Original Research

Child Protection in Digital Education for Primary School Students With ASD in Xi'an: A Whole-School Mixed-Methods Study

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Abstract

Digital education is rapidly expanding in primary school contexts, creating both opportunities and risks for vulnerable learners, particularly students with autism spectrum disorder (ASD). While existing research highlights increased exposure to online risks, empirical evidence on how protection is shaped across stakeholders and institutional settings remains limited. Addressing this gap, a mixed-method approach is employed to examine the mechanisms underlying child protection in digital education. In the first stage, semi-structured interviews were conducted with 37 key stakeholders, including teachers, parents, and school administrators, to explore experiences and challenges related to digital safety. Insights from this qualitative phase informed the development of an integrated framework capturing ASD-related digital vulnerability (ASDV), perceived digital risk (PDR), school safeguarding systems (SSG), adult protection capacity (APC), and home–school collaboration (HSC). In the second stage, the proposed model was tested using survey data from 360 respondents (180 teachers and 180 parents) and analyzed through partial least squares structural equation modeling (PLS-SEM). The results indicate that protection effectiveness in digital education (PECP) is jointly shaped by multi-level factors. Student vulnerability influences outcomes indirectly through PDR, while SSG exert both direct and indirect effects by strengthening adult capacity and collaborative practices. Multi-group analysis further reveals that teachers rely more on institutional mechanisms, whereas parents place greater emphasis on relational and collaborative processes. By developing and empirically validating a whole-school protection framework, this study clarifies how institutional safeguards, adult capacity, and HSC jointly shape digital protection for primary school students with ASD. It also reveals stakeholder-specific mechanisms by showing that teachers rely more on institutional safeguards, whereas parents place greater emphasis on collaborative processes.

Keywords: digital education; child protection; autism spectrum disorder; digital risk; school safeguarding; mixed-methods

Introduction

Protecting children from harm has long been a fundamental concern of educational systems worldwide. As schooling increasingly extends into digital spaces, this longstanding responsibility has acquired new dimensions. Digital technologies are now deeply embedded in primary education, reshaping how children learn, communicate, and participate in school life. Online platforms, mobile devices, and data-driven educational tools offer unprecedented opportunities for accessibility and individualized support, but they also expose young learners to new forms of risk, including harmful content, cyberbullying, privacy breaches, and excessive screen use. Because primary school children are still developing the cognitive and emotional capacities needed to recognize and manage such risks, ensuring their safety in technology-mediated learning environments has become a pressing global issue (Livingstone & Smith, 2014).

International policy frameworks increasingly conceptualize digital child protection as a matter of children's rights. The United Nations Committee on the Rights of the Child emphasizes that children's rights to safety, privacy, participation,

and development must be upheld in digital environments, including educational contexts (United Nations Committee on the Rights of the Child, 2021). Similarly, the United Nations Children's Fund (UNICEF) highlights that the adoption of educational technologies should balance expanding learning opportunities with preventing harm, exploitation, and inequality. In this study, child protection in digital education refers to systematic efforts to safeguard students' physical, psychological, and informational well-being during technology-mediated learning while enabling meaningful participation.

Children with autism spectrum disorder (ASD) represent a particularly vulnerable group within this context. ASD is characterized by persistent difficulties in social communication, emotional regulation, and adaptive functioning, which may limit students' ability to interpret social cues, assess risks, or seek assistance effectively (American Psychiatric Association, 2013). Empirical research indicates that students with ASD experience higher rates of victimization, including bullying and social exclusion, than their typically developing peers (Cappadocia et al., 2012). At the same time, many children with ASD rely heavily on digital technologies for learning, communication, and leisure activities, making technology both a crucial support and a potential source of harm (Mazurek & Wenstrup, 2013). This dual role underscores the need for targeted protective strategies rather than generalized approaches designed for the broader student population.

Schools occupy a central position in addressing these challenges. Digital learning activities are typically organized, guided, or facilitated by schools, meaning that institutional policies, teacher competence, technological infrastructure, and organizational culture collectively shape students' experiences of safety. Increasingly, scholars and practitioners emphasize that safeguarding cannot be achieved through isolated actions by individual teachers but requires coordinated institutional responses. This perspective, often described as a whole-school approach, conceptualizes student well-being as the product of interactions among leadership, staff practices, school climate, and collaboration with families (Cohen et al., 2009). In digital education, where learning frequently extends beyond classroom boundaries into home environments, the role of family support and home–school coordination becomes equally important.

Despite growing attention to digital safety and inclusive education, empirical research specifically addressing child protection in digital education for primary school students with ASD remains limited. Existing studies often focus on general student populations, adolescents, or single dimensions such as cyberbullying or technology use, without examining how institutional, instructional, and family factors interact within a comprehensive framework. Evidence from the Chinese context is particularly scarce, even as digital technologies rapidly transform primary education and inclusive schooling policies expand.

To address these gaps, the present study investigates child protection in digital education for primary school students with ASD in Xi'an, China, from a whole-school perspective. Using an exploratory sequential mixed-methods design, the study first explores stakeholders' perceptions and practices through qualitative interviews and then tests a comprehensive model using survey data from teachers and parents. By integrating multiple stakeholder perspectives and examining relationships among school-level, instructional, and family-related factors, the study aims to provide a contextually grounded understanding of how schools can more effectively safeguard vulnerable students while supporting their meaningful participation in digital learning. This article aligns with the following principle of Whole Schooling: Principle 8—Use technology to facilitate student learning.

Literature Review

Digital Safety Challenges in Primary Digital Education

Digital technologies have become increasingly embedded in primary education. Digital learning platforms, online communication tools, and AI-enabled applications can improve accessibility, personalization, and participation. However, they also introduce new safety challenges for young learners. These challenges include cyberbullying, exposure to inappropriate content, data misuse, privacy risks, and excessive screen use.

Such risks are particularly important in primary school contexts because younger children are still developing the cognitive, emotional, and social capacities needed to identify and manage online risks. In digital learning environments, interactions often extend beyond the classroom and may take place in home settings, where direct teacher supervision is limited (Zulqadri et al., 2022). Evidence from elementary school settings also shows that technology-mediated interactions can involve online conflicts and exposure to harmful content, indicating the need for systematic protective measures (Bacak et al., 2022).

Digital risks should not be understood only as technical problems. They are also shaped by institutional rules, adult supervision, children's digital habits, and the broader social context in which digital learning occurs. Therefore, effective digital protection requires coordinated measures related to data privacy, responsible technology use, monitoring of online behavior, and school-level safeguarding practices (Santos et al., 2024; Olumide & Adedoyin, 2024). In this sense, schools play a central role in balancing the educational benefits of digital technologies with the responsibility to protect children from harm. Digital risks should not be understood only as technical problems. They are also shaped by institutional rules, adult supervision, children's digital habits, and the broader social context in which digital learning occurs, including changing perceptions of risks associated with children's digital inculturation (Polianina & Andreeva, 2024).

Digital Participation and Vulnerability of Students With ASD

Within digital education, students with ASD represent a particularly vulnerable group. ASD is commonly associated with difficulties in social communication, restricted or repetitive behaviors, emotional regulation challenges, and adaptive functioning difficulties. These characteristics may limit students' ability to interpret social cues, recognize harmful situations, evaluate online interactions, or seek help when needed.

Previous studies show that students with ASD experience higher levels of bullying, victimization, and social exclusion than their typically developing peers (Cappadocia et al., 2012). These risks may become more complex in inclusive school settings, where communication differences and social misunderstandings can increase vulnerability (Gkatsa & Antoniou, 2024; Bardou et al., 2025). In digital environments, such vulnerabilities may be intensified because online communication often lacks clear contextual cues and immediate adult guidance.

At the same time, digital technologies are not only sources of risk. They can also provide important educational benefits for students with ASD. Tools such as virtual reality, game-based learning, computer-assisted instruction, and Internet of Things–enabled systems may support communication, social skills, engagement, and individualized learning (Grossard et al., 2017; Herrero & Lorenzo, 2020; Shyja & Jayaprakash, 2023). Computer-based technologies can also support inclusive education by increasing participation in mainstream classrooms (Ahmad Lawan, 2023).

