TECHNOLOGY-SUPPORTED INSTRUCTION FOR STUDENTS WITH AUTISM: A LITERATURE REVIEW

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Abstract

Digital technologies have become part of everyday teaching for students with autism, yet the evidence behind them is uneven. This review examined the international literature on technology-supported instruction for children and adolescents with autism and looked at what had been studied in Turkey and North Macedonia. A narrative literature review was conducted in October 2026 across international databases, publisher platforms, and Turkish and Macedonian national repositories. Systematic reviews, meta-analyses, controlled trials and single-case studies were grouped into seven technology types and analysed thematically for target skills, research design, effects, generalisation and implementation. Video modelling, augmentative and alternative communication apps and computer- or tablet-assisted instruction had the strongest and most consistent evidence, and communication devices did not hinder speech development. Augmented reality showed emerging support for academic learning, while virtual reality produced moderate pooled effects that became much smaller in controlled trials of social skills. Socially assistive robots performed about as well as conventional therapy but not better, and the evidence for serious games, artificial intelligence tools and smart glasses rested on small or uncontrolled studies. Across technologies, effects were larger when researchers rather than teachers delivered the intervention, and generalisation to everyday settings was weak. Turkish research consisted mainly of single-case studies conducted outside ordinary classrooms, whereas North Macedonia had a supportive legal framework but almost no school-based research. The findings suggested that teacher training, classroom-based trials and the involvement of people with autism in design should be the main priorities.

Keywords: students with autism; educational technology; video modelling; augmentative and alternative communication; social robots; inclusive education

1. Introduction

Walk into almost any special education classroom today and you will find a tablet somewhere: propped on a desk, playing a short video of a peer washing their hands, or speaking a word aloud when a child taps a picture. Technology arrived in autism education quietly, then all at once. Over the past fifteen years it has moved from a novelty used in a few research clinics to an ordinary part of teaching.

There are good reasons for the appeal. Screens are predictable. A video plays the same way every time, an app does not lose patience, and a picture on a device does not carry the social demands of a face. Secondary students with autism in the United States, asked directly, said that technology helped them work more independently, eased their anxiety and even opened doors to social contact (Hedges *et al.*, 2018). Teachers, for their part, value tools that let them individualise instruction without cloning themselves.

The research has started to back some of this up. The most recent major review of autism practices, covering 972 studies, lists technology-aided instruction and intervention, video modelling and augmentative and alternative communication among its 28 evidence-based practices (Steinbrenner *et al.*, 2020; Hume *et al.*, 2021). That is a real endorsement. It is also a little misleading if read carelessly, because "technology" is not one thing. A speech-generating app, a humanoid robot, a virtual-reality headset and an AI chatbot have almost nothing in common except a battery. The evidence behind them ranges from dozens of careful studies to a handful of pilots.

This matters for teachers and school leaders, who are increasingly asked to buy, adopt or defend particular tools. It matters more in countries where research on autism education is still developing and where decisions about technology may be driven by availability, enthusiasm

or marketing rather than evidence. Turkey and North Macedonia are two such countries, with very different research capacities and a shared commitment, at least on paper, to inclusive education.

Most existing reviews look at a single technology or a single skill. Fewer try to put the whole landscape in one place, from established tools to emerging ones, and ask what a classroom teacher can reasonably conclude. This review attempts that. It asks four questions:

1. Which technologies have been used to teach children and adolescents with autism, and for which skills?
2. How strong is the evidence for each?
3. What is known about generalisation, implementation and teacher readiness?
4. What has been studied in Turkey and North Macedonia, and where are the gaps?

2. Method

2.1 Design: This is a narrative literature review with an integrative, thematic synthesis. The field is too uneven for a single pooled analysis. Some technologies, such as video modelling, have been tested in hundreds of single-case studies and several meta-analyses. Others, such as AI-driven tutoring, have barely reached the classroom. A narrative design lets the two be read side by side without pretending they rest on the same kind of evidence.

Where possible, the review leans on systematic reviews and meta-analyses and uses individual studies to illustrate or fill gaps. A short regional section then looks at what has been published in Turkey and North Macedonia.

2.2 Sources and search: Searches were carried out in October 2026 across PubMed/PMC, ERIC, publisher platforms (Springer, Elsevier, Wiley, SAGE, Taylor & Francis, MDPI, Frontiers) and general academic web search. For the regional section, DergiPark, TR Dizin, the YÖK thesis repository and university repositories in Turkey were searched, together with the UKIM and UGD repositories and the *Journal of Special Education and Rehabilitation* (Skopje) for North Macedonia.

