Does the learning environment 'make the grade'? A systematic review of accommodations for children on the autism spectrum in mainstream school

Emma Leifler, Gabriella Carpelan, Anastasiya Zakrevska, Sven Bölte & Ulf Jonsson

Taylor & Francis
Taylor & Francis Group

REVIEW ARTICLE

Does the learning environment 'make the grade'? A systematic review of accommodations for children on the autism spectrum in mainstream school

Emma Leifler[a,b], Gabriella Carpelan[a], Anastasiya Zakrevska[a], Sven Bölte[a,c,d] (iD) and Ulf Jonsson[a,c,e] (iD)

[a]Karolinska Institutet Center of Neurodevelopmental Disorders (KIND), Centre for Psychiatry Research, Department of Women's and Children's Health, Karolinska Institutet, Stockholm Health Care Services, Region Stockholm, CAP Research Centre, Stockholm, Sweden; [b]Department of Pedagogical, Curricular and Professional Studies, University of Gothenburg, Göteborg, Sweden; [c]Child and Adolescent Psychiatry, Stockholm Health Services, Stockholm, Sweden; [d]Curtin Autism Research Group, School of Occupational Therapy, Social Work and Speech Pathology, Curtin University, Perth, Western Australia; [e]Department of Neuroscience, Child and Adolescent Psychiatry, Uppsala University, Uppsala, Sweden

ABSTRACT

Background: The 2030 Agenda for Sustainable Development adapted by the United Nations envisions inclusive and equitable quality education. While there is a growing body of research on interventions designed to help children on the autism spectrum adapt to the school environment, accommodations to children needs have been given less attention.

Objective: To synthesize the literature on accommodations in the learning environment for children on the autism spectrum (ages 5–19 years) in mainstream school, with a specific focus on the effects on functioning, educational outcomes and well-being.

Methods: A systematic search was conducted. The study selection and data extraction were performed by two independent reviewers. Eligible studies were assessed according to the *What Works Clearinghouse* (WWC) standards.

Results: The search yielded 6102 citations. Only 37 eligible studies were identified, of which 14 met the WWC standards. This inconclusive and heterogeneous body of research tentatively suggest that accommodations in the pedagogical and psychosocial leaning environment can improve performance and function in school.

Conclusion and significance: Accommodations in the learning environment is a promising but understudied approach. Creative research and innovation will be needed to support policy makers and school personnel in their quest to ensure inclusive and equitable education.

Introduction

Parties to the Convention on the Rights of Persons with Disabilities are required to ensure that children with disabilities are not excluded from primary and secondary education due to their disability, that they receive the support required within the general education system, and that reasonable accommodation is provided [1–3]. Inclusive education is based on the right of all children to a common education in their locality regardless of their background, attainment or disability [2]. The high priority given to inclusive education by the United Nations (UN) is further underscored by the 2030 Agenda for Sustainable Development, which embraces the goal 'to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all' [4].

There is a broad consensus that inclusion is much more than physically integration in school [5–9]. In contrast to integration, which focuses on the student's ability to adapt, inclusion demands environmental changes in response to diversity. In their general comment on inclusive education, the UN's Committee on the Rights of Persons with Disabilities states that 'inclusion involves a process of systemic reform embodying changes and modifications in content, teaching methods, approaches, structures and strategies in education to overcome barriers with a vision serving to provide all students of the relevant age range with an equitable and participatory learning experience and environment that best corresponds to their requirements and preferences' [10]. Consequently, main stream school for children with

---

disability is not inclusive education, unless it is accompanied by adequate structural change. The inclusive classroom is a milieu where diverse group of students are taught together, not separately [5,11]. Inclusive education should ideally consist of a broad repertoire of activities to help children develop and participate more fully in society. Across education, health services and social welfare, more inclusive agendas entail collective problem-solving procedures and collaborative practices [5,9]. However, the education system apparently experiences challenges finding practical solutions to the specific needs of each individual student [12–16]. The UN identifies several barriers to inclusive education for persons with disabilities, including lack of knowledge and research [10]. Better insight into efficacious practices, combined with implementation support, is therefore needed [17,18].

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterised by social communication impairments and restricted, repetitive behaviour [19], causing functional impairment [20–22]. The estimated prevalence is about 1.85% among children and adolescents in the USA and other high-income countries [23]. The condition is associated with challenges in several cognitive domains (e.g. executive functions, language, memory, theory of mind and generalisation of knowledge), which can affect functioning in school [24–27] and hinder successful learning [28]. Also, difficulties with social communication can complicate interaction with peers, non-verbal communication and comprehension of texts [19,29]. In addition, ASD co-varies with intellectual disability to a high degree [30]. Consequently, mainstream school can be stressful and challenging for children on the autism spectrum [15,31–33]. This group of students often struggle in school [34–36] and have high rates of absenteeism [37]. Moreover, children on the autism spectrum are at increased risk of bullying, loneliness, low quality of life and anxiety [31,38–42].

As the number of children with ASD educated in inclusive settings is increasing, the need for strategies to facilitate inclusion has become urgent [15,43,44]. While there is guidance for teachers in guidelines and expert testimony [45], more empirical evidence is needed. A recent systematic review of interventions for students with ASD in inclusive settings suggest that function-based interventions, visual supports, self-monitoring strategies and peer-mediated interventions have moderate to large effects on social communication skills [46]. The comprehensive review provides a timely overview of the field, and underscores the need for more high-quality studies. Notably, the implicit rationale for most of the interventions in this and other reviews [45,47–50] seems to be to help the child adapt to the school environment by modifying child behaviours (e.g. through improved social skills and reduced disruptive behaviour). While this approach has proven successful, there are potential downsides. The time and effort required can be demanding for the child, and the interventions will not always achieve the intended outcome. In addition, children might perceive that the responsibility for successful inclusion rests solely with them and their ability to adapt to the school environment. Furthermore, unless the environment is characterised by an understanding and positive attitude, it is unlikely that improved skills will automatically lead to better inclusion [51–53]. These approaches are also resource demanding and might not be sustainable in the school environment.

The opposite approach, to intervene indirectly by making accommodations in the learning environment, has been given less attention. This is surprising, especially since the UN clearly states that structural change is required for inclusive education. Accommodations in the physical, pedagogical, and psychosocial environments therefore emerge as understudied complements to interventions directly targeting the student's abilities. Theoretically, there might not always be a clear boundary between these two approaches. For instance, peer-mentoring, reinforcement, and prompting could be viewed as efforts to help children adapt to the environment, but also as accommodations in the environment. Furthermore, the outcome of interest is often the same in both approaches (e.g. improved skills, functioning, and well-being). These conceptual challenges might contribute to the relative neglect of contextual factors, and a one-sided focus on skills training. We, therefore, believe that is important to delineate contextual interventions specifically designed to improve the learning environment, so that these options are given more attention in both research and practice. This might nudge the field to move beyond intensive behavioural treatments [54], and start focussing more on environmental changes that will not impose a disproportionate burden on the children themselves.

Recent years have seen a surge in research activity related to environmental barriers in general for people on the autism spectrum. The critical work on determining the functional circumstances of ASD using the World Health Organisation International

Classification of Functioning, Disability and Health (ICF) [20] clearly demonstrates that a multitude of functional potentials in autism lie outside of the individual [22,55]. The ICF is based on a bio-psycho-social model of functioning, which conceptualises functioning and disability as the outcome of complex interactions between health conditions and contextual factors (environmental and personal factors). Some countries, such as Australia, have already adopted the ICF as the leading theoretical framework for autism assessment and intervention [56]. The appropriateness of using the ICF model to address challenges in different real-life settings in ASD (e.g. employment and adulthood transitions) has previously been illustrated [57,58]. This development has set the scene for interventions focussing more specifically on environmental factors. The need for such accommodations is further underscored by a recent scoping review on supporting and hindering environments, suggesting that the environment can be an important facilitator for participation [59]. The modest body of research on workplace accommodations for adults with ASD tentatively suggest that minimising distractions, reducing noise, predictable job duties and considerations regarding technology can be helpful [60]. While similar aspects are likely to be relevant also in school, no comprehensive review of this literature is available. A review focussing narrowly on the design of the physical classroom environment on young children with ASD found a small number of relevant studies, most of which focussed on pre-school children or children in segregated settings [43].

To the best of our knowledge, there is no previous systematic review focussing specifically on accommodations in the learning environment of children on the autism spectrum in mainstream school. The objectives of this systematic review were:

1. To provide an overview of the different types of accommodation in the learning environment that have been evaluated to date, including mapping of the environmental factors targeted.
2. To review and synthesise the empirical evidence regarding the effects of these accommodations on school performance, functioning in school, and quality of life.