This dual role creates a central tension in digital education for students with ASD. Digital technologies can support learning and inclusion, but they may also increase exposure to online risks. Therefore, protection strategies for students with ASD should not simply restrict digital participation. Instead, they should enable safe, meaningful, and supported engagement with digital learning.

Whole-School Safeguarding in Digital Education

Because digital risks are shaped by multiple contextual factors, child protection in digital education requires a whole-school approach. A whole-school perspective emphasizes that student safety is not the responsibility of one teacher or one family alone. Instead, it depends on coordinated institutional systems, clear policies, adult competence, technical safeguards, and shared organizational practices.

School safeguarding systems (SSG) are important because they provide the institutional conditions for safe digital learning. These systems may include rules for technology use, data protection policies, platform selection procedures, content filtering, incident response mechanisms, and regular safety monitoring. Prior research highlights the importance of comprehensive safeguarding systems that integrate prevention, response, and management structures (Naeem & Munir, 2024). A supportive school environment can also reduce bullying and improve emotional well-being among students with ASD (Bardou et al., 2025).

Teacher competence is another essential part of whole-school safeguarding. Teachers are expected not only to use digital technologies for instruction but also to identify risks, guide safe behavior, respond to incidents, and support students with diverse needs. Research suggests that teachers often view digital technologies as both beneficial and risky, and they require specialized training in digital mediation and safety (Chiner et al., 2024). Inclusive teaching competence, including pedagogical knowledge, socio-emotional skills, and experience with students with ASD, is also necessary for effective support (Gallego-Jiménez et al., 2025).

At the institutional level, professional development, adequate resources, technical support, and coordinated school policies are needed to ensure that teachers can implement protective practices effectively (Sonya Sinyanyuri et al., 2024).

Thus, SSG and adult protection capacity (APC) are closely connected. Institutional support can strengthen teachers' ability to manage digital risks, while teacher competence helps translate school policies into daily practice.

Home–School Collaboration (HSC) and Multi-Stakeholder Protection

Digital learning often crosses the boundary between school and home. Students may use digital platforms in classrooms, after school, or at home. As a result, protection cannot rely only on school-based measures. Family supervision, parental digital literacy, and home–school communication are also critical.

Parents of children with ASD may face particular challenges in supervising digital technology use. Some parents experience elevated stress and burnout, which may affect their ability to provide consistent digital guidance (Liu et al., 2024). At the same time, parental mediation and digital literacy strongly influence children's online experiences and risk exposure (Purnama et al., 2021). This means that family capacity is an important part of digital protection.

HSC can help create consistent expectations across learning environments. When schools and families communicate regularly, they can share information about students' digital behavior, emerging risks, supervision strategies, and support needs. Such collaboration is especially important for students with ASD, whose digital safety may depend on predictable routines, clear guidance, and coordinated adult support. Prior research on inclusive education also emphasizes the need for cooperation among teachers, parents, and related professionals (Vlcek et al., 2020).

Recent research further suggests that children's digital safety requires multi-stakeholder involvement. Effective cybersafety strategies involve educators, families, community institutions, and the development of children's own digital awareness (Luo et al., 2025). This view is consistent with ecological perspectives, which suggest that children's development and safety are shaped by interactions across multiple environments. Therefore, digital protection for students with ASD should be understood as a coordinated process involving schools, teachers, families, and students themselves.

Research Gap and Contribution of the Present Study

Although existing research has examined digital safety, ASD education, teacher competence, and family support, several gaps remain. First, many studies focus on general student populations or adolescents, while less attention has been paid to primary school students with ASD. Second, previous research often examines isolated risks, such as cyberbullying, technology use, or parental mediation, rather than integrating these issues into a comprehensive protection framework. Third, empirical studies that examine how school systems, APC, and HSC jointly influence digital protection remain limited, especially in non-Western educational contexts.

To address these gaps, the present study investigates child protection in digital education for primary school students with ASD from a whole-school perspective. It examines how key stakeholders perceive digital risks, what institutional and interpersonal mechanisms are used to protect students, and how SSG, APC, and HSC jointly shape protection effectiveness in digital education (PECP).

This study contributes to the literature in three ways. First, it extends digital safety and ASD research by focusing specifically on primary school students with ASD in digital education. Second, it develops an integrated whole-school framework that connects ASD-related digital vulnerability (ASDV), PDR, SSG, APC, HSC, and PECP. Third, by combining qualitative thematic analysis with partial least squares structural equation modeling (PLS-SEM) and multi-group analysis, the study identifies key protection dimensions and tests how these mechanisms operate differently from teacher and parent perspectives in the Chinese primary school context. The following section describes the research design and methodological procedures used to investigate these questions through sequential qualitative and quantitative studies.

Research Design

This study employs an exploratory sequential mixed-methods approach to examine child protection in digital education for primary school students with ASD from a whole-school perspective. This design is particularly appropriate for contexts where empirical research remains scarce and where initial qualitative exploration is necessary to guide subsequent quantitative inquiry. The overall research design is presented in Figure 1. The study was carried out in two distinct phases.

During the first phase, qualitative semi-structured interviews were conducted with key stakeholders—including classroom teachers, school administrators, information technology (IT) teachers, special education staff, and parents. The aim

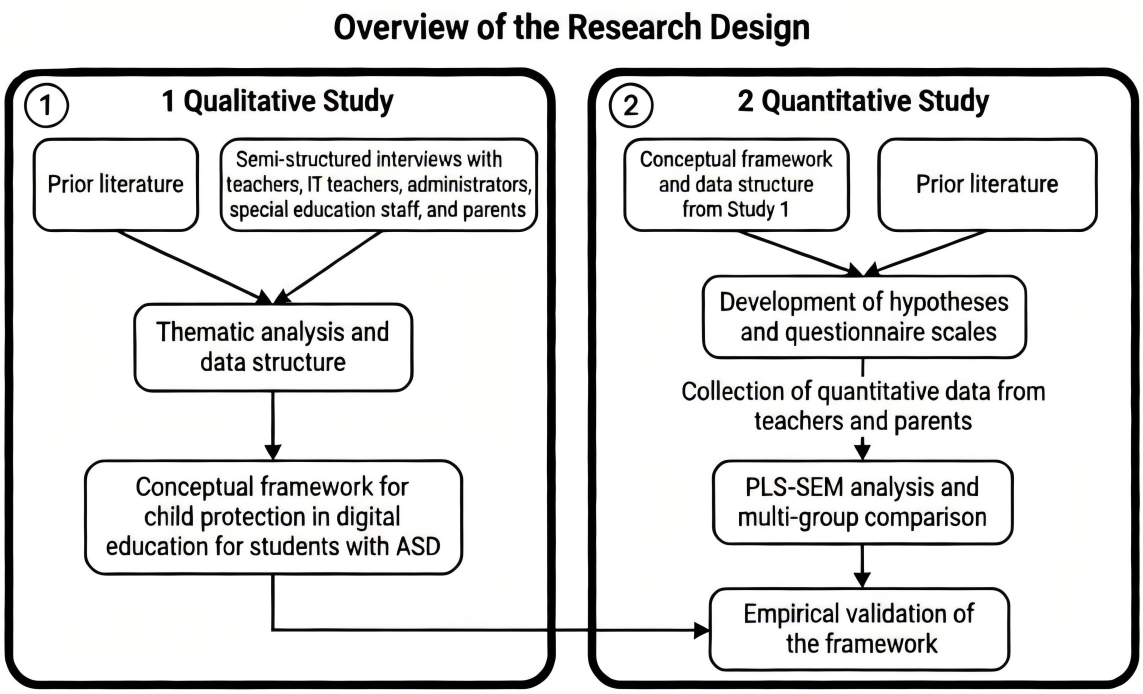

Figure 1. Research design of the study. Source: Authors' own elaboration.

was to gain in-depth insights into PDRs, existing safeguarding practices, institutional arrangements, and the challenges associated with supporting students with ASD in digitally mediated learning contexts. The interview data were examined through thematic analysis, which allows for the systematic identification of patterns and meanings within qualitative datasets (Braun & Clarke, 2006). The insights derived from this stage informed the construction of the conceptual framework as well as the development of measurement instruments.

