by referencing feelings of liking, inclusion, class comfort, positive affect, and positive teacher qualities, respectively. As shown in Table 7, aligned responses were similarly frequent in both curricular contexts except Pedagogy-Teacher Characteristics, Respect-Attentive Listening, and Respect-Valuing Ideas. Aligned responses were also all attributed to interpersonal sources (i.e., Teacher, Peers, General).

[1] This notation refers to student identification number and curricular context (T=traditional, I=inquiry). Here, this is Student 468, Traditional context

Community. Students across both curricular contexts attributed their belonging to reasons consistent with the interpersonal focus of extant belonging literature. Although most responses attributed belonging to academic interactions, some responses highlighted the social aspects of the classroom. Specifically, students spoke of belonging due to having friends in their classrooms (Community-Friendships, *n* = 11) and positive affect during class (Community-Positive Affect, *n* = 12). For example, when speaking of *Community-Friendships*, a student responded "[I feel I belong because] I have some very good friends in my science class" (S413-I, line 274[2]). This student felt included knowing they had classes with their friends. Another student reflected on the positive affect experienced in science class, "[I feel I belong] when I make the class laugh… There we are all laughing where it makes the class lovely" (S605-T, lines 323-325). Here, being able to laugh with the class supported this student's sense of belonging in the class. Both examples capture social aspects of students' belonging.

Most students fore fronted academic interactions as reasons for their science classroom belonging. Specifically, students spoke of giving and receiving help (Community-Helping, *n* = 17), feeling included (Community-Inclusion, *n* = 7, e.g. due to invitations to join a group), participating in class (Community-Participation, *n* = 7), working with their peers (Community-Peer work, *n* = 17), and the positive classroom climate (Community-Class Climate, *n* = 10). For example, when asked of a time they felt they belonged, one student spoke of *Community-Helping* as knowing that they can turn to their peers if they needed help:

> I think that's why I belong in there because if I don't get the hang of it, then they'll try to help me out and stuff... When we were with a group and we didn't know how to get [inaudible] delta. I couldn't figure out how to do delta. We asked Jane

[2] This notation refers to student identification number, curricular context (T=traditional, I=inquiry), and lines in the transcript. Here, this is Student 413, inquiry context, excerpt taken from line 300.

> for help, and the Teacher explained it to us. Then if me and [my partner] still didn't understand it, we asked Alice or [inaudible]. They would always help us (S478-T, lines 254-260).

Here, the student highlighted the importance of knowing the people in their classroom were willing to explain how to calculate delta until they understood.

Community-Inclusion included ways students felt like an integral part of class functioning. For example, one student spoke of inclusion as "When sometimes I don't want to work by myself, a group comes up and ask me if I like to work with them and I usually say yes" (also Community-Peer work[3], S520-T, lines 300-301). This student shared on the common trend of being invited to join a group as a source for inclusion. Another responded "[I feel included] In the labs… [because] there's a part for every person… [It makes me feel included because] you all have to work together to finish the lab" (S495-T, lines 223-231, also Pedagogy-Science practices). Here, inclusion is described as having responsibilities during science activities.

Students spoke of *Community-Participation* as involvement in class. Passive involvement included references to being on-task. For example, when asked of a time they felt they belonged, one student responded, "When everyone was there at the same time… and focusing on science… It just made me feel really happy to see everyone working on the stuff they needed to work on" (also Community-Positive affect; S646-T, lines 213-217). For this student, seeing classmates working on assigned tasks facilitated belonging. More active forms of involvement included students' reference to raising their hand, being called on, answering questions, and asking questions. For example, one student shared "The fact that our lessons are hands-on, we always

[3] Additional coding applied to the excerpt

get to raise our hand. We get called on. That makes me feel that I'm included and doing something in science class, answering questions" (S636-I, lines 189-191).

Generally, students spoke of *Community-Peer work* as a justification of belonging when they got to work with partners and groupmates on projects. For example, one student shared "I like working in groups because it's fun and we get to work together. I like having people around me. I work better in groups" (S685-I, lines 168-169). Peer work experiences were often accompanied with Community-Contributing ideas (discussed in aligned extensions), Community-Helping, Community-Inclusion, and Respect-Value ideas. For example, a student shared about being included in peer work "[When] the people ask me to be my partner, that made me feel included. When I do work in a group, everyone in the group is helping. I'm waiting where to go" (also Community-Helping; S530-I, lines 230-231). Here, the student shared feeling included when a peer invited them to form a pair. Additionally, the student appreciates classmates helping each other when working in groups. Together, these experiences of being invited to join a group and helpful groupmates explain this student's belonging. Finally, a student shared about the *Community-Classroom Climate*

> Yeah, I feel like everybody belongs. Everybody has an idea whether that idea's wrong or right. Everybody has the freedom to say that idea and speak or ponder the thought. Even if no one likes you, or even if you never get called on, you still belong there because you're still there to learn." (S612-I, lines 175-178).

This student attributed their belonging to a class climate where the goal is to learn and there is no judgement.

Pedagogy-Teacher Characteristics. Although infrequent (n = 4) and limited to inquiry contexts, students attributed belonging to characteristics of their Teacher. For example, when

asked for experiences that made them feel they belonged in science class, a student responded "Just motivation from the teacher… When the teachers push you to do better. It makes me feel I know I can do something" (S479-I, lines 204-208). Here, the student attributed their belonging to their perception of their teacher being motivating and pressing for academic rigor.

Respect. Respect was operationalized here as attentive listening, valuing ideas, and challenging ideas (see aligned extensions). Most of the Respect responses were made by students in inquiry classrooms (n = 16), with fewer responses from traditional classrooms (n = 2). *Respect-Attentive Listening* in inquiry classrooms (n = 3) captured students' belief that their peers or teacher gave their undivided attention when the student was sharing their ideas. For example, when asked to think of a time they felt they belonged, a student responded, "In science class, we always have these discussions before a unit, what we think, what everybody thinks. It felt good because that means everyone is listening to your idea and really thinking about it" (S491-I, lines 292-299, also Pedagogy-Science practices). Here, the student emphasized sensing belonging due to everyone listening to and thinking about their ideas. Similarly, another student shares:

> I feel that I'm included in science class… When people ask questions. If you can ask a question, that means you're actually thinking about it… I'd be like, "OK. You were actually thinking about what I'm saying." That makes me feel good because I know that you care (S501-I, lines 335-342, also Respect-Challenge/Question ideas).

Both students emphasize the importance of students taking time to think about their ideas, with the second student also appreciating follow-up questioning.

Respect-Value Ideas in inquiry classrooms (*n* = 8) conveyed students' perceptions that their contributions were appreciated. For example, when asked of a time they felt they really belonged, one student shared: "One time we were doing a group project… They were taking my ideas for what to do and we were all working together. I would say something and they would think that it was smart and we should use it." (S445-I, lines 235-237, also Competence-High competence/efficacy). Similarly, another student responded, "If I contribute to something and, it's again with the [engineering] designing stuff, you could say, 'This plan works and I helped do it'" (S446-I, lines 216-217). Both students emphasized the importance of belonging due to their contributions being used in a final product.

Aligned classroom-level extensions

While maintaining an interpersonal focus, many responses further elaborated classroom belonging. One such extension relates to students' interpersonal interactions with academic work. This ranged in quality from giving and receiving help (as discussed earlier) to higher-quality forms of contributing ideas (Community-Contributing ideas, *n* = 16). Similar to helping, contributing ideas enabled students to interact with and understand academic content at a deeper level due to their peers' assistance or contributions. For example, when asked what makes them feel included, one student responded, "being able to tell other people my ideas…" (S433-I, lines 243-244). Another student shared about discussing ideas in small groups "[I belong when in small groups because] I feel like I get more say in things. Like yesterday… we did it by ourselves first. Then we shared because everybody had an own opinion and everybody gave ideas" S607-I, lines 247-250). For both students, their belonging was supported by opportunities to share and discuss ideas with others, with the second student reflecting on this experience while in a group. Another student highlighted the ability of contributing ideas as a start to the learning

process, “Whenever someone has a really good idea, and it's the snowball effect, they say something, and then someone else says something. You're technically the root of it, so then you belong.” (S612-I, lines 181-183). Contributing ideas in this instance highlights belonging experienced when collectively constructing knowledge. Although previous literature has spoken of receiving help as facilitating belonging, these responses, and others like them, suggest that students also benefited from and experienced belonging when they were able to contribute ideas in class and in groups. Thus, belonging can be experienced even when students are not experiencing challenge and are simply able to participate in discussions.

Aligned curricular-context extensions

Although the above extensions are unique to examining belonging at the classroom level, additional extensions were unique to the instructional context. Specifically, Respect-Challenge ideas and interpersonal forms of Competence were primarily or exclusively used in inquiry classrooms.