Search strings combined autism terms (autism, autistic, ASD; otizm, OSB; аутизам; autizëm) with technology terms such as:

- computer-assisted instruction, tablet, iPad, mobile app
- video modelling, video prompting
- augmentative and alternative communication, speech-generating device
- robot, virtual reality, augmented reality, serious game
- artificial intelligence, wearable

These were combined with education terms (instruction, teaching, school, classroom, skill). Reference lists of key reviews were also scanned. The search was supported by three parallel AI-assisted search streams, and every source was checked against a retrieved bibliographic record before inclusion.

2.3 Inclusion criteria: Sources were included if they:

1. involved children or adolescents with autism (roughly ages 2–21), alone or as an identifiable subgroup;
2. used a digital or electronic technology to teach or support a skill (academic, communication, social, daily living, vocational or behavioural);
3. were systematic reviews, meta-analyses, controlled trials, single-case experimental designs, or national practice frameworks, or, for the regional section, any empirical or review study;

4. were published from 2005 onward, with earlier landmark work included where it shaped the field; and
5. could be verified bibliographically.

Technologies used only for screening or diagnosis were excluded, as were studies of adults outside an educational or vocational-training context.

2.4 Analysis: Sources were grouped by technology type:

- computer and tablet-based instruction;
- video-based instruction;
- augmentative and alternative communication;
- socially assistive robots;
- virtual and augmented reality;
- serious games;
- artificial intelligence and wearables.

Within each group, the review noted the skills targeted, the dominant research designs, the size and consistency of reported effects, and what was said about maintenance and generalisation. Cross-cutting issues (teacher readiness, access, ethics, and the involvement of people with autism in design) were then drawn together in the discussion.

3. Findings by technology type

The established tools come first: computer and tablet instruction, video-based teaching and communication devices. Between them they account for most of the research and nearly all of the formal evidence-based-practice endorsements. The emerging technologies follow, and the tone of the evidence changes noticeably when we reach them. Figure 1 summarises where each technology stands.

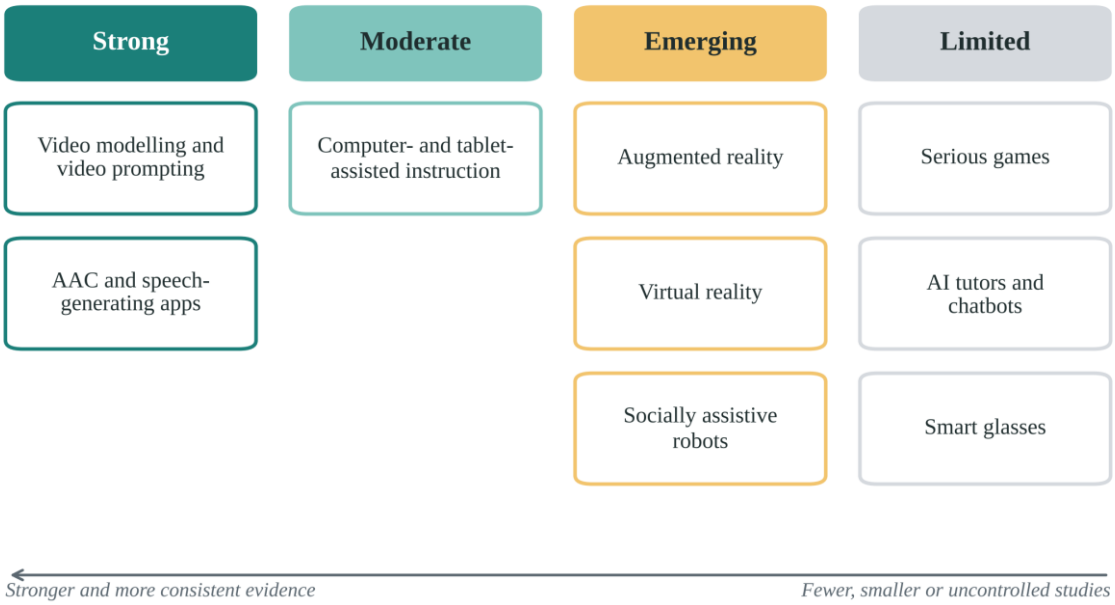


Figure 1. Strength of evidence for technology-supported instruction with students with autism, by technology type (synthesised from the reviewed literature)

3.1 Computer- and tablet-based instruction: The earliest reviews were cautious. A systematic review of computer-based communication teaching found that all ten included studies reported some gains, but only two gave conclusive evidence, and the software involved was already

dated (Ramdoss *et al.*, 2011). A wider look at academic interventions was blunter: of 25 studies, only three single-case studies and no group studies met accepted quality standards (Knight *et al.*, 2013). Pennington (2010) reached a similar verdict. Computer-assisted instruction (CAI) seemed to work for a limited range of academic skills, but few studies demonstrated a clear functional relation.