In the second phase, a quantitative survey was distributed to teachers and parents across several primary schools in Xi'an, China. Drawing on constructs identified in the qualitative phase and supported by prior literature, the survey investigated the relationships among ASDV, PDR, SSG, APC, HSC, and PECP. PLS-SEM was applied to evaluate the proposed model and to examine differences between stakeholder groups. This method is well suited for exploratory studies involving complex models and is widely used in research aimed at prediction and theory development rather than strict theory confirmation (Hair et al., 2017).

By combining qualitative exploration with large-scale quantitative analysis, this research design provides a comprehensive perspective on how multiple stakeholders and contextual conditions interact to shape the protection of students with ASD in digital learning environments.

Ethical Considerations

This study involved only adult stakeholders, including teachers, school administrators, IT teachers, special education staff, and parents of children with ASD. No children were directly interviewed or surveyed. All participants provided informed consent before participation. They were informed about the study purpose, voluntary participation, the right to withdraw, confidentiality, and data protection procedures. No identifiable personal information about children with ASD was collected, and participants were instructed not to disclose any identifying information about individual children.

Study 1: Qualitative Study

This research follows an exploratory sequential mixed-methods design to examine child protection in digital education for primary school students with ASD from a whole-school perspective. Such an approach is particularly suitable in contexts where empirical evidence remains limited and where preliminary qualitative insights are required to guide subsequent quantitative analysis.

Overview

Participants were recruited through purposive sampling, complemented by convenience and snowball strategies, to ensure the inclusion of stakeholders with relevant experience in supporting students with ASD (Patton, 2015). The study was conducted in primary schools in Xi'an, China, covering both mainstream inclusive schools and special education settings. Initial participants were contacted through existing professional networks, and additional informants were identified through participant referrals.

The final sample comprised 37 participants, including classroom teachers, school administrators, IT teachers, special education staff, and parents of children with ASD, thereby capturing diverse perspectives within a whole-school context (Eisenhardt, 1989). Semi-structured interviews were employed to maintain a balance between comparability across participants and the flexibility needed to explore emerging issues (Kallio et al., 2016). The interview protocol was developed based on the research objectives and further refined through pilot testing.

The interview guide addressed several core areas, including participants' professional background and experience with students with ASD; digital teaching and learning practices; perceived risks associated with digital technologies (e.g., privacy, safety, and exposure to inappropriate content); safeguarding measures implemented at both school and family levels; institutional policies, training, and support systems; collaboration between schools and families; and challenges and unmet needs in protecting students with ASD in digitally mediated environments. Participants were also encouraged to offer suggestions for improving protection practices.

Interviews were conducted between December 2025 and March 2026, either face-to-face or online, and typically lasted between 30 and 60 minutes. With participants' consent, all interviews were audio-recorded and transcribed verbatim. Data collection and analysis proceeded iteratively, with insights from earlier interviews informing subsequent data collection, until thematic saturation was achieved (Charmaz, 2014; Glaser & Strauss, 1967).

Data Analysis

The interview data were examined using a thematic analysis approach informed by the Gioia methodology for inductive qualitative research (Gioia et al., 2013; Braun & Clarke, 2006; Braun & Clarke, 2021). This approach was appropriate given that the purpose of the qualitative phase was not to develop a formal grounded theory, but to derive key themes that could inform the development of a conceptual framework and measurement model for the subsequent quantitative study.

All interviews were transcribed verbatim and analyzed with the support of qualitative data analysis software. The analytical process was iterative and interpretive, involving repeated engagement with the data, the generation of initial codes, the development of themes, and their ongoing refinement. To strengthen the credibility of the findings, a subset of transcripts was independently coded by two researchers, with differences discussed until agreement was reached (Boyatzis, 1998). The remaining transcripts were coded by one researcher and subsequently reviewed by the research team.

At the initial stage, first-order concepts were derived by closely examining participants' accounts and identifying meaningful segments of text related to digital risks, safeguarding practices, institutional arrangements, and stakeholder experiences. These concepts remained closely tied to participants' own expressions. Representative examples included challenges in monitoring students' online behavior, concerns regarding privacy and data security, insufficient digital safety training, inconsistencies in school policies, and difficulties in home supervision.

Subsequently, these first-order concepts were organized into second-order themes that reflected more abstract patterns and theoretical interpretations across the dataset. This stage involved continuous comparison and iterative refinement to ensure internal consistency within themes and clear differentiation between them. The resulting themes captured key domains shaping child protection in digital education, including PDRs, SSG, APC, and HSC.

In the final stage, aggregate dimensions were developed by examining the relationships among second-order themes and aligning them with the research objectives. These higher-level categories formed a structured data framework that conceptualizes PECP as the outcome of interactions among ASDV, perceived risk, institutional safeguards, adult competencies, and home–school coordination.

To ensure the robustness of the analysis, the emerging data structure was repeatedly reviewed within the research team and refined in light of relevant literature (Tracy, 2010). Data collection and analysis proceeded in parallel until thematic

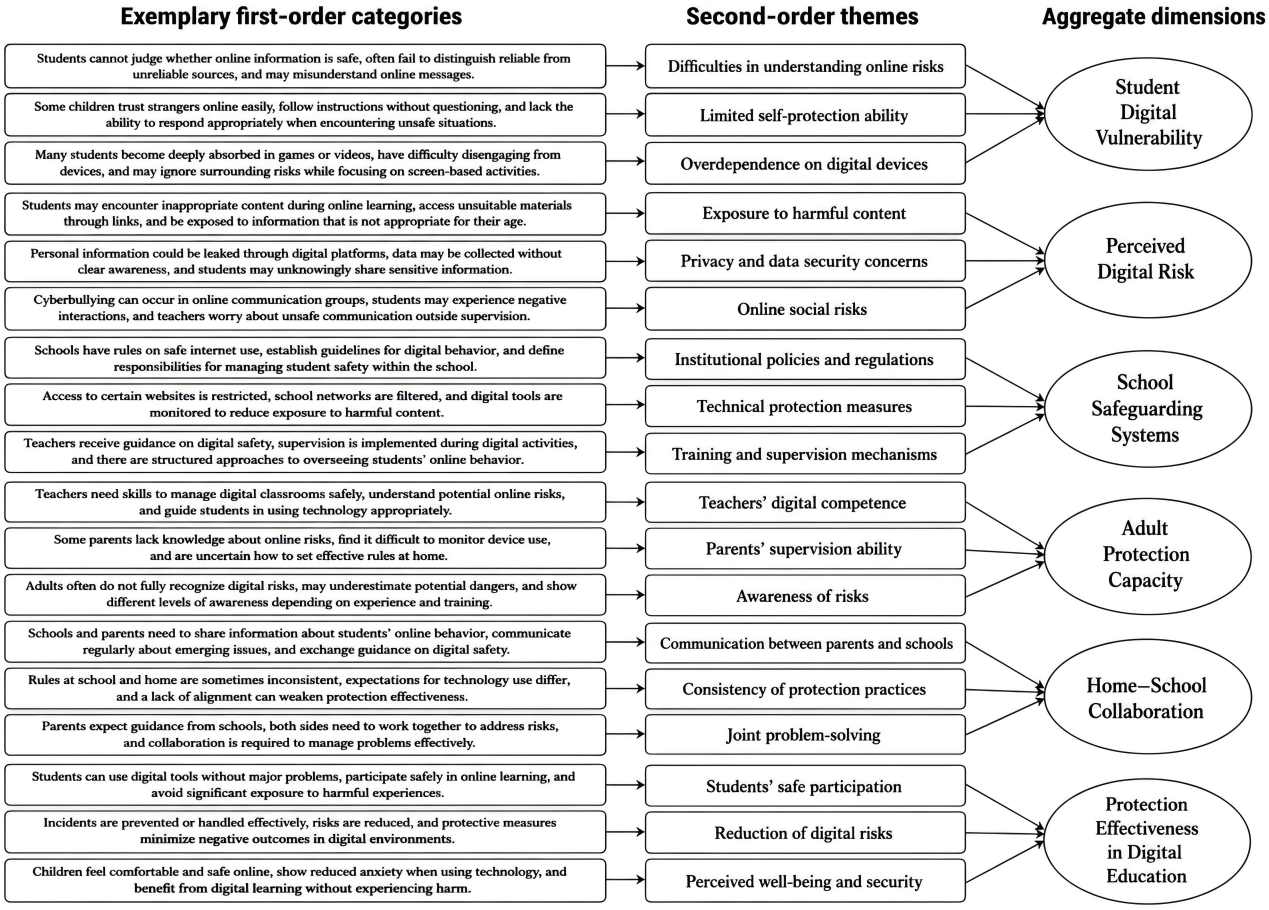

Figure 2. Data structure of the thematic analysis. Source: Authors' own work.

saturation was reached, indicating that additional interviews did not yield substantially new insights. The final data structure is illustrated in Figure 2.