Respect-challenge ideas. *Respect-Challenge Ideas* in inquiry classrooms (n = 5) was often double-coded with Science Practices, as this form of respect was contextualized in the science practice of argumentation (see pedagogical facilitators). *Respect-Challenge Ideas* is operationalized as having peers question or disagree with their ideas. For example, one student shared, “I think that the idea that people are arguing with me… think to feel that I do belong, because people address my point and try to contradict it.” (S621-313-I, lines 313-314). This common trend of contradicting or arguing with one’s ideas shows students’ belief that belonging can also include peers taking the time to disagree with their perspectives and challenge their ideas. In a similar fashion, another student shared:

> While we were building [our engineering design], we had different ideas about a thing and we sort of fought a lot about that. [laughter] It wasn't like an angry fight. It was just like my idea is better… We still understood their ideas but we just didn't like them. [laughs]… We accepted each other's ideas… Then we came up with a compromise. But, if we would have used that [compromise], we would have accepted everyone's ideas. (S707-I, lines 359-388).

This student acknowledges that despite tension and having their ideas challenged, they felt included due to the safe climate and because they were able to reach a compromise.

The above responses related to Community and Respect forefront the interpersonal nature of belonging accepted in the extant literature. However, students' responses extended this interpersonal nature by specifying interactions characteristic of the classroom and of science. Additionally, the Respect responses operationalized what respect means as it related to science classroom belonging.

Competence. Competence captured students' perceptions of their own knowledge or abilities. Students spoke of competence as either similar to or useful for other classmates.

Similar relative competence. A small subsample of students (n = 3) spoke of competence as perceiving their competence to be at the same level as their peers as contributing to their experience of belonging. For example, students spoke of being in the same group as others:

> [I feel I belong in science class] When I feel if the teacher ask a question, and I wrote down the answer that I think it is. Then I feel like other people exactly wrote the same thing. If we all get it wrong, then we'll all be a part of the same group. And if we get it right, then we're all going to be part of the same group… [because I'm in the] same group

> as others. I'd feel I understand more. I'm on the same level where I'm supposed to be at. It's that being behind or forward (S521-T, lines 215-222).

For this student, being where they are "supposed to be at" compared to others' performance facilitated their belonging. Another student reflected on the comfort of knowing others experience challenge, "when you get a bad grade and your friend gets a bad grade too, that sort of makes you like not freak out about it too much... like other people go through it too, sort of" (S623-I, lines 245-248). This student's response suggests that despite getting a bad grade, students can still feel they belong by knowing others struggled on the assignment or test as well.

Interpersonal competence. Although students from both contexts reference High Competence/Efficacy as a Justification for belonging, students from inquiry classrooms tended to sustain an aligned interpersonal focus. For example, when asked to share an experience when they belonged, one student responded:

> If I'm ever chosen to do something in front of the class to show and we're explaining what we're learning… It just feels like I think they would trust me to understand or they want to give me a chance to try to explain it to the class and help me understand it better as well" (S553-I, lines 249-255).

Here, the student views sharing their knowledge as an opportunity to build trust with peers. This response is interpersonal through the focus on a shared opportunity to learn and build community and competence. Similarly, another shared:

> [I feel I belong when] people support each other. I mean if two people who you're not friends with or anything, they ask you a question because they're not sure… When someone is asking me a question, I think they know that maybe I might know it. So, it makes me feel kind of smart and things like they generally they

need help sort of. It makes me feel useful I guess to be able to help someone." (S623-I, lines 255-264).

Here, the student views their competence as "useful" to individuals other than themselves. Using one's self-competence to contribute to class functioning highlights the alignment inquiry students' responses had with existing belonging literature on the interpersonal nature of belonging.

In summary, aligned responses were interpersonal and drew from experiences of community and respect. Extensions of these aligned experiences captured interpersonal interactions that were specific to science or the science classroom (Community-Contributing ideas, -Peerwork, Pedagogy-Science Practices) or further operationalized belonging (Respect, Competence).

Misaligned responses

It was anticipated that examining belonging at the science classroom level would result in extensions of the construct with reference to more contextualized, interpersonal sources of belonging. It was not anticipated, however, that students would voice sources that were intrapersonal and, thus, misaligned with existing literature. The following section details how students in traditional contexts conceptualized Competence-High Competence as an intrapersonal Justification for their belonging.

The previous section evidenced the interpersonal focus of Competence-High Competence responses for students in inquiry classrooms. Inquiry students tended to view their competence as useful to peers and facilitating community knowledge building. When students from traditional classrooms spoke of belonging related to competence, however, responses were typically self-focused, suggesting a lack of alignment with the interpersonal nature of extant belonging

literature. A self-focus means belonging was attributed to a focus on personal characteristics or perceptions, without a relation to others or others' benefit. For example, when asked about a time when they experienced belonging, one student responded "… when no one [else] knew what [the] Teacher was talking about and I just knew what [the] Teacher was talking about" (S495-T, lines 220-221). Here, the student forefronts their own high relative competence as facilitating belonging which is counter to belonging's focus on interacting with others. Further, when another student was asked if they felt included in their science class they responded, "Yes, because I'm really good at it and I'm really smart at it… I'm really good with the experiments" (S599-T, lines 588-589, 201). For these students, knowing the answers and being "good at" science, unrelated to others, facilitated their belonging. This common trend in traditional classrooms forefronts students' own perceived competence, often over or beyond others' competence, as facilitating belonging. This intrapersonal focus is incongruent with the focus of belonging on interpersonal experiences such as membership and inclusion.

Pedagogical facilitators of science classroom belonging

Pedagogical practices captured students' perceptions of their teachers' instruction and of science practices that facilitated their science classroom belonging. Science practices captured activities characteristic of engaging in science.

Instructional practices

Students valued a variety of instructional practices as facilitating their science classroom belonging. These ranged from classroom configurations to acknowledgement of students. In reference to the classroom configuration a student shared that "The teacher does a random generation of seats which is better. No one's been chosen to sit next to certain people, everyone is

just randomly dispersed everywhere" (S413-I, lines 278-279). Students drew on not being singled out in the seating arrangement as evidence of belonging. Other students referenced the ways their teacher acknowledged them, such as being called on and validating their answers. For example, one student shared about the benefit of being called on "whenever the teacher calls on me, knowing everyone else has their hand raised in the class… The Teacher knowing that I know the material, and I help everyone" (also Community-Helping; S530-I, lines 205-209). For this student, being called on was an indicator that the Teacher knew the student had knowledge useful to share with the class. Students in traditional contexts tended to reflect on belonging when the teacher validated their knowledge. For example, one student shares,

> Every time that we raised a hand to answer questions in the class... It makes me feel like I belong there, basically… I love hearing that, when Teacher says, "That's the right answer. Everybody, copy this down." It motivates me so much (S204-T, lines 316-320).

For this student, they valued being told they were correct by the teacher.

Science practices. Students infrequently (n = 5) referenced labs and experiments when sharing science practices that facilitate belonging. For example, one student shared about the benefit of experimentation,

> [A time in science class when I feel I really belong is] When I get to participate in experiments and not just watch from the sideline, I really feel like I'm getting deep into it and that I'm included in the class… [Because] I think it's more just experiencing it myself and not just watching. I can actually include and share my ideas as I do the experiment (S709-I, lines 214-220).

For this student, active engagement during experimentation made them feel they belonged in the science classroom.

The most distinguishing science practice mentioned by students in inquiry classrooms was their reference to the reform-aligned disciplinary practice of argumentation as facilitating belonging. This seemed to be partially supported by the participation structure within their classroom. Argumentation was setup as a class "debate" where the teacher asked the class to take a position on a topic then separate into different sides of the room. Using evidence either provided to them or discovered through experimentation, students argued their position to the opposing side using rationale and justification. During this argumentation or debate process, students could move to the other side of the room if they decide to revise their position. Here, a student describes their classroom debate process and why that encourages belonging:

> Oh, in our group discussions. We'll have people standing on opposite sides of the classroom, because that's what they believe. I love it when you say something and then someone from that side of the room will come to your side of the room. That's the best. That's the best feeling… It made me feel like I belonged because I feel like not only did *I put value to the lesson* but I might have *helped that person with what they were struggling with. Not only knowing that I contributed to the lesson but knowing that I helped someone else along the way*, that's amazing (S682-I, lines 319-334, also Respect-Value ideas and Community-Helping)

For this student the debate process facilitated belonging due to helping peers and having their ideas valued (see italics). Another student shares about the social environment needed for debates to encouraging belonging:

> [A time I feel I really belong in science class is] when we just start a unit we sometimes go on either side of the classroom and we debate about it and why we think our answer's right. It feels like I belong when you say like, "I think this is

> right because this, this and this." Then some people agree and *even if they don't they're not going to bully you about it or anything. When you get to say your opinion, the people who agree with you will support you and the people who don't agree with you, they don't make fun of you about it*. That makes you feel like a part of the class. (S623-I, lines 236-242, also Community-Class climate)

This common trend highlights the disciplinary practice of argumentation unique to inquiry contexts. Additionally, denoted by italics, the student paired debating with a supportive environment where students felt safe to disagree with peers on scientific content.

