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REVIEW PAPER

The Core Elements of Strength-Based Technology Programs for Youth on the Autism Spectrum: A Systematic Review of Qualitative Evidence

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Abstract
Strength-based programs that incorporate technology have gained increasing popularity as an approach to improve outcomes for individuals with autism spectrum disorder (ASD). Despite this, the core elements of strength-based technology programs remain poorly described. This study aimed to identify the core elements of strength-based technology programs for youth with ASD through a systematic review of the literature. Electronic databases were searched for qualitative studies delivering strength-based technology-driven interventions to youth on the spectrum. Ten of the 874 studies identified met the criteria. Qualitative analysis revealed three core elements of strength-based technology programs for this population: mutual respect, demonstrating skills, and interests. The findings underpin the design of future strength-based technology programs for youth with ASD.

Keywords Autism spectrum disorder · Strength-based approach · Meta-ethnography · Qualitative research · Computer coding · Technology programs

The diagnostic processes of autism spectrum disorder (ASD) are largely concerned with identifying difficulties, primarily in the areas of social communication, social interaction, and restricted, repetitive patterns of behavior (American Psychiatric Association, 2013). To date intervention has primarily focused on addressing these social and behavioral impairments, focusing on remediating ASD symptomatology (de Schipper et al., 2016). Despite efforts to improve outcomes for individuals with ASD by providing interventions aiming to remediate social and behavior deficits, outcomes in adulthood remain poor (Myers et al., 2015). Internationally, individuals with ASD experience low employment rates (Cimera & Cowan, 2009; Eaves & Ho, 2008; Howlin et al., 2004), a high prevalence of anxiety (Dubin et al., 2015), and restrictions in community participation rates (Myers et al., 2015). Adolescents with ASD experience more loneliness and poorer friendship quality than their neurotypical peers (Bauminger & Kasari, 2000; Chang et al., 2019; Lasgaard et al., 2010; Locke et al., 2010). This loneliness persists into adulthood, being associated with decreased life satisfaction and self-esteem, and increased depression and anxiety (Mazurek, 2014). Improving outcomes of adults with ASD is an ongoing challenge and there have been calls to review intervention approaches, particularly during adolescence (Drmic et al., 2017).

Individualised strength-based approaches have been proposed as particularly suited to supporting adolescents with ASD (G. Lee & Carter, 2012). Mounting evidence points to the efficacy of these approaches when exploring vocational possibilities (Patten Koenig & Hough Williams, 2017), during transition planning (Hatfield et al., 2017), in mentoring programs (Lucas & James, 2018), and work experience (E.

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Lee et al., 2019). Many of these programs focus on Information and Communication Technology (ICT) related activities, due to the wide recognition of alignment between ICT tasks and the strengths of individuals with ASD (de Schipper et al., 2016; Diener et al., 2016a, b; Mottron et al., 2006; Spek & Velderman, 2013; Wei et al., 2013).

While there is mounting enthusiasm for strength-based technology programs, there is little agreement in terms of their optimal design and delivery to youth with ASD. Technology programs purporting to be strength-based vary widely in relation to their reported active ingredients or core elements. The active ingredients or core elements define the intervention, causing change for the participants (Craig et al., 2008). Previous studies have targeted special interest with the goal of increasing motivation (Ashburner et al., 2018; Diener et al., 2016a, b), leveraged intrinsic abilities including attention to detail or visual-spatial abilities (Bianco et al., 2009), focused on developing skills in preference to remediating deficits (Diener et al., 2016a, b), and applied frameworks drawn from positive psychology (Dunn et al., 2015). Understanding of the utility of strength-based technology programs for youth with ASD would be progressed by consolidating the core elements to practically inform the design and delivery of these programs.

An important component of designing complex interventions, such as a strength-based technology program, is proposing 'how' the intervention will work; specifically, theorizing how the core elements of the intervention will exert their effect on participants (Craig et al., 2008). While a systematic review of quantitative data can inform understanding of the efficacy of an intervention, meta-ethnography through synthesizing qualitative studies, can reveal how individuals experience an intervention (Atkins et al., 2008). These insights can underpin an understanding of how the intervention works, produces outcomes and reasons for success or fail (Atkins et al., 2008). Given the aim of the present review was to explore the core elements contributing to reported outcomes of strength-based technology programs for individuals with ASD a meta-ethnographic approach was adopted. This approach has been used to explore parents experiences of their child receiving a diagnosis of ASD (Legg & Tickle, 2019) and disparities in autism services for marginalized communities (Singh & Bunyak, 2019). Specifically, the objectives of this review included (a) describing the core elements of strength-based technology programs, (b) describing the reported outcomes of strength-based technology programs, and (c) describing the interaction between core elements and outcomes for strength-based technology programs.

Methods

Selection Criteria

The systematic review employed the following inclusion criteria: (a) peer reviewed articles published in English, (b) the intervention described involved using technology and taught technology skills, (c) individuals who participated in the technology program were diagnosed with ASD, (d) individuals who participated in the technology program were aged between 8 and 21 years old, and (e) the authors describe the intervention as a "strength-based approach" (or similar, such as strengths perspective or strengths model).

The exclusion criteria were as follows: (a) studies that only included quantitative data, (b) dissertations and (c) systematic reviews.

Search Strategy and Data Extraction

A literature search was conducted by the first author, an Occupational Therapist and doctoral student with both clinical and academic experience. The following electronic databases were searched in October 2021: AMED, CINAHL, MEDLINE, PsychoINFO, EMBASE, Cochrane library, Scopus, and ERIC. Studies from the earliest electronic record to the most recent publication were included (2021). A Boolean search strategy was applied with search terms truncated and exploded. The search terms primarily focused on an ASD diagnosis and a strength-based approach (Table 1) in order to capture as many potential technology interventions as possible. The diagnostic term 'ASD' was mapped to Medical Subject Headings (MeSH) when available. Studies were selected for full review by the first author applying the selection criteria to the title and abstracts. Borderline studies were discussed within the authorship team. Excluded studies, specifically, systematic reviews or meta-analyses were hand searched to identify further potential studies. The selected studies were then read in full to confirm the inclusion and exclusion criteria.

The following data were extracted from the finalized studies: author, year, country, aim, population, participant's age

Table 1 Key search terms

Diagnosis	Intervention
Autis*, autism spectrum disorder*, Asperger*, autistic disorder*	Strength* base* approach, strength* base*, strength* perspective, strength-based, strengths-based

(range, mean, SD), qualitative methods, key features of the technology program, perspective and data analysis method. Participant quotes and key findings were extracted as part of the meta-analysis.