Results

The thematic analysis identified six interrelated dimensions shaping child protection in digital education for primary school students with ASD. These dimensions reflect individual characteristics, perceived risks, institutional safeguards, adult competencies, collaborative processes, and outcomes of protection efforts. Together, they form a multi-level explanatory structure consistent with ecological perspectives on child development (Bronfenbrenner, 1979) and provide the conceptual foundation for the subsequent quantitative phase.

Student Digital Vulnerability

Participants consistently indicated that students with ASD are particularly vulnerable in digital environments, largely due to challenges related to social understanding, impulse regulation, and risk awareness. These observations are consistent with prior research showing that individuals with ASD often face difficulties in interpreting social cues and recognizing potentially harmful situations (American Psychiatric Association, 2013; Cappadocia et al., 2012). Teachers reported that many students have trouble distinguishing between safe and unsafe online contexts and may share personal information without fully understanding the consequences. As one teacher noted, "Some students trust online messages too easily and cannot judge whether the information is reliable" (Teacher T3). Parents similarly highlighted excessive engagement with digital devices. One parent explained, "My child can stay focused on videos for hours and does not notice potential risks" (Parent P2). These findings underscore the need to account for individual characteristics when developing effective protection strategies in digital learning environments.

Perceived Digital Risk

Stakeholders expressed considerable concern regarding the risks associated with digital education, particularly in relation to exposure to harmful content, privacy issues, and problematic online interactions. These concerns align with existing research on children's online experiences, which identifies cyberbullying, inappropriate content, and data privacy as key risks in digital environments (Livingstone & Smith, 2014). Participants noted that digital learning often takes place beyond direct supervision, increasing uncertainty about students' online activities. As one administrator stated, "Once students are online, it is difficult to control what they might encounter" (Administrator A1). Teachers also emphasized the prevalence of cyberbullying and inappropriate communication in online groups, suggesting that digital interaction may intensify social risks for vulnerable students. Overall, these perceptions highlight that awareness of digital risks plays a crucial role in shaping protective behaviors.

School Safeguarding Systems

Institutional measures within schools were identified as central to ensuring digital safety. Participants described policies regulating internet use, technical controls such as content filtering, and procedures for responding to incidents. These findings resonate with whole-school approaches emphasizing the importance of coordinated institutional strategies for safeguarding and well-being (Langford et al., 2015; Barry et al., 2013). However, implementation was uneven across schools. One IT teacher noted, "We have technical restrictions, but supervision still depends on teachers" (IT Teacher IT2). Training opportunities and clear guidelines were viewed as essential for effective protection. Consistent with school climate research (Cohen et al., 2009), the findings suggest that safeguarding requires integrated organizational practices rather than isolated interventions.

Adult Protection Capacity

The competence of teachers and parents emerged as another key factor influencing protection outcomes. Participants reported variability in digital literacy and confidence in managing online risks. This finding is consistent with research highlighting the importance of adult mediation and competence in shaping children's digital experiences (Purnama et al., 2021). Teachers emphasized the need for professional development, while parents expressed uncertainty about supervising technology use at home. A parent commented, "I worry about my child's online activities, but I am not always sure what to do" (Parent P4). These findings indicate that adult capability directly influences students' safety and suggest that capacity-building is a critical component of effective protection.

Home–School Collaboration

Effective communication between schools and families was widely regarded as necessary for consistent protection. Participants highlighted that digital learning often occurs across both contexts, requiring shared expectations and coordinated practices. This aligns with ecological perspectives emphasizing the importance of mesosystem interactions between home and school (Bronfenbrenner, 1979). Teachers noted that inconsistent rules between home and school can undermine safety efforts. One teacher stated, "If parents allow unrestricted use at home, school measures alone are not enough"(Teacher T6). Regular information exchange and guidance were considered beneficial for addressing emerging risks, supporting prior findings on the importance of collaborative approaches in inclusive education (Vlcek et al., 2020).

PECP in Digital Education

Participants described PECP in terms of students' ability to engage safely in digital learning while minimizing potential harm. Key indicators included fewer incidents, more effective supervision, and an increased sense of security among students. These observations reflect a balanced perspective on digital participation, where opportunities for inclusion coexist with the need for adequate protection (Livingstone & Smith, 2014). As one administrator noted, "Digital education should help students grow without exposing them to unnecessary risks" (Administrator A2). This outcome dimension brings together the combined influence of student vulnerability, perceived risk, institutional safeguards, adult capacity, and HSC.

The interconnections among these dimensions provided the basis for constructing a conceptual framework, which subsequently informed the development of research hypotheses and measurement instruments for the quantitative phase.

Study 2: Quantitative Study

Overview

To empirically examine and validate the relationships identified in the qualitative phase, this study applies PLS-SEM (Hair et al., 2019). This method is well suited for analyzing complex models that involve multiple constructs and mediating mechanisms. At the same time, it is acknowledged that structural modeling alone cannot establish causal relationships without a solid theoretical foundation. In this research, the hypotheses are derived from the conceptual framework developed in the qualitative phase, which helps strengthen the theoretical grounding of the model and reduces the likelihood of spurious associations.

Theoretical Background and Hypotheses Development

Drawing on the data structure and conceptual framework derived from the qualitative study, we develop hypotheses to explain the relationships among the key constructs. The proposed hypotheses capture both direct and indirect (mediating) effects and are subsequently examined through quantitative analysis.

Direct Effects

First, qualitative findings indicate that ASDV contributes to higher levels of PDR. Students with ASD often experience challenges in social communication, risk awareness, and adaptive functioning (American Psychiatric Association, 2013), which may limit their ability to recognize potentially harmful situations in digital environments. Previous research has also shown that children with ASD are more likely to encounter victimization and unsafe situations compared to their peers (Cappadocia et al., 2012). In digital contexts, these vulnerabilities may translate into heightened perceptions and experiences of risk. Accordingly, we propose:

Hypothesis 1: ASDV has a significant positive influence on PDR.

Second, our data indicate that SSG play a critical role in enhancing APC. Schools that establish structured policies, provide training, and implement technical safeguards create conditions that enable teachers and parents to better manage digital risks. This observation is consistent with whole-school approaches emphasizing the importance of coordinated institutional efforts in promoting student safety (Langford et al., 2015; Barry et al., 2013). Accordingly, we hypothesize:

Hypothesis 2: SSG have a significant positive influence on APC.

Third, our findings reveal that SSG also foster HSC. Institutional arrangements such as communication mechanisms, guidance, and coordinated policies facilitate interaction between schools and families. From an ecological perspective, interactions between home and school environments are essential for supporting children's development and well-being (Bronfenbrenner, 1979). Thus, we propose:

Hypothesis 3: SSG have a significant positive influence on HSC.

Fourth, our qualitative results highlight that APC contributes directly to PECP in digital education. Teachers' professional competence and parents' supervision ability influence how effectively risks are identified and managed. Prior research shows that adult mediation and digital literacy are critical in shaping children's online experiences and reducing exposure to risks (Purnama et al., 2021). Therefore, we hypothesize:

Hypothesis 4: Adult protection capacity has a significant positive influence on PECP.

Fifth, our findings indicate that HSC plays a key role in improving PECP. Consistent communication and shared practices between parents and schools help ensure coherent supervision across contexts. Previous studies have emphasized the importance of collaborative partnerships in supporting children with special needs (Vlcek et al., 2020). Hence, we propose:

Hypothesis 5: HSC has a significant positive influence on PECP.

Sixth, our data suggest that PDR negatively affects PECP. When risks are higher or more difficult to manage, the effectiveness of protection measures may be reduced. Research on digital environments highlights that exposure to online risks such as harmful content and cyberbullying can negatively impact children's well-being (Livingstone & Smith, 2014).

Therefore, we hypothesize:

Hypothesis 6: PDR has a significant negative influence on PECP.