In summary, across contexts, students primarily attributed their belonging to interpersonal sources with most responses attributed to peers. Although students' responses aligned with existing literature, examining classroom belonging between curricular contexts afforded extensions of the construct to include further contextualizations of respect, competence, and pedagogical practices. Namely, students in inquiry classrooms contextualized how respect and the disciplinary practice of argumentation facilitates belonging. Moreover, it seems respect created the required positive class climate needed for effective argumentation. Further, the detail and affordances of respect evidence richer and higher-quality justifications for belonging. Although students attributed belonging to inclusion and friendships, the rationale behind those justifications were often linked to the respectful responsiveness of peers. These respectful interactions enabled students to experience belonging while engaging in disciplinary practices, such as argumentation and group work. Surprisingly, misalignments with the construct's interpersonal focus were uncovered suggesting that students also experienced belonging due to intrapersonal forms of competence.

DISCUSSION

Previous research examining belonging has established related processes and advantageous outcomes for students' belonging across the K-16 pipeline. The current study aimed to extend this research by examining the domain-specific context of science at the classroom level, as well as contrasting how curriculum features of traditional and inquiry science classrooms differentially related to fostering belonging. This exploration considered whether the relationship between science classroom belonging and science engagement for middle-school aged students was sustained. More substantively, students' own conceptualizations of their sources and experiences of belonging were used.

Students' sources of belonging

Similar to previous research (Green et al., 2016; Nichols, 2008; Zumbrunn et al., 2014) students valued being able to interact with peers and classmates in both social and academic ways. Although substantial research supports the benefit of positive interactions with adults on students' belonging perceptions (Kiefer, Alley, & Ellerbrock, 2015; Murray & Greenberg, 2000; Nichols, 2008; Wallace et al., 2012), current findings suggest that students place significant value on the interactions with classmates for their belonging. Additionally, students in the current study primarily attributed their belonging to academic interactions with peers. Whereas school interactions with peers tend to be social (e.g. sports teams, friendships, etc) (Nichols, 2008), academic forms of belonging predominantly occur in classrooms. Even in the studies where students reflected on academic components of their school belonging, reasons were attributed to general experiences in classrooms (Kiefer et al., 2015; Nichols, 2008). For example, Nichols' (2008) learning and academic dimension captured students' perception of their general

learning and interactions with teachers in classrooms. Thus, it appears that when examined at the classroom level, academic interactions are brought to the forefront of students' conceptualizations of belonging.

As stated previously, much of the existing research on belonging has highlighted the important role adults play in fostering belonging (Green et al., 2016; Nichols, 2008; Wallace et al., 2012). However, only 22% (n = 12) of students attributed belonging to their teacher. Generally, students spoke of belonging attributed to the teacher as being respectful, expressing care for students, validating knowledge or correctness, and instructional moves. Zumbrunn, McKim, Buhs, and Hawley (2014) reported that students seldom mentioned interactions with teachers until prompted. The small percentage of students referencing teachers further supports the notion that students primarily experience classroom belonging due to interactions with their peers. Examining many of the justifications students indicated as belonging from peers shows students referencing respectful responsiveness, a lack of judgement, and a focus on learning that they share with peers. Research on classroom climate suggests that the quality of such peer interactions are explicitly and implicitly fostered by teachers (Patrick et al., 2007). Thus, the scarcity of students' attribution of belonging to teachers may not mean that teachers are less significant contributors to students' sense of classroom belonging. Instead, it may be that students only recognize the outcomes of norms established by teachers as manifested in their interactions with peers.

Social and academic conceptualizations of science classroom belonging

An aim of the current study was to examine how the belonging construct is extended when examined in science classrooms. To examine how students' conceptualizations extended past research, current findings were contrasted with those from research on school and general

belonging (see Table 5). Qualitative examinations of belonging has primarily been at the school level, with students identifying interpersonal (e.g. liking, friendships) and school level variables (e.g. school amenities, course offerings, school pride) as the contributing sources of belonging (Green et al., 2016; Nichols, 2008). By focusing on classroom experiences, students were able to speak of belonging in ways that further elaborate the construct. Similar to past research, friendship (e.g., knowing people, having friends), climate (e.g., nice people), inclusion (e.g., not feeling left out), teacher characteristics (e.g., caring, approachable, available), instructional practices (e.g., encouraging peer work), helping, and respect (e.g., attentive listening, acknowledgement of contributions) have been justifications for belonging (Green et al., 2016; Johnson, 2009; Nichols, 2008; Zumbrunn et al., 2014). In addition to these justifications, students in the current study also spoke of contributing ideas (i.e., being able to share ideas), peer work, and respect as challenging each other's ideas.

Further, compared to previous research where students reference both social and academic forms of belonging, all students in the current study spoke of their belonging in academic ways. Students primarily attributed belonging to content-based, interpersonal interactions such as completing schoolwork with friends, sharing ideas, being invited to work with groups, and engaging in argumentation. Some of students' classroom-level elaborations of belonging were consistent between curricular contexts (contributing ideas, peer-work, helping). This suggests that there are some common instructional practices that teachers in both traditional and inquiry contexts are implementing to facilitate classroom belonging. The commonalities of contributing ideas, peer-work, and helping could also be attributed to these being common instructional practices across contexts and domains. Thus, the prevalence of these interpersonal

experiences suggests that regardless of context and domain, students value opportunities to engage in academic content with peers.

Although respect is often included in conceptualizations and measurement of classroom belonging (Goodenow, 1993a, 1993b; Green et al., 2016; Nichols, 2008; Zumbrunn et al., 2014), current findings extend the belonging construct by providing students' concrete experiences and characterizations of respect that foster classroom belonging. Respect as challenging and questioning ideas was unique to inquiry contexts, primarily attributed the disciplinary practice of argumentation unique to the inquiry context. Nevertheless, it may be beneficial to explore additional participation structures that facilitate a safe platform to challenge and question each other's ideas. More broadly, when students spoke of respect they highlighted a level of responsiveness, both verbal and non-verbal. This view of respect as responsiveness when examined at the classroom level may be a fruitful extension of measuring belonging. Taken together, these social and academic extensions were afforded by the intentional examination of classroom affordances. By understanding how students conceptualize belonging in classrooms, researchers can refine operationalizations and measures of classroom belonging.

Competence as a justification of science classroom belonging

Competence captured students' attribution of belonging to their self-competence/-efficacy. A small subsample of students referenced feeling they were at a similar competency level as peers as a source for belonging. This was interesting because students stated that despite low perceived competence/efficacy they still felt they belonged so long as their peers were performing at a similarly low level. While such a perception may be protective in reference to a single assignment, internalizing this belief by viewing oneself as incompetent or incapable in science could have detrimental implications of students' belonging should they feel they only

belong in science classes for students with low achievement. Despite this representing such a small sample of this dataset, knowing all ways students experience belonging can aid in identifying experiences that may become a detrimental facilitator of belonging and science engagement.

Students in inquiry contexts maintained an interpersonal focus on competence. The interpersonal experience of belonging could be attributed to the autonomy that is characteristic of inquiry instruction (Colley & Windschitl, 2016; Rogat, Witham, & Chinn, 2014). As mentioned previously, teachers utilizing inquiry practices tend to encourage student responsiveness to one another. Additionally, students in the current study experienced belonging when their teachers demonstrated answers to students' questions on the board or shared a students' response with the class. Both of these forms of instruction shift some of the responsibility for learning from the teacher and places it with the student (Furtak & Kunter, 2012; Rogat et al., 2014; Wallace & Sung, 2016). Specifically, encouraging student-student responsiveness and demonstrating a student's answer for the entire class creates an environment where students are expected to share in and hold each other accountable for their learning (Rogat et al., 2014). This may explain why students from inquiry contexts viewed their own competence and abilities as useful to others.

Further, students in inquiry contexts often referenced how their belonging was associated with their participation in science class. For example, students felt they belonged when classmates were inclusive of and responsive to their contributions. This inclusivity and responsiveness facilitated students' sense of science classroom belonging and supported their participation in science class functioning, such as class discussions, peer work, and argumentation. Thus, by identifying disciplinary features that facilitate students' sense of belonging, researchers can begin to understand features that promote disciplinary engagement.

