# Autistic Student strengths leveraging through Game Design and Development

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## Abstract

Start here.

## CCS Concepts

• **Human-centered computing** → *Human computer interaction (HCI).*

## Keywords

autism, teamwork, communication skills

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## 1 Introduction

Autism spectrum condition represents a heterogeneous constellation of neurodevelopmental differences marked by distinctive profiles in social communication, focused and intense interests with varying degrees of rigidity, preference for consistency and structure, and sensory processing variations including hyper and hypo-responsiveness to environmental stimuli [6]. Emerging research reframes these characteristics not as deficits but as differences reflecting natural neurological variation, with autistic individuals demonstrating unique abilities, and specialized expertise in areas of deep interest [18, 20]. Students on the autism spectrum are significantly underrepresented in higher education and STEM careers, despite evidence of strong interest and aptitude in STEM fields [17, 21]. For example, only about 17% of autistic youth enroll in four-year colleges (with fewer than half completing their degree), yet those who do attend college choose STEM majors at higher rates than the general population [21, 30]. Researchers have likewise observed that many autistic individuals gravitate toward technology and engineering careers [21]. These trends suggest a pressing need to support autistic students in leveraging their talents for STEM learning and pathways. In response, educators and HCI researchers have begun exploring inclusive, strength-based approaches to engage autistic learners in computing education and game development.



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Embracing a neurodiversity perspective, recent work advocates focusing on the unique strengths of autistic learners rather than perceived deficits [19]. Autistic students often excel in areas such as attention to detail, pattern recognition, systematic reasoning, and visual thinking [1, 19]. For instance, a scientific study confirmed that individuals with more autistic traits rely more on fine-grained details when processing images, demonstrating a detail-oriented cognitive style [1]. Such traits align well with skills valuable in computing and design from spotting coding errors to recognizing complex patterns in data or game mechanics. Strengths-based programs that leverage autistic students' intense interests and abilities have shown broad benefits, including improved skills, higher confidence, and better social engagement [19]. This strengths-focused paradigm, rooted in the neurodiversity movement (Singer 1998; Walker 2014), provides a foundation for designing learning experiences where autistic students can thrive by using what they do best [27, 29].

Game design and development represent a powerful yet underexplored avenue for STEM education. Grounded in constructionist learning theory, game creation enables students to learn through making personally meaningful artifacts [15, 24]. Research demonstrates that game-making as opposed to game-playing supports development of computational thinking, problem-solving, collaboration, and academic content knowledge [15]. For autistic learners specifically, the structured, rule-based, visual nature of block-based programming environments like Scratch may be particularly well-suited to their cognitive profiles. Moreover, game creation allows students to leverage special interests a core feature of autism to drive engagement and learning [19]. For example, Muñoz et al. adapted a game programming workshop for autistic adolescents and found that participants acquired computational thinking and programming skills at a high level, all within a collaborative and welcoming environment [22]. Likewise, a 13-day video game coding camp for autistic college freshmen led to self-reported gains in coding abilities, increased confidence in communication, and positive teamwork experiences [4]. Participants valued practicing teamwork becoming more vocal in sharing ideas and resolving differences and even reported reduced anxiety in the supportive, remote learning setting[9]. These encouraging results echo other research demonstrating that game-based and interest-driven STEM programs can effectively engage autistic learners [9]. At the same time, challenges (e.g. communication or collaboration barriers) remain, underscoring the importance of thoughtfully designed interventions [4].

Despite growing evidence that autistic students can succeed in coding and game design activities, gaps remain in our understanding of how their personal strengths can be intentionally harnessed throughout the creative process and which aspects of these activities yield the greatest educational benefits. Most prior work reports overall outcomes (e.g. improved skills or attitudes) without delving into the nuanced interplay between an autistic student's strengths and specific stages of learning (such as brainstorming a game story versus debugging code) [4, 22]. There is a need for deeper insight into questions like: When an autistic student who excels at pattern recognition engages in game testing, does that strength help them detect and solve bugs more effectively? Does a student's creativity shine during idea generation for game narratives, and how does that affect their motivation? Moreover, which particular activities in a game development curriculum for instance, writing code, debugging, visual art design, or teamwork exercises contribute most to growth in STEM competencies for these learners? Addressing these questions can inform the design of inclusive computing education programs that truly capitalize on neurodivergent strengths, ultimately bridging the persistent gap in STEM participation [9, 21]. To investigate these issues, we conducted a mixed-method study in the context of a summer coding camp for autistic students. The camp, which welcomed approximately 20 incoming college freshmen on the autism spectrum, was designed to teach video game development over several weeks. Participants worked in teams to brainstorm game ideas, code and create game assets, repeatedly test and refine their games, and practice sharing their work mirroring a real-world game design cycle. Throughout the program, we collected both qualitative and quantitative data: observations of student collaboration, interviews and surveys capturing their experiences, and assessments of STEM knowledge and skills before and after the camp. This approach allowed us to see not only what skills students learned, but also how they learned them and when their personal strengths emerged during the process.