Article Quality

The articles were assessed for methodological quality using the qualitative assessment tool developed by Kmet et al. (2004). The assessment consists of 10 questions, with questions receiving a score of 2 if the criteria are met, a score of one if partially met, and a zero if the criteria were not met, for a total possible score of 20. The scores were converted to a percentage indicating the overall quality of the article: strong (> 80%), good (70–80%), adequate (50–69%), and limited (< 50%) (L. Lee et al., 2008). The assessment was completed by two researchers independently, with discrepancies in scores discussed until a consensus was reached and the new score recorded.

Data Analysis

Meta-ethnography can be used to synthesize qualitative research to generate more comprehensive theories or explore how interventions work (Atkins et al., 2008). The steps of meta-ethnography outlined by Noblit and Hare (1988) guided the present review process. The studies were read multiple times to gain an understanding of the core elements underpinning successful technology programs for individuals with ASD. The core elements were grouped using Nvivo12 Pro (QSR International Pty Ltd., 2020). Reciprocal synthesis was then used to determined which studies shared the same core elements (Noblit & Hare, 1988). Refutational synthesis was then conducted to determine if any core elements conflicted or contradicted each other (Noblit & Hare, 1988). New interpretations and relationships between core elements emerged representing line-of-argument synthesis (Noblit & Hare, 1988). The line-of-argument synthesis generated a framework, defining the core elements of strength-based technology programs, likely to foster positive outcomes in youth with ASD.

Results

A total of 874 references were identified based on the search strategy, which was reduced to 583 following the removal of duplicates. Following a review of the title and abstract the number of eligible articles was reduced to 129. A full-text review was performed, with 58 references excluded based on population (age and diagnosis) inclusion criteria, and 61 excluded based on intervention (strengths-based, teaching technology, using technology) inclusion criteria. Finally, 10 identified studies met the inclusion criteria (Fig. 1).

Study Design and Quality

The 10 selected studies were published between 2010 and 2020, with 8 studies employing qualitative methods only. Two studies (E. Lee et al., 2020; Wainer et al., 2010) employed a mixed methods approach, with the qualitative data included as part of the meta-ethnography and the quantitative data excluded due to there being only limited quantitative data. Five studies (Ashburner et al., 2018; Diener et al., 2015; E. Lee et al., 2019; C. Wright et al., 2011; S. D. Wright et al., 2012) used one-on-one semi-structured interviews or focus groups to gather qualitative data. Two studies (Diener et al., 2016a, b; Dunn et al., 2015) primarily gathered data through observations, triangulating results with semi-structured interviews and field notes. One study used semi-structured interviews triangulated with survey data (C. Wright et al., 2018). The descriptive characteristics of each study are detailed in Table 2.

Qualitative article quality was assessed (Kmet et al., 2004), with two studies (E. Lee et al., 2019; E. Lee et al., 2020) receiving a strong (> 80%) score, six studies (Ashburner et al., 2018; Diener et al., 2015; Diener et al., 2016a, b; Dunn et al., 2015; C. Wright et al., 2011; S. D. Wright et al., 2012) receiving good (70–80%) score, one study (C. Wright et al., 2018) receiving adequate (50–69%) score, and one study (Wainer et al., 2010) receiving limited (< 50%) quality score (Table 2).

Participant Characteristics

All studies involved individuals diagnosed with ASD with ages ranging from 8 to 21 years old ($n = 65$). Three studies (Diener et al., 2015, 2016a, b; Dunn et al., 2015) also included individuals with pervasive developmental disorder—not otherwise specified (PDD-NOS). In 8 of the 10 studies, all participants were males with ASD (Diener et al., 2015; Diener et al., 2016a, b; Dunn et al., 2015; E. Lee et al., 2019; Wainer et al., 2010; C. Wright et al., 2011, 2018; S. D. Wright et al., 2012). Six studies included data from family members, including parents ($n = 83$), grandparents ($n = 12$) and siblings ($n = 7$) (Ashburner et al., 2018; Diener et al., 2015; E. Lee et al., 2019; E. Lee et al., 2020; C. Wright et al., 2011; S. D. Wright et al., 2012). The two observational studies only presented data from the researchers' perspective (Diener et al., 2016a, b; Dunn et al., 2015). One study gathered data from employers ($n = 6$) of individuals with ASD (E. Lee et al., 2019). This review synthesized qualitative evidence and therefore a statistical assessment of heterogeneity was not performed, rather the methodologies of each study were described.