Method

This systematic review was registered in advance with PROSPERO (CDR42019124496) and was reported in accordance with the PRISMA statement [61].

Theoretical framework

Accommodation in the learning environment was defined as a contextual change that did not require adaptation from the student, over and above what is required from their peers. The learning environment, in turn, was operationalized by applying a theoretical framework derived from a model used by National Agency for Special Needs Education and Schools (SPSM) [62–64], a Swedish government agency charged with ensuring that all children, young people and adults regardless of functional ability, have adequate conditions to fulfil their educational goals. The model covers physical, psychosocial and pedagogical environment (and subdomains). To clarify the relevance of each subdomain for students with ASD, we identified a sample of corresponding environmental factors from the second-level ICF categories included in the comprehensive ICF core set for individuals with ASD across the entire lifespan [22] (see Table 1).

Search

Following a pilot search in ERIC, the search was conducted in December 2018 and updated in June 2019. The search was performed by librarians at Karolinska Institutet Library (KIB) in the following databases: MEDLINE (Ovid), PsycInfo (Ovid), ERIC (ProQuest) and Web of Science. See Supplementary Appendix A for the full electronic search strategy.

Study selection

Studies were selected based on predefined eligibility criteria (Table 2). The study selection was conducted using Endnote X9, Clarivate Analytics. Titles and abstracts were assessed against the eligibility criteria by two independent reviewers. Any report selected by at least one reviewer was then assessed for eligibility based on full-text. Disagreements at this stage were resolved by a third reviewer. In some cases, a fourth reviewer was consulted. If insufficient information was provided, the corresponding author was contacted. If no response was received, the final decision was made based on the available information. The inter-rater agreement was 92% for the screening phase and 91% for the assessment in full text.

Risk of bias

Studies meeting the eligibility criteria were assessed for risk of bias using What Works Clearinghouse

Table 1. Model outlining domains of the learning environment and corresponding environmental factors.

Learning environment domain	Subdomain	Sample ICF environmental factors[a]
Psychosocial	Belonging and participation	e320, e325, e420, e455, e465 (friends, peers, individual attitudes, social norms)
	Coherence	e585 (education services and systems)
	Planned activities outside school	e320, e125 (friends, communication)
	Co-operation	e360, e455 (other professionals, individual attitudes)
	Social norms and attitudes	e320, e325, e420, e430 e455, e465 (friends, peers, individual attitudes, social norms)
Pedagogical	Pedagogical strategies and support	e125, e130 (products and technology for communication, education)
	Staff and other professionals	e330, 360 (people in positions of authority, other professionals)
	Different learning approaches	e585 (education services, systems)
	Tools for learning, supporting tools	e130 (products for education)
	Digital learning	e130 (technology for education)
	Language and communication	e125 (communication)
	Motivation	e320, e325, e360 (friends, other professionals)
Physical	Room for learning	e240, e250 (light, sound)
	Sound	e250 (sound)
	Visual environment	e125, e240 (communication, light)
	Air quality	–
	Outdoor environment	–

[a]Second-level International Classification of Functioning, Disability and Health (ICF) categories included in the comprehensive ICF core set for individuals with ASD across the entire lifespan [22].

Table 2. Eligibility criteria.

PICOS	Inclusion	Exclusion
Population	• Autism spectrum disorder[a] according to the current or previous editions of the Diagnostic and Statistical Manual of Mental Disorders (DSM) or the International Classification of Diseases (ICD), and; • Between 5 and 19 years of age, and; • Primarily attending mainstream school (50% or more)	• Below 5 and above 19 years of age, or; • Primarily attending segregated settings, pre-school, kindergarten, college or university
Intervention	Accommodations in the physical, psychosocial, or pedagogical learning environment, including: • Organisation (e.g., classroom organisation, teacher assistants, collaboration between professionals); • Teacher competence (e.g. teacher training); • Peer involvement/social activities; • Assistive technology; • Accommodations related to school subjects (e.g., maths or science) or other school-specific activities	• Training of skills or functioning in general (e.g., social skills training); • psychological treatment of cooccurring conditions (e.g. cognitive behavioural therapy for depression or anxiety); • Pharmacological treatment; • Interventions that partly consist of accommodations in the learning environment, but did not evaluate the effect of these elements separately
Comparator	No treatment, treatment as usual, waitlist control, experimental control designs matched for time/contact, active comparator, or no comparator	N/A
Outcome	Observations, test scores, or teacher-, parent- or self-assessment of any of the following: • functioning in school context (e.g., social engagement, on-task behaviour, transitions between activities); • educational outcome, including performance, achievement, and participation (e.g., test scores, grade point average, attendance); • quality of life/well-being (any validated measure)	Any other outcome
Setting	Mainstream school settings	Interventions taking place outside mainstream schools (e.g., clinical and segregated settings)
Study design	Randomised and non-randomised studies of interventions, mixed method studies	Qualitative design, observational study (no intervention)
Publications	Peer-reviewed original research published in English from 1990 onward	• Gray literature; • Publications prior to 1990; • Publications in other languages than English

[a]Including the diagnostic terms autistic disorder, Asperger's syndrome, and pervasive developmental disorder – not otherwise specified/unspecified from DSM-IV and ICD-10.

(WWC) *Standards Handbook Version 4.0* and *Reviewer Guidance for Use with the Procedures Handbook and Standards Handbook* [65,66]. Two independent reviewers assessed study quality according to WWC standards. The reviewers completed the WWC group design standards online training and were certified. Since it was deemed that level of attrition in the studies could have been affected by the intervention in group designs, the cautious set of assumptions for acceptable attrition was used. For single-case design (SCD) studies, the inter-assessor agreement (IAA) was assessed per outcome. IAA for at least 20% of the data points for every outcome of interest was deemed sufficient. When the information

Table 3. Study characteristics of studies meeting the What Works Clearinghouse standards.

Author, year, country, reference	Study design, age and sample size	Type of accommodation (ICF environmental factors targeted)[a]	Outcome	Study quality	Effect
Adcock and Cuvo (2009) USA [89]	SCD, MBD across three behaviours $n = 3$ Age = 7 − 10	Pedagogical environment: package of behavioural procedures (e130, e455)	Educational outcome: Academic tasks	Meets standards with reservations	Strong evidence of a causal relation PEM = 1 (SD = 0)
Asaro-Saddler and Saddler (2010) USA [96]	SCD, MDB across multiple baselines $n = 3$ Age = 6 − 9	Pedagogical environment: self-regulated strategy development for story writing (e125, e130)	Educational outcome: Number of words in writing sample	Meets standards with reservation	No evidence (minor change in level for one participant) PEM = 0.89 (SD = 0.19)
Asaro-Saddler and Bak (2012) USA [95]	SCD, MBD across participants $n = 3$ Age = 8 − 9	Pedagogical environment: SRSD for story writing (e125, e130)	Educational outcome: Holistic quality of writing	Meets standards with reservations	Strong evidence of a causal relation PEM = 1 (SD = 0)
Chiak et al. (2010) USA [92]	SCD, RD $n = 4$ Age = 6 − 8	Pedagogical environment: Video-modelling with response-based prompting (e130)	Functioning in school: Transitions between school activities	Meets standards with reservations	Strong evidence of a causal relation (for 3/4) PEM = 0.96 (SD 0.08)
Dugan et al. (1995) USA [72]	SCD, RD $n = 2$ Age = 9 − 10	Pedagogical environment: Cooperative learning group (e125, e320, e325)	Functioning in school: Social interaction	Meets standards with reservations	Strong evidence of a causal relation PEM = 0.97 (SD 0.06)
Jones et al. (2013) USA [90]	SCD, RD $n = 1$ Age = seventh grade	Pedagogical environment: Token economy and a contingency contract (e130)	Functioning in school: On-task behaviour; talk -outs	Meets standards with reservations	Strong evidence of a causal relation, on-task PEM = 1 (SD = 0) No evidence, talk-outs PEM = 0.59 (SD = 0.12)
Kamps et al. (1994) USA [77]	SCD, MDB across participants with reversal $n = 3$ Age = 8 − 9	Psychosocial environment: Classwide peer tutoring (e125, e320, e325, e465)	Functioning in school: Social interaction	Meets standards with reservation	No evidence (no convincing baseline pattern for one participant) PEM = 0.93 (SD = 0.10)
Kasari et al. (2012) USA [75]	RCT Exp. group $n = 15$ Age M = 7.60 (SD = 1.35) Control group $n = 15$ Age M = 8.23 (SD = 1.48)	Psychosocial environment: Peer-mediated intervention (e125, e320, e325, e420)	Functioning in school: Social network salience; social engagement; solitary play	Meets standards without reservations (Attrition was determined based on available information)	Statistical analysis Hierarchical linear modelling (HLM) and 2 × 2 analysis of covariance (ANCOVA) Mixed results
Kasari et al. (2016) USA [76]	RCT Exp. group $n = 82$ Age M = 8.13 (SD = 1.55) Control group $n = 66$ Age M = 8.23 (SD = 1.63)	Psychosocial environment: Peer groups with social activities (e125, e320, e325, e420)	Functioning in school: Social network salience social engagement; solitary play	Meets standards without reservations (Full information about missing data was not available)	Generalized linear mixed models (GLMM) Mixed results
Koegel et al. (2012) USA [73]	SCD, MBD across participants $n = 3$ Age = 11-14	Psychosocial environment: Lunchtime clubs based on preservative interest (e125, e320, e325)	Functioning in school: Social engagement; social initiation	Meets standards without reservation	Strong evidence of a causal relation for engagement PEM = 1 (SD = 0) No evidence for initiation PEM = 0.94 (SD = 1)
Koegel et al. (2014) USA [74]	SCD, MBD across participants $n = 3$ Age = 8 − 10	Psychosocial environment: Paraprofessional training and social groups (e125, e320, e325, e455)	Functioning in school: Social engagement; social initiation	Meets standards with reservations	Strong evidence of a causal relation for engagement PEM = 1 (SD = 0) No evidence for initiation PEM = 1 (SD = 0)
Schatz et al. (2016) USA [93]	SCD, MBD across participants $n = 3$ Age = 9 − 11	Pedagogical environment: Video self-modelling (e130)	Functioning in school: On-task behaviour during maths class	Meets standards without reservations	No evidence (no convincing baseline pattern) PEM = 0.77 (SD = 0.22)
Stasolla et al. (2016) Italy [94]	SCD, changing criterion design $n = 3$ Age = 8 − 10	Pedagogical environment: Computer-based programs with vocal output (e130)	Educational outcome: Academic tasks Functioning in school: On-task behaviour	Meets standards without reservations	Strong evidence of a causal relation PEM not assessed due to raw data not available in the article
Tekin-Iftar and Olcay-Gül (2016) Turkey [91]	SCD, MPD across behaviours and replicated across participants $n = 3$ Age = 10 − 11	Pedagogical environment: Simultaneous prompting procedure in small group arrangement (e130)	Educational outcome: Academic target skills	Meets standards with reservations	Strong evidence of a causal relation PEM = 1 (SD = 0)