The picture firmed up over the following decade. Applying strict quality indicators to twelve adequate studies, Root *et al.* (2017) concluded that CAI now qualifies as an evidence-based practice for teaching academic content to students with autism. A 2014 meta-analysis of group studies covering computers, interactive DVDs, shared touch surfaces and virtual environments found a moderate effect (d = 0.47) that held regardless of age or IQ (Grynszpan *et al.*, 2014). Curiously, longer interventions went with smaller effects. Perhaps novelty wears off, or perhaps the harder cases get the longer programmes.

Tablets changed the practicalities. They are cheap, portable and fit in a backpack. A meta-analysis of 19 single-case studies on tablet-mediated academic teaching found that most successful interventions did not rely on commercial apps at all (Ledbetter-Cho *et al.*, 2018). Teachers used the camera and video functions to make their own materials. Effects were also notably larger when students operated the device themselves rather than watching an adult use it. Earlier reviews had already shown iPads and iPods being used for academic, communication, leisure and even employment skills (Kagohara *et al.*, 2013), and a later meta-analysis confirmed positive academic outcomes across subjects and grade levels (Larwin & Aspiranti, 2019).

When the field turns to controlled group comparisons, effects shrink. Across 19 controlled studies of digital interventions, mostly targeting social skills, the pooled effect was small (d = 0.32) and heterogeneity was extreme (Sandgreen *et al.*, 2021). A 2025 meta-analysis on socio-emotional skills reported much larger effects, strongest for emotion understanding, with desktop programmes outperforming mobile and emerging tools (Liu *et al.*, 2025). One detail in that analysis deserves attention. Interventions delivered by researchers or therapists had roughly double the effect of those delivered by parents or teachers (g = 1.14 against 0.56). What works in a study does not automatically work in an ordinary classroom.

Commercial programmes illustrate the point. A school-based evaluation of TeachTown: Basics in Los Angeles found greater language and cognitive gains than in a comparison group, yet the authors, who included the developers, still called the results inconclusive (Whalen *et al.*, 2010). A reading programme, Headsprout Early Reading, worked for six children with autism only after each received individually tailored extra support (Thompson *et al.*, 2022). The software was a scaffold, not a teacher.

3.2 Video modelling and video prompting: If one technology-delivered practice can be called well established, it is video modelling. The learner watches a short video of someone (a peer, an adult, or the learner themselves) performing a target skill, then practises it. Video prompting breaks the skill into steps, with a clip for each.

The evidence has been consistent for two decades. An early meta-analysis of 23 single-subject studies found video modelling and video self-modelling effective for social-communication, functional skills and behaviour, with gains that were maintained and transferred across people and settings (Bellini & Akullian, 2007). Later work using other people as models found large effects for participants with autism specifically (Mason *et al.*, 2012). Point-of-view modelling, filmed from the learner's own visual perspective, worked better for independent living skills than for social communication (Mason *et al.*, 2013). Self-modelling showed strong effects for participants with autism but weak ones for academic outcomes (Mason *et al.*, 2016). For functional living skills, video modelling was moderately effective whatever the learner's age or the type of video (Hong *et al.*, 2016).

Video modelling is listed as an evidence-based practice in the American framework (Steinbrenner *et al.*, 2020) and as an established intervention, within the broader category of modelling, by the National Standards Project (National Autism Center, 2015). Smartphones have made it almost effortless to produce. A teacher can film a classmate making a sandwich at break time and use the clip the same afternoon. Related work with learners with intellectual disability shows that handheld video prompting is effective for daily living skills (Stierle *et al.*, 2023).
The gaps are narrower here, but real. Academic skills are less well served than functional ones, and studies with secondary-age students with autism are relatively few (Mason *et al.*, 2016).