An aim of examining the alignment between students' responses and existing literature was to extend the field's conceptualizations of belonging. However, it was not anticipated that justifications misaligned with the interpersonal nature of belonging would be uncovered. Students from traditional contexts reflected on their competence in intrapersonal, self-focused ways. A self-focus meant belonging was attributed to a focus on personal characteristics or perceptions without a relation to others or others' benefit. In a subset of cases, this forefronted their own high relative competence as facilitating belonging which is counter to belonging's focus on interacting with others. These students felt they belonged when they outperformed other students, evidencing their higher science competence. Other students experienced belonging when they felt highly capable in science class. This intrapersonal focus is incongruent with the focus of belonging on interpersonal experiences such as membership and inclusion.

Although competence has long been included in belonging scales, the focus often remained interpersonal. For example, Goodenow's (1993) Perceived Sense of School Membership scale includes "People here notice when I'm good at something" and "People here know I can do good work." These items focus on other's perception of students' abilities. Students in the current study sample, however, also spoke of competence in self-focused, intrapersonal ways such as being good at science and knowing answers when peers did not. Although belonging maintains an interpersonal focus, it seems students also experience intrapersonal justifications for classroom belonging.

There are several explanations for why students discussed their competence in intrapersonal ways when asked about their classroom belonging for science class. First, students' reference to competence when discussing experiences of belonging could be attributed to the disciplinary focus of the current study. Similar to research by Good et al. (2012), students may

have been reflecting on their *academic belonging*, or their sense of belonging to an academic domain (i.e., science). Although Good et. al. found that college students' sense of academic belonging loaded separately from students' sense of belonging, middle school students may speak of these constructs interchangeably. It may be that despite prompting for belonging in science class, students, instead, reflected on belonging to the domain of science. In line with findings from Good et. al., students may have also viewed feeling competent in science as prerequisite to belonging to the science domain, but not necessarily to the science classroom.

Although academic belonging may explain the importance of competence in students' belonging in science, it does not fully explain why *only* students in traditional classrooms expressed intrapersonal forms of competence. This is interesting because students in both classes had opportunities to focus on their own competencies as a justification for belonging. As previously mentioned, the interpersonal focus of students in inquiry contexts could be attributed to the cognitive-autonomy enhancing features of inquiry curricula. However, in looking at students' responses about teacher interactions from traditional contexts, students situated their belonging in acknowledgement and recognition from the teacher of their correct answers. The instructional practice limiting feedback of correctness to the teacher, opposed to students evaluating their own work, is an indicator of diminished cognitive-autonomy (Furtak & Kunter, 2012). Compared to the cognitive-autonomy supportive practices of teachers in inquiry contexts, it may be that the level of autonomy in traditional contexts also plays a role in students' intrapersonal view of competence.

Inquiry practices support higher science classroom belonging and engagement ratings

Science classroom belonging was positively related to science engagement, confirming previous research supporting classroom belonging's prediction of engagement (Furrer &

Skinner, 2003). Additionally, students from inquiry contexts reported both higher belonging and science engagement ratings than students from traditional contexts. Higher ratings in inquiry contexts suggests that there are differences in students' experiences of science classroom belonging between contexts, thus, validating the focus of this study. Although previous research has yet to examine this relationship directly, it is plausible that reform-based science practices support higher-quality belonging. This is mainly attributable to possible benefits for engagement because these practices encourage students' active engagement in science activities, situated in social interactions (National Research Council, 2007b). Thus, it is possible that students would associate engaging in such social interactions in inquiry contexts to an increased sense of belonging. In particular, the focus of reforms on developing disciplinary skills for science requires students' participation in science practices that are inherently social in nature, such as argumentation, with the intent of increasing student participation in science classroom activities (Kuhn, 2007; Lead States, 2013; National Research Council, 2007b). This focus on increasing student participation in science practices may explain students from inquiry contexts higher ratings of science engagement, especially when considering their behavioral, cognitive, and social engagement. Although the differentiation in belonging ratings between curricular contexts has yet to be observed in previous research, qualitative results shed additional light on the sources and differential experiences of learners.

Participation structures as facilitators for science classroom belonging

As previously mentioned, students referenced a variety of participation structures that facilitated their belonging in science class. These included the teachers' instructional approach, participating in class, doing peer work, and engaging in science practices. While there were common practices between the two curricular contexts, there were also differentiating

experiences for inquiry that may help to explain the higher-quality belonging students reported on survey measures.

Argumentation's support of belonging

The examination of classroom belonging in science and between curricular contexts revealed the science disciplinary practice of argumentation that was unique to inquiry contexts. When speaking of argumentation, students often paired their justifications with respect. Respect captured instances of attentive listening, challenging ideas, and valuing ideas such as through incorporating students' ideas into final products. This suggests that students appreciated the responsiveness of peers.

Another participation structure common in inquiry contexts is the evaluation and development of models (Lead States, 2013; Rogat et al., 2014). During this process, students co-develop the criteria for evaluating models, apply those ratings, and engage in model development and revision (Pluta, Chinn, & Duncan, 2011). Although not mentioned explicitly in the current sample, the responsiveness of the modeling process may be another participation structure that offers additional sources of belonging for students. Additionally, the Next Generation Science Standards (NGSS Lead States, 2013) identify asking questions, modeling, and explanation, among others, as scientific practices that support disciplinary engagement in science.

Alternatively, it may be more than just participation structures that is differentiating inquiry. Instead, it may be that inquiry students are reporting high quality responsiveness. Both argumentation and model evaluation practices forefront interactions between students that could provide the desired responsiveness to facilitate belonging. Additionally, students reflected on the positive class climate during inquiry practices. Although disagreement can create tension (National Research Council, 2007), students referenced the importance of there not being

judgement when others have a different opinion. When enacted as intended, argumentation requires the critique of models and perspectives based on scientific evidence (Colley & Windschitl, 2016; National Research Council, 2007a; Rogat et al., 2014). This creates space to critique peers' perspectives without critiquing their character (i.e. no judgement).

Responsiveness in judgement-free spaces has also been conceptualized as yet another affordance of autonomy-supportive classroom interactions. Previous research examining autonomy-supportive instruction in math classes (Wallace & Sung, 2017) and science contexts (Colley & Windschitl, 2016; Rogat et al., 2014) found teachers' encouragement of peer responsiveness to be a practice that supports students' sense of autonomy. Specifically, this was exhibited through attentive listening and responding respectfully to others' questions and thoughts (Rogat et al., 2014; Wallace & Sung, 2017). In addition to attentive listening, students in the current sample appreciated being able to have their ideas challenged and even change their ideas without it reflecting poorly on their competence or value as a member of their class. Thus, while argumentation and respectful interactions are the experiences students drew from, students may, additionally, be reflecting on the autonomy-supportive classroom environment. Therefore, disciplinary practices alone do not seem to facilitate belonging. Instead, it may be that disciplinary practices must be accompanied with a respectful and positive class climate. Meaning that when collaborating in groups, sharing ideas with the class, and engaging in argumentation, students only felt they belonged when peers listened attentively, challenged their ideas, and valued their ideas by including them in the final product.

Limitations & future directions

An aim of this study was to examine the relationship between science classroom belonging and science engagement. Science classroom belonging was related to science

engagement with students in inquiry classrooms reporting higher ratings on both scales. However, the correlational nature of analyses did not enable the examination of directional relationships. Further research should be done to examine the directional relationship between these constructs. Additionally, the understanding of how students experience the relation between science classroom belonging and science engagement could be further contextualized by supporting quantitative examinations with interviews directly soliciting this relationship. Given differences between inquiry and traditional contexts, observations of science classroom instruction and student engagement could further operationalize these differences.

Students in inquiry contexts referenced the benefit of peer responsiveness during disciplinary practices such as argumentation. Further research on classroom belonging is needed considering the potential influence of disciplinary practices on students' reporting of classroom belonging. Particularly relevant to challenging ideas during argumentation was students' focus on the critique and challenge of ideas opposed to people. This was done in a supportive climate where mistakes and revision were welcome. However, of the few students who mentioned experiences of low belonging, one of the attributable factors was the devaluing of ideas. Thus, further research examining curricula and peer responsiveness should seek to understand how students differentiate critiquing ideas from the devaluing of ideas.

Although misalignments were not anticipated, students attributed belonging to intrapersonal competence. This self-focused form of competence, nevertheless, facilitated students' sense of belonging in science classrooms. This was theorized as students' speaking interchangeably of a sense of science classroom belonging and a sense of academic belonging. Thus, future research should examine whether middle school students conceptualize science

classroom and science domain belonging interchangeably, especially when considering intrapersonal competence.

