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Exploring interpersonal and environmental factors of autistic adolescents' peer engagement in integrated education

Yu-Lun Chen[1], Maxwell Schneider[1,2] and Kristie Patten[1]

Abstract

Autistic students often struggle to engage with peers in integrated education; however, research has largely focused on individual characteristics rather than the interpersonal and environmental factors affecting peer engagement. This mixed-methods study examined longitudinal peer interactions over a school year among 17 adolescents (seven were autistic) in an inclusive school club. The quantitative phase investigated participants' social behavior rates to identify sessions where each student demonstrated high and low peer engagement compared with their average participation levels. The qualitative phase compared social interactions and contexts between sessions of high and low peer engagement, revealing four themes regarding contextual supports and barriers to autistic peer engagement: (1) peer engagement is a participatory process where a student and their peer(s) navigate mutual understanding, shaped by both student and peer social characteristics, openness, and involvement; (2) student–peer synchronicity, such as shared interests or compatibility of social styles, was essential to autistic peer engagement; (3) peer engagement can be supported by activities facilitating joint engagement and exploration of mutual interests; (4) classroom interventions emphasizing strengths can support peer engagement, while normative behavioral standards without peer education on individual differences and diversity can perpetuate peers' negative perceptions of autistic difficulties.

Lay abstract

Peer engagement is essential but often challenging for autistic students in integrated education, especially for adolescents. Although peer engagement is bidirectional and context-dependent, research has largely focused on individual characteristics rather than the interpersonal and environmental factors affecting peer engagement. This mixed-methods study examined peer interactions over a school year among 17 adolescents (seven were autistic) in an inclusive school club at a public middle school in the Northeastern United States. The study began with a quantitative phase identifying sessions in which each student was socially engaged with peers more or less often than usual for them. We then qualitatively compared the social interactions and contexts between sessions where each participant experienced high and low peer engagement. Thematic analysis revealed four themes regarding contextual supports and barriers to autistic peer engagement: (1) peer engagement is a participatory process where a student and their peer(s) navigate mutual understanding, shaped by both student and peer social characteristics, openness, and involvement; (2) student–peer synchronicity, such as shared interests or compatibility of social styles, was essential to autistic peer engagement; (3) peer engagement can be supported by activities facilitating joint engagement and exploration of mutual interests; (4) classroom interventions emphasizing strengths can support peer engagement, while normative behavioral standards without peer education on individual differences and diversity can perpetuate peers' negative perceptions of autistic

[1]New York University, USA
[2]The Kull Initiative for Psychotherapy, USA

Corresponding author:
Yu-Lun Chen, Department of Occupational Therapy, Steinhardt School of Culture, Education, and Human Development, New York University, 6th Floor, Pless Hall, 82 Washington Square East, New York, NY 10003, USA.
Email: yulun.chen@nyu.edu

difficulties. The findings have implications for better inclusive practice to support autistic social participation by modifying the peer environments, activities, and classroom interventions.

Keywords
adolescents, double empathy problem, education services, environmental factors, inclusion, inclusive education, interpersonal factors, peer engagement, social cognition and social behavior, social participation

Introduction

At least 64% of the autistic students in the US education system learn in integrated classrooms (U.S. Department of Education, 2018–2019), yet they often experience challenges with peer engagement and commonly experience peer rejection and loneliness (Cresswell et al., 2019; Humphrey & Symes, 2011; Locke et al., 2016; O'Hagan & Hebron, 2016). Specifically, autistic secondary students experience salient social difficulties as social expectations rapidly change in early adolescence (Tierney et al., 2016). Autistic adolescents often desire peer relationships but face difficulties (Cresswell et al., 2019), and their experiences of interpersonal challenges have been associated with feelings of otherness and negative self-perception (Williams et al., 2019). With a lack of peer support as protection from bullying experiences (Humphrey & Symes, 2010), autistic adolescents were found to be at a greater risk of peer victimization than their non-autistic peers (Maiano et al., 2016). Positive peer engagement plays a supportive role in the mental health of adolescents (Roach, 2018), while peer challenges and victimization are negatively associated with mental health conditions and well-being (Long et al., 2020; Patalay & Fitzsimons, 2016). Research has shown that friendship connections predicted autistic individuals' self-esteem, depression, anxiety, and loneliness (Mazurek, 2014), and loneliness was correlated with decreased life satisfaction and thoughts of self-harm (Hedley et al., 2018; Mazurek, 2014).