In summary, this work sheds light on how an interest-driven, strength-based pedagogy can empower autistic students in computing education. We contribute empirical insights into leveraging neurodivergent strengths attention to detail, systemizing, creativity, perseverance through collaborative game development, and we discuss how these insights can inform the design of more inclusive HCI and computer science learning environments. Ultimately, our findings demonstrate the potential of game design programs not only to improve STEM skills in autistic students, but also to validate their abilities and foster a positive identity as capable STEM learners [4, 19].

## 2 Background and Related Work

This section will cover background and related work on Autism STEM affinity, Strength Based Approaches, Game Based Learning and Design for autistic students.

### 2.1 The Autism-STEM Affinity: Autistic Strengths in Computing and Game Design Activities

Drawing on the 2009 High School Longitudinal Study, Kim *et al.* report that although autistic students enroll in college at lower rates overall, those who do pursue higher education tend to show higher STEM self-efficacy and more positive expectations for STEM careers, especially in science, engineering, and mathematics [17]. A plausible cognitive account comes from Baron-Cohen's Empathizing–Systemizing (E–S) theory, which characterizes autism as relatively lower empathizing alongside average-to-elevated systemizing, the drive to analyze or build rule-based systems [3, 32]. Large-scale evidence supports this view. Greenberg *et al.* tested E–S predictions with 671,606 participants, finding patterns that align with both social-communication challenges and strengths in pattern recognition in autism [8, 12]. Building on this line of work, Crespi frames autism as fundamentally about pattern, contending that sharpened sensory acuity and a fine-grained attention support systemizing and may, in some cases, accompany high intelligence [7]. Temple Grandin argues that autistic cognition often clusters into three styles, visual thinking, pattern recognition and verbal specialization, with each style lending strengths to particular STEM roles [11]. Empirical evidence aligns with these accounts: using feature diagnosticity mapping, Alink and colleagues found that participants with clinically relevant autistic traits relied more on high-spatial-frequency information during object recognition, consistent with a detail-focused perceptual style [1]. Woods and Estes report that autistic individuals often outperform their neurotypical peers on visuospatial tasks, such as embedded-figure problems and fast visual search, reflecting a detail-focused, systematic style of processing [33]. Well-designed courses can harness these strengths pattern recognition, attention to detail, systematic thinking, and visual processing to meet the everyday demands of programming, game design, and computational problem solving[28].

### 2.2 Strength-Based Approaches: From Deficit to Difference

Judy Singer (1998/1999) introduced the neurodiversity paradigm, and Walker later expanded it, casting autism as a natural human variation rather than a disorder in need of cure [27, 29]. That reframing has shifted advocacy and education toward a strength-based approach. Consistent with this, Lee *et al.* three-year repeated cross-sectional study of community STEM/STEAM programs found significant improvements in health and well-being, social ties, self-confidence, belonging, and participation when programs were built on students' strengths and interests [19]. A complementary scoping review by White *et al.* shows that effective strength-based models attend to both the person (individual strengths, interests, abilities) and the environment (adapted instruction, inclusive practices, and system-level supports)[6, 31]. In interviews with 12 STEM faculty, Shmulsky *et al.* highlight both clear strengths, such as attention to detail, following directions, and pattern recognition, as well as the way a trait like rigidity can serve as productive persistence during problem-solving [26]. This perspective favors strength-based innovation over deficit-only accommodations. Extending this argument, Da *et al.* recommend task-analytic inquiry for science, video prompting plus explicit instruction for technology, and metacognitive routines for mathematics [9]. Tuning pedagogy to these strengths and layering systematic supports yields effective learning.

