Journal of Autism and Developmental Disorders
https://doi.org/10.1007/s10803-020-04532-1

ORIGINAL PAPER

Thinking Small to Think Big: Modular Approach for Autism Programming in Schools (MAAPS)

Cynthia M. Anderson[1] · Rose Iovannone[2] · Tristram Smith[3] · Lynne Levato[3] · Ryan Martin[1] · Brenna Cavanaugh[3] · Sam Hochheimer[3] · Hongyue Wang[3] · Suzannah Iadarola[3]

Abstract

To date there are no evidence-based comprehensive interventions for use in school settings. There are numerous barriers to delivery of high-quality interventions in schools that have limited the transfer of research-based interventions to school settings. *Modular Approach to Autism Programing for Schools (MAAPS)* is a framework for implementation of evidence-based interventions in school settings that is designed to address these barriers. The development and initial evaluation of MAAPS was conducted using an implementation-science framework and results indicate that MAAPS is aligned with needs and resources available in schools, that it had excellent social validity, and that there is good evidence that MAAPS is effective for addressing core and associated features of autism in educational settings.

Keywords Autism · Autism spectrum disorder · School · Comprehensive intervention · RE-AIM · Feasibility study · Pilot research

The current reported prevalence of autism spectrum disorder (ASD) is estimated at 1 in 59 (Baio et al. 2018). Given that many individuals with ASD are served in public schools, educators are increasingly responsible for identifying, designing, and delivering interventions to address the needs of this diverse group of students. Recent reviews of the literature have identified both comprehensive and focused interventions that address core and associated features of ASD. Comprehensive interventions are designed to address most or all features of ASD and to be delivered over multiple months or even years (see Smith and Iadarola 2015 for a recent review) whereas focused interventions are limited in scope and designed to be implemented for shorter periods of time (see Wong et al. 2015 for a review). To date, there are no comprehensive interventions with evidence supporting their use in schools. Although a growing body of work supports use of focused interventions within school settings (Anderson et al. 2017, 2018), they are rarely adopted or implemented with fidelity in schools (Hess et al. 2008; Stahmer and Aarons 2009; Stahmer et al. 2005). Further, even when evidence-based interventions (EBIs) are implemented, educators tend to use them alongside untested interventions or interventions shown to be ineffective (Burns and Ysseldyke 2009; Ferreri et al. 2016; Hendricks 2011; Stahmer 2007).

There are two likely reasons for the lack of adoption or sustained use of EBIs. First, most research has been conducted in highly-controlled settings (e.g., clinics, university-run lab schools) by trained research project staff instead of typical educators (Kasari and Smith 2013), and often on a 1:1 basis (Strain and Bovey II 2011). Educators typically have little or no training in a specific intervention, fidelity of implementation is not monitored in schools, and resources to support implementation are limited. Oftentimes 1:1 support is not available for most students with ASD. Second, the wide diversity in presentation of students with ASD also makes adoption challenging as significant knowledge and skill is needed to match and customize EBIs to each unique student's needs. Unfortunately for educators, there are no evidence-based resources to guide how best to select and

Dr. Tristram Smith passed away after completion of data collection for this project.

✉ Cynthia M. Anderson
canderson@mayinstitute.org

[1] May Institute, 41 Pacella Park Drive, Randolph, MA 02368, USA

[2] University of South Florida, Tampa, FL, USA

[3] University of Rochester Medical Center, Rochester, NY, USA

Published online: 14 May 2020

combine targeted intervention strategies into a package that is both appropriate for any given student and also feasible within the educational context.

Within school-based research, there is growing emphasis on using implementation science frameworks to systematically assess factors related to uptake of new interventions in real world settings (Eccles and Mittman 2006). Of existing frameworks, RE-AIM (Glasgow et al. 1999) has particular relevance for dissemination efforts in schools (Cook and Odom 2013). RE-AIM represents critical implementation-related elements (i.e., Reach, Efficacy, Adoption, Implementation, and Maintenance) that should be addressed in research on an intervention to improve the uptake and sustainability of that intervention. In this framework, *reach* is the number of individuals who participate in a study and the extent to which they are representative of the target population. For example, the large body of research on multicomponent interventions for young children with ASD may not be generalizable to school-aged children. *Effectiveness* refers to not simply whether an intervention was found to result in significant improvement in targeted outcomes but also documentation of any negative effects or unintended consequences. *Adoption* refers to those (in this case schools) who agree to adopt an intervention and the representativeness of those settings and individuals. For example, if an intervention is adopted only by private schools for students with ASD, we might question whether it would and could be adopted within public schools. *Implementation* refers to the extent to which an intervention could be and was implemented as designed (i.e., with fidelity). Equally important is an assessment of the cost of implementation with quality, in terms of staff time and other resources needed. Finally, *maintenance* refers to whether and how the intervention "sticks," and becomes part of the organizational practices of the classroom, school, or district that participated in the study. Although the RE-AIM framework has been evaluated in public health research (e.g., Glasgow et al. 1999), and various models of implementation science frameworks have been examined in exploring the research-practice gap (e.g., Dingfelder and Mandell 2011; Locke et al. 2016), RE-AIM dimensions have not been consistently included or evaluated for classroom-based EBIs focused on students with ASD.

To address (1) the above-described challenges, and (2) the broader implementation context, there is a need for a comprehensive intervention approach that provides a framework for school teams to select and implement focused interventions that can address the array of needs presented by students with ASD. This framework should provide a structure that can enhance feasibility of intervention implementation in authentic school environments by having contextual fit and be both effective and sustainable. We developed the Modular Approach for Autism Programs in Schools (MAAPS) to address these needs.

As a first step towards the evaluation of efficacy and adoption of MAAPS, we assessed the feasibility of MAAPS in schools and the practicality and utility of our proposed measures. Feasibility studies such as this are a key first step to determine whether further evaluation of an intervention in a more rigorous clinical trial is appropriate. An intervention that is appropriate for further study is one that is both relevant to the needs the intervention is designed to address and has evidence that it will be adopted and sustained. Thus, the purpose of our study was to use the RE-AIM framework to assess the viability of MAAPS for adoption, sustained and high-quality implementation, and achievement of meaningful outcomes for students with ASD. We assessed this by (1) obtaining feedback on MAAPS from experts in the field and stakeholders, and (2) conducting a study to assess whether outcomes achieved via MAAPS were suggestive of positive outcomes for participants.

Methods

Phase I: Feedback from Experts and Stakeholders

Expert Feedback

Prior to conducting a pilot of MAAPS, we solicited feedback from experts in the field and from stakeholders. From experts we hoped to assess the perceived validity of the MAAPS framework and of intervention modules. We asked stakeholders for feedback on the feasibility and social validity of MAAPs.

We began by soliciting feedback from six researchers who had published widely in the areas of ASD and EBP and from five practitioners who provided behavioral consultations and assistance to individuals with ASD and stakeholders. Experts completed two structured surveys in which item responses were scored on 4-point Likert-scale (Not at all, A little, Mostly, Completely). Questions on one survey were organized around the overall framework for delivery of MAAPS and the other focused on module content. The survey on the MAAPS framework consisted of five items assessing the extent to which MAAPS aligned with extant research, had contextual fit and relevancy for students with ASD and their educators, was functional for use by educators, and would increase inclusive opportunities. Content-specific surveys included items similar to those on the framework survey but focused on the specific topic as well as additional questions regarding the appropriateness and usefulness of the materials. For each survey item, we divided the number of experts who rated an item positively by the total number of experts. We reviewed all items with a rating of less than 0.8 (as recommended by Davis 1992). This

feedback informed question development for subsequent focus groups.

Feedback on the framework was positive and resulted in no modifications. Feedback on modules also was positive; experts provided suggestions for enhancing several modules, for example by combining two modules into one and providing clearer guidelines for implementation for another. We incorporated their feedback in all cases.

Focus Groups

To gather information specific to the MAAPS intervention package, we conducted a series of focus groups with school administrators, educators, and parents/guardians. A total of 69 people participated across 13 groups, and we separated groups based on role (administrator, educator, parent). Groups were run by a trained facilitator who used a semi-structured interview protocol that was standardized across all sites. We audio-recorded the interviews for later transcription and scoring. Content analysis of data followed standard conventions of team-based qualitative research (Guest and MacQueen 2008; Miles et al. 2013; Silverman et al. 1990), which included an iterative discussion process among research team members as themes and patterns were identified for each of the five primary codes and sub-codes. All data were gathered before starting content analysis. A set of codes based on the focus group questions was identified and defined a priori by the research team, followed by development of a codebook. The codebook included code names, definitions, inclusion/exclusion criteria, and code application examples (Miles et al. 2013). The analysis phase was conducted at two levels-individual and cross-site. First, at least two members of the research team from each site independently coded their site's transcripts and entered the coded transcripts into a shared database. Next, several virtual cross-site meetings were held to discuss the coding results, resolve disagreements, and come to consensus on themes. Intercoder reliability (Guest and MacQueen 2008; Silverman et al. 1990) was developed via discussions of similarities and differences in coding and coming to agreement on the final codes, making any necessary modifications to codes and definitions based on the collective understanding of the research team members.

Not surprisingly, groups identified a lack of resources (time, trained personnel, finances) as the primary barrier to supporting students with ASD. They also noted a lack of training in EBIs as a significant barrier (Iovannone et al. 2019). With regard to MAAPS, participants' statements suggested that MAAPS would fit within their schools well and that the framework, particularly the training and ongoing coaching, would address existing barriers including lack of adequate training and trained staff. No changes to the MAAPS modules were recommended by stakeholders. Stakeholders uniformly commented on the collaborative nature of MAAPS as a positive feature, and so we modified a manual we developed for coaches to provide more guidance around collaborative work with educators and families. For example, we included material on how to develop and maintain rapport, provide support to teachers, and how to give performance feedback in an evidence-based and supportive manner.