However, given that only students in traditional contexts spoke of intrapersonal competence, another explanation was the limited autonomy-supportive instruction in that context. Further research should compare students' sense of science classroom belonging between contexts high and low in autonomy-support. For example, analyses of instructional observations supplemented with student interviews can elicit students' belonging and competence based on observations of their actual classrooms. Understanding behaviors that facilitate belonging in contexts low in autonomy-support can determine whether students' reasons for their intrapersonal focus on competence is attributable to the low-autonomy support or to some other classroom experiences.

The current study aims did not include an examination of differences by demographic backgrounds (e.g., race, gender, sexuality, ethnicity, citizenship, socioeconomic status). Although outside the scope of this study, sense of belonging has been shown to vary between students with a history of marginalization in American educational systems (Good et al., 2012; Gray, Hope, & Matthews, 2018; Murphy & Zirkel, 2015; Strayhorn, 2018). Thus, it would be fruitful for further research to make intentional efforts to determine whether differences in reports of science classroom belonging are a result of student demographics and whether classroom belonging is of more, or less, value for students from marginalized groups.

Additionally, current findings draw from students' reflections on belonging but did not solicit students' value of belonging nor their association of belonging with science outcomes like engagement or persistence. Nichols (2008) proposed a 2 x 2 model of belonging comparing students' perception of the school climate (positive or negative) with their perceptions of school

belonging (belongs or does not belong). Further research could adapt this model to examine the interaction of students' science classroom belonging and students' science engagement or persistence (i.e. alignment between students' expressions of science classroom belonging and the value placed on engagement in or pursuit of science). In doing so, belonging researchers may be able to further understand the value students place on classroom belonging for their science achievement, engagement, or persistence.

Implications for Practice

Students' attribution of belonging to argumentation, respect, and classroom climate have implications for malleable components of the classroom; as opposed to school level variables that focus on having approachable adults and co-curricular facilities. Malleable classroom components (e.g. instructional practices, class climate) may have direct relations to student learning and engagement. As previously discussed, instructional practices and classroom norms are fostered by teachers. By teaching effective disciplinary practices, modeling and encouraging respectful discourse, and fostering supportive class climates, educators can indirectly promote students' sense of belonging in science and support science engagement. The conceptualizations here, given from students' perspectives, provide rich descriptions for teachers and teacher educators as they consider ways to promote belonging in the classroom. Moreover, previous research on autonomy-supportive instruction combined with the current samples' discussion of interpersonal competence suggests an additional path to classroom belonging. By emphasizing the utility of individuals' knowledge towards developing shared competencies, educators can create a class climate of respectful responsiveness and facilitate classroom belonging.

CONCLUSION

This study explored the influence of context-specific, instructional, and science experiences on science classroom belonging and engagement. Middle school students from traditional and inquiry contexts completed a survey on their science classroom belonging and engagement then participated in an interview on their belonging experiences. Findings supported the relationship between science classroom belonging and engagement and richly described students' voiced sources of their domain-specific, science classroom belonging. These findings extended the belonging construct with affordances of classrooms and a subject domain (science). In both contexts, students reported common social, academic, and contextual sources of belonging, with additional emphasis on content-based and interpersonal interactions. In addition to justifications consistent with previous literature, students from traditional contexts also referenced self-focused forms competence, suggesting that students associate intrapersonal experiences with their sense of belonging. Students from inquiry contexts, however, had higher belonging and engagement ratings and richer conceptualizations of belonging. Specifically, students from inquiry contexts reflected on argumentation, supported interpersonal forms of competence, and introduced respect as having one's ideas challenged. Taken together, students' conceptualizations suggest that peer responsiveness and science disciplinary practices further support students' sense of belonging. This contextualization of students' science classroom belonging can inform approaches to addressing students' declining pursuit of science beginning in the middle grades.

REFERENCES

Anderman, L., & Freeman, T. (2004). Students' sense of belonging in school. *Advances in Motivation and Achievement, 13,* 27–63.

Anderman, L. H. (2003). Academic and social perceptions as predictors of change in middle school students' sense of school belonging. *The Journal of Experimental Education, 72*(1), 5–22.

Anderman, L. H., & Anderman, E. M. (1999). Social Predictors of Changes in Students' Achievement Goal Orientations. *Contemporary Educational Psychology*, *24*(1), 21–37. https://doi.org/10.1006/ceps.1998.0978

Appleton, J. J., Christenson, S. L., & Furlong, M. J. (2008). Student engagement with school: Critical conceptual and methodological issues of the construct. *Psychology in the Schools*, *45*(5), 369–386. https://doi.org/10.1002/pits.20303

Archer, L., Osborne, J., DeWitt, J., Dillon, J., Wong, B., & Willis, B. (2013). ASPIRES: Young people's science and career aspirations, age 10–14. *London: King's College*, *11*, 119–132.

Astin, A. W. (1999). Student Involvement: A Developmental Theory for Higher Education. *Journal of College Student Development*, *40*(5), 13.

Baumeister, R. F., & Leary, M. R. (1995). The Need to Belong: Desire for Interpersonal Attachments as a Fundamental Human Motivation. *Psychological Bulletin*, *117*(3), 497–529.

Bennett, J., & Hogarth, S. (2009). Would you want to talk to a scientist at a party? High school students' attitudes to school science and to science. *International Journal of Science Education*, *31*(14), 1975–1998.

Caleon, I. S., & Subramaniam, R. (2008). Attitudes towards science of intellectually gifted and mainstream upper primary students in Singapore. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *45*(8), 940–954.

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. https://doi.org/10.1002/sce.21243

DeWitt, J., Archer, L., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2011). High aspirations but low progression: The science aspirations–careers paradox amongst minority ethnic students. *International Journal of Science and Mathematics Education*, *9*(2), 243–271. https://doi.org/10.1007/s10763-010-9245-0

Finn, J. D. (1989). Withdrawing from school. *Review of Educational Research, 59*(2), 117–142.

Finn, J. D., & Zimmer, K. S. (2012). Student engagement: What is it? Why does it matter? In *Handbook of research on student engagement* (pp. 97–131). Springer.

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., Filsecker, M., & Lawson, M. A. (2016). *Student engagement, context, and adjustment: Addressing definitional, measurement, and methodological issues*.

Fredricks, J. A., Wang, M.-T., Schall Linn, J., Hofkens, T. L., Sung, H., Parr, A., & Allerton, J. (2016). Using qualitative methods to develop a survey measure of math and science engagement. *Learning and Instruction, 43*, 5–15. https://doi.org/10.1016/j.learninstruc.2016.01.009

Freeman, T. M., Anderman, L. H., & Jensen, J. M. (2007). Sense of Belonging in College Freshmen at the Classroom and Campus Levels. *The Journal of Experimental Education*, *75*(3), 203–220. https://doi.org/10.3200/JEXE.75.3.203-220

Furrer, C., & Skinner, E. (2003). Sense of relatedness as a factor in children's academic engagement and performance. *Journal of Educational Psychology*, *95*(1), 148–162. https://doi.org/10.1037/0022-0663.95.1.148

Furtak, E. M., & Kunter, M. (2012). Effects of Autonomy-Supportive Teaching on Student Learning and Motivation. *The Journal of Experimental Education*, *80*(3), 284–316. https://doi.org/10.1080/00220973.2011.573019

Good, C., Rattan, A., & Dweck, C. S. (2012). Why do women opt out? Sense of belonging and women's representation in mathematics. *Journal of Personality and Social Psychology*, *102*(4), 700.

Goodenow, C. (1993a). Classroom belonging among early adolescent students: Relationships to motivation and achievement. *The Journal of Early Adolescence*, *13*(1), 21–43.

Goodenow, C. (1993b). The psychological sense of school membership among adolescents: Scale development and educational correlates. *Psychology in the Schools*, *30*(1), 79–90. https://doi.org/10.1002/1520-6807(199301)30:1<79::AID-PITS2310300113>3.0.CO;2-X

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. https://doi.org/10.1080/00461520.2017.1421466

Green, M., Emery, A., Sanders, M., & Anderman, L. H. (2016). Another Path to Belonging: A Case Study of Middle School Students' Perspectives. *The Educational and Developmental Psychologist*, *33*(01), 85–96. https://doi.org/10.1017/edp.2016.4

Jenkins, E. W., & Nelson, N. (2005). Important but not for me: Students' attitudes towards secondary school science in England. *Research in Science & Technological Education*, *23*(1), 41–57.

Johnson, L. S. (2009). School Contexts and Student Belonging: A Mixed Methods Study of an Innovative High School. *School Community Journal*, *19*, 99–118.