Peer engagement is inherently bidirectional with both autistic students and their peers; however, research on autistic peer engagement in integrated education primarily focuses on individual factors and social characteristics, while interpersonal and environmental factors of peer engagement remain under-researched. Such emphasis on individual factors reflects the medical model's framing of autistic social challenges as individual social impairment, shaping the focus of social interventions on normative social skills acquisition. However, research has shown that autistic social cognition, social motivation, and social skills only minimally predict social interaction outcomes, highlighting the need to consider the interpersonal and ecological contexts of autistic social interaction (Morrison, DeBrabander, Jones, Ackerman, et al., 2020). As interpersonal and environmental contexts shape social expectations, attitudes, and dynamics, it is critical to understand their influences on autistic peer engagement.

Interpersonal factors of peer engagement

As social interactions are interactive processes contributed to by all involved people, recent theoretical models posited that barriers to social connections do not solely reside in an individual, but the interpersonal synchronicity between all social actors (Bolis et al., 2017; De Jaegher, 2013; Milton, 2012; Milton et al., 2020). The double empathy problem theory resituates social barriers between autistic and non-autistic individuals as a disjuncture in reciprocity due to interpersonal differences in social norms and expectations (Milton, 2012; Milton et al., 2020). The differences in social perceptions and interpretations between autistic and non-autistic people make their interactions liable to miscommunication and disconnection, causing a "double empathy problem" where both people experience difficulties in empathizing with the other person. Supporting the theory, recent studies found that both autistic and non-autistic adults experienced better social outcomes with same-neurotype than cross-neurotype peers (Crompton, Ropar, et al., 2020; Crompton, Sharp, et al., 2020; Morrison, DeBrabander, Jones, Faso, et al., 2020). Autistic individuals also reported feeling more comfortable, understood, and accepted when socializing with autistic than non-autistic families and friends, and they described social experiences with non-autistic people as pressure to conform to social norms (Crompton, Hallett, et al., 2020). Similarly, our previous study found that autistic and non-autistic adolescents tended to interact with their same-neurotype peers (Chen, Senande, et al., 2021). These findings revealed the influences of interpersonal contexts on autistic social interaction, yet it is unclear how interpersonal social characteristics and behaviors collectively shape the social dynamics between autistic students and their peers.

Peer acceptance and attitudes also play a crucial role in autistic peer engagement. Research suggested that non-autistic peers often hold misconceptions and negative attitudes toward autistic students (Campbell et al., 2011; Swaim & Morgan, 2001), and non-autistic adolescents can immediately develop negative first impressions and reduced social intention toward autistic adolescents after brief observations of autistic social expressions (Sasson et al., 2017). In addition, non-autistic individuals' first impression and social intention toward autistic adults were more driven by the non-autistic adults' stigma and knowledge about autism, rather than autistic people's social representation (Morrison et al., 2019). These studies

underscored peers' role in autistic social engagement. Examining the interpersonal dynamics and peer involvement in autistic peer engagement can provide valuable insights into autistic students' social supports and barriers.

Environmental factors of peer engagement

Environment factors, such as classroom interventions as well as activities and physical settings, directly influence autistic students' participation in integrated education, yet little is known about how these factors shape autistic peer engagement. Research has explored classroom interventions to socially include autistic students in preschool and primary education, suggesting effective strategies, such as adapting teaching practice, building a rapport with students, facilitating an acceptive classroom climate, assigning playmates or activities, and mediating peer conflict (Chang et al., 2016; Hollingsworth & Buysse, 2009; Lindsay et al., 2013). Classroom teacher interventions might also hinder social inclusion; for example, extensive individual instruction to autistic students can impede peer engagement (Anderson et al., 2004). However, little research has focused on classroom interventions to support autistic peer engagement in secondary education. Investigating how classroom teacher interventions support and hinder autistic peer engagement can help improve inclusive practice.

Similarly, research on classroom activities and environments affecting autistic social engagement primarily focused on young children (Boyd et al., 2008; Reszka et al., 2012), while how activities and physical settings shape autistic adolescents' peer engagement remain unknown. Despite the limited research, studies have shown how activity settings may shape autistic peer engagement.

Activities incorporating autistic adolescents' interests have been found to support autistic students' social engagement (L. Koegel et al., 2012; R. Koegel et al., 2012). Autistic adolescents also expressed their peer interaction preferences to socialize with peers through common interests, emphasizing the central role of shared interests in their friendships (O'Hagan & Hebron, 2016). Exploring how classroom activities and settings further shape the social opportunities of autistic students can help educators and practitioners create socially integrated education environments.

The current study

This mixed-methods observational study aimed to explore the interpersonal and environmental factors of autistic adolescents' peer engagement in integrated education. Our research questions were (1) What are the interpersonal and environmental contexts of peer engagement among autistic and non-autistic students in an integrated school club? (2) What are the interpersonal and environmental supports and barriers associated with autistic peer engagement?