3.3 Augmentative and alternative communication: For children with autism who speak little or not at all, communication technology can be transformative. Speech-generating devices (SGDs), once heavy and expensive, now run as apps on ordinary tablets.
The evidence for aided communication is strong. A meta-analysis of 24 single-case studies found very large effects for both picture exchange and speech-generating devices, compared with other picture-based systems (Ganz *et al.*, 2012). The benefits extended to social skills and challenging behaviour. A review of SGD studies found that 87% reported positive outcomes, mostly for requesting (van der Meer & Rispoli, 2010). When tablets and iPods took over the SGD role, children often learned to use them faster than picture exchange or signing, and many preferred them (Lorah *et al.*, 2015; Alzrayer *et al.*, 2014). A meta-analysis of 21 comparison studies by Turkish researchers found the same: 35 of 44 participants preferred the SGD when given a choice (Aydın & Diken, 2020). Preference matters, because a child who likes a system is more likely to use it outside the training room. In one comparison of three systems, the SGD also showed the best generalisation and maintenance (McLay *et al.*, 2015).
There are limits. In a larger meta-analysis, high-tech AAC had only low to moderate effects on broader social-communication outcomes (Ganz *et al.*, 2017). Most studies teach requesting; far fewer address commenting, conversation, or the needs of adolescents and adults (Holyfield *et al.*, 2017). Even so, AAC is now listed as an evidence-based practice in its own right (Steinbrenner *et al.*, 2020).
Parents often worry that a device will stop their child from learning to talk. The evidence says otherwise. Reviews from 2006 onward found no case where AAC caused speech to decline, and most showed modest speech gains (Millar *et al.*, 2006; Schlosser & Wendt, 2008). The most recent review confirms that speech does not suffer, while noting that speech gains are usually smaller than gains in AAC use itself (White *et al.*, 2021). AAC is not a rival to speech. At worst it is neutral, and often it helps.

3.4 Socially assistive robots: Robots attract more attention than their evidence base would justify, though the evidence is not nothing. Early reviews found that children with autism often engaged more readily with a robot than with a human partner. Attention was high, and a few tiny studies reported fewer repetitive behaviours during robot sessions (Pennisi *et al.*, 2016). But the same review found the robot sometimes distracted from joint-attention tasks rather than supporting them, and the authors concluded that robots could not replace a therapist.
The best pooled estimate comes from a pre-registered meta-analysis of 12 randomised trials with 346 participants (Kouroupa *et al.*, 2022). Social outcomes improved by a small-to-moderate amount ($g = 0.35$); emotional and motor outcomes did not. Two details stand out. Effects were larger for younger children and in clinic settings, and in school settings they disappeared altogether ($g = -0.16$). And in 95% of studies the people rating outcomes knew which children had worked with the robot. A 2025 meta-analysis reported a much larger effect ($d = 0.83$), but it included non-randomised studies, which probably explains the gap (Wang *et al.*, 2026).

The strongest recent evidence is sobering in a useful way. Two randomised trials from the European DREAM project, with 69 and 63 young children, found robot-assisted therapy as effective as conventional therapy for joint attention, imitation and turn-taking, but no more effective (David *et al.*, 2025). Engagement was higher in the clinic version. A month-long home study with an autonomous robot reported improved joint attention with adults even when the robot was not present (Scassellati *et al.*, 2018), though without a control group. The "novelty effect" worry may be overstated: in one longitudinal study, children engaged more with familiar robot activities than with new ones (Rakhymbayeva *et al.*, 2021).
A recent clinical review found that only 18% of robot papers had direct clinical relevance. Many relied on a hidden human operating the robot, the so-called Wizard-of-Oz set-up, and the longest home studies ran for about a month (Vagnetti *et al.*, 2026). For a school considering a robot, the honest summary is this: it can motivate, it is expensive, and so far it has not outperformed a skilled human.

3.5 Virtual and augmented reality: Virtual reality promises safe rehearsal of situations that are hard to practise for real: crossing a road, ordering food, a job interview. An early systematic review of 31 studies found that nearly all reported some improvement, but only ten showed statistically significant gains, and none could show VR was better than conventional teaching (Mesa-Gresa *et al.*, 2018). Parsons (2016) made a sharper conceptual point. Realism on screen does not automatically produce transfer to the real world; what matters is whether the learner's responses in VR are authentic.
Pooled effects are moderate. A meta-analysis of 35 trials found $g = 0.45$ in controlled trials and $g = 0.74$ in uncontrolled ones (Karami *et al.*, 2021). The gap is telling. Daily living skills showed the strongest gains ($g = 1.15$). For social and communication skills, controlled trials showed only a small effect ($g = 0.2$). The most recent extended-reality meta-analysis, covering 31 studies, found significant moderate effects across social skills, behaviour, emotion recognition and cognition (Sun *et al.*, 2026), though only 11 of those studies were randomised. In one of the larger single studies, 94 children aged 6 to 12 made gains in emotional expression and social reciprocity after 28 sessions in a semi-immersive VR environment (Ip *et al.*, 2018).
For schools, augmented reality may be the more practical option, because it overlays information on the real classroom rather than replacing it. A review of 20 studies found promising social, communication and emotional results (Berenguer *et al.*, 2020). A 2025 review focused on learning found gains in science vocabulary, reading, mathematics and attention, and rated AR a probable evidence-based practice for academic outcomes, although most of the 12 studies were single-subject designs and generalisation was rarely tested (Fuentes *et al.*, 2025).
Safety is a reasonable question with headsets. In a laboratory comparison with 35 children, short headset sessions produced no more anxiety or cybersickness than watching the same content on a monitor, and most children preferred the headset (Malihi *et al.*, 2020b). No model could predict which children would experience discomfort (Malihi *et al.*, 2020a), and those studies excluded children with intellectual disability. A practical process model for minimising adverse effects is available for practitioners (Schmidt *et al.*, 2021).