Kiefer, S. M., Alley, K. M., & Ellerbrock, C. R. (2015). Teacher and Peer Support for Young Adolescents' Motivation, Engagement, and School Belonging. *RMLE Online*, *38*(8), 1–18. https://doi.org/10.1080/19404476.2015.11641184

Krajcik, J., Blumenfeld, P. C., Marx, R. W., Bass, K. M., Fredricks, J., & Soloway, E. (1998). Inquiry in Project-Based Science Classrooms: Initial Attempts by Middle School Students. *Journal of the Learning Sciences*, *7*(3–4), 313–350. https://doi.org/10.1080/10508406.1998.9672057

Krippendorff, K. (2013). *Content analysis: an introduction to its methodology* (3rd ed..). Los Angeles ; London: SAGE.

Kuhn, D. (2007). Is Direct Instruction an Answer to the Right Question? *Educational Psychologist*, *42*(2), 109–113. https://doi.org/10.1080/00461520701263376

Lead States, N. (2013). *Next generation science standards: For states, by states*. https://doi.org/10.17226/18290

Linnenbrink-Garcia, L., Rogat, T. K., & Koskey, K. L. K. (2011). Affect and engagement during small group instruction. *Contemporary Educational Psychology*, *36*(1), 13–24. https://doi.org/10.1016/j.cedpsych.2010.09.001

Midgely, C., Middleton, M., Gheen, M., & Kumar, R. (2002). Stage-environment fit revisited: A goal theory approach to examining school transitions. *Goals, Goal Structures, and Patterns of Adaptive Learning*, 109–142.

Murphy, M. C., & Zirkel, S. (2015). Race and Belonging in School: How Anticipated and Experienced Belonging Affect Choice, Persistence, and Performance. *Teachers College Record*, 41.

Murray, C., & Greenberg, M. T. (2000). Children's Relationship with Teachers and Bonds with School An Investigation of Patterns and Correlates in Middle Childhood. *Journal of School Psychology*, *38*(5), 423–445. https://doi.org/10.1016/S0022-4405(00)00034-0

National Research Council. (2007a). Participation in Scientific Practices and Discourse. In *Taking Science to School: Learning and Teaching Science in Grades K-8*. https://doi.org/10.17226/11625

National Research Council. (2007b). *Taking science to school: Learning and teaching science in grades K-8*. Retrieved from https://www.nap.edu/read/11625/chapter/1

NGSS Lead States. (2013). Appendix F: Science and Engineering Practices in the NGSS. *Next Generation Science Standards: For States, By States.*

Nichols, S. L. (2008). An Exploration of Students' Belongingness Beliefs in One Middle School. *The Journal of Experimental Education*, *76*(2), 145–169. https://doi.org/10.3200/JEXE.76.2.145-169

Nystrand, M., & Gamoran, A. (1991). Instructional Discourse, Student Engagement, and Literature Achievement. *Research in the Teaching of English*, *25*(3), 261–290.

Patrick, H., Kaplan, A., & Ryan, A. M. (2011). Positive classroom motivational environments: Convergence between mastery goal structure and classroom social climate. *Journal of Educational Psychology*, *103*(2), 367–382. https://doi.org/10.1037/a0023311

Patrick, H., Ryan, A. M., & Kaplan, A. (2007). Early adolescents' perceptions of the classroom social environment, motivational beliefs, and engagement. *Journal of Educational Psychology*, *99*(1), 83–98. https://doi.org/10.1037/0022-0663.99.1.83

Rimm-Kaufman, S. E., Baroody, A. E., Larsen, R. A. A., Curby, T. W., & Abry, T. (2015). To what extent do teacher–student interaction quality and student gender contribute to fifth graders' engagement in mathematics learning? *Journal of Educational Psychology*, *107*(1), 170–185. https://doi.org/10.1037/a0037252

Ritchie, J., Spencer, L., Bryman, A., & Burgess, R. G. (1994). Qualitative data analysis for applied policy research. In *Analysing qualitative data* (pp. 173–194).

Roeser, R. W., Midgley, C., & Urdan, T. C. (1996). Perceptions of the school psychological environment and early adolescents' psychological and behavioral functioning in school: The mediating role of goals and belonging. *Journal of Educational Psychology*, *88*(3), 408–422. https://doi.org/10.1037/0022-0663.88.3.408

Rogat, T. K., Witham, S. A., & Chinn, C. (2014). Teachers' Autonomy-Relevant Practices Within an Inquiry-Based Science Curricular Context: Extending the Range of Academically Significant Autonomy- Supportive Practices. *Teachers College Record*, 46.

Strayhorn, T. L. (2018). *College Students' Sense of Belonging* (2nd ed.). https://doi.org/10.4324/9781315297293

Vedder-Weiss, D., & Fortus, D. (2011). Adolescents' Declining Motivation to Learn Science: Inevitable or Not? *Journal of Research in Science Teaching, 48*(2), 199–216. https://doi.org/10.1002/tea.20398

Voelkl, K. E. (1997). Identification with School. *American Journal of Education, 105*(3), 294–318.

Walker, C. O., & Greene, B. A. (2009). The Relations Between Student Motivational Beliefs and Cognitive Engagement in High School. *The Journal of Educational Research, 102*(6), 463–472. https://doi.org/10.3200/JOER.102.6.463-472

Wallace, T. L., & Sung, H. C. (2016). Student Perceptions of Autonomy-Supportive Instructional Interactions in the Middle Grades. *The Journal of Experimental Education*, *85*(3), 425–449. https://doi.org/10.1080/00220973.2016.1182885

Wallace, T. L., & Sung, H. C. (2017). Student Perceptions of Autonomy-Supportive Instructional Interactions in the Middle Grades. *The Journal of Experimental Education*, *85*(3), 425–449. https://doi.org/10.1080/00220973.2016.1182885

Wallace, T. L., Ye, F., McHugh, R., & Chhuon, V. (2012). The Development of an Adolescent Perception of Being Known Measure. *The High School Journal*, *95*(4), 19–36.

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

TABLES

Table 1

School Demographics & Sample

Demographics	**Tinsdale Middle***	**Dawson Middle***	**†River Middle**	**†Hicks Charter**
Enrollment	1,074	349	782	376
Female	49.5%	50.7%	48.5%	49%
Male	50.5%	49.3%	51.5%	51%
K – 5th grades	-	-	-	79.8%
6th grade	-	29.5%	78.8%	11.7%
7th grade	48.0%	35.2%	78.5%	8.5%
8th grade	52.0%	35.2%	66.8%	-
Ethnic Group				
American Indian	0.5%	0.3%	0.0%	0.0%
Asian	5.0%	-	4.9%	13.0%
Black	17.0%	0.6%	1.4%	6.4%
Hispanic	28.2%	9.0%	5.0%	8.2%
Multiracial	6.2%	2.0%	2.0%	2.7%
Native Hawaiian/Pacific Islander	-	-	0.4%	0.0%
White	47.6%	88.2%	86.3%	69.7%
FRL	72.4%	46.3%	1.3%	5.0%
Sample	19 (13)	40 (12)	214 (37)	37 (7)
Curricular Context	Traditional	Traditional	Inquiry	Inquiry

Note. FRL=free and reduced lunch. Sample=count of students surveyed (interviewed) from 7th grade classrooms.

Table 2

Percentile splits of achievement goal and belonging scale ratings

	Low	**Moderate**	**High**
Mastery approach	1.0 – 4.0	4.0 – 4.7	4.7 – 5.0
Performance approach	1.0 – 1.8	1.8 – 3.0	3.0 – 5.0
Performance avoid	1.0 – 2.0	2.0 – 3.0	3.0 – 5.0
Belonging	1.0 – 3.6	3.7 – 4.3	4.4 – 5.0
	(109)	(102)	(93)

Note. Low=bottom 33%, Moderate=middle 33%, High=top 33%. Belonging counts displayed in parentheses.