Two theoretical frameworks guided this descriptive study. The theory of the double empathy problem provided a theoretical perspective to examine barriers to peer engagement as a bidirectional interaction process, which considers the outlooks of autistic students and their peers, and the social context of peer interactions, such as social norms and stereotypes (Milton, 2012; Milton et al., 2020). To explore the dynamic between environmental and activity factors associated with peer engagement, we drew from activity theory, which considers the role of activity systems and the social-cultural context in mediating individual actions (Engeström, 1999). Activity theory provided a framework to examine an interactive activity system that is mediated by the multitudinous relations between the subject of the activity, the desired outcome of the activity, the material or conceptual artifacts and tools being used, the community of people influencing the subject's engagement in the activity, the rules of the activity, and the division of tasks, power, positions, access to resources, and rewards (Engeström, 1990; Foot, 2014). This multidimensional framework enables a systematic, multifaceted analysis of human activity and professional practice in environmental and cultural-historical contexts.

Methods

Research design

To identify interpersonal and environmental supports and barriers to peer engagement, we observed students' social interactions in an integrated school club over a school year based on video recordings, with a focus on the peer and environmental contexts of social engagement. This sequential explanatory mixed-methods study consisted of two stages: (1) a quantitative phase measured student social interaction rates to identify the club sessions where students presented high and low peer engagement, followed by (2) a qualitative phase exploring the interpersonal and environmental factors associated with students' high and low peer engagement. Details about the development of and rationales for the research design are documented in Chen (2021).

Participants

Participants were drawn from a larger study evaluating an integrated extracurricular program (the Maker club) to support STEM competency and postsecondary pathways in autistic and non-autistic students (Chen, Murthi et al., 2021; Martin et al., 2019; Martin et al., 2020). The Maker club was a design and engineering curriculum emphasizing hands-on and peer-to-peer learning (see supplementary material for more information). This study included the 17 students (seven were autistic) enrolled in the Maker club at a public middle school in a large, urban area over

Table 1. Participant demographics.

Pseudonym	Gender	Grade	Group	Race/ethnicity
Andrew	Male	Sixth	Non-autistic	Hispanic; Black/African American
Brayden	Male	Sixth	Autistic	Black/African American; Other Race
Dylan	Male	Sixth	Non-autistic	Hispanic; Other Race
Emma	Female	Seventh	Autistic	Hispanic; Other Race
Ethan	Male	Sixth	Autistic	Asian
Hannah	Female	Sixth	Non-autistic	Hispanic
Ian	Male	Sixth	Non-autistic	Other Race
Jacob	Male	Seventh	Autistic	White
John	Male	Sixth	Non-autistic	Hispanic
Joshua	Male	Eighth	Non-autistic	Hispanic; American Indian/Alaska Native
Kayla	Female	Seventh	Non-autistic	Hispanic; White; Black/African American; American Indian/Alaska Native; Native Hawaiian/Pacific Islander
Lauren	Female	Sixth	Non-autistic	Hispanic; Other Race
Liam	Male	Sixth	Autistic	White
Madison	Female	Sixth	Non-autistic	Black/African American
Mathew	Male	Seventh	Autistic	Black/African American
Owen	Male	Sixth	Non-autistic	Hispanic; American Indian/Alaska Native
Samuel	Male	Sixth	Autistic	Hispanic; White

a school year. The Maker club was open to all students between grades six and eight at the school, and all participants self-selected to participate. All autistic students were enrolled in the school's autism inclusion program, which required them to exhibit the following: a diagnosis of autism spectrum disorder confirmed by an up-to-date evaluation by the Department of Education, and average to above-average intellectual functioning, academic skills, and verbal language. Table 1 presents participants' demographics. Ethical approval for the study was obtained from the institutional review boards of the school district and the research institutes. Student assent and parent consent were obtained from all participants.

Quantitative methods

Social behavior coding. The quantitative research phase quantified the peer engagement level of each student in each club session, to identify the sessions where each participant had high and low peer engagement. We coded student social behaviors based on video recordings of a total of 21 45 min club sessions, as well as transcriptions of student conversations. Efforts to ensure recording quality included capturing multiple video angles with three camcorders, recording student conversations with professional audio recorders, and enhancing recording quality with editing technology (e.g. noise reduction). To minimize students' discomfort with recording and ensure observations of students' natural behaviors, we placed the recording equipment at a maximum distance from the students that still allowed acceptable recording quality. The students consented to the recording at their enrollment, and the recording was piloted for a few sessions before actual data collection to allow students to familiarize themselves with the setting.