Phase II: Pilot Randomized Controlled Trial

Because there are currently no comprehensive modular interventions with empirical support in school settings, our primary goal was to assess educator perceptions of the feasibility and sustainability of MAAPS after they had experience implementing the intervention. Feasibility outcomes are critical in new interventions, as they provide the following information: (1) Proof-of-concept for the ability to recruit and retain target participants; (2) Evidence supporting the ability to implement procedures with fidelity; (3) Data on social validity of interventions, which could inform intervention refinements; and (4) Quality of data collected. In combination, the data gathered from a feasibility study are essential for supporting the rationale for a larger-scale efficacy trial. As described earlier, we used the RE-AIM model (Kessler et al. 2012) to evaluate feasibility by comparing the intervention and control groups. Indicators, data collection methods and measures used to operationalize RE-AIM are in Table 1 and are described in the next section. Because our primary question had to do with overall feasibility of MAAPS and the sensitivity of our measures to detect change in the RE-AIM framework, we elected to conduct an underpowered RCT (smaller sample size) to determine whether it

Table 1 data collection methods and measures used to operationalize reach, effectiveness, adoption, implementation, and maintenance (RE-AIM) dimensions

Dimension	Indicator(s)	Data collection method/measure
Reach	Students receiving the intervention at each school at exit	Demographic data
Effectiveness	Student outcomes	DD-GAS
Adoption	Ratings of contextual fit at exit	URP-IR
Implementation	Fidelity ratings	Coach self-assessment
Maintenance	Fidelity at exit as compared to mid-year	Fidelity checklist

is reasonable and feasible to conduct a full trial and whether the components of MAAPS were effective.

Methods

Participants and Setting

The study was conducted in Florida, Massachusetts, and New York. The study was approved by the Institutional Review Board (IRB), and University of Rochester served as the IRB of record. We used a hierarchical recruitment process, that moved through permissions from district administration, to building principals, to classroom educators, and finally to parents and students (when able to do so). Consent to participate was provided by teachers and parents. When appropriate, students provided assent.

Students were recruited from 14 schools (4 in Florida, 4 in Massachusetts, and 6 in New York). Using National Center for Educational Statistics (USDE 2017) categorization, 71% of participating schools were suburban, 14% urban, and 14% rural. Ninety-three percent of the schools were eligible to provide free and reduced fee lunches, and 57% were Title I schools. The average school size was 620 students (range 508 to 748). Student teacher ratio averaged 14:1 (range 13:1 to 14:1).

Student inclusion criteria were as follows: (1) placement in grades, K-8 (2) receipt of individual educational plan (IEP) services under the educational category of Autism in their district; and (3) confirmation of ASD diagnostic criteria via the Autism Diagnostic Observation Schedule, 2nd Edition (ADOS-2; Lord et al. 2012) as administered by a research-certified diagnostician. The ADOS is considered the gold standard of autism diagnostics and is a semi-structured assessment that includes standardized activities with a combination of highly structured activities and interactions and less structured interactions. Teacher criteria included (1) having an eligible student in their classroom whose parents provided consent and who, when appropriate, provided assent to participate; and (2) identification as a "lead" teacher (i.e., the teacher with whom the consented student spent the bulk of his/her school day). To characterize the sample, data were collected on student IQ from school records, if completed within a 1-year period, otherwise project staff administered an appropriate and psychometrically valid assessment of IQ.

A total of 35 students and 39 educators were screened for participation. Of potential student participants, 2 did not meet diagnostic criteria for ASD, 4 were excluded because educators declined to participate, and one student was excluded due to a change in school placement after consent but prior to randomization. Of the 39 educators who were screened, nine consented to participate; however, their selected student did not participate, and two declined to participate (one was taking family/medical leave and the other switched to a new classroom). Thus, a total of 28 students and 28 educators participated. Demographic information for all participants is in Table 2. Of note, although the mean IQ for both groups was in the average range, there was diversity of IQ in both groups (range 47–139).

Because we were evaluating the feasibility of the MAAPS intervention, project staff served as MAAPS coaches. Coaches held a Master's or Doctoral degree in Behavior Analysis, School Psychology, or Clinical Psychology and had backgrounds in behavior analysis and school-based interventions for students with ASD. A single coach worked with each student and his/her teacher and team; each coach worked with multiple teams. Prior to serving as coaches, each attended a 3-h training on implementation of MAAPS, reviewed the coaching manual, and the goals and process for each of the 27 modules (see Table 4). When a module was selected by the team, the coach received behavioral skills training on the module. This included didactic instruction, modeling, and role-plays, and continued until the coach was able to implement all features of the module with 100% fidelity during role-plays. The duration of training ranged between 30 min and 1 h per module. The duration of training varied somewhat per coach but ranged between 30 min and 1 h per module. completed after module selection and prior to the next scheduled meeting.

Measures

As noted earlier, we used the RE-AIM model (Kessler et al. 2012) to evaluate feasibility and potential for sustainability by comparing the intervention and control groups. The schedule of measures is in Table 3.

Reach is a measure of the number of individuals who participated in MAAPS as well as the extent to which participants represented our target population (students with ASD and their teachers). We evaluated our reach using demographic data on students, teachers, and schools. These data were collected at screening via demographic surveys (parents, educators).

Effectiveness is a measure of the efficacy of MAAPS and involves assessing both positive outcomes and any negative or unintended consequences. For the latter, we developed a comprehensive system for reporting unintended outcomes and protocol deviations, however none was reported by participants or observed by our research team. We measured effectiveness in several different ways. To assess changes in overall functioning we used the *Developmental Disability-Clinical Global Assessment Scale (*DD-CGAS; Wagner et al. 2007). The DD-CGAS is a rating scale organized in deciles (range 1–100 where 1 is extreme and pervasive impairment and 100 is superior functioning) and is used to assess global

Table 2 Participant characteristics

	MAAPS (n = 14)	ETAU (n = 14)	p-value
Students			
Gender			0.307
Male	10 (71%)	11 (79%)	
Female	4 (29%)	3 (21%)	
Age (years): M(SD)	8.07 (2.0)[a]	8.14 (2.1)[a]	0.926
IQ: M(SD)	90.4 (24.3)[a]	84.5 (25.0)[a]	0.540
ADOS Comparison Score	7.7 (1.8)[a]	7.6 (1.5)[a]	0.947
Race			0.296
African-American	3 (21%)	0 (0%)	
American Indian/Alaskan Native	0 (0%)	1 (7%)	
Asian	2 (14%)	0 (0%)	
Caucasian	9 (64%)	12 (86%)	
Multi-racial	0 (0%)	1 (7%)	
Ethnicity			0.684
Hispanic/Latino/Spanish	1 (7%)	2 (14%)	
Not Hispanic/Latino/Spanish	12 (86%)	10 (71%)	
Did not disclose	1 (7%)	2 (14%)	
Classroom placement			0.184
General education	0 (0%)	2 (14%)	
General education with some special education	5 (36%)	7 (50%)	
General special education	1 (7%)	2 (14%)	
DD-specific special education	8 (57%)	3 (21%)	
Attending Title 1 School	6 (43%)	6 (43%)	0.481
	MAAPS (n = 14)	ETAU (n = 14)	p-value
Teachers			
Gender			
Male	0 (0%)	0 (0%)	
Female	14 (100%)	14 (100%)	
Race			0.222
African-American	1 (8%)	0 (0%)	
American Indian/Alaskan Native	1 (8%)	0 (0%)	
Asian	1 (8%)	0 (0%)	
Caucasian	11 (84%)	14 (100%)	
Multi-racial	0 (0%)	0 (0%)	
Ethnicity			0.480
Hispanic/Latino/Spanish	0 (0%)	2 (14%)	
Not Hispanic/Latino/Spanish	12 (92%)	11 (84%)	
Did not disclose	1 (8%)	0 (0%)	
Highest level of education			0.157
Bachelor's degree	4 (31%)	2 (14%)	
Graduate degree	7 (54%)	12 (86%)	
Other	2 (14%)	0 (0%)	
Did not disclose	1 (7%)	0 (0%)	

DD developmental disabilities, *ETAU* enhanced treatment as usual, *MAAPS* modular approach for autism programs in schools

[a]Standard deviation

Table 3 Schedule of measures

Measure	Assessment timepoint			
	Screen	Pre-intervention	Mid-intervention	Exit
ADOS-2	+			
SB-5	+			
SSIS-RS		+		+
ABAS-3		+		+
CYBOCS-ASD[a]		+	+[b]	+
DD-CGAS[a]		+	+	+
TNTB[a]		+	+	+
AET		+	+	+
URP-IR				+
Coach Quality			+	+

ADOS-2 Autism Diagnostic Observation Schedule, Second Edition, *SB-5* Stanford Binet Intelligence Scales, Fifth Edition, *SSIS-RS* Social Skills Improvement System Rating Scales, *ABAS-3* Adaptive Behavior Assessment System, Third Edition, *CYBOCS-ASD* Children's Yale-Brown Obsessive Compulsive Scale for children with autism spectrum disorder,, *DD-CGAS* Developmental Disabilities Clinical Global Assessment Scale, *TNTB* Teacher Nominated Target Behaviors, *AET* Academic Engaged Time, *URP-IR* Usage Rating Profile-Intervention (Revised)

[a]Measures completed by independent evaluators blind to treatment condition

[b]Optional assessment timepoint

functioning in treatment studies with children with ASD. The DD-CGAS has excellent inter-rater reliability (0.79) and temporal stability (0.86), shows convergent validity with other measures of functioning (0.50), and is sensitive to treatment effects (Wagner et al. 2007). Blinded raters completed the DD-CGAS using scores on other measures at baseline, at midpoint, and at the end of the year (exit, June). In addition to the primary outcomes (i.e., DD-CGAS), we identified several secondary outcomes.