Seventh, our qualitative findings indicate that SSG may also directly influence PECP. Institutional policies, technical controls, and organizational practices contribute to safer digital learning environments. Research on school climate similarly suggests that structured and supportive environments enhance students' sense of safety (Cohen et al., 2009; Thapa et al., 2013). Thus, we propose:

Hypothesis 7: SSG have a significant positive influence on PECP.

Indirect Effects

Beyond the direct relationships, our qualitative findings also suggest several mediating mechanisms.

First, ASDV may influence PECP indirectly through PDR. Students with higher vulnerability are more likely to encounter or perceive risks, which in turn may reduce the effectiveness of protection measures. This aligns with research indicating that exposure to digital risks mediates the relationship between individual characteristics and outcomes (Livingstone & Smith, 2014). Accordingly, we propose:

Hypothesis 8: PDR mediates the relationship between ASDV and PECP.

Second, SSG may influence PECP indirectly through APC. Institutional support enhances the competencies of teachers and parents, which subsequently improves protection outcomes. Therefore, we hypothesize:

Hypothesis 9: APC mediates the relationship between SSG and PECP.

Finally, SSG may also influence PECP through HSC. By facilitating communication and coordination, schools strengthen collaborative practices, thereby enhancing protection outcomes. Thus, we propose:

Hypothesis 10: HSC mediates the relationship between SSG and PECP.

Data Collection

To examine the proposed hypotheses within the context of primary education, a survey-based approach was adopted, targeting both teachers and parents of students with ASD. The questionnaire was developed based on the conceptual framework derived from the qualitative phase and supplemented with measurement items adapted from prior studies to ensure content validity and reliability. Each construct in the model was measured using multiple indicators, in line with established guidelines for structural equation modeling (Hair et al., 2019; Sarstedt et al., 2022).

The survey instrument included six latent constructs, each operationalized with four reflective items, yielding a total of 24 measurement items. All items were rated on a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Two versions of the questionnaire were designed to capture the perspectives of different stakeholder groups. While the underlying construct structure remained identical, item wording was adapted to reflect the roles of teachers and parents. In particular, APC was operationalized as teacher safeguarding competence (TSCP) in the teacher version and as family-mediated home support (FMHS) in the parent version.

Before the main data collection, a pilot study was conducted with a small group of teachers and parents to evaluate the clarity and contextual relevance of the questionnaire. Based on their feedback, minor revisions were made to improve item wording and overall comprehensibility.

Data were collected through an online survey platform using a purposive convenience sampling strategy, complemented by snowball sampling. The questionnaire was initially distributed via school networks and parent communities, and participants were encouraged to share the survey within their professional and social networks to reach additional eligible respondents.

A total of 360 valid responses were obtained, including 180 from teachers and 180 from parents. All responses satisfied the predefined inclusion criteria and were retained for analysis. The balanced sample design enabled subsequent multi-group analysis to compare structural relationships across the two stakeholder groups. Detailed sample characteristics are presented in **Appendix A**.

Data Analysis

To evaluate the proposed model and test the hypotheses, PLS-SEM was applied using the R-based plspm package. This method is well suited for exploratory studies involving complex models with multiple constructs and mediating relationships, and it is particularly appropriate when the focus is on prediction and theory development rather than strict theory testing (Hair et al., 2019). In addition, PLS-SEM provides robust estimation under conditions of relatively moderate sample sizes and facilitates multi-group comparisons.

Following established methodological guidelines (Hair et al., 2019; Ringle et al., 2023), the analysis was conducted in two stages. First, the measurement model was evaluated to assess the reliability and validity of the constructs. Second, the structural model was examined to test the hypothesized relationships among latent variables.

For the measurement model, indicator reliability, internal consistency, convergent validity, and discriminant validity were assessed. Indicator reliability was evaluated based on outer loadings, with all items demonstrating loadings above 0.70. As reported in Table 1, Cronbach's alpha values for all constructs exceeded 0.84, composite reliability (CR) values were above 0.89, and the average variance extracted (AVE) for each construct was greater than 0.67. These results indicate satisfactory internal consistency and convergent validity across both groups.

Discriminant validity was examined using both the Fornell–Larcker criterion (Fornell & Larcker, 1981) and the heterotrait–monotrait (HTMT) ratio (Henseler et al., 2015). The maximum HTMT value was 0.637 for the parent group and 0.831 for the teacher group, both below the conservative threshold of 0.85. In addition, the upper bounds of all HTMT confidence intervals were below 1, and the square roots of AVE for each construct exceeded their correlations with other constructs. Together, these findings confirm adequate discriminant validity.

Table 1. Reliability and convergent validity[i].

Construct	Cronbach's alpha (Parents)	CR (Parents)	AVE (Parents)	Cronbach's alpha (Teachers)	CR (Teachers)	AVE (Teachers)
ASDV	0.846	0.897	0.684	0.863	0.907	0.708
PDR	0.864	0.908	0.71	0.879	0.917	0.732
SSG	0.884	0.92	0.742	0.884	0.92	0.742
APC	0.864	0.907	0.71	0.858	0.904	0.702
HSC	0.843	0.895	0.679	0.879	0.917	0.733
PECP	0.926	0.948	0.819	0.919	0.943	0.805

Source: authors' own work. [i]Note. ASDV, ASD-related digital vulnerability; PDR, perceived digital risk; SSG, school safeguarding systems; APC, adult protection capacity; HSC, home–school collaboration; PECP, protection effectiveness in digital education; CR, composite reliability; AVE, average variance extracted.

For the structural model, explanatory power was assessed using the coefficient of determination (R^2), while predictive relevance was evaluated based on Q^2 values. Effect sizes (f^2) were calculated to estimate the relative influence of exogenous constructs on endogenous variables. To address potential multicollinearity, variance inflation factors (VIF) were examined. The maximum VIF was 2.903 at the structural level and 3.783 at the indicator level, both well below the commonly accepted threshold of 5.0. Most indicators showed VIF values below 3.0, indicating that multicollinearity does not pose a concern for model estimation.

To assess mediation effects, the procedure recommended by Zhao et al. (2010) was applied. Specific indirect effects were estimated using bootstrapping, and their statistical significance was examined to determine whether the influence of exogenous variables on PECP operates through mediating constructs.

Finally, differences in structural relationships between teachers and parents were examined using partial least squares multi-group analysis (PLS-MGA). Group differences in path coefficients were evaluated through permutation tests with 5000 resamples and two-tailed significance testing, allowing for the identification of statistically significant differences between stakeholder groups.

Results

Structural Model Results

The structural model was evaluated by examining the path coefficients and their significance levels for both stakeholder groups.The model demonstrates satisfactory explanatory power, as indicated in Table 2.

Table 2. Structural path coefficients and hypothesis testing[ii].

Hypothesis	Path	β (Parents)	95% CI (Parents)	t (Parents)	β (Teachers)	95% CI (Teachers)	t (Teachers)	Result
H1 (+)	ASDV → PDR	0.461***	[0.325, 0.559]	7.87	0.507***	[0.379, 0.620]	8.33	Supported
H2 (+)	SSG → APC	0.485***	[0.367, 0.588]	8.81	0.724***	[0.645, 0.784]	20.38	Supported
H3 (+)	SSG → HSC	0.520***	[0.402, 0.613]	9.76	0.627***	[0.533, 0.701]	14.48	Supported
H4 (+)	APC → PECP	0.267***	[0.142, 0.378]	4.34	0.192*	[0.024, 0.331]	2.45	Supported
H5 (+)	HSC → PECP	0.387***	[0.273, 0.490]	7.01	0.190**	[0.060, 0.314]	2.91	Supported
H6 (–)	PDR → PECP	–0.220***	[–0.311, –0.110]	–4.32	–0.180***	[–0.278, –0.078]	–3.38	Supported
H7 (+)	SSG → PECP	0.220***	[0.097, 0.341]	3.51	0.399***	[0.227, 0.582]	4.48	Supported

Source: authors' own work. [ii]Note. ASDV, ASD-related digital vulnerability; PDR, perceived digital risk; SSG, school safeguarding systems; APC, adult protection capacity; HSC, home–school collaboration; PECP, protection effectiveness in digital education; CI, confidence interval. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

The model demonstrates adequate explanatory power and predictive relevance. The R^2 results suggest that a moderate to substantial share of variance in the endogenous constructs is accounted for by the model, particularly with respect to PECP. In addition, all Q^2 values are positive across both groups, indicating satisfactory predictive capability.