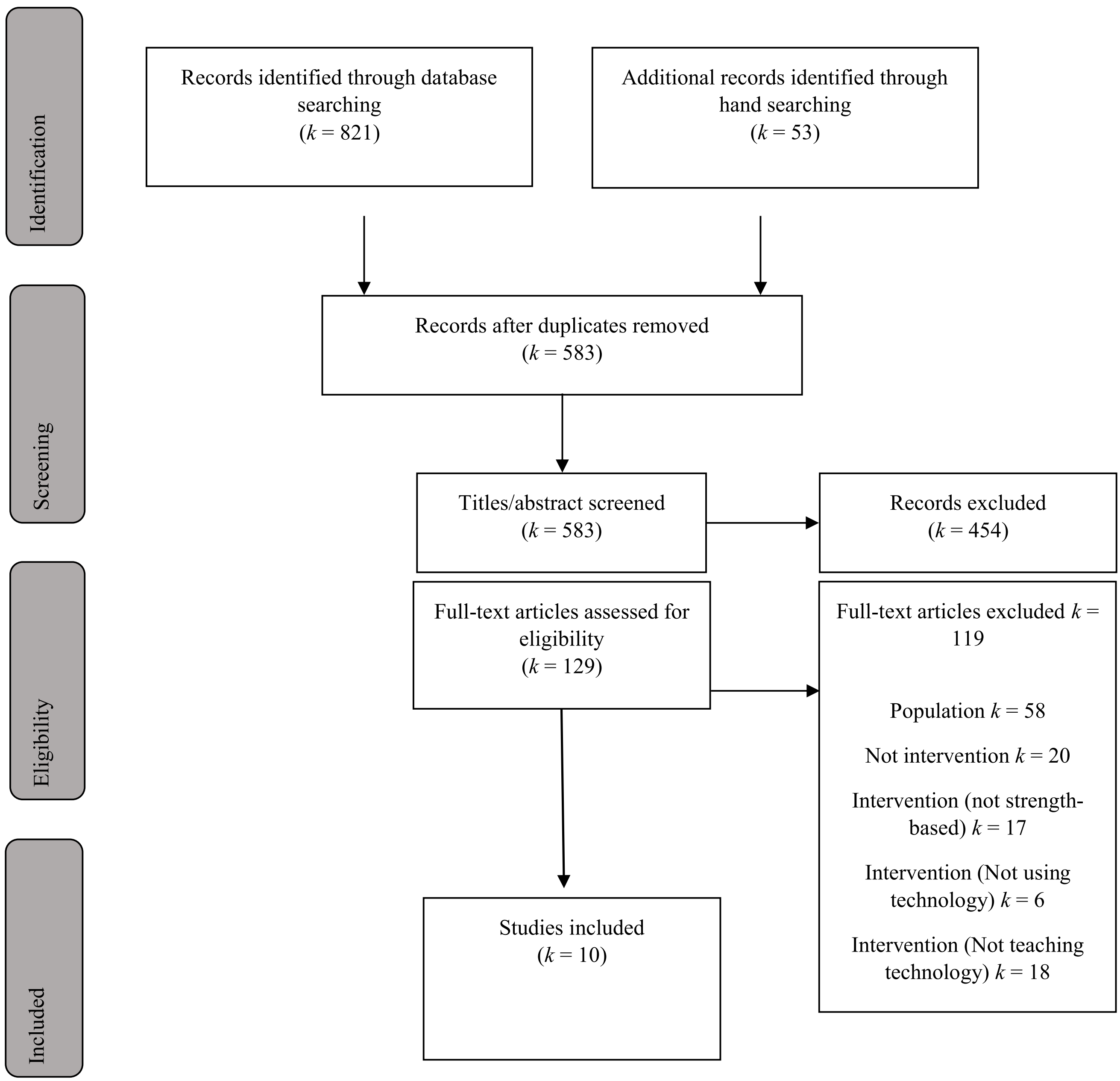

Fig. 1 Flowchart of study selection

Technology Program

Nine studies delivered technology sessions lasting between one and three hours (Ashburner et al., 2018; Diener et al., 2015; Diener et al., 2016a, b; Dunn et al., 2015; E. Lee et al., 2020; Wainer et al., 2010; C. Wright et al., 2011; S. D. Wright et al., 2012). The remaining study described a work experience program comprising of 7-h-long working days (E. Lee et al., 2019). Three studies started with an intensive teaching period, 5 days over 1 week, and then provided 1–2 sessions every week for 6–9 weeks (Diener et al., 2016a, b; C. Wright et al., 2011; S. D. Wright et al., 2012). Three programs delivered technology sessions for 5 days over 1 week (Dunn et al., 2015; E. Lee et al., 2019; C. Wright et al., 2018). Three studies delivered 1–2 technology sessions every week for 10–20 weeks (Ashburner et al., 2018; E. Lee et al., 2020; Wainer et al., 2010). One study reported participants participating in the technology program for up to 2 years, however, did not provide the specific duration or frequency of the program (Diener et al., 2015).

Nine of the 10 studies were group-based (Ashburner et al., 2018; Diener et al., 2015; Diener et al., 2016a, b;

Table 2 Descriptive summary of included studies

Author, year, country	Aim	Participants	Age Range Mean SD	Qualitative methods	Program Days per week Hours of session Total duration	Perspective	Data Analysis	Quality
Ashburner, 2018, AUS	Evaluate the impact of Studio G on social participation, friendship, emotional well-being, project skills and awareness of and transition into education and/or employment	ASD $n = 11$ (8 male, 3 female) Parents $n = 12$ (3 male, 9 female) Mentors $n = 7$ (6 male, 1 female)	17–21 years $M = 19.00$ $SD = 1.61$ * 21–30 years M = 23.71 $SD = 3.20$	Semi-structured interviews (one-on-one)	Studio G (multi-media activities such as game development, photography, graphic design) 2 days per week 3 h per session 20 weeks total	Individuals with ASD Parents Mentors	Qualitative content analysis	16/20 (80%) Weakness - Justifying sampling strategy - Reflexivity
Diener, 2015, USA	Investigate perspectives of mothers and daughters of son/brother with autism in the context of a strengths-based technology program	ASD $n = 6$ PDD-NOS $n = 1$ (7 male) Siblings $n = 7$ (7 female) Parents $n = 6$ (6 female)	10–14 years M = 11.57 $SD = 1.27$ 7–14 years M = 10.41 $SD = 2.82$ *	Semi-structured interviews (one-on-one)	3D Technology Program (Sketch-UP) * days per week * hours per session 2 years total	Mothers Sisters	Thematic analysis	16/20 (80%) Weakness - Data collection description - Reflexivity
Diener, 2016, USA	What factors facilitate social engagement in an interest-based technology program	ASD $n = 6$ PDD-NOS = 1 (7 male)	8–17 years $M = 11.57$ $SD = 2.76$	Observation (videotapes) Transcripts of sessions (Videotapes) Semi-structured interviews	3D Technology Program (Sketch-UP) 5 days per week * hours per session 1 week total Followed by: 1 day per week 1.15 h per session 6 weeks total	Researcher	Thematic analysis	14/20 (70%) Weakness - Research objective description - Data collection and analysis description - Reflexivity
Dunn, 2015, USA	Explore themes that promote learning and engagement in a technology based program	ASD $n = 7$ PDD-NOS $n = 1$ (8 males)	8–19 years *	Observation (videotapes) Transcripts of sessions (videotapes) Field notes (Facilitators)	3D Technology Program (Sketch-UP) 5 days per week 3 h per session 1 week total	Researcher	Grounded-theory analysis	14/20 (70%) Weakness - Research objective description - Justifying Sampling strategy - Study design - Data analysis description - Reflexivity

Table 2 (continued)