We assessed changes in core deficits of ASD using two measures, the *Social Skills Improvement System-Rating Scales (SSIS-RS*; Gresham and Elliott 2008) and the *Children's Yale-Brown Obsessive Compulsive Scale, ASD Version (CY-BOCS-ASD* Scahill et al. 2006). The SSIS is an informant-rated questionnaire that includes items related to two broad domains: Social Skills and Problem Behavior. Informants rate the individual on the frequency of various behaviors using a 4-point Likert scale (Never, Seldom, Often, Always). The SSIS-RS has good median scale (0.90) and test–retest reliability (0.82–0.87; Gresham et al. 2011), and it correlates with other well-established measures, such as the Vineland and the BASC (Gresham et al. 2010). In this study, teachers completed the SSIS-RS at baseline, midpoint, and exit. Domain scores were used as secondary outcome measures, in addition to informing independent evaluator ratings on the DD-CGAS. The CYBOCS-ASD is a modified version of the CY-BOCS originally developed for use in children with Obsessive–Compulsive Disorder and later adapted for children with ASD (Scahill et al. 2014) to rate the current severity of repetitive behavior. The CYBOCS-ASD is a semi-structured scale completed by trained assessors (project staff). A given participant's repetitive behaviors are rated on five dimensions: Time Spent, Interference, Distress, Resistance, and Control on a 5-point scale from 0 (least symptomatic) to 4 (most symptomatic), yielding a Total score from 0 to 20. It has established internal consistency (0.86) and reliability (0.90; Wu et al. 2014) and is a standard outcome measure for assessing restricted and repetitive behavior in intervention studies of ASD (Scahill et al. 2014). The CY-BOCS ASD was used as a secondary outcome measure and to inform independent evaluator ratings for the DD-CGAS.

We measured changes in the following features often associated with a diagnosis of ASD: challenging behavior, adaptive behavior, academic engagement. We assessed challenging behavior using an adapted form of Goal Attainment Scaling (Ruble et al. 2012; Schlosser 2004) that we called *Teacher-Nominated Target Behavior (TNTB)*. Studies using Goal Attainment Scaling have assessed progress toward IEP goals but because student IEP goals did not necessarily align with core and associated features of ASD, we instead asked teachers to identify three priority outcomes for the student at baseline. An independent evaluator helped the teacher develop operational definitions of the outcomes prior to the start of the study. Then, the evaluator reviewed each skill and definition with the teacher at midpoint and exit, and an improvement rating was assigned (from 1 = Very much improved to 7 = Very much worse).

To assess changes in adaptive behavior we used the *Adaptive Behavior Assessment System, Second Edition (ABAS-2* Harrison and Oakland 2003)—*Self-Direction Subscale.* Teachers provided ratings on the Self-Direction Subscale of the ABAS-2 at baseline and exit to assess changes in the student's independent academic and social behaviors in the classroom. Items were rated on a 4-point Likert scale from 0 (not able) to 3 (always). The ABAS has acceptable internal consistency (0.98) and construct validity (0.78–0.93) for the subscales).

Finally, as a measure of engagement with academic activities, we used *Academic Engaged Time (AET).* The AET, part of the multi-gated Systematic Screening of Behavior Disorders (SSBD; Walker and Severson 1990), is a direct observational measure that uses a stop-watch to record the duration of time a student is actively engaged during independent instructional time. Each student was observed by a trained rater for two 15–20 min sessions which were averaged at each measurement interval (baseline, mid-point, exit). Training procedures included raters getting a didactic training on observational procedures used by the AET,

examples and non-examples of AET definitions, practice using the AET with videos of students in classroom sessions, and feedback from project PIs. All raters were required to demonstrate 0.90 interobserver agreement prior to collecting the data from the participants. The AET has been used in multiple research studies and has shown excellent interrater reliability (Walker et al. 2009).

Measures of *adoption* assess the number and representativeness of the individuals who participated and factors that may affect widespread adoption. Within the MAAPS group, we assessed this via the *Usage Rating Profile-Intervention (Revised)* (URP-IR; Chafouleas et al. 2009). The URP-IR is a 29-item, 6-point Likert rating (Strongly disagree to Strongly agree) with four factors: acceptability, understanding (which may reflect likelihood of continued use), feasibility, and systems-support for the intervention. The four factors of the URP-IR were derived from a study of 254 educators (Chafouleas et al. 2009). The URP-IR was completed at the end of the school year.

Implementation is an indicator of fidelity of each element of the intervention. For MAAPS that included fidelity of coaching and coaching quality, and teacher use of interventions developed via MAAPS modules.

Fidelity of Coaching

First, coaches used a fidelity checklist to self-assess dose of coaching and adherence to the MAAPS process (i.e., coach fidelity). The checklist was completed after each coaching session. Second, project staff scored 30% of team-meetings using a fidelity checklist of key features to be covered during team meetings. To facilitate this process, all team meetings were audio-recorded and at least 30% (range 30–70% scored for IOA) were randomly selected for coding by an independent evaluator.

Teacher Fidelity and Quality

Second, coaches monitored fidelity of implementation of MAAPS modules by teachers (i.e., teacher fidelity) using a 10-item checklist. The checklist had four content areas: General/Organizational Components (e.g., intervention implemented when it should have been, educator arranged environment or had materials needed), Teaching/Antecedent Strategies (specific antecedent strategies such as reviewing rules), Prompting Strategies (specific stimulus and/or response prompts as indicated in the student's intervention), and Consequence Strategies (specific strategies to follow desired and/or undesired behavior). Each time a coach assessed fidelity of implementation of a module by a teacher, the coach also assessed quality of implementation. The quality rating indicated how well teachers delivered the intervention to students. Quality was assessed by three items including: Rapport and Responsiveness (e.g., attentive to student, high ratio of positive to negative statements), Communication (e.g., developmentally and child-appropriate tone and volume, clear and specific instructions, appropriate nonverbal communication), and Flexibility (e.g., implemented intervention fluently) on the same 3-point scale. Ratings were assigned across individual items for adherence (0 = not completed to 3 = full adherence) and quality (0 = seldom demonstrates the skill to 3 = always demonstrates the skill). Means were expressed as a percentage of points earned divided by total possible points.

Coaching Quality Scale

We assessed teacher-reported quality of coaching delivery using a 10-item checklist with items rated on a 4-point scale ranging from never to always. Items on this scale evaluated teacher impressions of coach interactions such as the extent to which they agreed on goals, whether the coach communicated effectively, was approachable, and whether the teacher trusted the coach. Coaching quality was evaluated at midpoint and again at the end of the year.

Randomization and Condition Descriptions

Participant flow is documented in Fig. 1. A cluster randomized design was implemented in this study. Participating schools from 3 sites were equally assigned to either MAAPS or enhanced treatment as usual (ETAU) group. The randomization sequence was generated by the project statistician and was stratified by site. Randomization occurred once consent from participating teachers and students' parents was obtained.

MAAPS

The MAAPS program is a framework for implementation of evidence-based treatments. Interventions in MAAPs were identified based on systematic reviews of the literature (National Autism Center 2015; Wong et al. 2015), that used published and agreed upon criteria for defining a practice as evidence-based. Although the initial aim was to include only interventions with evidence supporting their effectiveness in school settings, there were insufficient interventions that met this standard (Anderson et al. 2017); therefore we included all interventions that met criteria established by Wong et al., and the National Autism Center as evidence-based regardless of where implementation occurred. Interventions in MAAPS are organized into modules around the core and associated features of ASD as depicted in Table 4 Each module was designed to be implemented independently of others, as a standalone module, although multiple modules could be implemented simultaneously.