3.6 Serious games: Games designed to teach social and emotional skills are now numerous. Their validation is not. A review of 31 such games found that five had never been tested with children with autism at all. Samples were small, controls were rare, and transfer to daily life was seldom shown (Grossard *et al.*, 2017). The same review noticed an awkward trade-off: games with stronger clinical validation tended to be less fun to play. A more recent review of nine intervention studies found that every one improved at least one social skill, yet none included children under five or adolescents over twelve (Carneiro *et al.*, 2024).

The classic trial in this area shows both the promise and the ceiling. In the *Let's Face It!* randomised trial, 79 children played face-recognition games for about 20 hours (Tanaka *et al.*, 2010). They improved on the specific skills the games trained, but not on recognising faces across changes in expression, orientation or memory. Near transfer happened; far transfer did not.

3.7 Artificial intelligence and wearables: This is where enthusiasm most clearly outpaces evidence. A 2025 review of AI interventions for students with autism identified only 13 empirical studies, with about 148 participants in total (Kotsi *et al.*, 2025). Most of the "AI" was embedded in robots, glasses or VR rather than working as a stand-alone tutor. All 13 reported positive results, but there was no risk-of-bias assessment and no follow-up data, and only one study addressed STEM learning. A scoping review of generative AI found ten studies, of which only three actually delivered an intervention to participants with autism. The authors flagged hallucinated content, AI ratings that diverged from human judgement, and data bias (Sohn *et al.*, 2025).

There is one randomised trial worth knowing. An AI conversation coach based on a large language model improved empathetic responses in 30 adolescents and adults with autism over four weeks, compared with a waitlist group, and the gains carried over into conversation (Koegel *et al.*, 2026). It is a small trial with participants partly beyond school age, but it is a start. On adaptive tutoring, the evidence is thinner still. An early intelligent tutoring system for mathematics, co-designed with young people with autism, showed only that students could use and understand its learner model (Grawemeyer *et al.*, 2015). No classroom trial of an AI tutor for school-age students with autism was found.

Wearables have a similar profile. The Superpower Glass system, which uses face-tracking software to cue emotion recognition, produced a modest gain in socialisation in a randomised trial with 71 children (Voss *et al.*, 2019). Three other primary outcomes did not survive correction for multiple testing, and the senior author had a commercial stake in the technology. A single-case school study of another smart-glasses product was funded by the company that made it (Sahin *et al.*, 2018). These are interesting tools, but not yet ready for routine classroom use.

4. Research in Turkey and North Macedonia

The two countries sit at very different points. Turkey has a substantial, methodologically consistent body of intervention research. North Macedonia has a handful of clinical and engineering studies and a promising policy framework that has not yet been evaluated.

4.1 Turkey: Turkish research in this area is dominated by single-case experimental studies from university special education departments. Most use multiple-probe designs with two or three young children and embed the technology in systematic instruction drawn from applied behaviour analysis. The work concentrates on the two technologies with the strongest international evidence.

Video modelling and prompting. Turkish studies have used video to teach:

- emotional and social responses, presented on a smartboard (Pektaş Karabekir & Akmanoğlu, 2018);
- multi-step drawing, using video prompting on an iPad (Akmanoğlu & Pektaş-Karabekir, 2020);
- play skills, with mothers delivering the videos at home (Beşler & Kurt, 2016);
- self-introduction to adolescents with autism (Çetrez Arıcan *et al.*, 2018).

An earlier comparison of video and live modelling for teaching chained skills found that two of three children learned with both, while the third did better with live modelling (Ergenekon *et al.*, 2014). A 2026 study compared ordinary video modelling with animated video and found both effective. Neither was consistently faster; it depended on the child and the behaviour (Gökçe & Ülke-Kürkçüoğlu, 2026). The results are strikingly uniform: children learn the skill, keep it at follow-up, and usually show it in new settings, and parents and teachers rate the approach highly. The one adolescent study is a useful reminder of the limits. Both students learned to introduce themselves, but only one did so with unfamiliar people.