MBD: multiple baseline design; MPD: multiple probe design; PEM: percentage exceeding the median, evidence of effect demonstrated according to visual analysis; RCT: randomised controlled trial; RD: reversal design; SCD: single case design.
[a]Second-level International Classification of Functioning, Disability and Health (ICF) categories included in the comprehensive ICF core set for individuals with ASD across the entire lifespan [22].

about the IAA was not sufficient to determine the study quality, an author query was sent. In cases the author did not respond, a judgement was made based on the information provided in the published article.

Data collection process

Data extraction for studies meeting WWC standards (with or without reservation) was performed by two independent reviewers. A data extraction form was created and piloted. Extracted information included: study setting, demographic characteristics, study methodology, intervention, comparator, and outcomes. In studies reporting disaggregated data, data was only extracted for participants that met the eligibility criteria.

Synthesis

In order to address the two separate review questions, the synthesis was performed in two steps. First, the different types of accommodations evaluated in the eligible studies (regardless of risk of bias assessment) were identified. In order to provide a perspicuous overview, all eligible studies were categorized as physical, psychosocial or educational learning environment. This categorization was decided by consensus among the authors. For each domain, we identified environmental factors reflecting the specific accommodation, using the second-level ICF categories included in the comprehensive ICF core set for individuals with ASD across the entire lifespan [22].

In the second part of the synthesis, the relevant outcomes were presented (and synthesized when possible) for the studies meeting the WWC design standards (with or without reservations). This was done separately for each of the three outcome domains considered in this review. For SCD studies, a visual analysis was conducted only for the outcomes and participants meeting the inclusion criteria and the WWC design quality standards. Visual analysis was performed according to the WWC *Standards Handbook Version 4.0* in order to identify indications of a causal relation [65]. Visual analysis was performed within phases (level, trend, variability), and across phases (immediacy of effect, overlap and consistency). A study had to demonstrate three effects without any non-effect to be judged as showing strong evidence of a causal relation, while three effects and at least one non-effect was judged as moderate evidence of a causal relation [67–69]. The assessment of the design standards and visual analysis was piloted

on five articles to ensure inter-rater agreement. For effect size of each individual study using SCD, the points exceeding the median of the baseline phase (PEM) was calculated [70,71]. PEM is not sensitive to outliers and have a statistical distribution [69,71] and was therefore deemed appropriate. A PEM score above 0.90 represented high effectiveness, PEM of 0.70–0.89 was determined moderate effectiveness and a PEM score below 0.70 was judged as ineffective [69]. The quantitative synthesis was performed for SCD studies by calculating the mean effect size across studies for the studies which used similar outcome measures.

Results

Study selection

The database search yielded 6102 citations. After the screening of abstracts, 723 articles were assessed for eligibility in full-text. A total of 37 articles (reporting on 37 unique studies) were deemed eligible, while 686 articles were excluded. The most common reason for exclusion was that the intervention was conducted in a segregated school setting (see Figure 1).

Study characteristics

The 37 eligible studies were published between 1994 and 2019. The majority of the articles ($n = 30$) used an SCD. Other designs were group design without comparison ($n = 4$), randomised controlled trials (RCT; $n = 2$) and quasi-randomised design ($n = 1$). Studies were conducted in USA ($n = 24$), UK ($n = 4$), Australia ($n = 3$), Italy ($n = 2$), Canada ($n = 1$), Turkey ($n = 1$), Greece ($n = 1$) and Spain ($n = 1$).

A total of 14 studies met WWC standards with and without reservations, while 23 did not meet the standards (see Supplementary Appendix B). An author query was sent for eight articles regarding IAA, randomisation process, or the handling of missing data. Two RCTs, both of which compared peer interventions with didactic social skills training, met the WWC group design standards without reservations. While the peer interventions were deemed to fit our definition of accommodation (i.e. with the peers representing the social environment of the child), the social skills training did not. Thus, the social skills training arms in these studies were strictly regarded as comparators. Participants were predominantly boys around eight years of age (see Table 3). The additional 12 studies that met the WWC standards ($n = 3$ without reservations and $n = 9$ with reservations) used
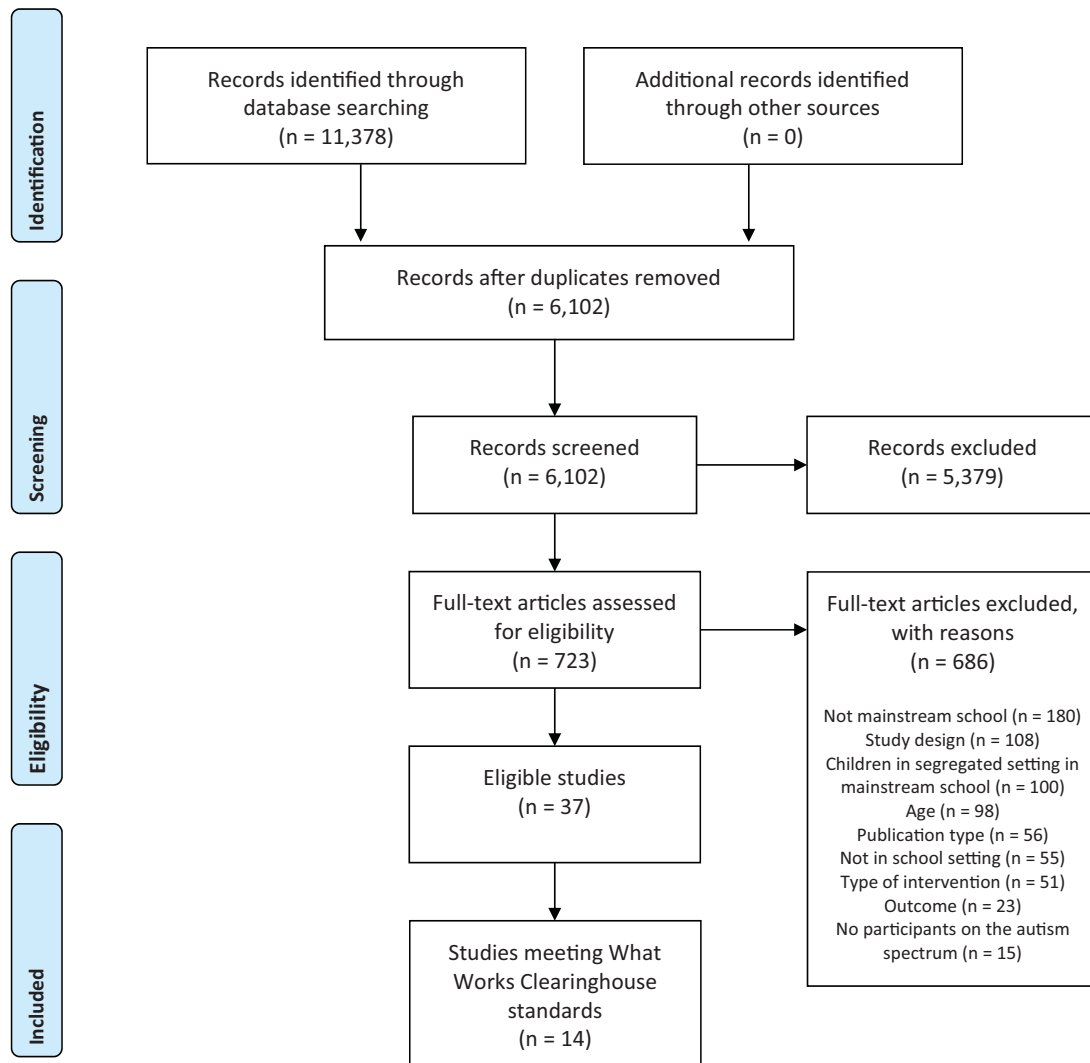
Figure 1. PRISMA flow chart.