Table 3

Sense of Science Classroom Belonging Qualitative Coding Framework

BELONGING
NO BELONGING: States they do not belong, are excluded, and/or cannot share experiences of belonging *S303: No, because there's division groups in the school. That's the hierarchy… the "Populars" shut me out because I'm not friends with them.*
INTERMITTENT BELONGING: States they belong but cannot provide an example; Suggests belonging is intermittent *S167: I do, but then again, there's always those people who are really judgmental. For the most part, I don't really feel like I'm judged that much.*
BELONGS: States or shares experiences that suggest belonging
LOCATION OF BELONGING
TEACHER: interactions with science classroom teacher *S203: When the teacher listens to everybody's ideas...and the Teacher makes us explain what out of that question is important (Competence)*
PEERS: interactions with peers/classmates. Examples include affect, [dis]respect/[lack of] valuing student's social and academic contributions, collaboration, and inclusion in class functioning *S167: When I'm in a group and what I say, they take it into account, and sometimes we even use my ideas. (Community, Respect)*
SELF: self-focused reasons for belonging often paired with self-competence or self-efficacy codes *S312: Sometimes we get to design our own experiments, which is really cool. (also Instruction; Domain)*
GENERAL CLASSROOM/UNSPECIFIED: reference to self and intrinsic motivations. Examples: discussion, curiosity *S282: I feel like I'm belonged when I'm adding to the argument or the conversation that's going on about the topic that we're doing. (Competence)*
DOMAIN: features of the academic domain and disciplinary practice. Examples: subject (e.g. science); research; hypothesizing, argumentation, presentation *S212: [I felt included during labs because] there's a part for every person... you all have to work together to finish the lab. (Also Peers; Domain, Community, and Instruction)*

Table 3 continued

JUSTIFICATION OF BELONGING
COMMUNITY: quality of collaboration; inclusion; membership; shared values and social climate. Examples: shared roles and responsibilities, peers wanting to collaborate with student, feeling pride in being a member in one's classroom, positive or negative social climate, exclusion *S203: When we work in groups and everybody listens to everybody's ideas. If we were making something and everybody listened to my idea and then listened to everybody's idea in person, and then we made something like out of all our ideas combined. (also Respect; Peers)* *S303: No, because there's division groups in the school. That's the hierarchy. We call them the "Populars." They shut me out because I'm not friends with them. (Peers)*
COMPETENCE: indicators of knowledge and competence. Examples: making knowledgeable contributions, ability to demonstrate or develop competence, [in]correctness, prior achievement *S282: [I feel I belong in science class because] I can usually understand what's going on, and sometimes add points to our conversations that we're having in class (General)*
PEDAGOGY: influence of classroom features, instructional approach, pedagogy, lessons, activities, and disciplinary practices. Examples: quality of teacher caring (e.g. liking, attentiveness), affect displayed while/towards teaching, teacher approachability, hands-on activities, resource availability *S204: [Raising my hand makes me feel I belong because] I love hearing that, when the Teacher says, "That's the right answer. Everybody, copy this down." It motivates me so much. (also Competence; Teacher)*
RESPECT: Extent to which individuals in the classroom value the student and appreciate their contributions. Examples: attentive listening, welcoming student's points of view, respecting student's contributions as valid, discouraging student's participation *S312: When someone doesn't agree with me, I feel included… if they don't agree with me that means they're actually taking their time to argue… It means they're really engaged and they think that we can help each other understand it.*

Table 4

Justification qualitative coding framework

Primary Code	Secondary Code	Exemplars
Community	**Alienation** – Exclusion due to hierarchy or poor friendships.	*S603-T*: [People don't respect my ideas] Because they just *push me off to the side...*
	***Class Climate** – Class norms facilitating belonging such as personal characteristics of peers/teacher (e.g. nice, supportive), shared goals/motivations, freedom to speak without judgement	*S413-I:* I have a *very nice science class and not just the kids but the teacher and the environment make it very inclusive*. *S467-T:* Being around a lot of *people that support you*
	****Contributing ideas*** *– Discussing/sharing ideas, working together, distributing work*	*S446-I*: [I feel I really belong in science class] If we're working with groups, it gives you a chance, propose your ideas and come up with something, compromise with each other's plans and form them into one better plan, and come up with something together… If I contribute to something… you could say, "This plan works and I helped do it."
	#Friendships – Positive interpersonal relationships	*S622-I*: [I feel I belong] *When I'm with my friends…*
	#Helping – Giving & receiving help	*S557-I*: [I feel included in science class] When I see someone *and they don't understand what they're doing and I help them or the opposite ways*. I feel I'm included *because they're helping me and I'm helping them*.
	Inclusion – Membership; inclusion/inviting involvement	*S520-T*: [I feel included in science class] When sometimes I don't want to work by myself, a group comes up and ask me if I like to work with them

Table 4 continued

	Participation – Involvement in classroom activity or functioning. Being on task	*S646-T*: [A time in science class when I felt I really belonged was] *When everyone was… focusing on science*… [because] *everyone working on the stuff they needed to work on*.
	Peer work – Pair/group work	*S430-T*: [I feel included in science class] Whenever the teacher lets us work in *partners*… [because] You don't really have to work by yourself, you *get to work with somebody else*.
	Positive affect – Student's mood toward science or while in science	*S457-T*: …I just feel good in the class.
Competence	***+ High Self-efficacy/-competence*** *– Student's perception of their own high knowledge or abilities*	*S430-T*: [I feel I belong in science class because] In some labs, I know more than other people. Then they would ask me questions… Because I know the answer to it and they don't.
	Low Self-efficacy/-competence *– Student's perception of their own low knowledge or abilities*	*S432-I*: Sometimes [I feel I belong in science class]. For me, *I'm not the best at science*. A lot of people in my class are really good at science. It comes out so easy for them. They are constantly getting good grades, and it comes really easy to them
	Prior content knowledge *– Pre-existing knowledge/experience with the topic*	*S531-I*: [I feel included when] Sometimes that we're doing an activity and I know from preknowledge I know it. I like saying some things that are predictions that will happen.
	Similar relative competence *– Student's perception that their competence is similar to their classmates*	*S645-I*: [I feel I belong] Because, also some people don't understand things. I don't understand things so we can relate to each other. It's not like everyone's above anyone else, more like underachieved than anyone else. Everyone's kind of at the same level.

Table 4 continued

Pedagogy	**** Science practices/activities*** *– Belonging experienced during or facilitated by the disciplinary practices or activities of science (e.g. argumentation, labs, experiments).*	*S312-I*: [I feel I belong when] we do experiments, [and] we all have different interpretations of it and you don't get to really know what happened until the end. Sometimes we get to design our own experiments, which is really cool. That is like belong because everyone gets to put an idea to design the experiment
	Instructional approach – Teacher's pedagogical approach that facilitate for belonging	*S612-I*: The teacher does a really good job at this. The teacher tends to call on random people. the equally distributes the amount of responsibility of work, helping, so if anyone has an idea, you get to share it.
	Teacher characteristics – Teacher attributes that encourage/ facilitate for student belonging (e.g. support, caring)	*S479-I*: [I feel I belong in science class] When the teachers push you to do better. It makes me feel I know I can do something.
Respect	**Attentive listening** – Effort peers make to attend to and try to understand student's contributions/perspective	*S674-T*: [A time in science class where I felt I belonged was]… When it was my turn to say what I thought happened… and everybody was just focused and not wandering off or commenting or whispering or anything. I felt really comfortable in that I could just talk out whatever I wanted to say about the lab, because nobody was judging.
	Devaluing ideas – Negative effects of an exclusion of ideas and ignoring contributions	*S603-T*: [People don't respect my ideas] It's really during big science labs that I'm sitting out to the side. I'm like, "Hey, I've got an idea," they're like, "*We don't care*."

Table 4 continued

**** Challenging/Questioning ideas*** *– Significance of peers taking time to critique or ask questions about student's contributions*	*S312-I*: When someone doesn't agree with me, I feel included. It sounds weird but if they don't agree with me that means they're actually taking their time to argue. We're actually having a discussion. If they're saying, "You're wrong," and goodbye that's like I don't belong. If they actually want to talk and discuss it with me, and if they just agree with me that means it's the right answer. It means they're really engaged and they think that we can help each other understand it.
*** Valuing ideas** – Ideas are elaborated and/or integrated into collective product (e.g. during class, partner, or group work). Lower quality enactment could include liking or agreeing with ideas.	*S614-I*: When we are having a group discussion, and people ask me what I think. *S167-T*: [I feel people respect my ideas] when I'm in a group and what I say, they take it into account, and sometimes we even use my ideas.