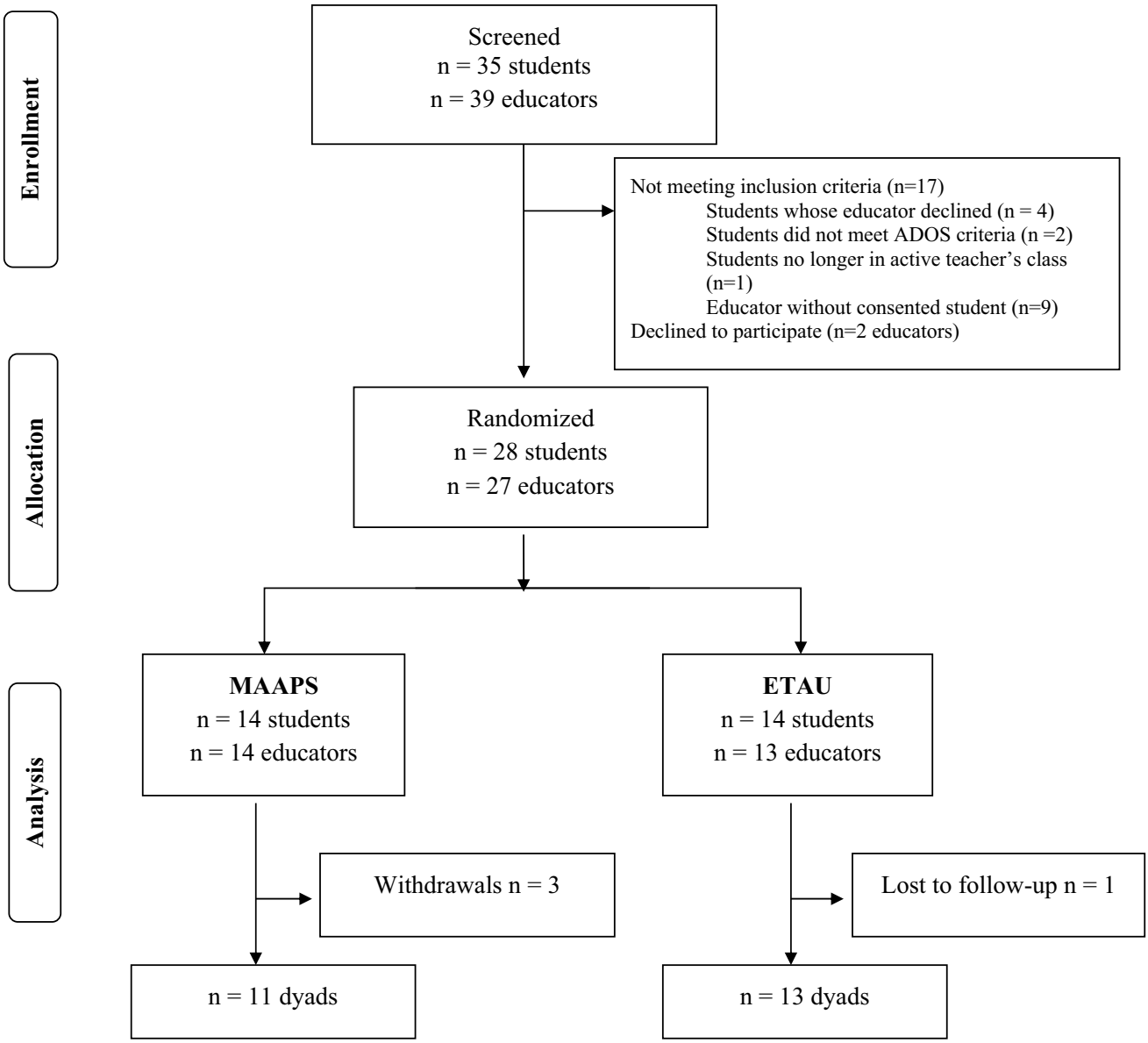

Fig. 1 MAAPS consort diagram

Module selection for a student occurred during an initial MAAPS meeting attended by the student's teacher, parent or care provider, and any other stakeholders identified as important by the parent and teacher (e.g., speech therapist). During this meeting, coaches used a semi-structured interview to help team members identify goals for a student and select appropriate module(s) based on a student's specific strengths and deficits that would directly address the goals. If a team selected multiple modules, the coach helped them prioritize up to three modules, and to set a tentative date to begin each module, only one module was taught at a time. When the team was ready to begin another module, the coach met with the teacher and provided training on the next selected module.

Each intervention module included all of the materials a coach would need to teach an educator how to design, initiate, and implement an intervention including: (a) an overview of the conceptual basis and empirical support for the intervention in the module, (b) an outline for the coach to follow in meeting with an educator to fully develop the intervention and train the teacher in its use, (c) sample materials, and (d) vignettes illustrating implementation of the module. Once an intervention module was selected, the coach met with the teacher to explain the main components of the intervention and to determine key features of implementation. For example, if the intervention focused on increasing requesting, the coach would help the teacher identify activities or items the student enjoyed, determine how each

Table 4 MAAPS modules by core or associated feature of autism addressed

Social communication and interaction	Cognitive/academic difficulties
Foundational skills	Motivation and work completion
Requesting	Visual cues
Basic communication	Reinforcement systems
Peer partner and engagement	Environmental modifications
Basic play skills	Opportunities to respond
Advanced communication Skills	Learning new skills
Nonverbal communication	Instructional support
Recognizing social cues	Learning strategies
Conversation	Peer tutoring
Sustaining social interactions	Restricted and repetitive behavior
Group games	Difficulty with unexpected changes
Group activities	Planning for the unplanned
Dramatic play	Schedules
Developing friendships	Repetitive behaviors
Peer networks	Automatically reinforced SIB
	Motor stereotypy
	Vocal stereotypy
	Sensory differences
	Restricted interests
	Increasing variability
	Engagement
	Rituals

would be requested (e.g., by saying the name of the item or an approximation of the name), and when and how teaching would occur (e.g., how many times per day, by whom, where). Prior to implementation, the coach used behavioral skills training (e.g., Parsons et al. 2012) to help the teacher learn the intervention. When implementation began, the coach conducted classroom observations at least weekly to assess fidelity of implementation and provide feedback based on teacher reflection and observations to enhance implementation. The MAAPS team continued to meet at least monthly (face-to-face or via email as desired by the team) to monitor outcomes and plan next steps, including implementing subsequent selected modules.

Enhanced Treatment as Usual

Teachers in schools randomized to the control group received a book guiding implementation of a school-based intervention (Smith 2011). In addition, the schools in the control group were offered an array of training topics aligned with the MAAPS modules from which they could select up to 12 h of didactic training. Training presentations were 1–3 h in length and covered key features of interventions associated with the selected topic; didactics also focused on implementation of procedures in a school setting. No other supports were provided.

Analysis Plan

Baseline group differences were assessed across demographic variables, as well as primary and secondary outcomes using t-tests (for continuous variables) or Chi-square tests (for nominal variables). All outcome analyses were conducted following the intention-to-treat principle. For the primary outcomes, linear mixed effects models were fitted with repeated DD-CGAS scores as dependent variables, and treatment group as the independent variable. Based upon previous literature, analyses were controlled for baseline measures, student IQ, ethnicity, classroom type, and whether schools were designated as Title 1. To evaluate how the outcome at all assessment points, including baseline, changed over time for each group, the interaction between treatment and time was tested. Specified contrasts were tested to assess both the within-group changes and the between group-differences at each time point. Effect sizes were calculated as Cohen's *d* for paired samples, to account for change from baseline. Site effects were investigated by comparing the DD-CGAS outcomes across three sites and calculating the Intraclass Correlation Coefficient (ICC). Identical procedures were conducted for secondary outcomes. Missing data and missingness patterns were examined to determine if the subjects with missing data differed significantly from the remaining sample in terms of subject characteristics. All missing data were determined to be missing completely at random. Inference-based Linear Mixed Modeling is valid for situations that include non-informative (i.e., randomly) missing data or when missingness does not depend on the value of the unobserved outcome.

Results

Baseline Analyses

Both groups were compared at baseline on multiple child and teacher demographic characteristics, as well as on the outcome measures. No significant baseline group differences were observed, with the exception of higher impairment ratings for the Self-Care Domain of the DD-CGAS for the MAAPS group ($p = 0.048$) (see Tables 2 and 5). At baseline, IQ was positively correlated with DD-CGAS total score ($p < 0.001$) and negatively related to impairment across the following DD-CGAS subdomains: Communication ($p < 0.001$), School/ Academic ($p < 0.001$), and Self-Care ($p = 0.007$), but not Social Behavior ($p = 0.61$). More time spent by the student in a special education setting was positively correlated to impairment on three DD-CGAS subdomains (i.e., Communication; $p = 0.004$; School/ Academic; $p = 0.01$; and Self-Care; $p = 0.05$) and negatively related to DD-CGAS total score ($p = 0.03$). With respect to school characteristics, placement in a Title 1 school was positively related to impairment for the Communication ($p = 0.04$) subdomain and negatively related to DD-CGAS total score ($p = 0.03$).

Reach

We assessed REACH by comparing the number of students for whom a MAAPS team formed to the number of students still participating at exit (see Fig. 1). Our study periods included recruitment (October 2017–February 2018), baseline (January–February 2018), and exit (May–June, 2018). With respect to recruitment and retention, we enrolled 74% of participants screened, including teachers and students. Across sites, 85% of students in schools randomized to MAAPS completed the study (12 of the 14 students) and 93% of students in schools assigned to control completed the study (13 of 14 students). All withdrawals occurred due to either a change in student placement (one student each in MAAPS and control) or to loss of a teacher (one student in MAAPS whose teacher took family/medical leave).

Effectiveness

Although we were underpowered to detect meaningful change and to confidently extrapolate from the findings, efficacy analyses were completed with the goals of identifying initial trends in child outcomes.

Preliminary Child Outcomes

Preliminary efficacy was explored on our primary child-level outcome, overall school functioning, with the DD-CGAS (see Table 5). Students in the MAAPS group showed gradual increases in DD-CGAS scores from baseline ($M = 51.5$) to midpoint ($M = 54$) and then at exit ($M = 61$). When controlling for baseline scores, the MAAPS group demonstrated a significant main effect of time, with an increase in the mean DD-CGAS total score at exit ($p \leq 0.001$) and with a large effect size ($d = 0.94$). In addition to statistically significant change, the increased total score in the MAAPS group represents a clinically significant improvement in functioning from "moderate" impairment to "slight" impairment. In contrast, the ETAU group did not show change in functioning across timepoints (i.e., M = 57.5 at baseline, $M = 58.5$ at midpoint, $M = 60$ at exit; $p = 0.22$), with scores remaining stable.

A group by time analysis did not reveal significant interaction effects for either change from baseline to midpoint ($p = 0.44$) or for change from baseline to exit ($p = 0.67$) for the DD-CGAS Total Score and for the subdomain impairment ratings (Table 5). However, for DD-CGAS Total Score there was group by time interaction for improvement from midpoint to exit that favored the MAAPS group over the ETAU group (Difference in Least Squared Means = 3.19; $p = 0.01$). Further, visual analysis (see Fig. 2; DD-CGAS Total Score) demonstrates that the pattern of results is suggestive of a group by time interaction at exit for the overall DD-CGAS and for the individual subscales. In the context of these favorable trends for MAAPS, the lack of significant findings is likely resultant from low power to detect change.

In addition to DD-CGAS total score, we evaluated the groups across the four domains (i.e., social behavior, communication, school/academic, and self-care; see Table 5 and Figs. 3, 4, 5 and 6). With respect to raw means, students in the MAAPS group were rated as having greater impairment than the ETAU group at baseline across all domains. For communication (Fig. 3), social behavior (Fig. 4), and school/academic (Fig. 5), the MAAPS group improved over time, such that impairment was lower at exit, as compared to ETAU, although not significant (p = 0.06). Within the communication and school/academic domains, MAAPS had caught up to ETAU by midpoint. However, when controlling for baseline score, these improvements were not statistically significant. In contrast to the overall trends towards improvement in MAAPS, the ETAU group's impairment ratings were fairly stable (i.e., school/academic, communication) or decreased slightly (i.e., social behavior) over time. There were no changes in either group over time on the self-care subdomain (Fig. 6), with the MAAPS group rated as having more impairment at baseline, midpoint, and exit.