We coded students' social initiation and response behaviors, where social initiations were defined as verbal or non-verbal attempts to begin a social sequence (e.g. starting a conversation or greeting a peer), while social responses were defined as verbal or non-verbal reactions to a peer's social initiation or ongoing interaction (e.g. answering a question, granting a request, or joining a conversation). Facial expressions were not coded nor considered as a required component of social behaviors, as students' faces were blurred for deidentification and because such behaviors do not necessarily reflect the social motivation of autistic people (Jaswal & Akhtar, 2018). Two coders coded all data and achieved high inter-coder reliability with the first author (initiation: 92% agreement, Cohen's $k=0.73$; response: 88% agreement, $k=0.74$; Chen, Senande, et al., 2021). The students' diagnosis information was not shared with the coders and the students' faces were blurred, although the coders may have ascertained students' group memberships by listening to the audio.

Quantitative data analysis. Peer engagement rates, including social initiation and response rates, were calculated as the number of coded social behaviors divided by the observation length for each student and in each session. To identify the club sessions where each participant experienced high and low peer engagement, we calculated the first and third quartile (Q_1 and Q_3) of each student's observed social initiation and response rates over the school year. Club sessions where a student had social initiation rates lower than their Q_1 were labeled as the student's low initiation sessions, while sessions with initiation rates higher than Q_3

Table 2. Descriptive summary of social behavior rates of high and low engagement cutoffs.

Behavior	Cutoff	Autistic		Non-autistic	
		M (*SD*)	Range	*M* (*SD*)	Range
Initiation	High (Q3)	0.76 (0.15)	0.58–0.99	0.71 (0.31)	0.23–1.36
	Low (Q1)	0.36 (0.17)	0.16–0.69	0.41 (0.25)	0.11–0.78
Response	High (Q3)	2.67 (0.83)	1.11–3.49	2.77 (1.69)	1.09–5.82
	Low (Q1)	1.34 (0.65)	0.22–2.05	1.39 (1.16)	0.34–3.69

SD: standard deviation.
Note. Unit: behavior count per minute.

were labeled as their high initiation session. High response and low response sessions were identified in the same way. We chose this within-student comparison over a group contrast between autistic and non-autistic students to eschew a norm-based comparison. The following qualitative exploration focused on the sessions labeled as high and low peer engagement, while all data were used.

Qualitative methods

The qualitative phase observed and described the interpersonal and environmental context of high and low peer engagement, contrasting club sessions where each student presented high and low social initiation and response rates. Thematic analysis was used to identify patterns in the data across students and video sessions (Braun & Clarke, 2006). For each student, all video recordings and transcripts were closely watched and read, and memos were taken on the relational and environmental contexts. Comparisons between sessions labeled as high and low peer initiation and response were made to compare the contextual factors presented in these sessions. Based on the memos, we generated a list of initial codes and coded all data. After coding, codes were collated into potential themes. The codes included a priori codes reflecting each component of the activity theory (i.e. tools, rules, community, division of labor, and objective) and data-driven codes identified during observations. We further examined the relationships between codes by checking their co-occurrence in quotes and compared cases in the autistic and non-autistic groups as well as contrasting sessions within each student.

Community involvement

The second author is autistic and reviewed the research questions, theoretical framework, method, and findings interpretation of the study. They further guided the focus of data analysis based on their lived experience, perspectives, professional, and background in mental health counseling. In addition, the school club was developed in collaboration with an autistic educator who chaired the program's advisory board.

Results

All students demonstrated varied peer engagement across time, and Wilcoxon Rank Sum tests found no statistically significant differences in the low and high cutoff rates of social initiation and response between autistic and non-autistic students ($ps = 0.96$, 0.70, 0.74, and 0.60 for low initiation, low response, high initiation, and high response cutoffs, respectively). Table 2 presents the high and low cutoffs of social interaction rates in autistic and non-autistic students. Qualitative descriptions of club sessions with high and low social interaction rates revealed nuances in students' peer engagement in the interpersonal context. A student's high social initiation rate, depending on the social context, could either reflect high social activity or repeat initiations due to peers' lack of response. Likewise, low social initiation rates did not always indicate passivity and could also reflect peers' high social activity (hence frequent initiation was not required) or highly reciprocal interactions (where social initiations often elicit more than one reciprocating response). High social response rates could suggest highly reciprocal peer interactions or peers' active social initiations, while low social response rates could imply low responsiveness, peers' low social initiation, or low social reciprocity in peer engagement. As such, the analysis of the interpersonal and environmental factors of peer interaction did not solely compare sessions with high and low behavior rates but incorporated qualitative descriptions of student engagement.