multiple baseline design ($n = 6$), reversal-design ($n = 3$), multiple probe design ($n = 2$) and changing criterion design ($n = 1$). These 12 SCD studies included a total of 34 children between the ages of 6 to14 (87% male overall) with a diagnosis of ASD. IQ was reported for 58% of the participants, with a mean IQ of 70.6 (SD = 23.2, range 35–105). Additional support provided in school was applied behaviour analysis, speech and language therapy, occupational therapy, support teacher, individual educational plan, pull-out recourses, attendance in special education classes, one-on-one support, counselling and recourse room support. Some articles ($n = 7$) reported co-occurring conditions of the participants such as language impairment, intellectual disability, ADHD, depression and anxiety disorder. The majority of the interventions in the SCD studies were conducted in the child's classroom ($n = 7$), while some took place in a resource room ($n = 1$), therapy room ($n = 1$),

school cafeteria ($n = 1$), school playground ($n = 1$) or a changing setting in the school ($n = 1$). All SCD studies used a treatment-as-usual approach or a baseline condition without the intervention (see Table 3). Due to the high heterogeneity of the interventions and outcomes, a quantitative synthesis (using PEM) could only be conducted for three studies with similar outcome [72–74].

Types of accommodations

Psychosocial environment

Four of the studies meeting the WWC standard assessed peer interventions designed to improve the psychosocial environment for children with ASD. In an intervention called PEER [75], typically developing (TD) peers were trained to use strategies to engage children with ASD on the playground. The peers were taught to identify children who were not

involved in play and engage the children through role play, modelling or direct instructions. An intervention called ENGAGE [76] focussed on arranging social groups to engage the children in social activities, without directly training the TD-children involved. Another study used a peer-mediated teaching strategy called class-wide peer tutoring [77]. Students with ASD and their TD-peers were assigned to a tutor-learner dyad each week, with altered roles. Further, one study assessed the effectiveness of lunch clubs based on perseverative interest [73]. Finally, one study assessed paraprofessional training. Paraprofessionals were given 1-h didactic training workshop. Social groups were then held by the paraprofessionals, where TD peers and children with ASD met for games or other activities at lunch or recess [74].

In addition, several of the studies that were ultimately excluded from the synthesis due to insufficient study quality investigated interventions in the psychosocial environment. Seven studies evaluated interventions to improve participation and belonging through peer training [78–84]. Additional studies assessed a class-wide system with support in multiple domains within the learning environment [85], computer group work with adult support to improve functioning and interactions [86], and a model where personnel was trained to implement social engagement programs to reduce loneliness [87]. Finally, a quasi-experimental controlled trial assessed a transition support model for children from primary to secondary school [88].

In the psychosocial domain, accommodations related to the second level ICF codes e320 (acquaintances, peers, colleagues, neighbours and community members), e325 (friends), e420 (individual attitudes) and e465 (social norms) were identified. All these categories, in turn, were related to belonging and participation.

Pedagogical environment

Nine studies that met the WWC standard assessed accommodations focussed on functioning in school and academic achievement. Adcock and Cuvo [89] assessed a behavioural package to improve academic performance of children with ASD. Prompting fading, praise and tokens were used in different ways during task acquisition. Another study assessed a reward system with tokens, which was collaboratively framed with the participant [90]. Finally, one study assessed simultaneous prompting in small group arrangement, in order to learn specific academic tasks, after which children were rewarded with an activity [91]. Dugan

et al. [72] assessed reinforcement and cooperative learning groups with instructional strategies for problem solving and enhanced on-task engagement. Three studies evaluated assistive technology to improve functioning in school and academic achievement. Two of the studies assessed video modelling [92,93]. In both studies, the child with ASD watched a video recording of him-/herself performing a certain task (e.g. sitting down at his/her desk). The third study [94] assessed assistive technology in the form of an Android touch tablet with vocal output on completion of academic tasks (e.g. mathematics or history). Two additional studies assessed self-regulated strategy development (SRSD) to improve story writing. The training involved six lessons on planning, creating, and reviewing one's story writing. This included learning different writing strategies (e.g. mnemonics to remember instructions for story writing), as well as strategies to self-monitor [95,96].

The studies that did not meet WWC standards investigated a range of interventions in the pedagogical domain: how structural sessions of practical philosophy with the whole class affects participation and engagement [97]; assistive technology for written composition [98]; scaffolding models to improve writing [99]; cooperative learning groups in reading [100]; access to the general curriculum by modified activities [79]; explicit scaffolding of strategies for mathematical problem-solving [101]; reinforcement for academic productivity [102]; robots for educational adjustment [103]; repeated reading for oral reading fluency [104]; functional activities and multimedia for constructive engagement [105]; peer support for academic engagement [106] and visual schedules and support [107,108].

The accommodations in the pedagogical environment covered by this body of literature concerned e125 (products and technology for communication), e130 (products and technology for education) and e455 (individual attitudes of other professionals).

Physical environment

We identified no studies evaluating accommodations specifically targeting the physical environment.

Outcomes

Functioning in the school context

Ten of the 14 studies meeting the WWC standards involved outcomes concerning functioning in school. Six studies, two of which were RCTs, measured social interaction in the school context. The two RCTs evaluated the effects of peer interventions on social

network salience, as well as on social engagement and solitary play in the playground [75,76]. One of the studies also included teacher perception of social skills as an outcome measure [75]. The first of these studies [75] used a 2×2 factorial design, where the participants were randomised to a peer-mediated intervention (PEER), skills-training (CHILD), a combination of those or neither. Children receiving both PEER and CHILD had significantly higher social network salience scores at postintervention and 12-week follow-up compared to those receiving only CHILD, but not compared to those receiving only PEER. There was a faster decrease in solitary play among participants receiving PEER, and there was also an increase in joint engagement at follow-up in this group. While PEER was associated with a higher number of received friendship nominations at postintervention, there were no group differences regarding outward friendship nominations, rejections, or reciprocal friendships. Teacher-ratings of children's social skills significantly changed to post-treatment, with a significant main effect for PEER. In contrast, the second RCT [76] found no difference between a peer intervention (ENGAGE) and didactic social skills training (SKILLS) regarding change in social network salience, while the SKILLS group increased social engagement and decreased solitary play significantly more than the ENGAGE group [76].

One SCD study evaluating class-wide peer tutoring did not show any evidence of effect on social interaction [77]. Additionally, a cooperative learning group [72], lunch clubs based on perseverative interests [73] and paraprofessional training [74], demonstrated effects on social engagement. A quantitative synthesis of the effect sizes in these studies resulted in mean PEM = 0.99 (SD = 0.0017). In two of these studies [73,74], social interaction was measured both as social engagement and social initiation. Strong evidence of causal relation was shown for social engagement, while no evidence of causal relation was demonstrated for social initiation in any of the studies.