Author, year, country	Aim	Participants	Age Range Mean SD	Qualitative methods	Program Days per week Hours of session Total duration	Perspective	Data Analysis	Quality
Lee, 2019, AUS	Key factors that contribute to a successful work placement	ASD $n=5$ (5 male) Parents $n=6$ (6 female) Work supervisors $n=6$ (*)	15–18 years $M=16.86$ $SD=1.07$ * *	Semi-structured interviews (one-on-one) Focus group Written feedback	Work experience placement 5 days per week 7 h per session 1 week total	Adolescents with ASD, parents and employers	Thematic analysis	17/20 (85%) Weakness - Justifying sampling strategy - Reflexivity
Lee, 2020, AUS	Explore components contributing to success of strengths-based programs for youth with ASD	ASD $n=53$ (39 male) Parents $n=52$	10–18 years $M=14$ $SD=2.3$	Participatory observations and interviews	1 day per week 2 h 4 × 10 week terms	Parents of children and youth with ASD	Thematic analysis	18/20 (90%) Weakness - Justifying sampling strategy - Reflexivity
Wainer, 2010, ENG	Robotics class effectiveness in encouraging collaboration among children with ASD	ASD $n=7$ (7 male)	8–14 years $M=9.86$ $SD=2.12$	Mixed methods, Including semi-structured interviews (one-on-one)	Lego NXT robots 1 day per week 1 h per session 12 weeks total	Parents/carers	Not described	9/20 (45%) Weakness - Qualitative study design - Sampling strategy description and justification - Qualitative data analysis description - Credibility procedures - Reflexivity
Wright, 2011, USA	Examine intergenerational relationships	ASD $n=7$ (7 male) Parents $n=7$ (1 male, 6 female) Grandparents $n=6$ (2 male, 4 female)	8–17 years * * *	Focus group	3D Technology Program (SketchUP) 5 days per week * hours per session 1 week total Followed by: 1 day per week 2 h per session 9 weeks total	Parents and grandparents	Thematic analysis	14/20 (70%) Weakness - Study design - Description of context - Reflexivity

Table 2 (continued)

Author, year, country	Aim	Participants	Age Range Mean SD	Qualitative methods	Program Days per week Hours of session Total duration	Perspective	Data Analysis	Quality
Wright, 2012, USA	Examine the perceptions of grandparents about their grandchild's experience in a strength's based technology program	ASD $n=7$ (7 male) Grandparents $n=6$ (2 male, 4 female)	8–17 years * 54–81 years *	Focus groups	3D Technology Program (Sketch-UP) Summer workshop * days per week * hours per session * week total Followed by: 2 days per week * hours per session 6 weeks total	Grandparent	Thematic analysis	14/20 (70%) Weakness - Justifying sampling strategy - Data collection description - Reflexivity
Wright, 2018, USA	Investigate the development and implementation of a strengths-based peer teaching program	ASD $n=9$ (9 male)	15–26 years $M=20$ $SD=4.12$	Semi-structured interviews (one-on-one) Survey	3D Technology Program (Sketch-UP) 5 days per week 3 h per session 1 week total	Peer teachers with ASD	Thematic analysis	12/20 (60%) Weakness - Description of context - Connection to theoretical framework - Justifying sampling strategy - Data analysis description - Reflexivity

* Data not provided by original author; *ASD* autism spectrum disorder, *PDD-NOS* pervasive developmental disorders not otherwise specified

Dunn et al., 2015; E. Lee et al., 2020; Wainer et al., 2010; C. Wright et al., 2011; S. D. Wright et al., 2012). In 6 of the 10 studies, students with ASD were taught a 3D technology program called "SketchUp" by mentors experienced with the program (Diener et al., 2015; Diener et al., 2016a, b; Dunn et al., 2015; C. Wright et al., 2011, 2018; S. D. Wright et al., 2012). SketchUp is a free 3D modeling computer program used in a variety of industries, including architecture, engineering, landscape design, film and game design (C. Wright et al., 2011). Students with ASD were taught the program by a SketchUp expert and designed their own 3D models and environments. One study delivered a course called "Studio G" which included exposure to a range of activities related to game development, photography, graphic design, animation, music and creative writing (Ashburner et al., 2018). The mentors had a background in digital creative arts. Two studies recruited participants from the Autism Academy of Software Quality Assurance (AASQA) where students learnt computer coding or robotics from computer science, mechatronics, and mechanical engineering students (E. Lee et al., 2019; E. Lee et al., 2020). The program was also supported by Occupational Therapy students. Interested participants were then offered the opportunity to participate in a work experience program. One study included participants from strengths-based groups delivered by a non-profit organization, which incorporated special interests such as coding, visual arts, digital media, and music (E. Lee et al., 2020). One study taught students how to code LEGO NXT robots, with learning applied to a series of challenges (Wainer et al., 2010).

Reciprocal Synthesis

Reciprocal synthesis was achieved by performing thematic analysis across all studies in order to identify common themes. Across the studies eight themes emerged: confidence, future options, friendship, socializing, mutual respect, demonstrating skills, interests, and a safe place (Table 3). As this review focused on qualitative studies, it was not possible to conduct sensitivity analysis in the traditional sense. Rather the studies underpinning each theme are presented in Table 4. The robustness of themes is presented in Table 4, which demonstrates that each theme is underpinned by at least five studies.

Confidence

Seven studies described youth with ASD as experiencing increased confidence as a result of participating in the technology programs (Ashburner et al., 2018; Dunn et al., 2015; E. Lee et al., 2019; E. Lee et al., 2020; Wainer et al., 2010; C. Wright et al., 2011, 2018; S. D. Wright et al., 2012). Family members spoke about observing a general increase in their child's confidence, as well as increased confidence in specific tasks.

> ''I was amazed at the school presentation my son gave—he was confident, articulate, and funny.''—Parent (C. Wright et al., 2011, p. 142)

Family members felt that their child/grandchild, as a result of attending the technology program, had more confidence when speaking, and would spontaneously "talk more" with others (Ashburner et al., 2018; E. Lee et al., 2020). Researchers observed that increased confidence was fostered by peer teaching, opportunities to present to the group, and individuals with ASD "show[ing] others what they could do" (Dunn et al., 2015, p. 463). Individuals with ASD highlighted their increased confidence with technology and specific technology activities, saying, "it shows me that I'm destined to ace this stuff. It's so easy, and I'm just so good at it" (E. Lee et al., 2019, p. 3094). Attending a technology program also increased participants' confidence in other major life areas such as transport, with attendance prompting them to access public transport, building "the confidence of actually getting there [technology program]" (Ashburner et al., 2018).

Future Options

Five studies identified the role of technology classes in encouraging individuals with ASD in exploring future education and employment options (Ashburner et al., 2018; Dunn et al., 2015; E. Lee et al., 2019; C. Wright et al., 2011; S. D. Wright et al., 2012). Program mentors sharing their experiences of working in the ICT industry improved participants understanding of their career options, inspiring them to consider their personal opportunities and possibilities.

