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Research Article

“A different environment for success:” a mixed-methods exploration of social participation outcomes among adolescents on the autism spectrum in an inclusive, interest-based school club

Yu-Lun Chen, Wendy Martin, Regan Vidiksis & Kristie Patten

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Abstract

Background: Adolescents on the autism spectrum often experience challenges participating socially in inclusive education. The majority of school-based social supports focuses on social skills training, although research shows that students on the spectrum prefer activity-based social groups over social instructions. Thus, activity-based school clubs incorporating student interests may support social participation.

Method: This mixed-methods study explored the preliminary social participation outcomes of adolescents on the spectrum in an inclusive Maker Club at three public schools. The quantitative phase examined longitudinal social behavior rates throughout the school club among students ($n = 12$). The qualitative phase interviewed six teachers in three schools ($n = 6$) to explore teacher perceptions of student social outcomes compared to general classrooms and program outcomes associated with the programs.

Results: Mixed-effects modeling revealed increased social response rates and social reciprocity over time in both students on the spectrum and non-autistic peers without any group differences. Teachers reported that students on the spectrum engaged more socially than in general classrooms and attributed the positive outcomes to activities encouraging shared interests and the flexible social environment.

Conclusions: Inclusive school clubs incorporating shared interests and joint activities among students may socially support students on the spectrum in inclusive education.

Keywords: social interaction | peer engagement | inclusive education | school club | interest-driven | strength-based

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Introduction

An estimate of 58% of students on the autism spectrum scale[1] in the US education system are learning in inclusive education environments (U.S. Department of

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Education 2018), yet physical proximity alone does not lead to social inclusion. Research has reported that students on the spectrum engaged in significantly fewer peer interactions and spent more time alone in general educations settings than their non-autistic peers (Humphrey and Symes 2011, Locke *et al.* 2016). Lacking peer connections and support, students on the spectrum in general education experience more loneliness, rejection, and bullying compared with their non-autistic peers (Lasgaard *et al.* 2010, Cresswell *et al.* 2019, Williams *et al.* 2019). These negative social experiences in inclusive education have been associated with negative self-perception and low self-esteem in adolescents on the spectrum (Williams *et al.* 2019). Indeed, positive peer interactions and relations are crucial to a student's cognitive and social development, academic achievement, school adjustment, and wellbeing (Rubin *et al.* 2009, Ryan and Ladd 2014). For adolescents, positive peer experience is a significant factor associated with mental health and quality of life (Bakker *et al.* 2010, Helseth and Misvaer 2010). Given the central role of feelings of connection with others and positive accepting relationships in the well-being and belonging of people on the spectrum (Milton and Sims 2016), it is important to support the social experience of adolescents on the spectrum in inclusive education.

Social interventions for students on the spectrum primarily focus on improving social skills, yet remedial approaches to building normative skills may lead to negative social-emotional outcomes (Milton and Sims 2016). Bottema-Beutel *et al*. (2015) investigated the perspectives of students on the spectrum regarding school-based social interventions and found a marked dislike for instruction-based social skill training. Students on the spectrum in the study perceived direct social skill instructions as unpleasant and pressuring and questioned the authenticity of arranged peer interactions. Similarly, first-person narratives of autistic people associate the focus on mediation with the pressure to conform to normative social communication behaviors, which causes mental distress, experiences of otherness, and compromised self-esteem and efficacy in the long term (Milton and Sims 2016, Vidal *et al.* 2018).

Alternatively, social support for students on the spectrum can be provided through activities based on shared interests. Engagement in shared interests is important social support identified by autistic people, which fosters natural social opportunities, connections with like-minded people, and a sense of belonging (Muller *et al*. 2008). Being able to share one's interests with others is key to autistic narratives of well-being and belonging (Milton and Sims 2016). Compared with social skill instructions, adolescents on the spectrum reported a stronger preference for social interventions based on shared activities with peers with common interests, which provide a natural focus for peer interaction (Bottema-Beutel *et al*. 2015). Preliminary evidence has supported the effects of interventions incorporating student interests on promoting the social engagement of children and youths on the spectrum in natural social environments (Dunst *et al.* 2012, Gunn and Delafield-Butt 2016, Koegel *et al.* 2013).