The f^2 effect size analysis further shows that SSG exert relatively strong influences on key endogenous constructs, especially APC and HSC, whereas the remaining relationships range from small to moderate in magnitude. Regarding model fit, the standardized root mean square residual (SRMR) values for the parent group (0.057) and the teacher group (0.059) are both below the recommended threshold of 0.08, suggesting an acceptable level of model fit.

The structural model results are presented in Figure 3 and 4 and Table 2. All seven hypothesized paths are statistically significant in both groups, and the directions of the relationships are consistent with theoretical expectations. In the parent group, all path coefficients reach significance at the $p < 0.001$ level. In the teacher group, the effects associated with H4 (APC → PECP, $p = 0.014$) and H5 (HSC → PECP, $p = 0.002$) are comparatively weaker, while the remaining paths remain significant at the $p < 0.001$ level.

With regard to the magnitude of the path coefficients, the most notable differences between the two groups are observed in the relationships from SSG to APC and from HSC to PECP. These patterns are further corroborated by the results of the subsequent multi-group analysis.

Mediation effects were tested using bootstrapping with 999 resamples. This procedure was used to estimate the stability and confidence intervals of specific indirect effects. Mediation effects were assessed using bootstrapping procedures, and three indirect pathways were found to be statistically significant in both groups (see Table 3).

First, PDR was found to mediate the association between ASDV and PECP. The indirect effect was negative and statistically significant in both the parent group ($\beta = –0.101$, $p < 0.001$) and the teacher group ($\beta = –0.091$, $p < 0.001$), suggesting a full mediation pattern. This indicates that the influence of student vulnerability on protection effectiveness is primarily transmitted through heightened perceptions of digital risk.

Second, APC serves as a significant intermediary in the relationship between SSG and PECP. The indirect effects

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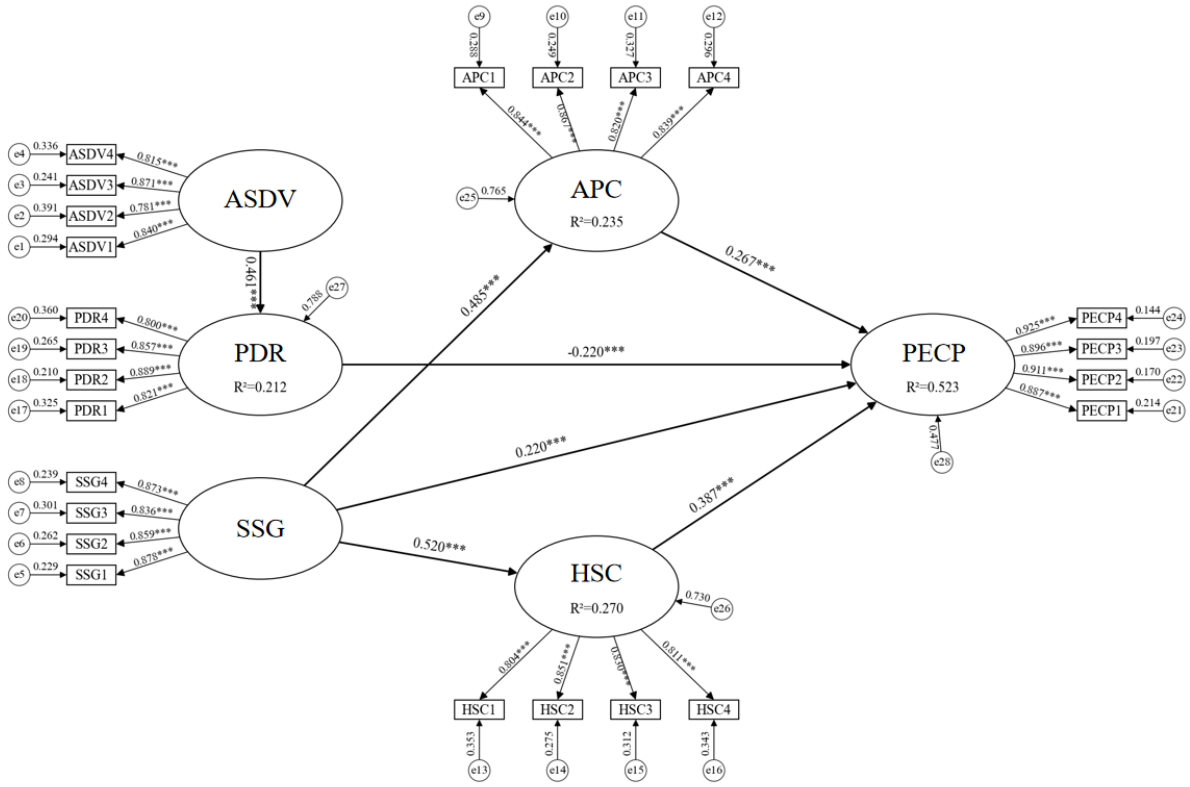

Figure 3. Structural model results (parent group)[iii]**.** Source: Authors' own work. [iii]Note. ASDV, ASD-related digital vulnerability; PDR, perceived digital risk; SSG, school safeguarding systems; APC, adult protection capacity; HSC, home–school collaboration; PECP, protection effectiveness in digital education; R^2, coefficient of determination. Item codes, such as ASDV1–ASDV4, PDR1–PDR4, SSG1–SSG4, APC1–APC4, HSC1–HSC4, and PECP1–PECP4, refer to the measurement items listed in **Appendix B**. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

are positive and statistically significant in both groups (parents: $\beta = 0.129$, $p < 0.001$; teachers: $\beta = 0.139$, $p < 0.001$), indicating complementary partial mediation.

Similarly, HSC also functions as a mediator between SSG and PECP. Positive and significant indirect effects are observed in both groups (parents: $\beta = 0.201$, $p < 0.001$; teachers: $\beta = 0.119$, $p < 0.001$), further supporting the presence of complementary partial mediation.

Further decomposition of total effects reveals that the overall influence of SSG on PECP is slightly stronger in the teacher group (total effect = 0.657) than in the parent group (total effect = 0.551). However, the proportion of mediation differs notably between groups. In the parent group, 60.0% of the total effect is transmitted through mediators, compared to 39.2% in the teacher group (see Table 4).

This indicates that parents' perceptions of protection effectiveness rely more on indirect mechanisms such as adult capacity and HSC, whereas teachers' perceptions are more directly influenced by institutional safeguards.

Multi-Group Analysis

Multi-group differences were examined using permutation tests with 5000 resamples. This resampling procedure was used to assess whether path coefficients differed significantly between the teacher and parent groups. Partial least squares multi-group analysis (PLS-MGA) was applied to compare structural relationships between teachers and parents. Based on permutation tests with 5000 resamples, the findings indicate that most paths do not show statistically significant differences across the two groups, suggesting a generally stable model structure across stakeholders (see Table 5).

However, two paths show significant group differences. First, the relationship between SSG and APC is significantly stronger in the teacher group ($\beta = 0.724$) than in the parent group ($\beta = 0.485$; $p < 0.001$). This finding indicates that

Table 3. Specific indirect effects[v].

Mediation path	β (Parents)	95% CI (Parents)	β (Teachers)	95% CI (Teachers)	Type of mediation
ASDV → PDR → PECP	–0.101***	[–0.158, –0.049]	–0.091***	[–0.150, –0.040]	Full mediation
SSG → APC → PECP	0.129***	[0.068, 0.205]	0.139*	[0.027, 0.246]	Complementary partial mediation
SSG → HSC → PECP	0.201***	[0.138, 0.281]	0.119**	[0.037, 0.203]	Complementary partial mediation

Bootstrap with 999 resamples. Confidence intervals that do not include zero indicate statistical significance. Mediation types are classified following Zhao et al. (2010). Source: authors' own work. [v]Note. ASDV, ASD-related digital vulnerability; PDR, perceived digital risk; SSG, school safeguarding systems; APC, adult protection capacity; HSC, home–school collaboration; PECP, protection effectiveness in digital education; CI, confidence interval. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Table 4. Decomposition of the total effect of SSG on PECP[vi].