> "If I was going to go for a job, I could definitely ask the mentors or [Coordinator] and they would know the answer to those sorts of questions."—Individual with ASD (Ashburner et al., 2018, p. 276)
> "I used that … as a leaping off point to talk to him about game development and the different sorts of areas that he could … work in"—Mentor (Ashburner et al., 2018, p. 277)

Mentors assisted participants in exploring future education options, "working with [students] to try and select the best one that's fitted for them" providing the "knowledge to make decisions" (Ashburner et al., 2018, p. 276). Participants knowledge and understanding of future career options was enhanced through opportunities such as work experience, which for one participant "reinforce[d] [his] interest in software development" (E. Lee et al., 2019, p. 3093). Program mentors also supported participants with practical employment related tasks, including practicing writing job

Table 3 Theme operational definitions and exemplar quotes

Theme	Operational definition Quote
Confidence	Technology classes increased the confidence of individuals with ASD in the following areas; socialising, using public transport (for individuals who caught public transport to class), workplace tasks, helping others, presenting their work to other people and technology skills ‘‘I was amazed at the school presentation my son gave—he was confident, articulate, and funny.’’—Parent (C. Wright et al., 2011, p. 142)
Future options	Facilitators of the technology classes provided assistance to individuals with ASD when considering future education and employment options. Facilitators assisted by; suggesting future study and employment options, matching interests to potential career paths, assisting with resumes and job applications, and organising vocational activities, such as visiting a game development studio “If I was going to go for a job, I could definitely ask the mentors or [Coordinator] and they would know the answer to those sorts of questions.”—Individual with ASD (Ashburner et al., 2018, p. 276) “I used that … as a leaping off point to talk to him about game development and the different sorts of areas that he could … work in”—Mentor (Ashburner et al., 2018, p. 277)
Friendship	Technology classes promoted friendships. Students made friends with each other, and also with facilitators. Genuine friendships developed because they were “like-minded” and had similar interests “It was the ‘first time in our whole life she’s actually invited some friends to our home.”—Parent (Ashburner et al., 2018, p. 274) “[My daughter] made a close friend with one of the other female participants her age and they see each other outside of the group and have playdates.”—Parent (E. Lee et al., 2020, p3187)
Socialising	Technology classes helped to improve social skills of individuals with ASD, including; reciprocal conversations, approaching people, problem solving with others, presenting their work in a group situation and teaching others “When I started here, Harry wasn’t very good at talking to people … He’s having conversations with everyone and he’s kind of a chatterbox actually now.”—Mentor (Ashburner et al., 2018, p. 274)
Mutual respect	Facilitators treated individuals with ASD with respect, and even though were technically the technology experts, they did not act with high authority. Facilitators were scene more as roles models, rather than teachers or bosses. In turn, individuals with ASD respected facilitators “It is really helpful to have someone like him (Steve) communicate with him on a really equal level. What I mean is that he talks to these kids with such respect and he talks to them like they are his colleagues and he respects their ideas in a way that has made my son feel really important.”—Parent (Diener et al., 2015, p. 1067) “He feels like he can contribute to and learn from mentors and other ninjas. Roger (pseudonym) also feels completely welcome and nurtured by the staff…It is the most nurturing and non-confrontational environment and everyone involved is so in tune to each child, their needs and what may impact on their comfort.”—Parent (E. Lee et al., 2020, p. 3186)
Demonstrate skills	Technology classes provided the opportunity for individuals with ASD to demonstrate their technology skills and knowledge to family, other students, and other adults. Opportunity to demonstrate skills was provided through presentation days, where students would present their work, such as a 3D model they have created. Demonstration of skills was also encouraged through peer mentoring “We have preconceived ideas about how they will behave and because of those, they don’t always get the chance to show what they can do.’’—Parent (C. Wright et al., 2011, p. 143)
Interests	Individuals with ASD had common interests with each other and with mentors. Technology classes provided activities that were based upon student’s interests “It appeared that the programme naturally facilitated social participation by creating ‘an opportunity to mix with like-minded people’ who ‘have the same interests”—Parent (Ashburner et al., 2018, p. 274)
Safe place	Individuals with ASD described technology classes as a safe environment, and felt safe when attending We come to this [program] knowing it is a safe place…we’re going to be happy and he’s going to be happy. We walk away and take this feeling home with us.—Parent (C. Wright et al., 2011, p. 143)

applications and resumes (Ashburner et al., 2018). Several technology programs provided vocational activities, such as visiting a game development studio (Ashburner et al., 2018; Dunn et al., 2015; E. Lee et al., 2019).

Friendship

Six studies identified that technology programs were catalysts in building ‘genuine’ friends, with friendships extending beyond the programs, involving playdates, sleep overs, or going bowling (Ashburner et al., 2018; Diener et al., 2015; Diener et al., 2016a, b; E. Lee et al., 2020; C. Wright et al., 2011; S. D. Wright et al., 2012).

> “It was the first time in our whole life she’s actually invited some friends to our home.”—Parent (Ashburner et al., 2018, p. 274)
> “[My daughter] made a close friend with one of the other female participants her age and they see each

Table 4 Studies contributing to themes

Author	Themes							
	Confidence	Future options	Friendship	Social skills	Mutual respect	Demonstrate skills	Interests	Safe place
Ashburner 2018	•	•	•	•	•		•	•
Diener 2015			•		•	•	•	•
Diener 2016			•	•	•	•	•	•
Dunn 2015		•		•	•	•	•	•
Lee 2019	•	•		•		•	•	
Lee 2020	•		•	•	•		•	•
Wainer 2010	•			•		•	•	
Wright 2011	•	•	•	•	•	•	•	•
Wright 2012	•	•	•	•	•	•	•	
Wright 2018					•			

> other outside of the group and have playdates."—Parent (E. Lee et al., 2020, p3187)

Mentors attributed the forming of friendships between youths with ASD to the social context which allowed them to be "comfortable with what their interests are" and being able to "nerd out" (Ashburner et al., 2018, p. 274). Parents attributed the development of friendships to meeting "like-minded people" (Ashburner et al., 2018, p. 274) and identifying with their peers, "it's like they have this sense when they meet another person on the spectrum" (C. Wright et al., 2011, p. 141) and that they can "act normal" and not "have to worry about the other kids being affected" (Diener et al., 2015, p. 1067).

Socializing

Eight studies identified technology classes as providing opportunities to socialize and improve the social skills of individuals with ASD (Ashburner et al., 2018; Diener et al., 2016a, b; Dunn et al., 2015; E. Lee et al., 2019; E. Lee et al., 2020; Wainer et al., 2010; C. Wright et al., 2011; S. D. Wright et al., 2012). While the technology programs did not specifically target socials skills, they did provide opportunities for interacting with others while learning technology skills.