Three SCD studies evaluated the effects of different interventions on the children's on-task behaviour. A behavioural intervention (i.e. token economy with a contingency contract) [90] and a computer-based program [94] showed strong evidence of a causal relation, while video-self modelling showed no evidence of effect [93]. The studies on token economy with a contingency contract also assessed the effect on talkouts in the classroom, but demonstrated no evidence [90]. Finally, video-modelling showed strong evidence

of causal relation on transitions between school activities for three out of four participants [92].

Educational outcomes
Five of the 14 studies meeting the WWC standards assessed educational outcomes. All of these included educational outcomes in the form of academic achievement [89,91,94,96]. Two studies assessed self-regulated strategy development for story writing [95,96], and used number of words and holistic quality of a writing sample as outcomes. No evidence of a causal relation was demonstrated for number of words in any of the studies. However, one of the studies showed strong evidence of a causal relation on holistic quality [95]. In the remaining studies, a computer-based program showed strong evidence of a causal relation with completion of academic tasks [94], a behavioural intervention with outcomes such as correct responding on maths task demonstrated effects [89], and another behavioural intervention demonstrated effect on academic skills [91].

Well-being
None of the 14 studies included outcomes related to the child's well-being or quality of life.

Discussion

This systematic review focussed on accommodations to improve the learning environment for children on the autism spectrum in mainstream school. No more than 14 articles of sufficient study quality were identified, underscoring the need for more research in this field. The evaluated interventions were heterogeneous and the results were inconsistent. However, the preliminary evidence suggests that interventions in this domain can be effective. A few studies indicate that pedagogical interventions (e.g. behavioural strategies, writing instructional strategy and computer-based programs) can have positive effects on school performance. In addition, specific forms of peer interventions, behavioural strategies, assistive technologies and paraprofessional training seemed to have the potential to improve functioning in school. Despite the relatively wide range of interventions evaluated, few high-quality studies were available for each of these interventions. In addition, generalizability was restricted by the small number of participants. Our confidence in the results is therefore limited.

The present review included several accommodations in the psychosocial and pedagogical environment, but no accommodations in the physical

environment were identified for inclusion. Several of the studies evaluated pedagogical interventions with the aim to improve school performance, none of which were included in a recent comprehensive review of interventions for students with autism in inclusive settings by Watkins et al. [46]. This discrepancy seems to stem from differences in eligibility criteria, as Watkins and colleagues specifically focussed interventions that targeted skill-based or behavioural outcomes. All except one of these studies suggested evidence of a causal relation. Parents express a lack of proper academic adjustments for their children with ASD [42,109–111], and previous research has mainly been conducted in segregated settings [112–115]. Clearly, it is now time to give more priority to research on pedagogical strategies in mainstream school. Studies in the psychosocial domain predominantly evaluated peer interventions, which partly overlapped with the review by Watkins et al. [46]. The only RCTs included showed inconsistent results, when comparing peer interventions with social skills training. A recent systematic review of peer-mediated interventions for children with ASD reported that the only study that did not include a peer training component also was the single one that did not have a significant effect on social initiation [116], suggesting that an element of training might be necessary. The studies investigating the effect of assistive technologies yielded mixed results regarding functioning in school, including transition between activities and on-task behaviour. Meta-analyses examining video modelling in general suggest strong effects for some children with ASD, and also that age moderates the effect, with greater benefits for younger children [117,118]. With the rapid technological development and steadily increasing use of technological devices in school, this area seems bound to be front and centre in the coming years.

Several gaps in the literature were identified. No study included adolescents above 14 years of age and participants were predominantly males. Consequently, the literature provides no guidance regarding age- and sex-specific challenges and solutions. The mean IQ score of the participants was two standard deviations below the population average, which is unlikely to be representative of children on the autism spectrum in mainstream school [119,120]. It is also problematic that no study measured the effects on the children's well-being. School has a major role in promoting well-being for children with diverse needs, and it is important to clarify how accommodation of the school environment might improve the adverse situation many children on the spectrum find themselves in. Our mapping of environmental factors, based on the ICF core set for ASD, revealed that some areas of the learning environment so far seem to have been neglected by researchers. Notably, studies of the physical environment (e.g. light, sound) are lacking. The outdoor environment at school is presumably also of importance, although this aspect was missing from the ICF core set. Moreover, attitudes and norms were not adequately covered by the included studies.

With a holistic view on inclusion, diverse aspects such as participation, belonging and achievement must be considered [121,122]. Individual needs may be approached from several entry points (e.g. individual training, group training, accommodations). It is also important to note that inclusion of students with disabilities requires flexible strategies and co-operation among different professions (e.g. school psychologist, special needs teacher, occupational therapists and classroom teacher) [43,45]. In fact, a lack of collaboration among different professions has been identified as a hindering factor in school settings and outside school for individuals with ASD [59]. It is possible that comprehensive approaches involving multiple professions could be the most effective way to address this complexity. While several comprehensive programs for school students with ASD have been developed [123–130], no evaluation of any such intervention was identified for the present review. Moving forward, co-operation and more focus on environmental factors seems crucial to reduce barriers and develop more inclusive agendas.

The results of this systematic review should be interpreted with caution. First, we used strict inclusion criteria in order to shed light on this specific body of research. Consequently, some studies of practical relevance did not make the cut. For instance, a small RCT evaluating peer engagement on the school playground [131] and a study of a web application designed to promote literacy development [132] were excluded due to the fact that some participants attended pre-school. In addition, a previous literature review on the impact of the classroom design on young children with ASD [43] did identify a few studies looking at the effects of (e.g. coloured overlays on reading ability [133], and alternative seating on classroom behaviour [134]). However, these studies were conducted either in pre-school or segregated settings, and were consequently not eligible for the present review. In practical decision-making, a wider scope of studies could therefore be considered. This also

includes the broader literature on accommodations for school children with different disabilities, and accommodations targeting specific functions related to ASD. Second, the disproportionately high number of single-case studies was striking. Single-case design can certainly be robust [68,135], and several of the included studies did show strong evidence of causal relations. Nevertheless, the results do not readily generalize to other students. Therefore, an important next step will be to replicate the findings systematically in SCDs and in group designs. Also, the relatively low number of RCTs identified raises questions about potential barriers to conducting large-scale studies in this field. Third, and equally important, there must be an increased awareness of sustainable research [18], including exploration of implementation in school settings [136] and identification of barriers for effective changes in the learning environment [17,129]. Furthermore, interdisciplinary collaboration between research fields and development of partnerships will be important to narrow the research and practice gap [18,59,137]. Thus, conceptual frameworks such as occupational adaptation [138] might shed more light on the student by environment interaction, and interdisciplinary teams including both occupational therapists and teachers could be particularly well-equipped to lead innovation in this field. Finally, while awaiting more research and better guidance, educators should be encouraged to keep up their daily work to ensure inclusive education and equal opportunities for children on the autism spectrum.

Acknowledgements

Disclosure statement

Funding

ORCID

Sven Bölte http://orcid.org/0000-0002-4579-4970
Ulf Jonsson http://orcid.org/0000-0002-5761-2943

References

[1] United Nations (UN). Convention on the rights of persons with disabilities. UN; 2007 [cited 2020 Feb 13]. Available from: https://treaties.un.org/doc/Publication/CTC/Ch_IV_15.pdf.

[2] United Nations Educational, Scientific and Cultural Organization (UNESCO). The Salamanca Statement and framework for action on special needs education. Paris (France): UNESCO; 1994.

[3] United Nations Educational, Scientific and Cultural Organization (UNESCO). Guidelines for Inclusion: Ensuring Access to Education for All. Paris: UNESCO; 2005.

[4] United Nations (UN). Sustainable development goals. [cited 2020 Feb 13]. Available from: https://www.un.org/sustainabledevelopment/sustainable-development-goals/.

[5] Ainscow M, Booth T, Dyson A. Improving schools, developing inclusion. Abbingdon: Routledge; 2006.

[6] Alenkaer R. Når laering har saerlige vilkår [When learning has special terms]. In: H Borgbjerg Hansen, B Degn Mårtensson, editors. Specialdidaktik i teori og praksis. Undervisning på specialskoler og i specialklasser. [Special didactics in theory and practice. Teaching in special schools and units]. Köpenhamn: Hans Reitzels Forlag; 2017.

[7] Artiles AJ, Harris-Murri N, Rostenberg D. Inclusion as social justice: critical notes on discourses, assumptions and the road ahead. Theor Pract. 2006;45(3):260–268.