Secondary Child Outcomes

A summary of within-group analysis can be found in Table 6. Results at mid- and exit indicated that the

Table 5 Means and standard deviations of both groups for primary and secondary outcome measures

Scale	MAAPS		ETAU		*p* value*
	M	SD	M	SD	
DD-CGAS total					0.69
Baseline	51.50	17.69	57.50	16.50	
Mid-point	54.00	20.71	58.54	15.38	
Exit	60.91	16.33	59.92	14.20	
Social behavior domain					0.45
Baseline	2.57	0.85	2.43	0.65	
Mid-point	2.50	1.00	2.15	0.69	
Exit	1.82	0.87	2.08	0.76	
School/academic domain					0.90
Baseline	2.36	1.15	1.93	1.14	
Mid-point	2.00	0.85	2.08	1.11	
Exit	1.72	0.64	1.92	1.04	
Communication domain					0.50
Baseline	2.21	1.05	1.86	1.23	
Mid-point	2.00	0.85	2.00	1.15	
Exit	1.72	1.00	2.00	1.08	
Self-care domain					0.13
Baseline	1.64	1.00	0.86	0.95	
Mid-point	1.67	1.23	0.85	0.98	
Exit	1.45	1.04	0.85	0.99	
SSIS social skills					0.04*
Baseline	72.46	14.84	73.85	12.32	
Exit	86.33	11.10	78.85	12.28	
SSIS problem behavior					0.75
Baseline	121.31	18.45	118.77	11.14	
Exit	113.25	13.60	113.69	35.69	
Scale	MAAPS		ETAU		*p* value
	M	SD	M	SD	
CY-BOCS total score					0.48
Baseline	14.00	3.14	14.15	3.63	
Exit	10.55	3.88	12.15	3.76	
ABAS self-direction					0.54
Baseline	29.90	8.55	29.20	11.61	
Exit	35.77	11.04	33.00	11.70	
Academic engaged time					0.66
Baseline	67.14	16.04	72.57	13.93	
Mid-point	73.00	14.59	64.31	22.21	
Exit	72.08	24.88	65.08	25.50	
			Odds ratio		p value
Teacher nominated target behaviors			3.62		0.017*

$N = 28$ at baseline and 24 at exit

p value between group differences at exit, *ABAS* Adaptive Behavior Assessment Scales, *CY-BOCS* Children's Yale-Brown Obsessive-Compulsive Scale, *DD-CGAS* Developmental Disabilities modification of the Children's Global Assessment Scale, *ETAU* Enhanced Treatment as Usual, *MAAPS* Modular Approach to Autism Programs in Schools, *SSIS* Social Skills Improvement System

*$p < 0.05$

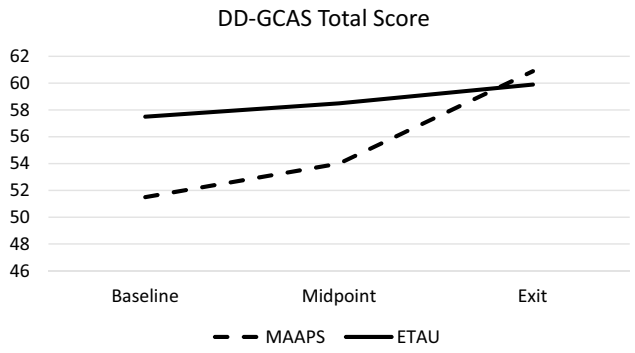

Fig. 2 DD-CGAS total scores at baseline, midpoint, and exit

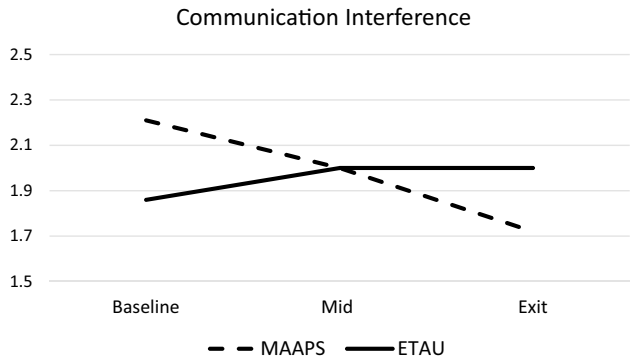

Fig. 3 DD-CGAS communication ratings at baseline, midpoint, and exit

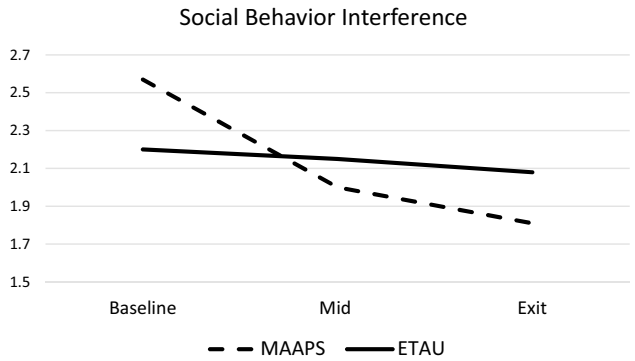

Fig. 4 DD-CGAS social behavior ratings at baseline, midpoint, and exit

MAAPS group experienced an increase in percentage of academic engagement on the AET from baseline (67.1) to exit (72.1), whereas there was a *decrease* in academic engagement in the ETAU group (from 72.6 to 65.1) that approached significance at midpoint (p = 0.07; see Fig. 7). However, the group by time interaction was not significant at midpoint or exit (Table 5 DD-CGAS). On the SSIS, MAAPS significantly outperformed ETAU at exit on the Social Skills scale (p = 0.04; see Fig. 8), and the treatment

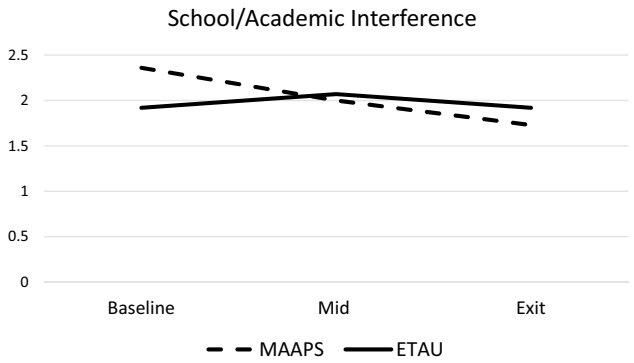

Fig. 5 DD-CGAS school/academic ratings at baseline, midpoint, and exit

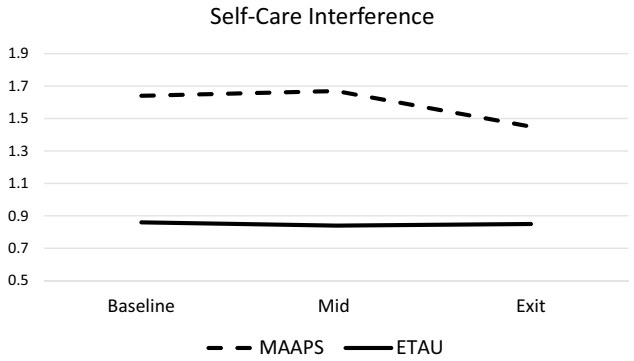

Fig. 6 DD-CGAS self-care ratings at baseline, midpoint, and exit

Table 6 Within-group analyses for MAAPS and ETAU from baseline to exit

Measure	MAAPS		ETAU	
	ES	*p*	*ES*	*p*
DD-CGAS total score	**0.94**	**< 0.001**	0.37	0.22
Social behavior domain	− 1.04	0.45	− 0.16	00.90
School/academic domain	− 0.24	0.86	− 0.41	0.79
Communication domain	− 0.30	0.87	*ns*	*ns*
Self-care domain	*na*	0.92	*na*	*ns*
SSIS social skills	**1.21**	**0.002**	0.45	0.12
SSIS problem behavior	**0.78**	**0.02**	− 0.21	0.46
CY-BOCS total score	0.28	0.38	0.11	0.71
ABAS self-direction	0.21	0.12	00.46	0.12
Academic engaged time	− 0.02	0.73	0.46	0.10

Statistically significant values are given in bold

ABAS Adaptive Behavior Assessment Scales, *CY-BOCS* Children's Yale-Brown Obsessive Compulsive Scale, *DD-CGAS* Developmental Disabilities Modification of the Children's Global Assessment Scale, *ES* Effect Size (Cohen's *d*), *ETAU* nhanced Treatment as Usual, *LSM-Diff* Difference in Least Square Means, *na* Change scores too close to 0 to calculate effect size, *ns* Not significant, where the p-value was too close to 1 to be interpretable, *MAAPS* Modular Approach to Autism Programs in Schools