Interpersonal factors of peer engagement

Thematic analysis on interpersonal support and barriers to peer engagement found two main themes: (1) participatory negotiation of mutual understanding and (2) shared interests and experiences.

Participatory negotiation of mutual understanding. In the interpersonal context, students' peer engagement revealed a bidirectional, participatory process where the student and their peer(s) collaboratively negotiate mutual understanding and social interest. As such, outcomes of peer interaction were determined by the social styles,

attitudes, and involvement of both the student and peer(s), rather than either individual. An autistic student's social characteristics might either serve as strengths or challenges in different interpersonal contexts, depending on peers' social interests and expectations. Brayden,[1] for example, was an autistic student who tended to interact actively and assertively with others at close physical distances. He was open to interacting with peers with whom he had few prior contacts, which resulted in several rejected social attempts. His openness allowed him to interact with a variety of peers, which although not always reciprocated, enabled him to identify certain peers who appreciated his social style and shared similar interests. In a session where he engaged in active peer interactions, he excitedly showed every student the Green Lantern ring he made with an LED light, pointing the light right in front of others' eyes. His relatively aggressive social initiations were mostly ignored or rejected by his peers (e.g. a student gently pushed the light away, which shone into his eye), who might find the action surprising or intrusive. However, Ethan, an autistic peer who rarely initiated interactions and had no prior interaction with Brayden in the club, seemed not bothered by the action and reciprocated Brayden by making another LED ring and joining the game. In this instance, Brayden's social style enabled an interaction opportunity that led to a developing relationship when welcomed by the peer, although the same action led to rejections by peers who did not share the same social expectations.

In the interpersonal process, peers' involvement in negotiating mutual understanding and openness to neurodivergent behaviors played a crucial role. For example, in a session where Samuel (autistic) and Joshua (non-autistic) both engaged in frequent peer interaction, Joshua was open to Samuel's stereotypical behaviors and initiated an interaction based on his perceived context.

Samuel:	Err. . .Grr. . .Grrr. . .*((knocking the audio recorder and sticking his face close to it, nodding while making sounds))*
Joshua:	Testing, testing, 1 2 3!
Samuel:	What? You gotta do a gulping noise.
Joshua:	Oh, you're doing gulping noises.

Joshua's continued interactions with Samuel after this conversation suggested his openness toward Samuel's behavior. Their interaction illustrated the role of peer attitudes to autistic behaviors in autistic peer engagement. Nevertheless, autistic students in the school club commonly experienced peer rejections, particularly for those presenting self-stimulatory behaviors or unique communication styles. These autistic students experienced rejections from both autistic and non-autistic peers, either explicitly (e.g. withdrawing or pushing away objects) or implicitly (e.g. ignoring).

Shared interests and experiences. Shared interests and experiences between a student and their peers were a threading theme across instances where students had high social response rates and reciprocal peer engagement. Common interests, experiences, and goals enabled highly engaging, reciprocal peer interactions in autistic students. Observations where autistic students had high peer engagement consistently found passionate interactions around common interests, which were also seen in non-autistic students yet to a lesser extent. For instance, Ethan, an autistic student, demonstrated high peer engagement only when having in-depth conversations with peers on their shared passion for anime, video games, and YouTubers. He was particularly active in those interactions, taking initiative in introducing and extending topics, in contrast to in other sessions where peers usually initiated interactions. He developed a close relationship with Mathew, an autistic peer who shared similar interests, and they spent several sessions engaging in reciprocal interactions on their interests, exchanging expertise and perspectives, or singing anime themes together. In other instances, autistic students clicked with each other on shared interests in sports teams, movies, and comic characters. Social initiations based on interests, when reciprocated by peers, led to engaging, sustaining conversations. By contrast, in cases where peers did not share interests, the initiations were rarely reciprocated, and student interactions tended to shift focus to other common backgrounds (e.g. club activities or shared school experiences), on which conversations were usually briefer and not evolving. The following conversation between two autistic students, Jacob and Emma, shows an example of disconnections between students with no shared interests, where Jacob repeatedly initiated conversations about basketball and Emma continued redirecting it. Eventually, Jacob called another peer with shared interest from another table:

Jacob:	I can't believe I beat the Golden State Warriors in the finals. Yeah they blew it. Yeah same as the raptors, they blew it too.
Emma:	My mom might come, who knows. *((referring to a club event))*
Jacob:	Yeah, and right after I talk to—
Emma:	You have my phone number, right? So you can text me a picture of that? *((referring to the event invite))*
Jacob:	I don't have your phone number. I have Mathew's phone number. I just got it yesterday.
	. . .
Jacob:	I can't believe I beat the Golden State Warriors in the finals.
Emma:	I can't believe I have to make Mathew a dragon.
Jacob:	Hey Ethan, I can't believe I beat the Golden State Warriors in the finals! *((yelling as Ethan was at another table))*