[8] Almqvist Almqvist L, Malmqvist J, Nilholm C. Three literature reviews within the area of special didactics and inclusion. What accommodations facilitate goal achievement in students with special needs?. Vetenskapsrådets rapporter. Stockholm: Vetenskapsrådet; 2015.

[9] Vislie L. From integration to inclusion: focusing global trends and changes in the western European societies. Eur J Spec Needs Edu. 2003;18(1):17–35.

[10] United Nations (UN). Convention on the rights of persons with disabilities: General comment no 4, article 24, right to inclusive education. UN; 2016 [cited 2020 Jul 03]. Available from: https://www.ohchr.org/EN/HRBodies/CRPD/Pages/GC.aspx.

[11] Booth T, Ainscow M. Index for Inclusion: Developing learning and participationin schools. Bristol: Centre for Studies in Inclusive Education; 2002.

[12] Allan J. The sociology of disability and the struggle for inclusive education. Brit J Sociol Educ. 2010; 31(5):603–619.

[13] Armstrong A, Armstrong D, Spandagou I. Inclusive education: International Policy & Practice. London (UK): SAGE Publications Ltd; 2010.

[14] Guldberg K. Educating children on the autism spectrum: preconditions for inclusion and notions of 'best autism practice' in the early years. Br J Spec Educ. 2010;37(4):168–174.

[15] Keane E, Aldridge FJ, Costley D, et al. Students with autism in regular classes: a long-term follow-up study of a satellite class transition model. Int J Inclusive Educ. 2012;16(10):1001–1017.

[16] Pellicano L, Bölte S, Stahmer A. The current illusion of educational inclusion. Autism. 2018;22(4): 386–387.

[17] Odom SL, Cox A, Brock M, National Professional Development Center On ASD. Implementation science, professional development and autism spectrum disorders. Except Child. 2013;79(3):233–251.

[18] Parsons S, Charman T, Faulkner R, et al. Commentary – bridging the gap in autism: the importance of creating research partnerships with schools. Autism. 2013;17(3):268–280.

[19] American Psychiatric Association (APA). Diagnostic and Statistical Manual of Mental Disorders: DSM-5. 5th ed. Arlington (VA): American Psychiatric Publishing; 2013.

[20] World Health Organization (WHO). International classification of functioning, disability and health. Geneva: WHO; 2001.

[21] World Health Organization (WHO). International classification of functioning, disability and health: child and youth version. Geneva: WHO; 2007.

[22] Bölte S, Mahdi S, de Vries PJ, et al. The Gestalt of functioning in autism spectrum disorder: Result of the international conference to develop final consensus International Classification of Functioning, Disability and Health core sets. Autism. 2019;23(2): 449–467.

[23] Centers for Disease Control and Prevention. Prevalence of Autism Spectrum Disorder among children aged 8 years – Autism and Developmental Disabilities Monitoring Network, 11 Sites, United States; 2016. [cited 2020 Jul 3]. Available from: https://www.cdc.gov/mmwr/volumes/69/ss/ss6904a1 .htm.

[24] Brown SM, Bebko JM. Generalization, overselectivity, and discrimination in the autism phenotype: a review. Res Autism Spectr Disord. 2012;6(2): 733–740.

[25] Charman T, Jones C, Pickles A, et al. Defining the cognitive phenotype of autism. Brain Res. 2011; 1380:10–21.

[26] Kercood S, Grskovic JA, Banda D, et al. Working memory and autism: a review of literature. Res Autism Spectr Disord. 2014;8(10):1316–1332.

[27] Kolb B, Whishaw IQ. 2008. Fundamentals of human neuropsychology. 6th ed. New York: Worth Publishers; 2008.

[28] Baron-Cohen S. Editorial perspective neurodiversity – a revolutionary concept for autism and psychiatry. J Child Psychol Psychiatr. 2017;58(6): 744–747.

[29] Moyse R, Porter J. The experience of the hidden curriculum for autistic girls at mainstream primary schools. Eur J Spec Needs Educ. 2015;30(2): 187–201.

[30] Matson JL, Shoemaker M. Intellectual disability and its relationship to autism spectrum disorders. Res Dev Dis. 2009;30(6):1107–1114.

[31] Humphrey N, Lewis S. 'Make me normal': the views and experiences of pupils on the autistic spectrum in mainstream secondary schools. Autism. 2008;12(1):23–46.

[32] Holcombe W, Plunkett M. The bridges and barriers model of support for high- functioning students with ASD in mainstream schools. AJTE. 2016;41: 27–47.

[33] Rotheram-Fuller E, Kasari C, Chamberlain B, et al. Social involvement of children with autism spectrum disorders in elementary school classrooms. J Child Psychol Psych. 2010;51(11):1227–1234.

[34] Ashburner J, Ziviani J, Rodger S. Surviving in the mainstream: capacity of children with autism spectrum disorders to perform academically and regulate their emotions and behavior at school. Res Autism Spectr Disord. 2010;4(1):18–27.

[35] Brown HM, Oram-Cardy J, Johnson A. A meta-analysis of the reading comprehension skills of individuals on the autism spectrum. J Autism Dev Disord. 2013;43(4):932–955.

[36] Keen D, Webster A, Ridley G. How well are children with autism spectrum disorder doing academically at school? An overview of the literature. Autism. 2016;20(3):276–294.

[37] Munkhaugen EK, Gjevik E, Pripp AH, et al. School refusal behaviour: are children and adolescents with autism spectrum disorder at a higher risk?. Res Autism Spectr Disord. 2017;41-42:31–38.

[38] Humphrey N, Symes W. Perceptions of social support and experience of bullying among pupils with autistic spectrum disorders in mainstream secondary schools. Eur J Spec Needs Educ. 2010;25(1): 77–91.

[39] Jamison TR, Schuttler JO. Examining social competence, self-perception, quality of life, and internalizing and externalizing symptoms in adolescent females with and without autism spectrum disorder: a quantitative design including between-groups and correlational analyses. Mol Autism. 2015;6:1–16.

[40] Jonsson U, Alaie I, Wilteus AL, et al. Annual research review: quality of life and childhood mental and behavioural disorders - a critical review of the research. J Child Psychol Psychiatr. 2017;58(4): 439–469.

[41] Lai MC, Lombardo MV, Baron-Cohen S. Autism. Lancet. 2014;383(9920):896–910.

[42] Lee LC, Harrington RA, Louie BB, et al. Children with autism: quality of life and parental concerns. J Autism Dev Disord. 2008;38(6):1147–1160.

[43] Martin CS. Exploring the impact of the design of the physical classroom environment on young children with autism spectrum disorder (ASD). J Res Spec Educ Needs. 2016;16(4):280–298.

[44] Parsons S, Guldberg K, MacLeod A, et al. Implications for practice from International review of the evidence on best practice in educational provision for children on the autism spectrum. Eur J Spec Needs Educ. 2011;26(1):47–63.

[45] Bond C, Symes W, Hebron J, et al. Educating persons with autistic spectrum disorder – a systematic review. NCSE Research Reports No: 20; 2016.

[46] Watkins LB, Ledbetter-Cho K, O'Reilly M, et al. Interventions for students with Autism in inclusive settings: a best-evidence synthesis and meta-analysis. Psychol Bull. 2019;145(5):490–507.

[47] Garrote A, Dessemontet RS, Opitz EM. Facilitating the social participation of pupils with special educational needs in mainstream schools: a review of school based interventions. Educ Res Rev-Neth. 2017;20:12–23.

[48] Reichow B, Volkmar FR. Social skills interventions for individuals with autism: evaluation for evidence-based practices within a best evidence synthesis framework. J Autism Dev Disord. 2010;40(2):149–166.

[49] Watkins L, ÓReilly M, Ledbetter-Cho K, et al. A meta-analysis of school-based social interaction interventions for adolescents with autism spectrum disorder. Rev J Autism Dev Disord. 2017;4(4):277–293.

[50] Wong C, Odom SL, Hume K, et al. Evidence-based practices for children, youth and young adults with Autism Spectrum Disorder. Chapel Hill: The University of North Carolina, Frank Porter Graham Child Development Institute, Autism Evidence- Based Practice Review Group; 2014.

[51] Jonsson U, Choque Olsson N, Bölte S. Can findings from randomized controlled trials of social skills training in autism spectrum disorder be generalized? The neglected dimension of external validity. Autism. 2016;20(3):295–305.

[52] Tonnsen B, Hahn ER. Middle school students' attitudes towards a peer with autism spectrum disorder: effects of social acceptance and physical inclusion. Focus Autism Other Dev Disabl. 2016;31(4):262–274.