School clubs are an important social avenue in general education where students connect and build relationships with peers sharing similar interests. School clubs with an inclusive practice that allows students on the spectrum to equally and fully engage in shared activities based on interests can create a supportive social context that encourages social interactions. However, findings from the National Longitudinal Transition Study revealed low extracurricular participation in adolescents on the spectrum, with only 30% of these students engaging in at least one extracurricular activity (Shattuck *et al.* 2011). Limited extracurricular participation may suggest a lack of truly inclusive extracurricular programs for students on the spectrum that align with or incorporate their interests.

In light of this need, the IDEAS project (Inventing, Designing, and Engineering for All Students) developed an interest-based inclusive Maker Club in public middle schools for youth on and off the spectrum (Martin *et al.* 2019; Martin *et al.* 2020; Chen *et al.* 2021a). The goals of the Maker program were to support students on the spectrum who have interests in design, making, and engineering to develop related skills in an inclusive and supportive social environment.

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This mixed-methods study investigated the peer interaction among students on the spectrum and their non-autistic peers in the inclusive Maker program in three public middle schools in a large urban area. The research purposes were (1) to examine the students' social participation outcomes and (2) to explore program ingredients associated with positive social outcomes.

Methods

Research design

This mixed-methods pre-post study used a convergent design, where qualitative and quantitative findings are compared and combined with equal emphasis (Creswell and Plano Clark 2017). The quantitative research investigated the longitudinal peer interaction rates and interaction reciprocity among students on the spectrum in comparison with their non-autistic peers, while the qualitative research examined teacher perceived student outcomes in Maker club compared to general classroom outcomes, as well as the active program ingredients through teacher interviews.

The maker club program

The IDEAS Maker program was a collaboration among researchers, educators, partner schools, and Maker program developers to adapt a museum-based Maker curriculum to be inclusive and accessible for students on the spectrum in public middle schools in a large, urban school district within the US (Martin *et al.* 2019). Maker programming leverages students' interests to facilitate science, technology, engineering, and mathematics (STEM) learning and supports students' engagement in interest-driven making projects by providing needed resources and opportunities (Honey and Kanter 2013, Peppler *et al*. 2016). In the IDEAS Maker program, students were encouraged to connect their personal interests in their creations utilizing the materials and techniques presented in the curriculum. The curriculum began with 12 Maker activities that allow students to build basic making skills (e.g. the use of circuits and 3 D modeling) through interest-driven tinkering. At the end of the program, students designed and created original projects of interest with provided resources and supports, such as 3 D design software and a 3 D printer. Teacher's facilitation focused on supporting students' making through the process of ideation, planning, building, testing, refining, finalizing, and sharing.

The program was implemented in three autism-inclusion public middle schools by the teachers in the schools. In each partner school, students in the sixth through eighth grades were invited to participate in the program, and student participants volunteered to enroll in the program. The school clubs were led by one special education and one general education science teacher in each school, who received autism inclusion training as part of the autism-inclusion model in the school districts (Koenig *et al.* 2009, Cohen and Hough 2013) and participated in two days of professional development in Maker principles. Maker program delivery and the data collection for this study were approved by the institutional review boards of the school district and the research institutes. All teachers and parents provided written consent and all participating students provided assent.

Quantitative research methods

The quantitative phase of the study investigated students' social participation outcomes through longitudinal observations of social behavior rates among students in one school over the five-month course of the program. The quantitative phase only took place in one of the three schools due to the feasibility of the program schedule and classroom space.

Student participants

Participants included in the quantitative analysis were all twelve students enrolled in the Maker program at the sample school in the school year (see Table 1 for participant demographics). To be enrolled in this autism inclusion middle school program, all autistic students exhibited the following: (1) a diagnosis of Autism Spectrum Disorder confirmed by an up-to-date evaluation of the Autism Diagnostic Observation Schedule conducted by trained psychologists in the Department of Education; (2) verbal language on or close to age level; (3) average to above-average intellectual functioning; and (3) academic skills on or above grade level.