Ethan: With the Sixers! *((yelling back))*

It is important to note that Jacob initiated the conversations with Emma as he thought she was also a basketball fan, instead of being insensitive about her interest. After multiple interactions, Emma confessed that she did not care for sports, and Jacob then stopped initiating topics on sports. The interactions between Jacob and Emma illustrated a process of participatory negotiation of conversation topics and mutual understanding. Despite an absence of shared interests and a misunderstanding of peer interest, the students reached a common ground through multiple attempts of initiations, redirection, disclosure, and clarification. In this collaborative process, peer contribution and acceptance were critical to achieving mutual understanding.

Environmental factors of peer engagement

Environmental factors associated with student social engagement presented two main themes: (1) activity and artifact and (2) classroom interventions and culture.

Activity and artifact. Autistic students' high peer engagement was consistently associated with activities and artifacts (e.g. materials and tools) that allowed connections to students' interests and provided opportunities for peer sharing and exchanging ideas. Activities encouraging the expression of personal interests allowed students to explore the shared interests of peers and facilitated interactions based on their interests. For example, Ethan (autistic) and Mathew (autistic)'s first connection in the club was in an LED card designing activity, where students were encouraged to create their designs based on their interests:

Ethan: You're drawing Kirby?
Mathew: *((Nods))*
Ethan: And his eyes?
Mathew: Mhmm. That's why I chose blue.
Ethan: I think I know it. Uh, let's draw a Pokeball. *((referring to his design))*
Mathew: Sure. But where'd be the LED part of it?
Ethan: Oh—Um, the light, when you catch a Pokemon.
Mathew: There it is! dun duru-dun duru-dun! *((humming Pokemon sound effects))*
Ethan: *((Hums different tune in Pokemon))*

Their conversation then evolved into a series of interactions on the video game and the anime, Mathew's YouTube channel on these interests, whistling theme songs, and collaboration in making the projects. The students' projects also attracted students from other tables and served as a common ground for their interactions.

Students' joint engagement in creative activities that shared common goals also served as a concrete basis for interactions, where the students observed peers' designs, exchanged ideas and strategies, and shared their discoveries and designs. For an instance, in a session where Liam (autistic) and Kayla (non-autistic) both showed high peer engagement, they collaborated and problem-solved together to improve their motor-driven robots. Before their collaboration, they only had few contacts, and their interactions began when Liam complimented Kayla's robot:

Liam: . . .Wow! Your bot is so fantastic. It's way better than mine.
Kayla: What? What's way better than yours?
Liam: Your bot's bigger and you used way more creativity on it.
Kayla: I like yours.
Liam: Yeah. *((long pause))* I mean, it's the first robot I ever created, so, it's not supposed to be all that majestic.
Kayla: I like it.

Their positive comments on each other's projects unfolded further interactions and collaboration, where they share opinions and suggestions on making. Liam was generous in giving advice, while Kayla recognized her strengths in making. The students playfully battled with their robots after finishing their project, and Kayla bridged between Liam and other non-autistic girls at the table in group conversations. The collaborative peer interaction was encouraged by the classroom culture and rules emphasizing peer learning and problem-solving.

Classroom interventions. Classroom interventions that promoted peer learning and recognized student strengths were associated with positive student interactions, while individual interventions and negative framing of autistic difficulties present barriers to autistic peer engagement.

Peer learning culture and community. Teachers at the club emphasized peer learning and encouraged students to ask peers before seeking teacher assistance with an "ask three before me" rule, facilitating a culture of peer collaboration. Such context promoted peer observations, collaboration, exchanging ideas, and offering or seeking assistance. Nonetheless, peer learning remained challenging in some instances, such as when students experienced frustration or had difficulty advocating for assistance. Autistic students might also perceive the rule rigidly and refrain from seeking help from teachers when needed. In these cases, teacher interventions to guide peer learning and support activity engagement were critical. In an instance where Brayden (autistic) experienced frustration in connecting his motor robot, a teacher encouraged him to observe Liam's (autistic) successful project and seeking advice:

Teacher: Look, Brayden, your motor might have to be on the outside. So, if this doesn't work then we are going to take a walk around the room and see other people's bots and see where they put their motors. Okay?
Brayden: I'm trying to get it to move and I don't want it to fall over *((distressed))*
Teacher: Come come let's see other people's. Come. There has to be another way. *((leading Brayden to Liam, who had finished a working robot and was usually willing to help peers))*
Liam: remember, uh, I recommend to have your motor held upright, like this—
Brayden: I know, but that's the problem. It won't stick! This tape won't stick! *((yelling))*
Liam: Brayden, Brayden, Brayden, Brayden, Brayden. *((in a calm, firm tone))*
((Brayden stopped yelling and sat back into the seat))
Liam: Okay first of all, one recommendation, I recommend a cup with no holes . . .