Effect type	Parents	Teachers
Direct effect (SSG → PECP)	0.22	0.399
Indirect effect (via APC)	0.129	0.139
Indirect effect (via HSC)	0.201	0.119
Total indirect effect	0.331	0.258
Total effect	0.551	0.657
Mediation proportion	60.00%	39.20%

Mediation proportion = indirect effect / total effect. Complementary partial mediation indicates that both direct and indirect effects are significant and in the same direction. Source: authors' own work. [vi]Note. SSG, school safeguarding systems; PECP, protection effectiveness in digital education; APC, adult protection capacity; HSC, home–school collaboration.

Table 5. Results of PLS-MGA (permutation test)[vii].

Hypothesis	Path	β (Parents)	β (Teachers)	Difference (T – P)	p-value	Result
H1	ASDV → PDR	0.461	0.507	0.046	0.5824	No significant difference
H2⋆	SSG → APC	0.485	0.724	0.239	0.0004	Teachers > Parents
H3	SSG → HSC	0.52	0.627	0.108	0.1202	No significant difference
H4	APC → PECP	0.267	0.192	–0.075	0.4236	No significant difference
H5⋆	HSC → PECP	0.387	0.19	–0.198	0.0294	Parents > Teachers
H6	PDR → PECP	–0.220	–0.180	0.04	0.5942	No significant difference
H7	SSG → PECP	0.22	0.399	0.179	0.0944	No significant difference

Source: authors' own work. [vii]Note. PLS-MGA, partial least squares multi-group analysis; ASDV, ASD-related digital vulnerability; PDR, perceived digital risk; SSG, school safeguarding systems; APC, adult protection capacity; HSC, home–school collaboration; PECP, protection effectiveness in digital education; T – P, teachers minus parents. Permutation test with 5000 resamples, two-tailed. Permutation test with 5000 resamples (two-tailed). ⋆ indicates significant group differences.

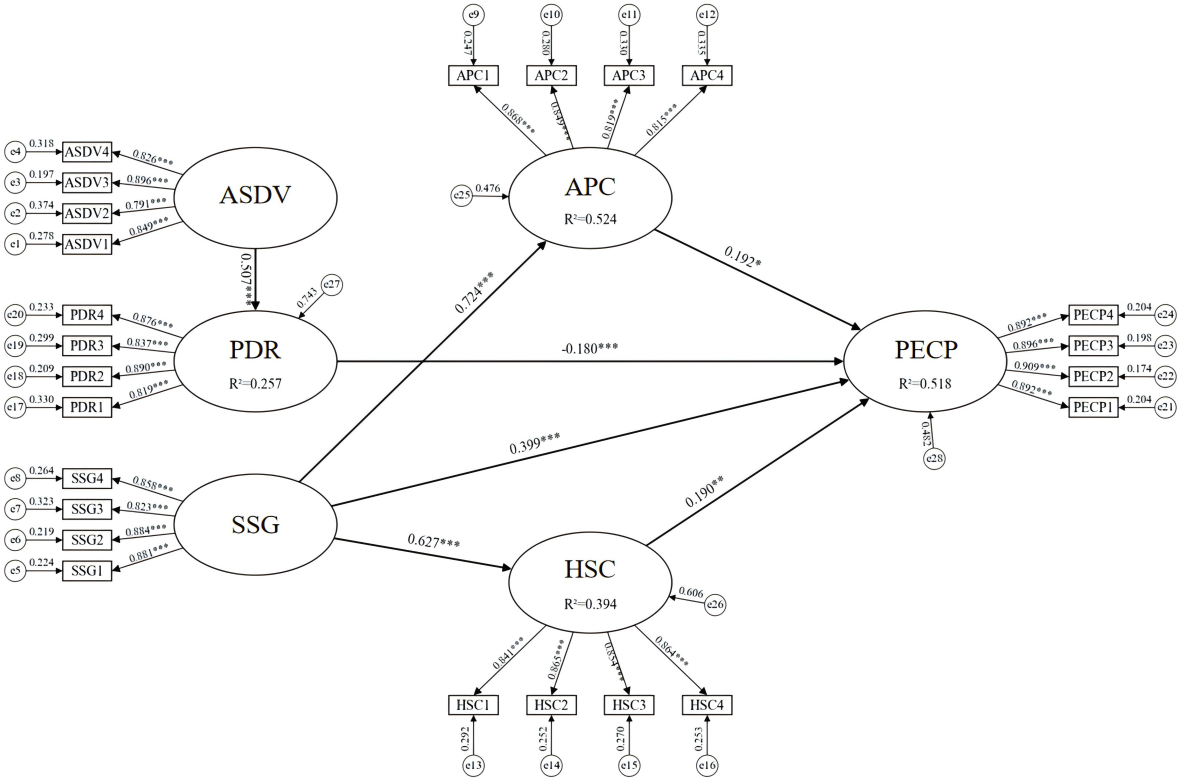

Figure 4. Structural model results (teacher group)[iv]**.** Source: Authors' own work. [iv]Note. ASDV, ASD-related digital vulnerability; PDR, perceived digital risk; SSG, school safeguarding systems; APC, adult protection capacity; HSC, home–school collaboration; PECP, protection effectiveness in digital education; R^2, coefficient of determination. Item codes, such as ASDV1–ASDV4, PDR1–PDR4, SSG1–SSG4, APC1–APC4, HSC1–HSC4, and PECP1–PECP4, refer to the measurement items listed in **Appendix B**. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

institutional support is more directly translated into professional competencies among teachers.

Second, the effect of HSC on PECP is significantly stronger in the parent group ($\beta = 0.387$) than in the teacher group ($\beta = 0.190$; $p = 0.029$). This suggests that parents rely more heavily on collaborative processes with schools when evaluating digital protection outcomes.

The remaining paths, including ASDV → PDR, SSG → HSC, APC → PECP, PDR → PECP, and SSG → PECP, do not show statistically significant differences between groups. Notably, the path from SSG to PECP approaches marginal significance ($p = 0.094$), indicating a potential tendency for teachers to be more directly influenced by institutional safeguards. This pattern warrants further investigation in future research.

Overall, the results suggest that while the structural model is largely consistent across groups, differences emerge in how institutional support and collaborative mechanisms are translated into PECP, reflecting distinct stakeholder perspectives.

Discussion

Theoretical Contributions and Implications

The present study advances the literature by articulating a multi-layered explanatory framework for child protection in digital education contexts involving students with ASD. Existing research has largely addressed digital risk, disability, or school safeguarding as discrete domains, with limited integration across these perspectives. While prior work has established that children—particularly those with disabilities—are disproportionately exposed to online risks (Livingstone & Smith, 2014; Hammond et al., 2023), it has remained unclear how such vulnerabilities are structurally translated into protection outcomes. By modelling the interplay between individual vulnerability, PDR, institutional safeguards, adult capacity,

and relational collaboration, this study contributes a more systemically grounded account of protection mechanisms.

The findings further reinforce an ecological understanding of child protection, demonstrating that PECP emerges not from isolated factors but from interdependent processes spanning individual, relational, and institutional levels. In particular, the indirect effect of student vulnerability through PDR aligns with evidence that children with ASD often face heightened exposure to and reduced coping capacity in online environments (Macmillan et al., 2022). At the same time, school-level safeguarding structures operate as both direct and enabling forces, shaping adult protective practices and collaborative dynamics. This underscores the structural embeddedness of protection, extending beyond child-level explanations.

Positioning PDR as a mediating mechanism offers a more nuanced conceptualization of how risk operates within digital education. Rather than treating risk as an external condition, the results suggest that risk perception functions as a translation layer, linking environmental exposure to behavioral and institutional responses. This perspective complements existing research on cyber risks such as privacy breaches and online harassment (Livingstone & Smith, 2014; Bacak et al., 2022), while shifting the focus toward how risk is cognitively and socially processed within protective systems.

The prominence of SSG in the model highlights the generative role of institutions in structuring digital safety. This finding resonates with prior research emphasizing the need for coordinated, system-level approaches to protecting vulnerable learners (Naeem & Munir, 2024). Beyond direct effects, the results indicate that institutional arrangements actively enable and amplify protective capacities, suggesting that safeguarding should be conceptualized as an infrastructural condition rather than a set of isolated practices.