[53] Williams E, Gleeson K, Jones B. How pupils on the autism spectrum make sense of themselves in the context of their experiences in a mainstream school setting; a qualitative metasynthesis. Autism. 2019;23(1):8–28.

[54] Odom SL, Hume K, Boyd B, et al. Moving beyond the intensive behavior treatment versus eclectic dichotomy: evidence-based and individualized programs for learners with ASD. Behav Modif. 2012;36(3):270–297.

[55] Mahdi S, Albertowski K, Almodayfer O, et al. An international clinical study of ability and disability in autism spectrum disorders using the WHO-ICF framework. J Autism Dev Disord. 2018;48(6):2148–2163.

[56] Available from: https://www.autismcrc.com.au/knowledge-centre/resource/national-guideline/.

[57] Scott M, Milbourn B, Falkmer M, et al. Factors impacting employment for people with autism spectrum disorder: a scoping review. Autism. 2019;23(4):869–901.

[58] Thompson C, Bölte S, Falkmer T, et al. To be understood: transition to adult life for people with autism spectrum disorder. PLoS One. 2018;13(3):e0194758.

[59] Krieger B, Piškur B, Schulze C, et al. Supporting and hindering environments for participation of adolescents diagnosed with autism spectrum disorder: a scoping review. PLoS One. 2018;13(8):e0202071.

[60] Khalifa G, Sharif Z, Sultan M, et al. Workplace accommodations for adults with autism spectrum disorder: a scoping review. Dis Rehab. 2020;42(9):1316–1331.

[61] Moher D, Liberati A, Tetzlaff J, PRISMA Group, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Ann Intern Med. 2009;151(4):264–269.

[62] Küller R. Environmental assessment from a neuro-psychological perspective. In: Gärling T, Evans GW, editors. Environment, cognition and action: An integrated approach. New York: Oxford University Press; 1991. p. 111–147.

[63] Swedish National Agency for Special Needs Education and Schools, SPSM. Handledning: Värderingsverktyg för tillgänglig utbildning [Guidance: an assessment tool for accessible education]. 2018 [cited 2020 Jun 25]. Available from: https://webbutiken.spsm.se/handledning-till-varderingsverktyg-for-tillganglig-utbildning/.

[64] Tufvesson C, Tufvesson J. The building process as a tool towards an all-inclusive school. A Swedish Example focusing on children with defined concentration difficulties such as ADHD, autism and Down's syndrome. J Hous and the Built Environ. 2009;24(1):47–66.

[65] Institute of Education Sciences [IES]. What Works Clearinghouse (WWC) Version 4.0 Standards Handbook. 2017a [cited 2020 Feb 13]. Available from: https://ies.ed.gov/ncee/wwc/Docs/referenceresources/wwc_standards_handbook_v4.pdf.

[66] Institute of Education Sciences [IES]. What Works Clearinghouse (WWC) Reviewer Guidance for use with the Procedures Handbook (version 4.0) and Standards Handbook (version 4.0). 2017b [cited 2020 Feb 13]. Available from: https://ies.ed.gov/ncee/wwc/Docs/ReferenceResources/wwc_reviewer_guidance_103017.pdf.

[67] Horner RH, Carr EG, Halle J, et al. The use of single-subject research to identify evidence-based practice in special education. Except Children. 2005;71(2):165–179.

[68] Kratochwill TR, Hitchcock JH, Horner RH, et al. Single-case intervention research design standards. Rem Spec Educ. 2013;34(1):26–38.

[69] Ma HH. An alternative method for quantitative synthesis of single-subject researches - Percentage

of data points exceeding the median. Behav Modif. 2006;30(5):598–617.

[70] Parker RI, Vannest KJ, Davis JL. Effect size in single-case research: a review of nine non overlap techniques. Behav Modif. 2011;35(4):303–322.

[71] Morley S. Single case methods in clinical psychology: a practical guide. New York (NY): Routledge; 2018.

[72] Dugan E, Kamps D, Leonard B. Effects of cooperative learning groups during social studies for students with autism and fourth-grade peers. J Appl Behav Anal. 1995;28(2):175–188.

[73] Koegel RL, Fredeen R, Kim S, et al. Using perseverative interests to improve interactions between adolescents with autism and their typical peers in school settings. J Posit Behav Interv. 2012;14(3):133–141.

[74] Koegel RL, Kim S, Koegel LK. Training paraprofessionals to improve socialization in students with ASD. J Autism Dev Disord. 2014;44(9):2197–2208.

[75] Kasari C, Rotheram-Fuller E, Locke J, et al. Making the connection: randomized controlled trial of social skills at school for children with autism spectrum disorders. J Child Psychol Psych. 2012;53(4):431–439.

[76] Kasari C, Dean M, Kretzmann M, et al. Children with autism spectrum disorder and social skills groups at school: a randomized trial comparing intervention approach and peer composition. J Child Psychol Psychiatr. 2016;57(2):171–179.

[77] Kamps DM, Barbetta PM, Leonard BR, et al. Classwide peer tutoring: an integration strategy to improve reading skills and promote peer interactions among students with autism and general education peers. J App Behav Anal. 1994;27(1):49–61.

[78] Bradley R. Why single me out?" Peer mentoring, autism and inclusion in mainstream secondary schools. Br J Spec Educ. 2016;43(3):272–288.

[79] Carter EW, Cushing LS, Clark NM, et al. Effects of peer support interventions on students' access to the general curriculum and social interactions. Res Pract Pers Sev Disabl. 2005;30(1):15–25.

[80] Collet-Klingenberg L, Neitzel J, LaBerge J. Power-PALS (Peers Assisting, Leading, Supporting): implementing a peer-mediated intervention in a rural middle school program. Rural Spec Educ Q. 2012;31(2):3–11.

[81] Harper CB, Symon JB, Frea WD. Recess is time-in: using peers to improve social skills of children with autism. J Autism Dev Disord. 2008;38(5):815–826.

[82] Owen-DeSchryver JS, Carr EG, Cale SI, et al. Promoting social interactions between students with autism spectrum disorders and their peers in inclusive school settings. Focus Autism Other Dev Disabl. 2008;23(1):15–28.

[83] Rodriguez-Medina J, Martin-Anton LJ, Carbonero MA, et al. Peermediated intervention for the development of social interaction skills in highfunctioning autism spectrum disorder: a Pilot Study. Front Psychol. 2016;7:1986.

[84] Trottier N, Kamp L, Mirenda P. Effects of peer-mediated instruction to teach use of speech-generating devices to students with autism in social game routines. Augment Altern Comm. 2011;27(1):26–39.

[85] Aspiranti KB, Bebech A, Osiniak K. Incorporating a class-wide behavioral system to decrease disruptive behaviors in the inclusive classroom. J Cathol Educ. 2018;21:1–12.

[86] Lewis L, Trushell J, Woods P. Effects of ICT group work on interactions and social acceptance of a primary pupil with Asperger's syndrome. Br J Educ Technol. 2005;36(5):739–755.

[87] Locke J, Kang-Yi C, Pellechia M, et al. It's messy but real: a pilot study of the implementation of a social engagement intervention for children with autism in schools. J Res Spec Educ Needs. 2019;19(2):135–144.

[88] Mandy W, Murin M, Baykaner O, et al. Easing the transition to secondary education for children with autism spectrum disorder: an evaluation of the Systemic Transition in Education Programme for autism spectrum disorder (STEP-ASD). Autism. 2016;20(5):580–590.

[89] Adcock J, Cuvo AJ. Enhancing learning for children with autism spectrum disorders in regular education by instructional modifications. Res Autism Spectr Disord. 2009;3(2):319–328.

[90] Jones N, Weber KP, McLaughlin TF. No teacher left behind: educating students with ASD and ADHD in the inclusion classroom. J Spec Educ Apprent. 2013;2:1–22.

[91] Tekin-Iftar E, Olcay-Gul S. Increasing instructional efficiency when using simultaneous prompting procedure in teaching academic skills to students with autism spectrum disorders. Int Electr J Element Educ. 2016;9:451–472.

[92] Cihak D, Fahrenkrog C, Ayres M, et al. The use of video modeling via a video iPod and a system of least prompts to improve transitional behaviors for students with autism spectrum disorders in the general education classroom. J Posit Behav Interv. 2010;12(2):103–115.

[93] Schatz RB, Peterson RK, Bellini S. The use of video self-modeling to increase on-task behavior in children with high-functioning autism. J Appl Sch Psychol. 2016;32(3):234–253.

[94] Stasolla F, Perilli V, Boccasini A, et al. Enhancing academic performance of three boys with autism spectrum disorders and intellectual disabilities through a computer-based program. Life Span Disabil. 2016;19:153–183.