Table 1. Participant demographics.

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Data collection

We video-recorded the participants' peer interaction in the club over the five-month program (October 2018 to February 2019) to track changes in peer interaction over time. The Maker Club in the school met twice a week in a 45-minute homeroom period, excluding days with school activities or holidays, and 14 club sessions were videotaped. To optimize recording quality, three camcorders and three professional stereo microphones were used at each session, with each pair of the equipment capturing a group of students (two to five depending on seat arrangement) at a table. After recording, we optimized the audio quality and blurred students' faces to protect their privacy using professional video editing software.

Data sampling

We excluded video sections of teacher instructions (either to the whole class or directly to the focal students), as peer engagement was not encouraged during instructions. After removing teacher instruction sections and recordings with insufficient quality, we included a total of 1136 min of observation (644 min for autistic students and 591 min for non-autistic students). The mean observation length for each student was 94.67 min (range = 31-153 min).

Social behavior coding

To quantify peer interaction during the program, we used a video-based social behavior coding system measuring the rates of social initiations and responses of the participants. Table 2 shows the definitions of social initiations and responses, which were modified from an existing coding scheme (Bauminger 2002). We used an event coding method, where an observer records each instance of a target social behavior, as it provides higher accuracy of social behavior incidence rates than an interval coding method (Bakeman and Gottman 1997). To enable accurate event coding, we coded social behaviors over video recordings of student interactions, which allowed the observers to repeatedly review student social behaviors.

Table 2. Definitions of social behaviors.

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To further measure the reciprocity of peer interactions, each social response was numbered according to its order in the interaction sequence (e.g. the first social response after initiation was numbered as one, and the second social response in the same interaction sequence would be numbered as two). Thus, a larger reciprocity index suggested a high level of reciprocity. All social responses were classified into three categories based on the quartiles of reciprocity indices of all social responses. A reciprocity index below the first quartile (25th percentile) was defined as low reciprocity, above the third quartile (75th percentile) was defined as high reciprocity, and within the interquartile range (between the 25th and 75th percentiles) was defined as average reciprocity.

Student conversations in the sampled video data were transcribed verbatim to ensure the quality of behavior coding. Two trained graduate students coded all sampled data based on video recordings and transcriptions. The two coders achieved high inter-coder reliability with the measurement developer (Chen) using 27% of all video data, with 92% agreement on social initiation and 88% agreement on social response. Cohen's Kappa was 0.73 for social initiation and 0.74 for social responses. The reliability sample and inter-coder reliability were sufficient for behavioral observation research (Heyman *et al.* 2014). Although the two graduate student coders may have ascertained the students' group memberships by listening to the audio, efforts were made to blind diagnosis information by blurring students' faces in the videos. The first author, who only participated in inter-coder reliability tests, was not blinded to students' diagnostic information.

Data analysis

We used mixed-effects Poisson regression to examine whether rates of social behaviors (i.e. the count of observed behaviors over an observation period) differed by group and changed over time. Poisson regression was chosen as it best reflects the nature and distribution of the behavior count data. Mixed-effect modeling is necessary to control for the dependency among the repeated measures. With the dependent variable being the observed counts of each social behavior, the model included a binary variable of diagnostic group, a time variable (Week 1 to 12), an interaction term of group and time to explore differentiated time effects between groups, an exposure variable of observation length, and a random intercept for each student. The same model was used to investigate the group and time effects on all social initiations and responses, social initiations with each initiation characteristics (i.e. initiation purpose, outcome, and type), and social responses with each response characteristics (i.e. response type, reciprocity).

To address the potential bias in the estimates of mixed-effects modeling with a small number of clusters (i.e. students), we used restricted penalized quasi-likelihood coupled with a Kenward-Roger correction, which has been reported to be a preferred method to generate unbiased estimates with mixed-effects Poisson modeling with as low as 10 clusters (McNeish 2019). Mixed-effects modeling was performed with Proc Glimmix in SAS 9.4.