Tablets and speech-generating devices. A second strand uses iPad-based speech-generating devices. Young children with autism learned multi-step requesting (Genç-Tosun & Kurt, 2017) and, in a later study, to answer questions, keeping the skill for five weeks (Genç-Tosun *et al.*, 2023). Teachers with no previous experience of such devices found them workable. A master's thesis extended this to three adolescents and young adults with autism, who learned to request food, drinks and activities (Şen, 2019). Tablets have also been used to teach visual schedule use (Eliçin & Tunalı, 2016) and to present social stories that increased sharing (Boşnak & Turhan, 2020). Turkish researchers have contributed at the review level too: the AAC comparison meta-analysis discussed in Section 3.3 (Aydın & Diken, 2020), a meta-analysis rating augmented reality as highly effective in single-case studies (Denizli-Gülboy *et al.*, 2023), and a 2026 systematic review of VR for social skills (Altın *et al.*, 2026).

Robots. Turkish engineering groups have taken part in European robot projects. In the Erasmus+ EMBOA project, children in Turkey, North Macedonia, Poland and the United Kingdom interacted with the Kaspar robot. Reading their emotions from voice, gaze and physiological signals turned out to be very difficult: voice data were usable only about 6% of the time (Erol Barkana *et al.*, 2024). The same consortium's systematic review covered 50 robot studies with 570 children with autism (Bartl-Pokorny *et al.*, 2021).

Teachers' views. Interviews with 15 teachers of students with autism in Bursa produced a telling result. All valued technology, yet 14 used none with their students (Eliçin, 2016). They worried about dependence on devices, limited usefulness for students with high support needs, and broken equipment. Special education teachers in a vocational school described how they obtained assistive technology and the difficulties of using it (Çay *et al.*, 2020). Speech and language therapists were positive about educational technology but wanted more training (Ergün Elverici & Sarı, 2021). This gap between enthusiasm and practice echoes the international findings in Section 5.3.

The overall picture. The Turkish evidence is internally strong but narrow. Samples are tiny, most children are aged three to seven, and the instruction is usually delivered by trained researchers in one-to-one settings. A meta-analysis of ABA-based interventions in Turkey noted the same pattern across the wider field (Sulu *et al.*, 2026). Studies in ordinary inclusive classrooms, run by class teachers, are almost absent. So are group-design trials and studies of VR, AR or games with Turkish children with autism.

4.2 North Macedonia: The Macedonian literature on technology and autism is small, and none of it is school-based. The most substantial study tested the Kaspar robot together with a companion mobile app in 20 young children with autism in Skopje. Eight of eleven developmental areas improved, most clearly language, imitation, communication and attention (Zorcec *et al.*, 2021). There was no control group. Follow-up work moved robot therapy into the home through an app monitored by therapists, reported as a single case (Ackovska & Ilijoski, 2023). Macedonian centres also contributed children to the EMBOA emotion-observation study (Erol Barkana *et al.*, 2024). At Goce Delčev University in Štip, researchers built a prototype emotion-recognition game for children with autism, but it has not yet been

tested with them (Ivanov *et al.*, 2019). A scoping review of ICT in special-needs education followed (Hristovska & Koceska, 2024).

Closer to the classroom, the evidence is thinner still. The only Tetovo-based item found was a two-child case study of augmentative and alternative communication in a kindergarten, and it is not clear whether the system was technology-based (Izeti, 2024). No published study of Macedonian teachers' readiness to use technology with pupils with autism was found.

The policy context is promising. The 2019 Law on Primary Education introduced individual education plans, school inclusive teams and educational assistants, and it provides for appropriate assistive technology through the individual plan. Former special schools now operate as resource centres (Timchevska & Petrinska Labudovikj, 2023). The same authors note that most mainstream schools still lack trained staff and equipment, a gap the pandemic made more visible. One practical initiative stands out. A free, open-source AAC app, Cboard, was localised into Macedonian and Albanian, and over 170 professionals were trained to use it (UNICEF North Macedonia, 2022). It has not been formally evaluated.

4.3 What the comparison shows: Turkey has the research but limited classroom implementation; North Macedonia has the legal framework but almost no research. In both, technology for learners with autism is studied mainly by specialists (behaviour analysts in Turkey, clinicians and engineers in Skopje) rather than in ordinary schools. In both, teachers' readiness is either documented as weak or not documented at all. The tools with the strongest international evidence, video modelling and AAC apps, are also the cheapest. Localised resources such as Cboard already exist in Macedonian and Albanian. A small, teacher-delivered evaluation in Macedonian or Tetovo schools would therefore be feasible, and it would be genuinely new.

5. Discussion

The research describes two different landscapes that happen to share the word "technology". In one, a teacher with a tablet and a clear teaching plan has a good chance of helping a student with autism learn a new skill. In the other, robots, headsets and AI tools are being tested in small, often uncontrolled studies, sometimes by the people who sell them. Table 1 sets out the difference.