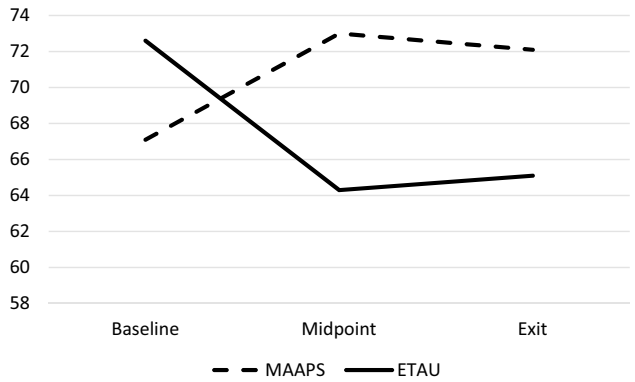

Fig. 7 Academic engaged time percentages at baseline and exit

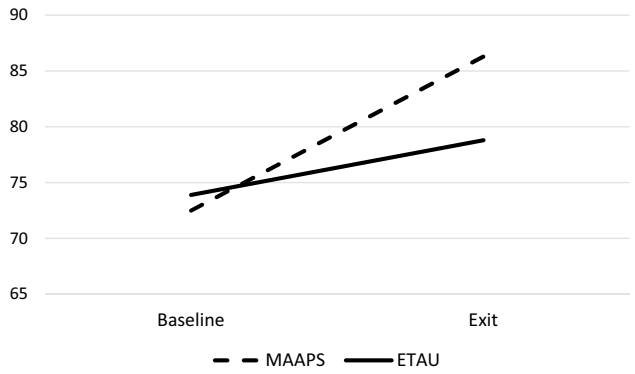

Fig. 8 SSIS social skills standard scores at baseline and exit

group also demonstrated a significant increase in Social Skills score from baseline (72.5) to exit (86.3; p = 0.002) and with a large effect size ($d = 1.21$), whereas change in ETAU (73.8 at baseline and 78.8 at exit) was not significant. Both groups demonstrated a decrease in the SSIS Problem Behavior scale (from 121.3 to 113.3 in MAAPS and 118.8 to 113.7 in ETAU), which was only significant in the MAAPS group (p = 0.02); and there was no notable interaction (Fig. 9). However, the effect size in MAAPS was moderate-to-large (0.78) as compared to a small effect size (0.21) for ETAU. With respect to repetitive behaviors, students experienced a non-significant decrease in repetitive and ritualistic behaviors on the CY-BOCS-in the MAAPS group (from 14 to 10.5) and the ETAU group (from 14.1 to 12.2), with no indication of a group by time interaction (Fig. 10). Ratings on the Self-Direction subscale of the ABAS indicated no significant changes in scores obtained from baseline to exit in the MAAPS group (5.7) or in the ETAU group (3.8; Fig. 11). Improvement ratings from the Teacher Nominated Target Behaviors (TNTB) indicated that students in MAAPS were significantly more likely to have any identified behaviors rated

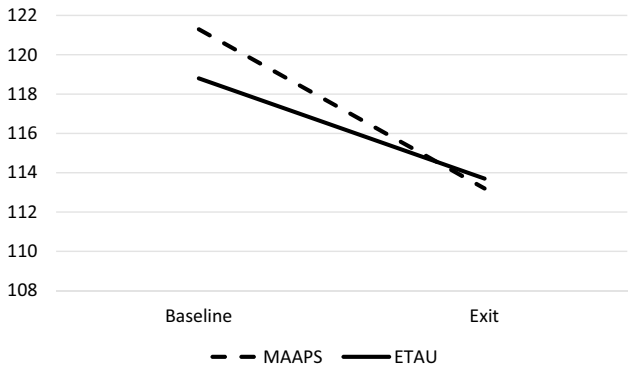

Fig. 9 SSIS problem behavior standard scores at baseline and exit

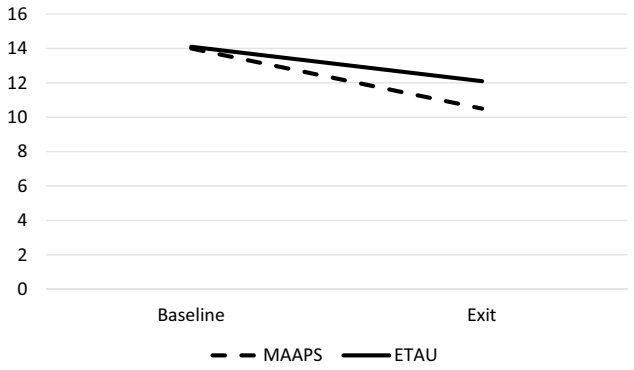

Fig. 10 CY-BOCS total scores at baseline and exit

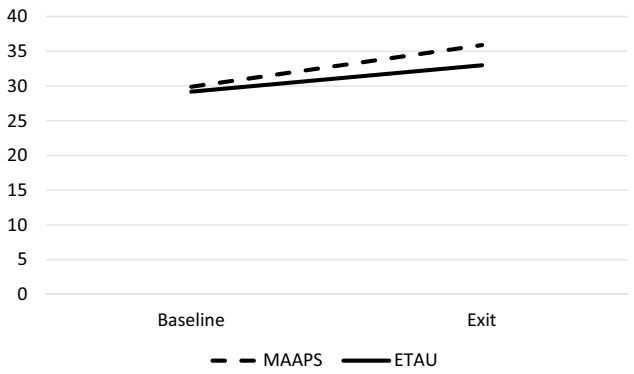

Fig. 11 ABAS self-direction subscale scores at baseline and exit

as improved, as compared to those in ETAU (OR 3.61; p = 0.017).

Adoption

Mean factor and item scores on the URP-IR ranged from 1 (strongly disagree) to 6 (strongly agree). Factor and item-level scores are in Table 7. Factor-level scores on four of

the domains—Acceptability = 5.2, Understanding = 5.1, Feasibility = 5.5, and System Climate = 5.3—were closer to the maximum score of 6. These factors indicate an overall positive perception of MAAPS in the areas assessed and specifically suggest that educators found MAAPS to be very acceptable, that they understood the intervention framework, that it was feasible, and that systems features in their school and district were supportive. On the Home–School Collaboration factor, educators rated parent involvement as not necessary for the success of MAAPS (a rating of 3.7 indicates "Slightly Disagree") which suggests the intervention could be useful even for students whose parents are not able to be involved with school-based services. This removes a potential barrier to widespread adoption, as some parents may be unwilling or unable to participate in a school-based intervention. Finally, elevated scores in the System Support factor ($M = 5.2$) indicate that more supports, such as coaching, resources, and training, are needed for long-term sustainability of the intervention than what is currently available. Most item scores within each factor are consistent with the overall ratings, with the exception of slightly elevated agreement on one item ("I would not be interested in implementing this

Table 7 Usage rating profile scores

Factor	Mean (SD)
Acceptability	5.2 (0.3)
This intervention is an effective choice for addressing a variety of problems	5.3 (0.6)
The intervention is a fair way to handle the child's behavior problem	5.5 (0.7)
I would not be interested in implementing this intervention[a]	3.7 (1.7)
I would have positive attitudes about implementing this intervention	5.3 (0.6)
This intervention is a good way to handle the child's behavior problem	5.2 (0.6)
I would implement this intervention with a good deal of enthusiasm	5.4 (0.7)
This intervention would not be disruptive to other students	5.3 (0.6)
I would be committed to carrying out this intervention	5.3 (0.6)
The intervention procedures easily fit in with my current practices	5.2 (0.8)
Understanding	5.1 (0.1)
I understand how to use this intervention	5.6 (0.7)
I am knowledgeable about the intervention procedures	5.5 (0.7)
I understand the procedures of this intervention	5.5 (0.7)
Feasibility	5.5 (0.3)
I would be able to allocate my time to implement this intervention	5.0 (1.1)
The total time required to implement the intervention procedures would be manageable	5.3 (0.6)
Preparation of materials needed for this intervention would be minimal	5.3 (0.8)
Material resources needed for this intervention are reasonable	5.3 (0.8)
This intervention is too complex to carry out accurately[a]	3.4 (1.9)
The amount of time required for record keeping would be reasonable	5.2 (0.7)
Home school collaboration	3.7 (2)
A positive home–school relationship is needed to implement this intervention	3.8 (1.6)
Parental collaboration is required in order to use this intervention	3.6 (1.6)
Regular home–school communication is needed to implement intervention procedures	2.5 (1.6)
System climate	5.3 (0.2)
My administrator would be supportive of my use of this intervention	5.5 (0.7)
Use of this intervention would be consistent with the mission of my school	5.3 (0.6)
Implementation of this intervention is well matched to what is expected in my job	5.3 (0.8)
These intervention procedures are consistent with the way things are done in my system	5.1 (1.0)
My work environment is conducive to implementation of an intervention like this one	5.3 (0.8)
System support[b]	5.2 (0.6)
I would need additional resources to carry out this intervention	3.4 (1.1)
I would need consultative support to implement this intervention	2.6 (1.5)
I would require additional professional development in order to implement this intervention	3.4 (1.7)

[a]These items were reverse scored

[b]As per developer instructions, items in this factor were reverse scored so that a score of 6.0 reflected high support, aligning scoring with other factors

intervention") within the Acceptability domain, indicating some ambivalence. The high standard deviation for this item shows that this perspective was not consistent across educators. Further, it is not clear whether raters indicating less interest in implementing did so because they found MAAPS to be either not useful or feasible or rather that it was no longer needed because students who received MAAPS no longer required intervention.

Implementation

We assessed fidelity of implementation of modules by teachers and teacher impression of the quality (value) of coaching, as shown in Table 8. Overall, high teacher fidelity was maintained across the 7 coaching schools, which ranged from 90.1 to 98.1, and scores were very high (mean at or above 95%). On the coaching quality scale, teachers provided a mean rating of 3.8 (0.07) out of a 4-point Likert scale (see Table 8 Teacher Fidelity). Questions included items such as "The coach and I agree on the most important goals for intervention for my student." High ratings were consistent across schools, with no average scores dropping below 3.0.

Coach fidelity was also very strong for adherence (ranging from 93.9 to 100) and quality (ranging from 96.5 to 100; see Table 9). All inter-rater agreement scores fell at 95% agreement or higher.