Liam then helped Brayden to collect the material and demonstrated his model, providing peer support in the club community.

Recognizing student strengths. A classroom climate that recognizes and emphasizes student strengths supported students' peer engagement, which can be facilitated by highlighting both autistic and non-autistic students' positive behaviors and achievements. In a session where a teacher publicly complimented Andrew's (non-autistic) paper circuit, he reached out to all peers in the club to help with peers' projects. In another instance, teachers recognized Liam's (autistic) strengths in instructing and assigned him to introduce the club activity to two new club members, Lauren and John (both non-autistic). Liam provided detailed instructions and step-by-step guidance, and the peers positively commented on his teaching at the end of the session:

Liam: . . . Alright. *((pointing at the clock))* Usually Maker's club sessions end at that time. After that we, Brayden and I, usually go straight to the technology room.
Lauren: *((Gives a thumbs-up))* This is fun! I like this club.
Teacher: Anyone wants to take a picture? Liam, you should take a picture of you, teaching, because you were teaching today.
Liam: Okay.
John: Liam did a good job.

Liam, John, and Lauren had several conversations in addition to activity instructions, which provided a positive foundation for future peer engagement. By contrast, teacher intervention that failed to recognize and empathize with autistic difficulties could lead to negative framing of autistic difficulties and othering.

Negative framing of autistic difficulties. Classroom interventions stressing universal expectations over individual difficulties might negatively frame autistic difficulties as misbehaving and promote negative peer perceptions. Specifically, behavioral management addressing autistic students' emotional or behavioral challenges could promote peer misunderstanding and negative attitudes, which should be provided carefully and alongside peer education. Instructions encouraging autistic students to behave as others without empathizing with autistic difficulties also implied expectations of normalcy, which might lead to peers' misconception of autistic students' differences as misbehaving. For example, Brayden was an autistic student with salient difficulties in emotional regulation and fine motor dexterity, who often experienced frustration when manipulating materials. In instances where he experienced emotional distress, the teachers would encourage him to work through the problem, emphasizing that all other club members were going through the same process. While the intervention might intend to emphasize the club as a community, it highlighted Brayden's differences from others without recognizing his unique difficulties. When Brayden experienced meltdowns, teachers would ask him to leave the classroom until he calmed down, which appeared to shape peers' reaction to Brayden:

Brayden: Well I'm not exactly done, but I, Ms. [Teacher].
Teacher: You gotta finish this, okay?
Brayden: Uhhhh!
Andrew: Yo! why is it you are going on raging?
(non-autistic) Why are you raging? You still haven't gotten enough—
Owen: Brayden, you're always stressed out.
(non-autistic) Calm yourself!
Brayden: *((raising a hand and talking to the teacher in a suppressed tone))* How am I supposed to—
Andrew: Chill out!
Brayden banged on the desk.
Owen: Brayden! [Andrew: Yo, Brayden!]
Teacher: Brayden, if you need a minute, go outside, take a breath and come back again, okay?
Brayden was still working on his project.
Teacher: I know, I get it, you want to move on, but we need to get you done with your circuit, [Andrew: Chill out!] so if you need a minute, take a step outside, but we are not banging on the desk.
Brayden: But I'm trying to—*((banging fists in the air, speaking inaudibly in a suppressed voice))*
Teacher: Why don't you take a break outside? *((in a firm tone))* You need to take a break, go. *((gesturing toward the*

*door))*Take a break, come back, and work on it.

((Brayden went outside and came back in a minute))

Owen: Brayden, aren't you supposed to be taking a break?

Teacher: Yeah, you don't seem calm. Come back, come back.

Owen: *((Pointing the door))* Go.

In this instance, classroom intervention failed to facilitate peers' understanding and empathy of autistic difficulty. Instead, it reinforced peers' negative interpretation of Brayden's emotional difficulties as a tantrum and failure to self-regulate like others, which was evident in Owen's command requesting Brayden to leave. The intervention also prioritized normative expectations over the individual difficulty, which failed to support Brayden's emotional needs and activity engagement. It was missed opportunity for peer education and social–emotional education, especially as all students experienced frustration to a varied extent in the program.