Table 1. Strength of evidence for technology-supported instruction with students with autism

Technology	**Main skills targeted**	**Dominant designs**	**Evidence strength**	**Note for classrooms**
Video modelling and prompting	Daily living, social, play, vocational	Many single-case studies; several meta-analyses	Strong; listed as evidence-based practice	Cheap and easy with a phone; weaker for academics
AAC and speech-generating apps	Requesting, communication, behaviour	Many single-case studies; meta-analyses	Strong for requesting; moderate beyond	Children often prefer devices; speech is not harmed

Technology	Main skills targeted	Dominant designs	Evidence strength	Note for classrooms
Computer- and tablet-assisted instruction	Academic, communication, social	Single-case studies; some controlled trials	Moderate; evidence-based for academics	Works best with teacher-made content and student control
Augmented reality	Academic vocabulary, reading, maths, social	Mostly single-case studies	Emerging; rated probable for learning outcomes	Fits real classrooms better than VR
Virtual reality	Daily living, social, emotion recognition	Mostly uncontrolled pre-post; some RCTs	Emerging; moderate pooled effects, small in controlled social trials	Headsets tolerated in short sessions; costly
Socially assistive robots	Joint attention, imitation, social	Small RCTs; one large trial pair	Emerging; equivalent to, not better than, standard therapy	No effect found in school-based RCTs
Serious games	Emotion recognition, social cognition	Small studies; one landmark RCT	Weak to emerging; near transfer only	Check whether the game was tested with children with autism
AI tutors, chatbots, smart glasses	Social communication, empathy, emotion cues	Pilots; two small RCTs	Very limited	Not ready for routine use; privacy concerns

5.1 The tool is rarely the active ingredient: A pattern repeats across technologies. The effect depends less on the device than on the teaching built around it. Tablet interventions worked best when teachers made their own materials and students controlled the device (Ledbetter-Cho *et al.*, 2018). Commercial reading software needed individual adaptation before it worked (Thompson *et al.*, 2022). The successful AAC studies taught device use systematically rather than handing a child a tablet and hoping (Alzrayer *et al.*, 2014). Even robots performed best when adults stayed closely involved (Wang *et al.*, 2026). Technology seems to amplify good instruction rather than replace it.

5.2 Generalisation remains the weak point: Teaching a skill on a screen is one thing; using it at the supermarket is another. A review of 21 tablet studies that measured transfer found only small gains from intervention to new settings, although maintenance over time was stronger (Hong *et al.*, 2018). Fewer than a third of those studies collected enough data points to judge this properly. The face-recognition games showed the same ceiling (Tanaka *et al.*, 2010), and controlled VR trials showed much weaker social gains than uncontrolled ones (Karami *et al.*,

2021). Any school programme should plan for generalisation from the start: practice in real settings, with real people, after the screen is switched off.

5.3 From research settings to real classrooms: Researchers and therapists get larger effects than teachers and parents (Liu *et al.*, 2025). School-based robot trials showed no benefit at all (Kouroupa *et al.*, 2022). Figure 2 sets the two patterns side by side. None of this means teachers are the problem. It suggests that research conditions (training, coaching, small groups, motivated staff) are hard to reproduce in a busy classroom.

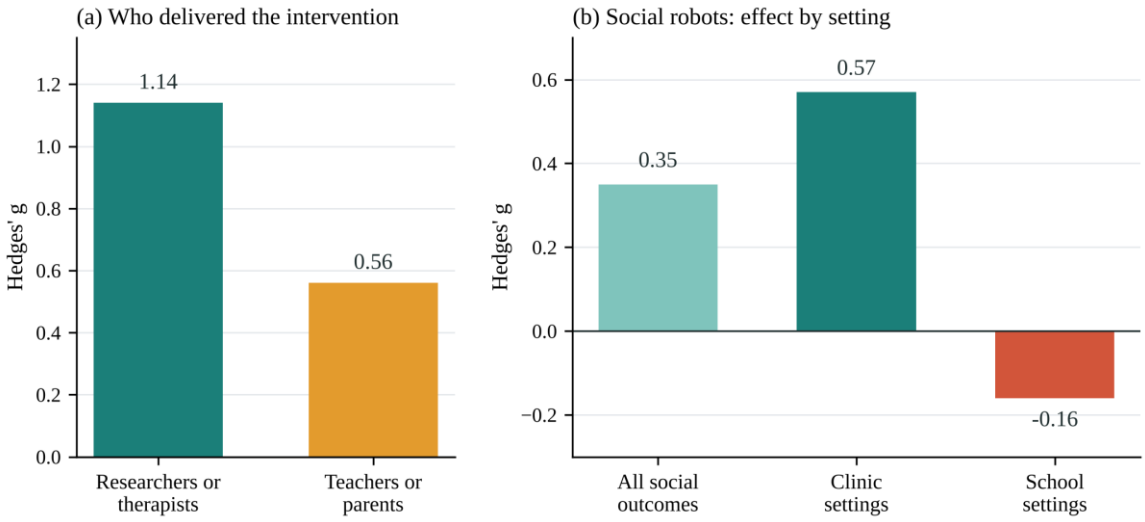


Figure 2. Effect sizes (Hedges' g) by (a) who delivered socio-emotional interventions (Liu *et al.*, 2025) and (b) the setting of social robot interventions (Kouroupa *et al.*, 2022)