[95] Asaro-Saddler K, Bak N. Teaching children with high-functioning autism spectrum disorders to write persuasive essays. Top Lang Disord. 2012;32:361–378.

[96] Asaro-Saddler K, Saddler B. Planning instruction and self-regulation training: effects on writers with autism spectrum disorders. Except Child. 2010;77(1):107–124.

[97] Cassidy C, Marwick H, Deeney L, et al. Philosophy with children, selfregulation and engaged participation for children with emotional-behavioural and

social communication needs. Emo Behav Difficult. 2018;23(1):81–96.

[98] Ashburner J, Ziviani J, Pennington A. The introduction of keyboarding to children with autism spectrum disorders with handwriting difficulties: a help or a hindrance? Australas j Spec Educ. 2012; 36(1):32–61.

[99] Asaro K, Saddler B. Effects of planning instruction on a young writer with Asperger syndrome. Inter Sch Clin. 2009;44(5):268–275.

[100] Kamps DM, Leonard B, Potucek J, et al. Cooperative learning groups in reading: an integration strategy for students with autism and general classroom peers. Behav Disord. 1995;21(1):89–109.

[101] Whitby PJS. The effects of "Solve It!" on the mathematical word problem solving ability of adolescents with autism spectrum disorders. Focus Autism Dev Disabil. 2013;28:78–88.

[102] Banda DR, Hart SL, Kercood S. Decreasing disruptive vocalizations of a student with high-functioning autism across three general education classrooms. Prevent Sch Failure. 2012;56(2): 104–109.

[103] Fachantidis N, Syriopoulou-Delli C, Vezyrtizis I, et al. Beneficial effects of a robot-mediated class activities on a child with ASD and his typical classmates. Int J Dev Disabil. 2020;66(3):245–253.

[104] Reisener CD, Lancaster AL, McMullin WA, et al. A Preliminary investigation of evidence-based interventions to increase oral reading fluency in children with autism. J Appl Sch Psychol. 2014;30(1): 50–67.

[105] Stasolla F, Damiani R, Caffo AO. Promoting constructive engagement by two boys with autism spectrum disorders and high functioning through behavioral interventions. Res Autism Spectr Disord. 2014;8(4):376–380.

[106] McCurdy EE, Cole CL. Use of a peer support intervention for promoting academic engagement of students with autism in general education settings. J Autism Dev Disord. 2014;44(4):883–893.

[107] Hall LJ, McClannahan LE, Krantz PJ. Promoting independence in integrated classrooms by teaching aides to use activity schedules and decreased prompts. Educ Train Ment Ret. 1995;30:208–217.

[108] Macdonald L, Trembath D, Ashburner J, et al. The use of visual schedules and work systems to increase the on-task behaviour of students on the autism spectrum in mainstream classrooms. J Res Spec Educ Needs. 2018;18(4):254–266.

[109] Hebron J, Bond C. Developing mainstream resource provision for pupils with autism spectrum disorder: parent and pupil perceptions. Eur J Spec Needs Educ. 2017;32(4):556–571.

[110] Saggers B, Tones M, Dunne J, et al. Promoting a collective voice from parents, educators and allied health professionals on the educational needs of students on the autism spectrum. J Autism Dev Disord. 2019;49(9):3845–3865.

[111] Tamm L, Duncan A, Vaughn A, et al. Academic needs in middle school: perspectives of parents and youth with autism. J Autism Dev Disord. 2020; 50(9):3126–3114.

[112] Alresheed F, Machalicek W, Sanford A, et al. Academic and related skills interventions for autism: a 20-year systematic review of single-case research. Rev J Autism Dev Disord. 2018;5(4): 311–326.

[113] El Zein F, Solis M, Vaughn S, et al. Reading comprehension interventions for students with autism spectrum disorders: a synthesis of research. J Autism Dev Disord. 2014;44(6):1303–1322.

[114] Grynszpan O, Weiss P, Perez-Diaz F, et al. Innovative technology-based interventions for autism spectrum disorders: a meta-analysis. Autism. 2014;18(4):346–361.

[115] King S, Lemons C, Davidson K. Math interventions for students with autism spectrum disorder: a best-evidence synthesis. Except Child. 2016;82(4): 443–462.

[116] Chang YC, Locke J. A systematic review of peer-mediated interventions for children with autism spectrum disorder. Res Autism Spectr Disord. 2016;27:1–10.

[117] Hong ER, Gong LY, Ninci J, et al. A meta-analysis of single-case research on the use of tablet-mediated interventions for persons with ASD. Res Dev Disabil. 2017;70:198–214.

[118] Wang SY, Cui Y, Parrila R. Examining the effectiveness of peer-mediated and video-modeling social skills interventions for children with autism spectrum disorders: a meta-analysis in single-case research using HLM. Res Autism Spectr Disord. 2011;5(1):562–569.

[119] Idring S, Rai D, Dal H, et al. Autism spectrum disorders in the Stockholm youth cohort: design, prevalence and validity. PLoS One. 2012;7(7): e41280.

[120] Kim SH, Bal VH, Lord C. Longitudinal follow-up of academic achievement in children with autism from age 2 to 18. J Child Psychol Psychiatr. 2018; 59(3):258–267.

[121] Bauminger-Zviely N. Social and academic abilities in children with high functioning autism spectrum disorder. New York: The Guilford Press; 2013.

[122] Bejnö H, Roll-Pettersson L, Klintwall L, et al. Cross-cultural content validity of the autism program environment rating scale in Sweden. J Autism Dev Disord. 2019;49(5):1853–1862.

[123] Koenig KP, Bleiweiss J, Brennan S, et al. The ASD nest program. Teach except Child; Reston. 2009; 42(1):6–13.

[124] Kemp S, Petriwskyj A, Shakespeare-Finch J, et al. What if you're really different? Case studies of children with high functioning autism participating in the Get REAL programme who had atypical learning trajectories. Eur J Spec Needs Educ. 2013;28(1): 91–108.

[125] Kuravackel G, Ruble L, Reese R, et al. COMPASS for hope: evaluating the effectiveness of a parent training and support progam for children with ASD. J Autism Dev Disord. 2018;48(2):404–416.

[126] Vivanti G, Paynter J, Duncan E, the Victorian ASELCC Team, et al. Effectiveness and feasibility of the early start Denver Model implemented in a group-based community childcare setting. J Autism Dev Disord. 2014;44(12):3140–3153.

[127] Morgan L, Hooker JL, Sparapani N, et al. Cluster randomized trial of the classroom SCERTS intervention for elementary students with autism spectrum disorder. J Consult Clin Psychol. 2018;86(7): 631–644.

[128] National Research Council. Educating children with autism. Committee on Educational Interventions for children with autism: Division of Behavioral and Social Sciences and Education. Washington (DC): National Academy Press; 2001.

[129] CAST. Universal Design for Learning guidelines: Version 1.0. Wakefield (MA): Author; 2008.

[130] Gustafson S, Svensson I, Fälth L. Respose to intervention and dynamic assessment: implementing systematic, dynamic and individualised interventions in primary school. Int J Disabil Dev Educ. 2014;61(1):27–43.

[131] Kretzmann M, Shih W, Kasari C. Improving peer engagement of children with autism on the school playground: a randomized controlled trial. Behav Ther. 2015;46(1):20–28.

[132] Arciuli J, Bailey B. Efficacy of ABRACADABRA literacy instruction in a school setting for children with autism spectrum disorders. Res Dev Disabil. 2019;85:104–115.

[133] Ludlow AK, Wilkins AJ, Heaton P. The effect of coloured overlays on reading ability in children with autism. J Autism Dev Disord. 2006;36(4):507–516.

[134] Schilling DL, Schwartz IS. Alternative seating for young children with autism spectrum disorder: effects on classroom behavior. J Autism Dev Disord. 2004;34(4):423–432.

[135] Barlow DH, Nock MK, Hersen M. Single Case Experimental Designs. Strategies for Studying Behavior Change. 3rd ed. Boston (MA): Pearson Education, Inc; 2009.

[136] Locke J, Wolk CB, Harker C, et al. Pebbles, rocks and boulders: the implementation of a school-based social engagement intervention for children with autism. Autism. 2017;21(8):985–994.

[137] Guldberg K. Evidence-based practice in autism educational research: can we bridgethe research and practice gap? Oxford Rev Educ. 2017;43(2): 149–161.

[138] Walder K, Molineux M, Bissett M, et al. Occupational adaptation - analyzing the maturity and understanding of the concept through concept analysis. Scand J Occup Ther. 2019;1:1–15.