The longitudinal observation inevitably yielded missing data. Across the 12 participants and 14 sessions, 41% of the observation was lost due to student absence, students positioned outside of camera frames (e.g. at a glue-gun station where videotaping was not feasible), or insufficient recording quality. Student absence was not consistent (no successive absence more than three sessions) and usually due to other school activities. Wilcoxon rank-sum tests with continuity correction showed that missingness was independent from group ($W = 814$, $p = 0.81$) yet dependent on time ($W = 2629.5$, $p = 0.01$). Thus, we used listwise deletion in analysis, which is a robust method to address nonrandom missingness on the dependent variable in logistic and Poisson regressions (Allison,2001).

Qualitative research methods

The qualitative strand of the study (1) investigated teacher perceptions of students' social engagement outcomes as compared to their usual engagement levels in general classrooms and (2) explored active program ingredients associated with the social outcomes. Data collection included teacher interviews, teacher program implementation logs, and field observation of the IDEAS Maker Club over a school year in all three partner schools.

Teacher participants and interviews

We conducted interviews with six teachers facilitating the club across three schools, including three special education teachers and three science teachers. In the mid-point of the program, two researcher moderators led a focus group with the six teachers from all schools. At the end of the program, the two teachers in each partner school were interviewed again by one researcher. The purpose of this combination of teacher focus groups and paired interviews was to understand both the teachers' feedback in a group discussion context as well as their experiences within each partner school. The length of the interviews ranged from 35-70 min, and the interviews were transcribed verbatim before analysis.

Supplementary data

Field observation

During program implementation, we conducted field observations during the IDEAS Maker program in all schools over the school year, creating 54 observation logs in total. The observation logs focused on the students' overall participation in program activities, including peer interactions among the students.

Teacher program implementation logs

All teachers were encouraged to record a program implementation log (n = 43) after each club session, where an item asked the teacher to share the social challenges, progress, or accommodations that they observed among student peer interaction during the program. While the data were collected to investigate overall program outcomes, this study focused on the analysis of data associated with student peer engagement.

Qualitative data analysis

We used an inductive thematic analysis based on the six-phase framework of Braun and Clarke (2006) to identify key patterns across the data. The analysis process involved data familiarization through an active and repetitive reading of the data, generation of data-driven initial codes, searching for themes, reviewing the relationships between themes, codes, and the data, defining and naming themes, and report production. The first and third authors conducted the first round of data coding, identifying information relevant to the student's social experience and social outcomes in the program. An inter-coder agreement was achieved through constant discussion throughout the coding process. The first coder then conducted the second round of coding and explored the themes representing students' social engagement in the program.

Results

Quantitative results

Across the 14 sessions, mean social initiation rate was 0.65 n/min (SD = 0.49) in students on the spectrum and 0.86 (SD = 0.54) in non-autistic peers. Mean social response rate was 1.94 n/min (SD = 1.55) in students on the spectrum and 2.59 (SD = 1.98) in non-autistic peers. Mean social reciprocity (number of social responses in an interaction) was 6.59 (SD = 6.76) in students on the spectrum and 6.04 (SD = 4.59) in non-autistic peers.

Social behavior rates

The model of social initiation rates showed no significant group difference in initiation rates at the beginning of the program and no significant time effects for either group. Table 3 shows the coefficient estimates of the model, and Figure 1 illustrates estimated social initiation rates in students on the spectrum and non-autistic peers over the 14 weeks. As for social response rates, no significant group difference was found in the first session. Over each session, students showed an 8% increase in social response rates (IRR = 1.08, *SE* = 1.03, *p* = .01), and the group difference in the growth trend was not statistically significant.

Figure 1. estimated initiation and response rates by group over time.

Notes. Lines present the point estimations of behavior rates and shades present the 95% confidence intervals.

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Table 3. Estimates of mixed-effects Poisson regression.