The evidence on teacher readiness is mostly small, single-country surveys, but they point the same way. Teachers of students with autism use iPads more than other special educators and want more training (Eden *et al.*, 2019). Practice varies widely from school to school, and training is uneven (Achtypi & Papoudi, 2024). Perceived usefulness and ease of use shape whether teachers adopt AAC at all (Alhuzimi, 2026). More generally, time, resources and the demands of the intervention itself are the main barriers to implementation in autism education (Barry *et al.*, 2020). Professional development, ideally practical and ongoing, appears to be at least as important as the hardware.

5.4 Access, ethics and whose goals count: Cost is the obvious equity issue. A tablet with a communication app is within reach of many schools; a humanoid robot or a VR lab is not. Ironically, the cheapest tools also have the strongest evidence, which is good news for schools with tight budgets.

Privacy matters more as tools become smarter. Robots, smart glasses and AI systems collect video, voice and behavioural data from children who may not be able to consent or understand what is recorded. These concerns are widely raised, but they are mostly argued rather than studied (Lakatos *et al.*, 2026; Sohn *et al.*, 2025). Screen time is another common worry. A meta-analysis of 46 studies found that the supposed link between screen use and autism weakened to non-significance once publication bias was corrected (Ophir *et al.*, 2023). That does not make unlimited screen time harmless, but it puts the fear of purposeful educational use in proportion.

There is also a deeper question about what technology is for. A critical review found that most autism technologies encode neurotypical norms, treat the child with autism as a secondary user, and rarely build on children's own interests (Spiel *et al.*, 2019). In robot research, about 90%

of papers left out the perspectives of people with autism at some stage (Rizvi *et al.*, 2024). Participatory design, in which people with autism help shape the tools, is possible and productive but still uncommon (Maun *et al.*, 2024). If the goal is learning and independence rather than hiding the characteristics of autism, the design has to reflect that.

5.5 Implications: For teachers and schools, a few practical points follow:

- Start with the tools that have the strongest evidence: video modelling, AAC and well-designed tablet instruction.
- Choose the skill first and the technology second.
- Make or adapt content for the individual student, and let the student operate the device where possible.
- Plan for generalisation from the start, and measure it.
- Treat robots, VR and AI as experiments, not solutions, and ask vendors for independent evidence.
- Protect children's data, and involve students with autism and their families in choosing tools.

For researchers, the priorities are larger controlled trials in real schools, delivered by teachers; outcome assessors who do not know which group a child is in; longer follow-up; inclusion of children with intellectual disability and of girls; and the participation of people with autism in design and evaluation.

5.6 Limitations: This is a narrative review, not a systematic one. Screening was not done independently by two reviewers, no formal risk-of-bias tool was applied, and no protocol was registered. Some databases restricted automated access during the search, so several details were confirmed only from abstracts or publisher pages. Different reviews use different effect-size metrics (Tau-U, IRD, d, g), so the numbers reported here are not directly comparable across technologies. Finally, the field moves fast. Studies of AI tools in particular may be outdated within a year.

6. Conclusions

The best-supported technologies for teaching students with autism are also the least glamorous. Video modelling, AAC apps and carefully designed tablet instruction have years of consistent evidence behind them, they cost little, and an ordinary teacher with a phone can use them. Robots, virtual reality, serious games and AI tools are interesting and sometimes promising. So far, though, they have not shown that they teach better than a skilled human, and the research behind them is small, often uncontrolled and sometimes commercially entangled.

Across all of these tools the same lesson keeps coming back. What helps is not the device but the teaching around it: a clear target skill, content adapted to the learner, systematic practice, and a plan for using the skill once the screen goes dark.

Turkey has shown that this kind of teaching works with very young children with autism in research settings; the next step is to show it in real classrooms. North Macedonia has written assistive technology into its education law but has not yet studied what happens in schools. In both countries, and perhaps especially in Tetovo, where Macedonian- and Albanian-language tools now exist, the most useful contribution would be modest and practical: train teachers in the few methods that work, try them in ordinary schools, and measure what happens.

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