> "Kyle is learning, he's mentally stimulated, and he's socializing'"—Parent (Ashburner et al., 2018, p. 276)
> "When I started here, Harry wasn't very good at talking to people …. He's having conversations with everyone and he's kind of a chatterbox actually now."—Mentor (Ashburner et al., 2018, p. 274)

Mentors described participants as "coming out of their shells" and "not so scared anymore to approach or be approached by someone" (Ashburner et al., 2018, p. 275). Parents felt that the technology programs gave their children more to talk about, giving them a new topic to "start conversations when meeting new people", improving their ability to "take turns" during conversations (Wainer et al., 2010, p. 451). Grandparents attributed the opportunities for teaching others and sharing their designs as improving participant's communication skills (S. D. Wright et al., 2012).

Mutual Respect

Eight studies highlighted the importance of mentors treating individuals with ASD with respect and as equals, even though they were technically the experts (Ashburner et al., 2018; Diener et al., 2015; Diener et al., 2016a, b; Dunn et al., 2015; E. Lee et al., 2020; C. Wright et al., 2011, 2018; S. D. Wright et al., 2012). Mentors were seen as role models rather than as teachers or bosses.

> "It is really helpful to have someone like him (Steve) communicate with him on a really equal level. What I mean is that he talks to these kids with such respect and he talks to them like they are his colleagues and he respects their ideas in a way that has made my son feel really important." Parent (Diener et al., 2015, p. 1067).
> "He feels like he can contribute to and learn from mentors and other ninjas. Roger (pseudonym) also feels completely welcome and nurtured by the staff…It is the most nurturing and non-confrontational environment and everyone involved is so in tune to each child, their needs and what may impact on their comfort."—Parent (E. Lee et al., 2020, p. 3186).

Students described mentors as "approachable and more like peers than authority figures" (Ashburner et al., 2018, p. 280) and as "interact[ing] on [their] level, instead of being like a higher authority" (Ashburner et al., 2018, p. 277). In one study, the researchers observed that mentors were humble and modeled making mistakes, with mentors having a willingness to learn from students saying, “you are teaching me all sorts of stuff” (Diener et al., 2016a, b, p. 192). Mentors were described as fostering a “relationship of trust”, valuing and respecting students as “assets to the community” (Diener et al., 2016a, b, p. 193), creating a safe learning environment (Diener et al., 2016a, b).

Demonstrate Skills

Seven studies explicitly described technology programs as providing opportunities for individuals with ASD to demonstrate their technology skills to family, other students, and other adults (Diener et al., 2015; Diener et al., 2016a, b; Dunn et al., 2015; E. Lee et al., 2019; Wainer et al., 2010; C. Wright et al., 2011; S. D. Wright et al., 2012). Across the programs ‘presentation days’ featured as a common strategy in providing opportunities for students to present their work to the class and family.

> “We have preconceived ideas about how they will behave and because of those, they don’t always get the chance to show what they can do.’’—Parent (C. Wright et al., 2011, p. 143)

Opportunities for demonstrating skills were encouraged through helping others and through peer mentoring. For example, a mentor may encourage a student to teach another student about a specific tool within the software program. Opportunities for demonstrating technology skills highlighted the technical skills of participants putting them in a “positive context”, highlighting to families previously “unrecognized skills” (Diener et al., 2015, p. 1069), and reframing their expectations of their young person (C. Wright et al., 2011). Parents reinforced that opportunities to demonstrate skills drew attention to positive “character traits” or youth with ASD, like, “bright, interesting, fascinating, creative and funny” (C. Wright et al., 2011, p. 143). Opportunities to demonstrate skills extended beyond the technology programs, with several students presenting their work to their school classmates, “engag[ing with] their teachers and classmates positively” (Diener et al., 2016a, b, p. 188).

Interests

Nine studies highlighted that individuals with ASD participating in the technology classes shared common interests with each other and with mentors, with activities within the classes leveraging these interests (Ashburner et al., 2018; Diener et al., 2015; Diener et al., 2016a, b; Dunn et al., 2015; E. Lee et al., 2019; E. Lee et al., 2020; Wainer et al., 2010; C. Wright et al., 2011; S. D. Wright et al., 2012).

> “Charlie (mentor) observed ‘people “nerding out”… and being comfortable with what their interests are”—Mentor (Ashburner et al., 2018, p. 274)

Parents reported students as “hav[ing] the same interests”, helping them feel “part of a group” (Ashburner et al., 2018, p. 274). Mentors agreed, that being with “like-minded” people “interested in the same things” created a safe environment, encouraging socializing (Ashburner et al., 2018, p. 274). Parents expressed that shared interests underpinned friendships, allowing students the freedom to be themselves (Diener et al., 2015; E. Lee et al., 2020). Researchers observed that the social interaction and communication within the groups centered around common interests (Diener et al., 2016a, b). Parents described students as developing friendships with the mentors through common interest referring to them as “my friend” (C. Wright et al., 2011, p. 142). Across the studies the technology programs described incorporated the interests of students into activities, for example, a student interested in jewelry was encouraged to create a business website for jewelry (Ashburner et al., 2018).

Safe Place

Six studies highlighted that individuals with ASD saw the technology programs as a safe place where they belonged and where they felt safe and happy, being motivated to attend (Ashburner et al., 2018; Diener et al., 2015; Diener et al., 2016a, b; Dunn et al., 2015; E. Lee et al., 2020; C. Wright et al., 2011).

> “We come to this [program] knowing it is a safe place… we’re going to be happy and he’s going to be happy. We walk away and take this feeling home with us.”—Parent (C. Wright et al., 2011, p. 143)

Students described the technology programs as their “sanctuary” contrasting their experience with school, where they experienced frequent bullying (Ashburner et al., 2018, p. 274). Parents felt that “everyone understands each other and they are very accepting of each other” (E. Lee et al., 2020, p. 3186). Researchers observed feelings of safety were fostered by mentors viewing students as “valued and respected assets to the community” (Diener et al., 2016a, b). Mentors also helped to create a safe environment by providing “positive feedback” and “mutual acceptance of all abilities” (Dunn et al., 2015, p. 462). Mentors focused on strengths rather than the challenges associated with ASD helping students to “recognize the things [they were] really good at” (C. Wright et al., 2011, p. 143).