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Social response reciprocity

No significant group differences were found in the frequency distribution of social response reciprocity (X^2 (2, *N* = 2466) = 3.91, *p* = .14; see Table 4). Models for response reciprocity (Table 3) showed no significant group and time effects in social responses of low and average reciprocity. A significant time effect was found in highly-reciprocal social responses, with both groups increased 27% each session (IRR = 1.27, *SE* = 1.06, *p* < .001). Group difference in the growth trend was not statistically significant. Table 3 displays the coefficient estimates of the models, and Figure 2 illustrated the estimated social response rates by levels of reciprocity over time.

Figure 2. Estimated rates of social responses by levels of reciprocity.

Notes. Lines present the point estimations of behavior rates and shades present the 95% confidence intervals.

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Table 4. Frequency distribution of social response reciprocity.

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Qualitative findings

Our qualitative analysis generated three major themes: spontaneous peer interaction, development of peer relationships, and opportunity for natural social interactions in the Maker Club.

Spontaneous peer interaction

Teachers reported observing increased peer interaction in students on the spectrum in the program compared with their usual engagement in classrooms. Peer interaction naturally unfolded when students spontaneously shared ideas and sought help from each other, which the teachers acknowledged positively. The teachers further highlighted their observation of mutual interactions amongst students accompanied by positive affection and enjoyment, which was consistent with our field observation.

> With one or two exceptions, all the students worked within groups, asked questions, discussed off-topic issues. This is not happening in everyday classrooms that often. (Teacher log in School 3)
> Something else I noticed a lot is the kids asking each other for help, where I feel like my students, a lot of times, go straight to me a lot. [Interviewer: And how did that, if that's not how it usually works, how did that evolve?] I don't know if it's because the activity is so different, and because there is more flexibility, that they think maybe another kid might [be more helpful]. (Mid-program teacher interview)

Teachers also noted positive changes in students' social engagement over time. Similarly, our field observation found several students took relatively peripheral social roles at the beginning of the program and gradually developed connections with peers over time.

> Students that may have not socialized before are getting to know each other, and they're working as a total group to get to know each other and give ideas beforehand. (Mid-program teacher interview)
> This student began the program back in early March sitting at a table by himself and not talking much at all. He often had his hair in front of his eyes when he worked on his various projects. At the start of today's session though, he was seated at a large table with the crew of older boys who always sit together. He was talking, interacting, and laughing with them, and playing a video game with them, for the first time since the club started! (Observation note in School 2)

Many teachers shared that they rarely prompted peer interaction in the Maker Club, as opposed to in regular classes where direct instruction to facilitate group work was commonly used. A teacher further compared the program with the therapeutic social development curriculum of the inclusion program at the school and highlighted the difference in students' active engagement.

> There are definitely a lot more social interactions and very natural social interactions with the club. A lot of times I feel that during class time certain students, especially those like Sally and Robert[2], you have to kind of say, "Okay, make sure you're working in a group," you know, "Oh, what do you think?" and probing them for the answer and kind of getting them to socialize and work with others whereas with the club it just seemed to happen naturally. (Post-program teacher interview in School 1)

> happen naturally… (Post-program teacher interview in School 1)
> It looks very different than [the social development curriculum in the school]. They're socially engaged. They're talking to each other. They don't require a lot of direct instruction to be social…this is a different environment for success. (Mid-program teacher interview)

Development of peer relationships

Teacher reports and field observations highlighted the social relationships in students on the spectrum developed in the programs and the associated positive affection. This social rapport extended beyond the program according to teachers' observation.

> Craig (on the spectrum), Alex (on the spectrum), Easton (non-autistic), and to some extent Kyle (on the spectrum), finished their projects early and really seemed to enjoy each other's company. It is one of the most pleasurable experiences in this program to see my students just enjoy themselves and each other's company. (Teacher log, School 3)
> Craig (on the spectrum) and Ethan (non-autistic) sat at the same table to practice their presentations, and Craig encouraged Ethan in both English and Spanish, then switched with Ethan so that they could practice presenting each other's projects, and showed Ethan how Craig would present his project in both Spanish and English. It seemed like a very supportive and sweet moment. (Teacher log, School 2)
> [Interviewer: Do you see any other ways that there could be carryover of what the kids are doing here into their school day?] Teacher: Yes. I think the social—I think the social component of it because I feel that—I supervise lunch duty and I see them sitting together and I see other students now interacting with the students they wouldn't interact [with] and I want to say that part of the reason why they're interacting with each other is because they have something in common to talk about. So I do hear that. (Post-program interview in School 2)

Opportunity for natural social interactions

Teachers associated positive peer interaction in students on the spectrum with the social opportunities provided by the Maker Club. They described the program as a relaxing environment with a flexible social structure that allowed more diverse peer interaction than in classrooms.