Note. I = Inquiry classrooms, T=Traditional classrooms, +=Unique and frequent in traditional contexts, * = Unique and frequent in inquiry contexts, # = Frequent in both curricular contexts, *Italics are extensions*

Table 5

Justifications of Belonging: Alignment and Extensions

Source	Justification	Conceptualization
Non-academic	Climate	Feeling comfortable in class Lack of judgement Shared goals, focus, interests
	Friendships	Having friends at school/in classes Knowing people
	Positive affect	Interest, liking, pride, enjoyment of school/class
Academic	* Contributing ideas	* Collaboratively building knowledge * Sharing ideas
	Helping	Giving and receiving help
	Inclusion	* Invitations to join pair/group Not being left out * Peers wanting to work with student
	* Interpersonal competence/efficacy	* Sharing ideas as contributing to collective knowledge * Social responsibility for others' learning
	Respect	Attentive listening * Challenging ideas Valuing ideas
	Teacher characteristics	Attentive listening Caring Support * Validating knowledge/correctness
	* Intrapersonal competence/efficacy	Being "good at" classwork/science skills * High performance * Understanding coursework
	* Prior content knowledge	* Familiarity with course content * Previous experience with course content

Table 5 continued

Source	Justification	Conceptualization
Classroom Structures	Instructional approach	* Calling on students Encouraging peer work/participation * Equally distributing responsibilities * Modeling students' questions/answers * Random seating
	Participation	Asking and answering questions * Being on task Class discussion * Doing science activities * Raising hand
	Peer work	Getting to work in pair/groups * Helping partner/groupmates * Invitations to join pair/group * Peers wanting to work with student * Sharing ideas with partner/groupmates * Using ideas in group product
	* Science Practices	Argumentation
No Belonging	Alienation	Discouragement of participation Exclusion
	Devaluing ideas	Exclusion of ideas Unconstructive critique of ideas Unresponsive to ideas
	Disrespect	Judgement Making fun of student

* Extension

Table 6

Frequencies and Percentages of Belonging, Locations, and Justifications of Full Sample

Category	Primary Code	Secondary Code	Curricular Context		Total
			Traditional *n* = 29	Inquiry *n* = 44	*N* = 73
Belongingness	Belongs		93% (27)	93% (41)	93% (68)
	Intermittent		21% (6)	30% (13)	26% (19)
	No Belong		7% (2)	5% (2)	5% (4)
Location	Domain		14% (4)	9% (4)	11% (8)
	General		52% (15)	80% (35)	68% (50)
	Peers		83% (24)	80% (35)	81% (59)
	Self		28% (8)	30% (13)	29% (21)
	Teacher		24% (7)	32% (14)	29% (21)
Justification	Community	Alienation	10% (3)	7% (3)	8% (6)
		Class Climate	14% (4)	25% (11)	21% (15)
		Contributing ideas	34% (10)	45% (20)	41% (30)
		Friendships	21% (6)	20% (9)	21% (15)
		Helping	45% (13)	36% (16)	40% (29)
		Inclusion	14% (4)	16% (7)	15% (11)
		Participation	21% (6)	27% (12)	25% (18)
		Peer work	52% (15)	50% (22)	51% (37)
		Positive affect	17% (5)	14% (6)	15% (11)
	Competence	High Self-efficacy/-competence	48% (14)	39% (17)	42% (31)
		Low Self-efficacy/-competence	0% (0)	7% (3)	4% (3)
		Prior content knowledge	0% (0)	9% (4)	5% (4)
		Similar relative competence	14% (4)	7% (3)	10% (7)
	Pedagogy	Science practices/activities	10% (3)	32% (14)	23% (17)
		Instructional approach	24% (7)	20% (9)	22% (16)
		Teacher characteristics	7% (2)	14% (6)	11% (8)
	Respect	Attentive listening	14% (4)	16% (7)	15% (11)
		Devaluing ideas	7% (2)	2% (1)	4% (3)
		Questioning/ Challenging ideas	0% (0)	14% (6)	8% (6)
		Valuing ideas	14% (4)	45% (20)	33% (24)

Note. Although there were 73 total interviews, counts may not add to 73 since coding was mutually inclusive. Due to unproportionate sample sizes percentages within each sample are provided.

Table 7

Frequencies and Percentages of Belonging, Locations, and Justifications of Interview Subsample

Category	Primary Code	Secondary Code	Curricular Context		Belonging Rating		Total
			Traditional *n* = 20	Inquiry *n* = 30	Low Belong *n* = 29	High Belong *n* = 20	*n* = 49
Belongingness	Belongs		85% (17)	90% (27)	83% (24)	100% (20)	92% (45)
	Intermittent		30% (6)	33% (10)	38% (11)	25% (5)	35% (17)
	No Belong		10% (2)	7% (2)	10% (3)	10% (2)	8% (4)
Location	Domain		10% (2)	10% (3)	10% (3)	10% (2)	10% (5)
	General		50% (10)	70% (21)	59% (17)	70% (14)	65% (32)
	Peers		70% (14)	77% (23)	69% (20)	85% (17)	76% (37)
	Self		20% (4)	30% (9)	31% (9)	20% (4)	27% (13)
	Teacher		6% (3)	27% (8)	17% (5)	30% (6)	22% (11)
Justification	Community	Alienation	15% (3)	7% (2)	14% (4)	5% (1)	10% (5)
		Class Climate	15% (3)	23% (7)	10% (3)	35% (7)	20% (10)
		Contributing ideas	25% (5)	43% (13)	38% (11)	35% (7)	37% (18)
		Friendships	20% (4)	23% (7)	21% (6)	25% (5)	22% (11)
		Helping	30% (6)	40% (12)	38% (11)	35% (7)	35% (17)
		Inclusion	15% (3)	13% (4)	17% (5)	10% (2)	14% (7)
		Participation	20% (4)	23% (7)	17% (5)	30% (6)	24% (12)
		Peer work	50% (10)	47% (14)	52% (15)	45% (9)	51% (25)
		Positive affect	20% (4)	13% (4)	14% (4)	20% (4)	16% (8)
	Competence	High Self-efficacy/-competence	40% (8)	37% (11)	38% (11)	40% (8)	39% (19)
		Low Self-efficacy/-competence	0% (0)	10% (3)	10% (3)	0% (0)	6% (3)
		Prior content knowledge	0% (0)	7% (2)	7% (2)	0% (0)	4% (2)
		Similar relative competence	10% (2)	3% (1)	7% (2)	5% (1)	6% (3)

Table 7 continued

Pedagogy	Science practices/activities	10% (2)	40% (12)	24% (7)	35% (7)	29% (14)
	Instructional approach	20% (4)	23% (7)	17% (5)	30% (6)	24% (12)
	Teacher characteristics	0% (0)	13% (4)	3% (1)	15% (3)	8% (4)
Respect	Attentive listening	10% (2)	10% (3)	7% (2)	15% (3)	10% (5)
	Devaluing ideas	10% (2)	3% (1)	7% (2)	5% (1)	6% (3)
	Questioning/Challenging ideas	0% (0)	17% (5)	3% (1)	20% (4)	10% (5)
	Valuing ideas	15% (3)	47% (14)	38% (11)	30% (6)	33% (16)

Note. Although there were 49 in the subsample, counts may not add to 49 since coding was mutually inclusive. Due to unproportionate sample sizes percentages within each sample are provided.

APPENDIX A. SURVEY

Classroom belonging PSSM (Goodenow, 1993b)

1. I feel like a real part of this class
2. I feel proud of being a student in this class
3. Sometimes I feel as if I am not included in this class (reversed).
4. People in this class like me the way I am
5. People in this class take my opinions seriously, even if they don't agree
6. I am treated with as much respect as other students in this class

Mastery Goal

1. It's important to me that I learn a lot of new concepts this year.
2. One of my goals in science class is to learn as much as I can.
3. One of my goals is to master a lot of new skills this year.
4. It's important to me that I thoroughly understand my class work.
5. It's important to me that I improve my skills this year.

Fredricks revised measure (2016 piece)

Behavioral engagement

1. I put effort into learning science.
2. I keep trying even if something is hard.
3. I complete my homework on time.
4. I do other things when I am supposed to be paying attention (Reverse coded).
5. If I don't understand, I give up right away (Reverse coded).

Emotional engagement

6. I look forward to science class.
7. I enjoy learning new things in science class.
8. I feel good when I am in science class.
9. I often feel frustrated in science class (Reverse coded).
10. I think that science class is boring (Reverse coded).

Cognitive engagement

11. I think about different ways to solve a problem.
12. I try to connect what I am learning to things I have learned before.
13. I try to understand my mistakes when I get something wrong.
14. When work is hard, I only study the easy parts (Reverse coded).
15. I do just enough to get by (Reverse coded).

Social engagement

16. I try to understand other students' ideas in science class.
17. I try to work with other classmates who can help me in science.
18. I try to help other students who are struggling in science.
19. When working with others, I don't share my ideas (Reverse coded).
20. I don't help my classmates with questions (Reverse coded).

APPENDIX B. INTERVIEW PROTOCOL

Belonging Interview Protocol

I'm interested in hearing your experiences on how you belong in your science class. Belonging is more than feeling people like you; it's about feeling that people accept you for who you are and respect your ideas. Does that make sense?

- Can you tell me about a time in science class when you felt you really belonged?
- What about that experience made you feel you belonged?
- What other experiences help you feel like you belong in science class?
- Can you share what [would] makes you feel you are included in science class?