Maintenance

Given that this trial was focused on feasibility and preliminary efficacy, no long-term follow-up was planned and therefore we cannot comment yet on intervention maintenance. As discussed earlier, scores on the URP-15 (see Table 7) indicated that educators perceive there is support for longer-term maintenance and that they would be committed to carrying out the intervention in the future. In the context of these early promising results, a larger-scale trial that includes systematic evaluation of maintenance is a logical next step.

Table 8 Fidelity and quality ratings

	Coach-rated teacher implementation fidelity		Coach-rated teacher implementation quality		Teacher-rated coaching quality	
	Mean (%)	Range	Mean (%)	Range	Mean	Range
School 1	96.3	81–100	100	100–100	3.8	3.4–4.0
School 2	94.4	75–100	95.6	67–100	3.9	3.6–4.0
School 3	n/a[a]	n/a	n/a	n/a	3.9	3.8–3.9
School 4	90.1	78–100	100	100–100	4.0	4.0–4.0
School 5	n/a[b]	n/a	n/a	n/a	3.0	3.0–3.0
School 6	93.9	90–97	100	100–100	3.0	3.0–4.0
School 7	98.1	96–100	100	100–100	4.0	4.0–4.0
Overall mean	94.6		99.1		3.8	

[a]Data not collected due to scheduling conflicts

[b]Participant at site withdrew before collected

Table 9 Coach implementation fidelity of MAAPS procedures by school

Site	Coach self-rated implementation adherence		Coach self-rated implementation quality		Independent evaluator-rated adherence IOA	Independent evaluator-rated quality IOA
	Mean (%)	Range	Mean (%)	Range	Mean (%)	Mean (%)
School 1	100	90–100	100	100–100	94.5	100
School 2	97.8	87–100	99.3	91–100	92.3	100
School 3	94.2	94–100	95.8	91–100	94.2	95.8
School 4	96.5	95–100	100	100–100	97.9	100
School 5	93.9	94–100	100	100–100	n/a[a]	n/a
School 6	100	100–100	100	100–100	100	100
School 7	100	100–100	100	100–100	100	100

[a]Participant at site withdrew before completed

Discussion

The purpose of this study was to evaluate the feasibility of further evaluation of MAAPS. We began by recruiting feedback from experts in the field and stakeholders and used this information to make modifications to MAAPS. We then conducted a randomized controlled trial to assess feasibility in a more in-depth manner and used the RE-AIM framework to guide our research analysis. Overall, results supported the potential feasibility and efficacy of MAAPS within the RE-AIM framework. With respect to *reach*, we successfully enrolled a majority of individuals screened for the study and the few individuals enrolled who did not complete the study dropped out due to extenuating circumstances (change in district placement, medical leave).

Our data also support the *effectiveness* of MAAPS, as students who participated in the MAAPS group significantly improved their overall functioning, the primary outcome, as measured by the DD-CGAS compared to the students who participated in the ETAU group. Students in the MAAPS group also significantly improved in secondary outcomes, including social skills and classroom behaviors identified as important by teachers, compared to their ETAU counterparts. Teachers found MAAPS to be highly acceptable, useful, and effective, and strong educator buy-in, as indicated by low rates of withdrawal from MAAPS and high levels of participation, may have contributed to data showing that teachers implemented the MAAPS interventions with high fidelity.

The likelihood of *adoption* is a key consideration in novel interventions because, if the intervention is unlikely to be taken up by end-users, then there is little need for further research. Our preliminary data suggest that educators overall found MAAPS to be acceptable, easy to understand, feasible, and a good contextual fit—all of which indicate a strong likelihood of adoption. Educators did note that MAAPS would require systems-level support from schools and districts. This suggests that, prior to implementing MAAPS, efforts should be made to secure buy-in at the district level to ensure resources will be available for initial and sustained implementation.

Implementation has to do with whether (and how well) and intervention is actually implemented as designed. We observed high levels of both fidelity and quality of implementation, suggesting that educators were willing and able to implement MAAPS with the support of coaches. Finally, we conducted an assessment of the potential for *maintenance* of MAAPs, by asking educators to self-report on several variables that could influence sustained adoption and maintenance over time. Educators indicated willingness to implement MAAPs over time and that they would have support within their school or district to do so.

Taken together, results from this feasibility study, suggest several important directions for future research. More specifically, our findings suggest that MAAPS is feasible in schools, that it resulted in positive outcomes, and that it has a high likelihood of being adopted and sustained by educators. MAAPS has unique features that may have contributed to the results. First, it is a comprehensive intervention that uses a modular approach to give teams multiple options about the selection of specific focused interventions, the quantity of interventions to be implemented, and the timing of when and how the interventions will be scheduled for implementation throughout the school year. This flexibility is key as students with ASD are very diverse in their presentation of diagnostic characteristics and associated difficulties and strengths, creating challenges for educators with limited resources to sufficiently ameliorate concerns and prioritize how and where to intervene. This diversity of behavioral presentation, mentioned often by the focus group participants, overwhelms educators in attempting to meet student needs, particularly in the absence of structured frameworks to guide application of EBIs.

A second unique feature of MAAPS is the embedded active coaching process. Extant literature identifies coaching as a necessary component to help teachers with implementation and generalization of new interventions for sustainability (e.g., Fixsen et al. 2009; Noell et al. 2005). Coaching processes that include performance feedback based on direct observations of teacher performance have been shown to be particularly powerful in increasing teacher implementation fidelity (Solomon et al. 2012). This was clearly the case in our stakeholder groups, as the coaching component was enthusiastically endorsed by all of the focus groups as one of the key factors that would increase the contextual fit of MAAPS in teacher classrooms and help support teachers to implement EBIs.

The MAAPS active coaching process blends two coaching models, practice-based coaching (Snyder et al. 2015) and behavior skills training (Hogan et al. 2015), that is provided in an ongoing, iterative cycle in which both performance feedback and teacher reflection were utilized to increase implementation fidelity to criterion. As seen in the fidelity data outcomes, most of the teachers in the MAAPS group achieved high implementation fidelity, and coaches also showed fidelity to implementation of MAAPS procedures. This bidirectionality of the coaching process is critical, as the higher quality and process fidelity of the coaches will result in higher teacher fidelity and perceived social validity of the intervention (Stormont et al. 2015). The URP-IR results appeared to confirm this bidirectionality as teachers found both the MAAPS framework and the coaching value to be high.

Limitations and Future Directions

Some limitations exist with the current study. First, the study was designed for a small N; thus, it was underpowered. A more rigorous randomized controlled trial with a larger N needs to be conducted to further examine the effectiveness of MAAPS and explore what child and teacher factors may moderate intervention effectiveness. To this point, it will be critical for such evaluations to include student participants with diversity in presentation of cognitive levels and characteristics to help identify whether the MAAPS framework has the sufficient flexibility to be applicable for any student with ASD or is more effective for students with specific needs. Further, due to the small N, not all of the MAAPS modules were selected and implemented; thus, it is unknown whether some modules may be more feasibly implemented or more effective than other modules.

A second limitation is that coaching was provided by research staff who were highly trained. We chose to use research staff as coaches so we could evaluate the potential of MAAPS under "ideal conditions." Coaching is evidence-based; however, research is needed to develop models for training educators to serve as coaches in MAAPS or other coach-driven interventions. Additionally, more research is necessary to determine the minimal dosage of coaching that can impact high teacher implementation fidelity. Both the expert reviewers and the focus group participants expressed concerns that implementation of MAAPS may require more resources (e.g., time and skills) than were available in typical schools. This issue would need to be resolved in order for MAAPS to be both implemented and sustained as an adopted framework in school settings.

To our knowledge, this is the first study that explored the feasibility of a modular approach to support implementation of EBIs for students with ASD in authentic schools. Further, this is one of the first feasibility studies that used the RE-AIM framework for structuring the research plan and evaluating the outcomes. Our findings suggest that modular approaches may be a viable programmatic option for implementation in authentic school environments to meet the needs of students with ASD. Finally, using a framework such as RE-AIM can aid the field in determining the viability and sustainability of future intervention research.

As described in more detail above, all procedures involving human participants were in accordance with the ethical standards of the University of Rochester Medical Center, which served as the IRB of record and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Acknowledgments The authors acknowledge the following for their contributions to this project: Krystal McFee, Rocky Haynes, and Nycole Kauk from University of South Florida; Caryn Stark, Leona Oakes, Jill Aldrich from University of Rochester; and Meghan Silva, Whitney Kleinert, and Brittany Juban from May Institute.

Author Contributions CA designed and directed the study and drafted the manuscript; RI designed and directed the study and contributed to the manuscript; TS designed and directed the study; LL assisted in data collection and analysis and assisted with the manuscript; RM and BC assisted in staff training, data collection, and analysis, and assisted with the manuscript; SH assisted in data management and analysis and assisted with the manuscript; HW assisted in data analysis; SI designed and directed the study and contributed to the manuscript.

Funding This research was supported in part by a Grant from Institute from Education Sciences, R324A150032-16, awarded to Drs. Smith, Anderson, and Iovannone.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

References

Anderson, C. M., Martin, R. J., & Haynes, R. D. (2017). Supporting students with autism spectrum disorder in rural schools. In K. D. Michael & J. P. Jameson (Eds.), *Handbook of rural school mental health* (pp. 213–230). NY: Springer.

Anderson, C. M., Smith, T. R., & Iovannone, R. (2018). Supporting students with autism in public schools. *Education and Treatment of Children, 41*, 107–138.

Baio, J., Wiggins, L., Christensen, D. L., Maenner, M. J., Daniels, J., Warren, Zl, et al. (2018). Prevalence of autism spectrum disorder among children aged 8 years: Autism and developmental disabilities monitoring network, 11 sites, United States, 2014. *MMWR Surveillance Summary, 67*, 1–23.

Burns, M. K., & Ysseldyke, J. E. (2009). Reported prevalence of evidence-based instructional practices in special education. *The Journal of Special Education., 9*, 3–11.