> With Sally (on the spectrum), I feel that she has—socially, she's kind of like more the fly on the wall and she kind of sits there and she's listening and she's interacting that way and then it's on her where she kind of chooses, "I'll go," and she chimes into certain discussions and then seeing that she did that more often during the club than in class…Even during group work [in class] and such, she's less likely to—maybe because she's focused on a task, I'm not sure exactly why, but she's more likely to jump in and the good thing was that students didn't mind her kind of putting herself into the conversations and it wasn't done in an overbearing or rude way or anything. It was kind of like a very open discussion that was going on and she just chimed in and it seemed very natural, so that was good to see as well. (Post-program interview in School 3)
> In class, his affect is kind of different… He's a little quicker to call out and stand out, but in the club, there was no real worry or there was no way to stand out in that way. There was no raising your hand to speak, there was no structure like a classroom would have where he would stand out. So while he would socialize, it wouldn't be as seamless and natural as it was in the club. (Post-program interview in School 3)

The flexible club activities that encouraged the students to develop their designs provided a common ground for social interaction in the forms of exchanging ideas and peer learning. As the students brought their interests and preferences into making, more social opportunities emerged, where the students explored the common interests with their peers in the shared making experience.

> They're talking to each other the whole time they're doing whatever they're doing. Whatever it might be about. But then when they come to a place where they get stuck, they're like, "Oh, can you help me with this?" That it's more natural. (Mid-program interview)
> I have seen them looking at each other. And it's like, "Oh, now I want to do that." Like, in our case, with the swords, there was a table that, when they were doing a block structure, one did a sword, and then everyone else did a sword. And they looked different, but it was inspired by the one student that they'd seen [make] the sword. So they see it, they're able to talk to each other about it, and then try it. (Mid-program interview)

When reflecting on their roles in supporting students, teachers highlighted the importance of enabling authentic peer interaction with minimal adult intervention. They discussed strategies to support social interaction without explicit guidance, such as setting up tables in groups rather than directly arranging seats for students.

> When we're noticing that a kid's having a hard time, offer a little bit of support, and then back away and see what they're capable of doing. And fade and fade as much as possible…The point is not for us to stay in the social moment, and to constantly have to facilitate. The point is to make ourselves obsolete and be able to fade into the background, so the students are looking to each other, rather than constantly getting distracted by adult faces, which are always in the way. (Mid-program interview)

Discussion

This study explored the effects of an interest-based school club on peer interaction. Differing from social interventions that facilitate normative social behaviors through adult or peer-directed interactions, the program sought to support peer engagement through shared activities and interests. Using a mixed-methods approach, we examined the qualitative and quantitative evidence of program outcomes and explored the program characteristics associated with social outcomes.

Our first research purpose was to explore students' social outcomes in the program. The qualitative and quantitative findings consistently showed positive program outcomes for peer engagement. The teachers highlighted increased social spontaneity in students on the spectrum during the program as compared with typical classrooms, and the students were observed to develop authentic peer relations over time that may extend beyond the program. Likewise, the analysis of social behavior rates revealed increased social responses over time in both students on the spectrum and non-autistic peers with similar growth trends. More importantly, increased social responses were only observed in social responses with high reciprocity. The growth of highly reciprocal social responses may suggest that the students developed mutual relationships or discovered shared interests over time, and thus demonstrated more engaging and in-depth conversations.