Discussion

This study examined the interpersonal and environmental factors of peer engagement in integrated education by contrasting the interpersonal and environmental contexts associated with high and low peer engagement. The findings showed that peer engagement is a collaboration between autistic students and their peers in navigating mutual understanding, where shared interests and peer acceptance played a crucial role. Supportive environmental factors included activities and artifacts that allowed exploration of shared interests or provided common goals among students, and classroom interventions facilitating a culture of peer learning and emphasizing student strengths. By contrast, interventions emphasizing normative expectations over individual difficulties and emotional support may perpetuate peers' negative perceptions and should be accompanied by peer education.

This study extended our understanding of autistic peer engagement by shifting the focus from individualistic social characteristics to the interpersonal context of peer engagement. This study challenged the social deficit framing of autism, revealing that interpersonal contexts heavily influenced autistic social outcomes and that autistic social characteristics served as strengths in supportive interpersonal contexts. These findings are consistent with the double empathy problem theory, which highlights the role of interpersonal contexts in shaping mutual understanding between two interacting people and the outcomes of their interaction (Milton, 2012; Milton et al., 2020). In peer interactions, shared interests and social expectations can provide a foundation of mutual understanding where social connections can build upon, while mismatched expectations and social styles can lead to disruptions in interactions. Although students with different social dispositions may experience an initial gap in mutual understanding (such as between an autistic and a non-autistic student), other interpersonal factors, such as shared interests and open-mindedness to social differences, may bridge the gap and facilitate peer interaction. The finding on the central role of shared interests in supporting autistic peer engagement is consistent with previous studies, which identified mutual interests as common grounds for social interactions and mutual enjoyment (Bottema-Beutel et al., 2016; Kuo et al., 2013; Muller et al., 2008; O'Hagan & Hebron, 2016). These findings suggest the possibility for social interventions and inclusive practices to support autistic peer engagement by promoting peer understanding and allowing opportunities for students to explore shared interests.

The findings on environmental factors of peer engagement have implications for inclusion practices. Although the school club context varied from classroom settings, environmental strategies, such as promoting shared activity engagement, exploration of shared interests, peer learning, and a strength-based classroom climate can be used in many educational settings. Classroom interventions to address autistic difficulties should empathize with individual differences, provide social–emotional support, and facilitate peer understanding and awareness. Training and resources to support teachers' and practitioners' emotional well-being and prepare them to help students cope with stress may be beneficial for classroom social inclusion.

This study emphasized the interpersonal and environmental factors associated with autistic peer engagement, seeking to shift the focus of research and practice with autistic students from autistic social characteristics to the inclusion of neurodivergent social styles. Such transition reflects the neurodiversity perspective, which values human neurological diversity and demands social inclusion and appreciation of neurodivergent differences (den Houting, 2019; Singer, 1999).

The study had several limitations. We were unable to include autistic students' subjective perceptions regarding the contextual support and barriers given logistical reasons. The autistic researcher in the study helped address this limitation by contributing to data analysis and interpretation with their lived experience in integrated education and daily socialization with autistic and non-autistic peers. The autistic participants were mostly male and all speaking, and thus the findings may not reflect the diverse population and the experience of autistic females. Since this study has a higher ratio of autistic students to non-autistic students than other integrated education settings, it may create a more equal power dynamic between autistic and non-autistic students, and the findings may not generalize to other integrated education settings. Finally, the study focused on immediate social environments of peer engagement, which is also shaped by the broader social context, such as the school district's behavioral policy and resources, and societal attitudes

of autistic differences and expectations of normalcy. Other social and interpersonal contexts also contribute to students' peer engagement, such as peers' awareness and attitudes to autistic students' diagnosis, the power structure in the classroom led by non-autistic teachers, and the societal expectations and perceptions of students' disability and other identities. Although the study mainly focused on neurotypes, a student's experience is contributed by their intersecting identities of disability, gender, race/ethnicity, and other group memberships and social constructs (Crenshaw, 1990). Future research may examine how these social constructs interactively shape an autistic student's peer engagement and the social challenges and biases they experience.

Conclusion

This study explored the interpersonal and environmental factors associated with autistic students' social participation and the findings have implications for integrated education practices. Strategies to support autistic peer engagement may include providing students with opportunities to socialize with peers who share similar interests, encouraging acceptance of social and behavioral differences, promoting peer learning, emphasizing students' strengths, and educating peers regarding individual differences and diversity, rather than exclusively focusing on normative behavior standards. The findings may apply to other educational environments and other social settings, by promoting a better understanding of autistic social participation and associated environmental factors.

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ORCID iD

Yu-Lun Chen https://orcid.org/0000-0002-0740-1347

Supplemental material

Supplemental material for this article is available online.

Note

1. Pseudonyms were used to protect participants' confidentiality.

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