### 2.3 Game-Based Learning and Game Design for Autistic Students

Games are a good fit for many autistic learners because they bundle clear rules, goals, and fast feedback into predictable system features that map onto shared cognitive preferences in autism [2]. In a 32-study systematic review, Honorato *et al.* report that 2D, PC-based games dominate the autism-education literature and that the most common settings are Nature, House, and City; they also note a geographically distributed field with no single country or author group in charge [13]. In practice, Minecraft consistently emerges as a commercial platform for autism education and social interaction, particularly in work focused on communication and belonging. Multiple studies document the Autcraft server as a Minecraft community specifically for users with ASD, where autistic youth engage in learning, educating about autism, and fostering positive autistic identity [25]. However, Minecraft groups have players defined roles, such as architect, artist, and foreman, inside the virtual world, allowing peers to coordinate builds in a low-stakes setting, which in turn supports social engagement, confidence, and competence [16]. In parallel, a theoretical paper introduces the Social Craft framework, arguing that social-communication routines practiced in Minecraft can generalize to everyday contexts because the game is popular with autistic youth and its rule-based systems naturally embed behavioral contingencies [5]. As the leading platform for CT through game design, Scratch anchors many interventions, one example is Muñoz *et al.* workshop for ASD adolescents with structured Scratch activities, learners who began without programming experience advanced to intermediate-level computational thinking[10, 22]. Despite its promise, autism-focused GBL research is often brief, primarily small-N, qualitative, and 2D/PC-centric, which limits comparability and obscures the aspects of game-making that drive learning. Assessment inconsistency compounds this. Moreover, while Scratch lowers entry barriers, blocks→text transfer usually needs explicit bridges. We address these gaps by pairing validated CT measures with artifact/log analytics, disaggregating phases (ideation, coding, debugging/testing, and collaboration), and testing blocks to text transfer and social-skill generalization within a strengths-based design.

### 2.4 Programming Education and Computational Thinking Development

Research specifically examining coding education for autistic learners reveals both significant potential and critical needs for appropriate instructional design. Israel et al. conducted a mixed-methods case study with three elementary students with ASD during computer science instruction, finding that while all students engaged with computational tasks, they experienced challenges leading to disengagement or limited independent problem-solving. Critically, students received "in the moment" reactive supports with little evidence of planned instructional scaffolding or individualized accommodations highlighting the gap between generic CS instruction and autism-responsive pedagogy [14]. Stuurman et al. analyzed cognitive styles of autistic persons versus software engineering requirements, finding that autistic students are overrepresented in software engineering programs because their cognitive style partially matches well with software engineering thinking. The research documented exceptional strengths in detail orientation, pattern recognition, out-of-the-box thinking, commitment to quality work, and strong analytical skills, with particular excellence in software testing. However, challenges with language comprehension and executive functioning require targeted support strategies [28]. Begel et al. concluded that effective approaches described a 13-day remote video game coding camp using MakeCode Arcade for incoming autistic college students, finding improved programming skills and increased communication self-efficacy, with students particularly valuing opportunities to practice teaming and expressing ideas [4]. The follow-up experience report by Moster et al. examining a hybrid coding camp emphasized that autistic students need explicit practice in teamwork during education, as social skills training alone is insufficient for effective collaborative software development [21]. A scoping review by Oswald et al. examining computational thinking and social-emotional skills in children with ADHD and ASD found that programming activities have beneficial effects persisting beyond intervention periods, with more than half of reviewed studies reporting positive impact on social-emotional skills. Students willingly taught peers after learning to code, with computers acting as mediators in social settings and improvements in pro-social behavior, verbal interaction, and collaboration documented across studies [23]. Although gamified CT studies with autistic learners demonstrate feasibility and short-term attainment at the platform level, they do not account for how autistic youth strengths are expressed across the phases of authentic game design, nor do they isolate which design activities drive STEM skill growth. Our study presents a phase-resolved analysis of autistic student strengths and links specific design activities to gains in programming, problem-solving, and teamwork.

## 3 Methods

Participants, setting, measures, analysis.

## 4 Results

Findings.

## 5 Discussion

Implications, limitations.

## 6 Conclusion

Wrap up.

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