Chaloufeas, S. M., Briesch, A. M., Riley-Tillman, T. C., & McCoach, D. B. (2009). Moving beyond measures of treatment acceptability: An examination of the factor structure of the Usage Rating Profile—Intervention. *School Psychology Quarterly, 24*, 36–47.

Cook, B. G., & Odom, S. L. (2013). Evidence-based practices and implementation science in special education. *Exceptional Children, 79*, 135–144.

Davis, L. L. (1992). Instrument review: Getting the most from a panel of experts. *Applied Nursing Research, 5*, 194–197.

Dingfelder, H. E., & Mandell, D. S. (2011). Bridging the research-to-practice gap in autism intervention: An application of diffusion of innovation theory. *Journal of Autism and Developmental Disabilities, 41*, 597–609.

Eccles, M. P., & Mittman, B. S. (2006). Welcome to implementation science. *Implementation Science, 1*, 1–3.

Ferreri, S., Witmer, S., & Shivers, C. (2016). Autism spectrum disorders and evidence based practices: A statewide exploration of public school programming. *Austin Journal of Autism & Related Disabilities, 2*, 1018.

Fixsen, D. L., Blasé, K. A., Naoom, S. F., & Wallace, F. (2009). Core implementation components. *Research on Social Work Practice, 19*, 531–540.

Glasgow, R. E., Vogt, T. M., & Boles, S. M. (1999). Evaluating the public health impact of health promotion interventions: The

RE-AIM framework. *American Journal of Public Health, 89*, 1322–1327.

Gresham, F. M., & Elliott, S. N. (2008). *Social skills improvement system: Rating scales*. Bloomington, MN: Pearson Assessments.

Gresham, F. M., Elliott, S. N., & Kettler, R. J. (2010). Base rates of social skills acquisition/performance deficits, strengths, and problem behaviors: An analysis of the Social Skills Improvement System—Rating Scales. *Psychological Assessment, 22*, 809.

Gresham, F. M., Elliott, S. N., Vance, M. J., & Cook, C. R. (2011). Comparability of the social skills rating system to the social skills improvement system: Content and psychometric comparisons across elementary and secondary age levels. *School Psychology Quarterly, 26*, 27.

Guest, G., & MacQueen, K. M. (2008). *Handbook for team-based qualitative research*. Lanham, MD: Altamira Press.

Harrison, P., & Oakland, T. (2003). *Adaptive behavior assessment system (ABAS-II)*. San Antonio, TX: The Psychological Corporation.

Hendricks, D. (2011). Special education teachers serving students with autism: A descriptive study of the characteristics and self-reported knowledge and practices employed. *Journal of Vocational Rehabilitation, 35*, 37–50.

Hess, K. L., Morrier, M. J., Heflin, L. J., & Ivey, M. L. (2008). Autism treatment survey: Services received by children with autism spectrum disorders in public school classrooms. *Journal of Autism and Developmental Disorders, 38*, 961–971.

Hogan, A., Knez, N., & Kahng, S. (2015). Evaluating the use of behavioral skills training to improve school staffs' implementation of behavior intervention plans. *Journal of Behavioral Education, 24*, 242–254.

Iovannone, R., Iadarola, S., Hodges, S., Haynes, R., Stark, C., McFee, K., et al. (2019). An extra set of hands: A qualitative analysis of stakeholder perspectives on implementation of a modular approach to teacher adoption of evidence-based interventions for students with autism spectrum disorders. *International Journal of Positive Behavioural Support, 9*(2), 25–40.

Kasari, C., & Smith, T. (2013). Interventions in schools for children with autism spectrum disorder: Methods and recommendations. *Autism, 17*, 254–267. https://doi.org/10.1177/1362361312470496.

Kessler, R. S., Purcell, E. P., Glasgow, R. E., Klesges, L. M., Benkeser, R. M., & Peek, C. J. (2012). What does it mean to "employ" the RE-AIM model? *Evaluation & the Health Professions, 36*, 44–66.

Locke, J., Beidas, R. S., Marcus, S., Stahmer, A., Aarons, G. A., Lyon, A. R., et al. (2016). A mixed methods study of individual and organizational factors that affect implementation of interventions for children with autism in public schools. *Implementation Science, 11*, 1–9.

Lord, C., Rutter, M., DiLavore, P. C., Risi, S., Gotham, K., & Bishop, S. L. (2012). *Autism diagnostic observation schedule* (2nd ed.). Torrance, CA: Western Psychological Services.

Miles, M., Huberman, M., & Saldana, J. (2013). *SAGE: Qualitative data analysis: A methods sourcebook*. London: SAGE.

National Autism Center. (2015). *National Standards Project: Addressing the need for evidence-based practice guidelines for autism spectrum disorder*. Randolph, MA: National Autism Center.

Noell, G. H., Witt, J. C., Slider, N. J., Connell, J. E., Gatti, S. L., Williams, K. L., et al. (2005). Treatment implementation following behavioral consultation in schools: A comparison of three follow-up strategies. *School Psychology Review, 34*, 87–106.

Parsons, M. B., Rollyson, J. H., & Reid, D. H. (2012). Evidence-based staff training: A guide for practitioners. *Behavior Analysis in Practice, 5*, 2–11.

Ruble, L., McGrew, J. H., & Toland, M. D. (2012). Goal Attainment Scaling as an outcome measure in randomized controlled trials of psychosocial interventions in autism. *Journal of Autism and Developmental Disorders, 42*, 1974–1983.

Scahill, L., Dimitropoulos, A., McDougle, C. J., Aman, M. G., Feurer, I. D., McCracken, J. T., et al. (2014). Children's Yale-Brown obsessive compulsive scale in autism Spectrum disorder: Component structure and correlates of symptom checklist. *Journal of the American Academy of Child & Adolescent Psychiatry, 53*, 97–107.

Scahill, L., McDougle, C. J., Williams, S. K., Dimitropoulos, A., Aman, M. G., McCracken, J. T., et al. (2006). Children's Yale-Brown Obsessive Compulsive Scale modified for pervasive developmental disorders. *Journal of the American Academy of Child & Adolescent Psychiatry, 45*, 1114–1123.

Schlosser, R. W. (2004). Goal attainment scaling as a clinical measurement technique in communication disorders: A critical review. *Journal of Communication Disorders, 37*, 217–239.

Silverman, M., Ricci, E. M., & Gunter, M. J. (1990). Strategies for increasing the rigor of qualitative methods in evaluation of health care programs. *Evaluation Review, 14*, 57–74.

Smith, T. (2011). *Making inclusion work for students with autism spectrum disorders: An evidence-based guide*. New York, NY: The Guilford Press.

Smith, T., & Iadarola, S. (2015). Evidence base update for autism spectrum disorder. *Journal of Clinical Child and Adolescent Psychology, 44*, 897–922. https://doi.org/10.1080/15374416.2015.1077448.

Snyder, P. A., Hemmeter, M. L., & Fox, L. (2015). Supporting implementation of evidence-based practices through practice-based coaching. *Topics in Early Childhood Special Education, 35*, 133–143.

Solomon, B. G., Klein, S. A., & Politylo, B. C. (2012). The effect of performance feedback on teachers' treatment integrity: A meta-analysis of the single-case literature. *School Psychology Review, 41*, 160–175.

Stahmer, A. C. (2007). The basic structure of community early intervention programs for children with autism: Provider descriptions. *Journal of Autism and Developmental Disorders, 37*, 1344–1354.

Stahmer, A. C., & Aarons, G. A. (2009). Attitudes toward adoption of evidence-based practices: A comparison of autism early intervention providers and children's mental health providers. *Psychological Services, 6*, 223.

Stahmer, A. C., Collings, N. M., & Palinkas, L. A. (2005). Early intervention practices for children with autism: Descriptions from community providers. *Focus on Autism and Developmental Disabilities, 20*, 66–79.

Stormont, M., Reinke, W. M., Newcomer, L., Marchese, D., & Lewis, C. (2015). Coaching teachers' use of social behavior interventions to improve children's outcomes: A review of the literature. *Journal of Positive Behavior Interventions, 17*, 69–82.

Strain, P. S., & Bovey, E. H., II. (2011). Randomized, controlled trial of the LEAP model of early intervention for young children with autism spectrum disorders. *Topics in Early Childhood Special Education, 31*, 133–154. https://doi.org/10.1177/0271121411408740.

U.S. Department of Education. Institute of Education Sciences, National Center for Education Statistics (2017). Common core of data. Retrieved September 2016, from https://nces.ed.gov/ccd/schoolsearch/.

Wagner, A., Lecavalier, L., Arnold, L. E., Aman, M. G., Scahill, L., Stigler, K. A., et al. (2007). Developmental Disabilities Modification of Children's Global Assessment Scale (DD-CGAS). *Biological Psychiatry, 61*, 504–511.

Walker, H. M., Seeley, J. R., Small, J., Severson, H. H., Graham, B. A., Feil, E. G., et al. (2009). A randomized controlled trial of the First Step to Success early intervention. *Journal of Emotional and Behavioral Disorders, 17*, 197–212.

Walker, H. M., & Severson, H. H. (1990). *Systematic screening for behavior disorders (SSBD): User's guide and technical manual*. Longmont, CO: Sopris West.

Wong, C., Odom, S. L., Hume, K. A., Cox, A. W., Fettig, A., Kucharczyk, S., et al. (2015). Evidence-based practices for children, youth, and young adults with autism spectrum disorder: A comprehensive review. *Journal of Autism and Developmental Disorders, 45*, 1951–1966.

Wu, M. S., et al. (2014). Psychometric properties of the Children's Yale-Brown Obsessive Compulsive Scale in youth with autism spectrum disorders and obsessive–compulsive symptoms. *Child Psychiatry and Human Development, 45*, 201–211.