Refutational Analysis

Refutational analysis revealed that while there were no directly conflicting themes, two studies reported cases of individuals with ASD experiencing increased anxiety prior to attending technology programs (Ashburner et al., 2018; E. Lee et al., 2019). Increased anxiety may be seen as conflicting with the themes of increasing confidence and creating a safe place. In one study, adolescents reported anxiety relating to entering an unfamiliar environment before starting their work placement (E. Lee et al., 2019). In the other study, one student reported anxiety related to the use of public transport to attend.

> "It's ramped up anxiety but it's certainly helped with depression. … He does get anxious about going there and catching public transport."—Parent (Ashburner et al., 2018, p. 275).

The studies documenting increased anxiety also reported that students were still motivated to attend the technology classes because the activities suited their strengths and interests.

Line of Argument

The reciprocal analysis results were translated into a line of argument, presenting a new understanding of technology programs for individuals with ASD, captured by eight themes which fell into the overarching categories of outcomes and mechanisms. Outcomes encompassed the impact of technology programs on individuals with ASD and mechanisms encompassed the service delivery aspects of the program.

The themes classified as outcomes included confidence, future options, friendships, social skills, and safe place. The themes classified as mechanisms included mutual respect, demonstrate skills, and interests. Mechanisms impacted outcomes. For example, the mechanism of interests enabled the outcome of a safe place. A study described how individuals with ASD felt safer in a context where they shared interests with others.

> "One of the best things is just being in an environment with lots of other people who are interested in the same things …. [Mentee] admitted to me that he was bullied in high school …. It feels safer to a lot of them … you can see them all having conversations and playing games with each other and just having fun."—Mentor (Ashburner et al., 2018, p. 274).

Table 5 demonstrates the relationship between mechanism and outcome themes. Mutual respect produced the outcome of exploring future options and creating a safe place. Demonstrating skills improved confidence, helped to explore future options, improved social skills and created a safe place. Interests impacted all outcomes.

Table 5 Mechanism themes contributing to outcome themes

	Outcome themes				
Mechanism themes	Confidence	Future options	Friendship	Social skills	Safe place
Mutual respect		•			•
Demonstrate skills	•	•		•	•
Interests	•	•	•	•	•

Discussion

Through a meta-ethnographic synthesis this review identified, for the first time, that the core elements of technology programs for individuals with ASD are mutual respect, demonstrating skills, and interests. While strength-based interventions have been proposed as an approach with the potential to improve the outcomes of adolescents with ASD (G. Lee & Carter, 2012), implementing these have been constrained by a lack of understanding of the core elements promoting outcomes. This understanding of 'how' these strength-based interventions work provides a foundational evidence-base, underpinning future intervention development and service delivery models.

Mutual Respect

Mutual respect defined the relationship and perceived understanding between facilitators and students. Rather than adopting an authoritative stance, that of an expert in a teaching role, facilitators fostered an environment of mutual respect. Facilitators treated students as individuals, valuing their opinion, acknowledging individual students' needs and abilities. The trust and respect with which students regarded the facilitators enabled feelings of safety and comfort, prompting students to talk with facilitators about their plans and options for future education and employment. Facilitators also felt comfortable sharing their own experience with education and employment within the ICT industry. The importance of establishing an environment of mutual respect is highlighted in the ASD literature, particularly in those examining mentoring programs. While the technology programs did not officially represent a mentorship program, facilitators employed many strategies evident in such programs. For example, during a mentoring program for university students with ASD, mentor–mentee partnerships failed when there was a perceived hierarchy or natural friendships could not be established (Hamilton et al., 2016; Roberts & Birmingham, 2017). Successful mentoring programs describe the mentoring relationship as combining the roles of a friend, peer and teacher, with mentees feeling they are on the same level as their mentor (Roberts & Birmingham, 2017), treated as individuals, and not defined by their diagnosis (Hamilton et al., 2016). Positive mentor–mentee relationships are facilitated through individualized approaches, adapting to the specific individual needs of mentees (Hamilton et al., 2016; Roberts & Birmingham, 2017). Positive mentorship is underpinned by mentors sharing their experiences and knowledge, normalizing mentees experiences, including feeling stressed or anxious when at university (Roberts & Birmingham, 2017). The strategies employed in mentoring programs with individuals with ASD parallel the findings of this review, collectively pointing to the importance of an emotionally safe environment free from judgement, in promoting social interaction and information seeking (Hamilton et al., 2016).

The strategies employed by facilitators across the studies included in this review consistently aligned with those of a client-centered approach (Hammell, 2013). Client-centered approaches encourage working partnerships between therapists and clients, focusing on minimizing power inequalities, acknowledging individual strengths, and avoiding authoritarian or judgmental behavior (Hammell, 2013). Training facilitators of strength-based ICT programs should include education on client-centered approaches, working towards reducing the perceived power imbalance between students and facilitators, which in turn will promote feelings of personal safety and opportunities to discuss future education and employment options. A key finding of this review was that facilitators with a background in technology or working in roles aligned with the ICT industry were able to draw on and share their experiences with students.

Demonstrate Skills

Across the studies included in this review, demonstrating skills emerged in multiple ways, including students teaching each other, showcasing their work to family or presenting their technology projects to the class. Demonstrating skills celebrates the strengths and abilities of students and is aligned with a positive youth development perspective (Dunn et al., 2015). A positive youth development perspective focuses on building strengths and positive qualities rather than fixing deficits (Bowers et al., 2010). Demonstrating skills specifically aligns with the youth development component of leadership roles within the family, at school and/or in community activities (Tirrell et al., 2019). Opportunities for teaching other students and showcasing their work allowed students to 'give back' to the technology program. Findings of this review also highlighted the opportunity for many students to contribute to their family system through sharing technology skills with family members. Sharing technology skills with family members improved sibling relationships and changed parent expectations (Diener et al., 2015). Parental expectations have a powerful influence on their children with ASD, predicting participation in postsecondary education (Chiang et al., 2013; Wagner et al., 2012), and impacting the social opportunities parents provide (Carter et al., 2014). Witnessing the abilities of their children with ASD in technology tasks, through showcasing events, is likely to positively impact parental expectations in relation to future education and employment prospects (Diener et al., 2015; C. Wright et al., 2011).