These positive social outcomes were consistent with previous studies on interventions that incorporated interests. For example, Koegel *et al.* (2013) created inclusive lunch clubs that reflected the preferred interests of each participant on the autism spectrum (e.g. movies, video games, or basketballs) in the school settings with seven adolescents on the spectrum, and the results showed increased peer engagement and social initiation. Similarly, Diener *et al*. (2015) implemented a 3-D design technology program (a one-week summer program followed by six after-school club sessions) with seven students on the spectrum (ages 8-17), which supported authentic peer relationship development through common interests and playful competition.

Inconsistent with previous studies, we found no group differences between adolescents on the spectrum and their non-autistic counterparts in baseline social behavior rates. For example, Humphrey and Symes (2011) found significantly fewer cooperative interactions in adolescents on the spectrum compared with their non-autistic peers during lunch and break periods in inclusive education. Similarly, Bauminger *et al.* (2003) observed peer interactions among children and adolescents in recess periods and found that students on the spectrum had significantly lower rates of social initiations and responses than their non-autistic peers. The discrepancy between our findings and prior studies may be explained by the different observation environments (i.e. a school club vs recess sessions) as well as the broader school context of the autism inclusion program. The differences in behavior definitions and classification between the studies may also explain for the inconsistent results.

The second purpose of this study was to explore program characteristics associated with peer engagement. Findings emphasized the supportive social environment of the interest-based school club that provided natural affordance for peer interaction. The shared club activities that supported individual interests and idea exchanges formed a natural common ground for peer interaction. The teachers in the program further associated the positive social outcomes with the flexible social environment of the club that encouraged diverse interactions without direct social instructions. Instead of teaching typical social skills, the program sought to support peer engagement by providing a safe social space that valued individual interests where adolescents on the spectrum could develop peer connections and a sense of belonging. This strength- and support-based approach has been shown by prior research to be beneficial for authentic peer relationship development and may cause less social-emotional distress than skill-building social interventions (Diener *et al*. 2015, Vidal *et al.* 2018). The research findings on program characteristics that support social interaction may be applied to other educational settings. While school clubs differ from general education settings in terms of students' voluntary participation and the flexibility of their curriculum, certain characteristics of school clubs can be replicated in classrooms. For example, curriculum design may emphasize activities that align with students' interests to promote peer interaction in the classroom (Chen *et al*. 2021b).

Limitations and future directions

There were several limitations to be considered in this study. Although this is one of the few studies to investigate real-world peer interaction among adolescents on the spectrum and their peers in an inclusive education setting, the small number of participants may decrease the power of the quantitative analysis. However, through a longitudinal observation, we were able to obtain a substantial amount of data, which further enabled an investigation of longitudinal changes in peer interaction.

We did not use any standardized social outcome measures, which prevented a direct comparison to other studies. However, existing social outcome measures primarily capture social skills or the presence of neurotypical social behaviors (e.g. eye contact or integration of verbal and non-verbal behaviors), which did not align with the purpose of the study. As the school program aimed to support peer engagement instead of building normative social capacities, we deemed a performance-based observation more appropriate. Although we were not able to capture facial expression and eye contact due to privacy concerns, these behaviors are not critical in autistic social communication nor do they reflect autistic people's social motivation (Jaswal and Akhtar 2018), thus we deemed this limitation acceptable.

Conclusion

This mixed-methods study explored the effects of an interest-based Maker Club for adolescents on the spectrum and their non-autistic peers in inclusive education, and the findings showed positive peer engagement, relationship development, and increased peer interaction and reciprocity. The study highlights the value of strength-based social interventions that provide supportive social environments for adolescents on the spectrum. The results can inform school-based social support programs that incorporate students' interests in extracurricular learning activities.

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Disclosure statement

The authors have no conflict of interest to declare.

Additional information

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Notes

1 This paper uses a neutral term "students on the spectrum" or an identity-first language (i.e. autistic student) instead of the person-first language (i.e. students with autism), because research shows that autistic individuals and their families preferered those terms Kenny, L., Hattersley, C., Molins, B., Buckley, C., Povey, C. & Pellicano, E. 2016. Which terms should be used to describe autism? Perspectives from the uk autism community. *Autism,* 20, 442-462.

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