Demonstrating skills was reported to improve confidence and social interaction in individuals with ASD, further aligning this mechanism with positive youth development, specifically the Five Cs model. The Five Cs model emphasizes that youth programs should focus on five core areas of development; competence, confidence, connection, caring, and character (Bowers et al., 2010). Demonstrating skills aligned with two of the five areas; improving confidence in students and connecting students with each other, their families and their community. Future technology programs should include activities that allow students to demonstrate their skills and abilities within the program but also to their wider social networks. The results indicate that providing youth with ASD with the opportunity to demonstrate skills and abilities can facilitate improved confidence, promoting social interaction and opportunities to contribute to family and community.

Interests

The mechanism of "interests" contributed to all outcomes associated with strength-based technology programs for adolescents with ASD. The findings of the present review highlight that when students share a common interest in technology, social interaction occurs naturally without need for prompting or therapeutic intervention. There are many examples of the role of shared interest in engaging individuals with ASD in social interaction (Daniel & Billingsley, 2010; Gunn & Delafield-Butt, 2016; L. K. Koegel et al., 2012; Müller et al., 2008; Peckett et al., 2016). The findings of this review demonstrate that sharing an interest not only encourages social interaction, but facilitates genuine friendships and a sense of belonging, paralleling findings in the broader literature (Carter et al., 2014; Daniel & Billingsley, 2010; Wilson et al., 2018). While studies included in the present review primarily focused on examining the shared interests between individuals with ASD, many of the programs utilised facilitators with similar interests to students (Ashburner et al., 2018; Dunn et al., 2015; C. Wright et al., 2011). This was noted to encourage communication between facilitators and students (Ashburner et al., 2018; Dunn et al., 2015; C. Wright et al., 2011). The peer mentoring literature supports this finding recommending that mentors build rapport through common interests with mentees (Curtin et al., 2016; Hamilton et al., 2016; Thompson et al., 2018).

Incorporating students' interests into the activities themselves was a strategy employed across programs included in this review, being a well-documented approach in motivating individuals with ASD to engage in activities (Asaro-Saddler et al., 2015; Gunn & Delafield-Butt, 2016; Jung & Sainato, 2015; L. K. Koegel et al., 2010; Patten Koenig & Hough Williams, 2017). Similar to leveraging shared interests, interest-based activities enable the development of social and communication skills (Ashbaugh et al., 2017; Campbell & Tincani, 2011; Daubert et al., 2014; Dunst et al., 2012; R. L. Koegel et al., 2018; Lindsay et al., 2017).

The interests of individuals with ASD are a powerful motivator in promoting engagement in social and learning activities (Asaro-Saddler et al., 2015; Brown & Stanton-Chapman, 2015; Lanou et al., 2012). For this reason, interests were linked to all outcomes and should form the centrepiece of future technology programs for individuals with ASD.

Limitations

This review has several limitations. The meta-ethnographic analysis was limited by the quality of articles available. Higher quality studies (Ashburner et al., 2018; Diener et al., 2015) are overrepresented in the results, given the robust nature of their findings supported by a greater number of participant quotes. Lower quality papers outlined fewer themes, substantiated by less participant quotes, limiting their contribution to the meta-analysis. However, given the aim of the present review was to synthesize all available qualitative research, generating new understandings of strength-based technology programs, articles of lower methodological quality were not excluded.

The participant quotes extracted from the included articles may not have represented the full experience of participants, given quotes were selected by authors as exemplars (Atkins et al., 2008). It is possible that the themes articulated in this review fail to represent the full experience of youth with ASD attending strength-based technology programs.

Six studies (Diener et al., 2015; Diener et al., 2016a, b; Dunn et al., 2015; C. Wright et al., 2011, 2018; S. D. Wright et al., 2012) described the same technology program (SketchUp), with authors collaborating across studies, which may negatively impact the generalization of the results. There are further several notable limitations associated with the participant samples across all of the included studies. While the initial intention of this review was to focus on studies involving adolescents with ASD only, this was not possible given the paucity of available research, with samples across studies ranging from 8 to 21 years old. Further, across studies there was a notable gender bias in the samples, which typically involved male participants with ASD, and their mothers. It therefore remains unclear whether the experience of female participants with ASD would differ from their male peers, and how fathers perceive the impacts of these programs.

Similar to other qualitative research approaches, replicating the findings of meta-ethnography is difficult given the subjective nature of synthesizing data (Atkins et al., 2008). Partly addressing this limitation, the present review documented the processes involved in reciprocal, refutational, and line-of-argument synthesis (Atkins et al., 2008) using Nvivo12 (QSR International Pty Ltd., 2020). The review was limited to articles published in English, potentially excluding studies published in other languages. However, due to the highly interpretative nature of the methods of synthesis used in this review, inclusion of non-English articles was deemed too challenging. The risk of misinterpreting themes was considered too great, given the potential for meaning to be lost in translation. Further, while the data extraction was completed by the first author only, the coding framework and process was comprehensively reviewed by an academic experienced in meta-ethnography (SG), with interpretation of the themes discussed among the research team to confirm the findings.

Conclusion

This meta-ethnographic review revealed that the three core elements impacting the outcomes of strength-based technology programs with youth with ASD are mutual respect, demonstrating skills, and interests. Mutual respect can be facilitated through employing client-centered practice and recruiting facilitators with ICT industry backgrounds. Demonstrating skills should be encouraged through presentation days and peer teaching, with students showcasing their technology projects and teaching each other. Program activities should be centered on common interests given this component emerged as a powerful influencer on all outcomes. Five outcomes of strength-based technology programs for youth with ASD were identified: confidence, future options, friendship, socializing, and safe place. Across the studies an increase in the general confidence of participants and confidence in relation to specific tasks, such as speaking with others became apparent. Future options related to the opportunities available to students to explore future education and employment options during the technology programs. Genuine friendships were reported as an outcome of technology programs. Despite not specifically targeting social skills across the included studies there was a noted improvement in participants' social skills. Individuals with ASD consistently reported that they 'felt safe' when attending strength-based technology programs. The relationship between core elements and the outcomes were chartered through line of argument synthesis, with mutual respect facilitating the outcomes of future options and safe place. Demonstrating skills helped to facilitate the outcomes of confidence, future options, socializing, and safe place. Interests facilitated all documented outcomes.

The findings of this review can inform the design of future strength-based technology programs for youth with ASD. The results demonstrated that strength-based technology programs are multifaceted, leveraging skills and interests to create positive outcomes for adolescents with ASD. Specific attention to leveraging the special interests of individuals with ASD should be prioritized, as special interests were linked with all documented outcomes. Future research can use the identified core elements to develop a framework to standardize the delivery of strength-based technology programs to adolescents with ASD, allowing efficacy testing.

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Declarations

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