Incorporating both teacher and parent perspectives further enriches current theoretical discussions by foregrounding the distributed and relational nature of protection responsibilities. While collaboration between schools and families has been widely advocated (Vlcek et al., 2020), empirical models rarely capture how these roles differ in function and influence. The observed group differences suggest that protection is not uniformly enacted but is instead contextually mediated across stakeholder positions, offering a more differentiated understanding of multi-actor governance in digital safety.

Implications for Practice

The findings point toward the necessity of rethinking child protection in digital education as a systemic and coordinated endeavor rather than a collection of isolated interventions. The centrality of SSG indicates that effective protection requires coherent institutional infrastructures, including clear policy frameworks, data protection mechanisms, and responsive governance structures. In increasingly digitized learning environments, where exposure to cybersecurity and privacy risks is expanding (Olumide & Adedoyin, 2024), fragmented or reactive approaches are unlikely to be sufficient.

The whole-school framework proposed in this study extends existing research in three ways. First, it connects digital safety research with ASD education by showing that online protection for students with ASD cannot be explained only by individual vulnerability or technology-related risk. Second, it extends child protection research by positioning safeguarding as a coordinated institutional and relational process involving schools, teachers, and families. Third, it contributes to inclusive digital education by demonstrating that PECP depends on the interaction between SSG, APC, and home-school collaboration.

At the same time, the role of adult capacity suggests that protection is contingent upon the competencies of both educators and families. Teachers' inclusive beliefs and practices have been shown to significantly influence outcomes for students with ASD (Pang et al., 2024), while parental mediation and digital literacy play a crucial role in shaping children's online risk experiences (Purnama et al., 2021). This underscores the importance of capacity-building strategies that extend beyond institutional settings, fostering shared responsibility across stakeholders.

The mediating role of HSC further highlights the need for aligned practices across learning contexts. As digital education increasingly blurs the boundaries between school and home environments, inconsistencies in supervision and guidance may weaken protection mechanisms. Strengthening communication channels and establishing shared norms therefore become critical components of effective safeguarding, echoing broader calls for collaborative support systems in ASD education (Vlcek et al., 2020).

Additionally, the findings suggest that interventions should not only aim to reduce exposure to risk but also enhance

children's ability to interpret and respond to it. Given that students with ASD may struggle to identify unsafe situations or social cues in digital contexts (Farid, 2024), digital safety education should incorporate structured, adaptive, and developmentally appropriate approaches that support both awareness and agency.

The differences observed between teachers and parents further imply that protection strategies may need to be differentiated rather than standardized. Institutional interventions may have greater leverage within school contexts, whereas relational and experiential factors may be more influential within family settings. Recognizing these distinctions can support more targeted and effective policy design.

Limitations and Future Research Directions

Despite its contributions, this study has several limitations that point to opportunities for future research. First, the study is situated within a specific socio-cultural and educational context, and the extent to which the proposed framework can be generalized to other settings remains uncertain. Cross-cultural validation would be valuable for understanding how institutional and family dynamics shape digital protection across different contexts.

Second, the reliance on self-reported data from teachers and parents may introduce perceptual bias. Future research could incorporate children's perspectives to provide a more comprehensive account, particularly as emerging evidence suggests that young children can meaningfully articulate their own digital experiences (Luo et al., 2025).

Third, the cross-sectional nature of the data limits the ability to capture how protection mechanisms evolve over time. Longitudinal designs would offer deeper insight into the dynamic interplay among digital risk, institutional responses, and stakeholder interactions in rapidly changing technological environments.

Moreover, the current model does not explicitly incorporate technological infrastructure or platform governance, factors that are increasingly recognized as critical determinants of digital safety (Rivera-Vargas et al., 2024). Including these elements in future research could further strengthen the explanatory scope of protection in digitally mediated learning environments.

Finally, future studies may examine heterogeneity within stakeholder groups, such as variations in teacher training, parental stress, or access to resources, which have been shown to influence support processes in families of children with ASD (Liu et al., 2024). Accounting for such intra-group differences would allow for a more nuanced refinement of the proposed model.

Conclusions

This research investigates child protection in digital education for primary school students with ASD through a mixed-methods design combining qualitative insights and quantitative validation. The findings show that PECP emerges from the interaction of multiple dimensions, including student vulnerability, PDR, institutional safeguarding systems, APC, and HSC.

Rather than being driven by isolated factors, digital protection is shaped by interconnected processes across individual, relational, and institutional levels. Student vulnerability operates primarily through PDR, while SSG play a central role by both directly enhancing protection and indirectly strengthening adult capacity and collaborative practices. At the same time, stakeholder roles are not uniform: teachers tend to rely more on institutional structures, whereas parents place greater emphasis on relational and collaborative mechanisms.

Taken together, these findings highlight the need to understand child protection in digital education as a coordinated, multi-stakeholder process. Building safe and inclusive digital learning environments therefore requires not only technological and institutional support, but also the alignment of professional practices and family engagement. Such an integrated approach is essential for ensuring that digital education can support the development of students with ASD without increasing their exposure to risk.

Author Contributions

JQW and MYY contributed equally to this work. Conceptualization was carried out by JQW and MYY, who jointly developed the research idea and theoretical framework. Methodology was designed by JQW and MYY, with JQW leading

the implementation of the mixed-methods approach and software-related procedures. JQW conducted the formal analysis and data curation, while investigation was undertaken by both JQW and MYY Validation of the results was performed by JQW, YKW, and MYY Resources were provided by YKW. JQW and MYY jointly prepared the original draft of the manuscript, with MYY making substantial contributions to the theoretical development and interpretation of findings. YKW and MYY contributed to writing—review and editing. Visualization was completed by JQW Supervision and project administration were undertaken by YKW, who also acquired funding for the project. All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study involved adult participants, including teachers and parents, and did not involve direct data collection from minors. The research was conducted in accordance with relevant ethical guidelines for human subjects research. According to institutional regulations, formal ethical approval was not required for studies involving minimal risk and voluntary participation. All participants were informed about the purpose of the study, and informed consent was obtained prior to participation. Participation was voluntary, and all responses were collected anonymously.

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Availability of Data and Materials

The datasets generated and/or analyzed during the current study are not publicly available due to privacy and ethical restrictions, as they contain information collected from human participants. However, anonymized data may be made available from the corresponding authors upon reasonable request.

Conflict of Interest

The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Appendix

Appendix A: Table 6

Appendix B: Table 7

Appendix C_1: Table 8; Appendix C_2: Table 9

Table 6. Overview of interview participants.

Role	Number	Percentage	Experience (years)	School type	Gender
Classroom Teachers	12	32.40%	5–15	Mainstream schools	8 Female, 4 Male
Special Education Teachers	6	16.20%	6–18	Special schools	4 Female, 2 Male
IT Teachers	3	8.10%	7–12	Mainstream schools	1 Female, 2 Male
School Administrators	4	10.80%	10–20	Mixed (Mainstream & Special)	2 Female, 2 Male
Parents of children with ASD	12	32.40%	—	—	8 Female, 4 Male
Total	37	100%	—	—	—

Note. Source: authors' own work. IT, information technology; ASD, autism spectrum disorder.

Table 7. Measurement items.

Construct	Item code	Measurement item
ASD-related digital vulnerability (ASDV)	ASDV1	Students with ASD have difficulty judging whether online information or interactions are safe.
	ASDV2	Students with ASD require adult guidance to safely use digital devices.
	ASDV3	Students with ASD tend to become excessively engaged when using digital devices.
	ASDV4	Students with ASD are unlikely to actively seek help when encountering online problems.
Perceived Digital Risk (PDR)	PDR1	Students with ASD may be exposed to inappropriate online content during digital learning.
	PDR2	Students with ASD may experience cyberbullying or unfriendly interactions online.
	PDR3	Students with ASD may have difficulty protecting their personal information.
	PDR4	Digital learning may increase emotional or behavioral problems among students with ASD.
School Safeguarding Systems (SSG)	SSG1	The school has established clear rules for safe digital learning.
	SSG2	The school emphasizes the protection of students' data and privacy.
	SSG3	The school considers safety when selecting digital learning platforms.
	SSG4	The school has clear procedures for handling digital safety incidents.
Adult Protection Capacity (APC / FMHS / TSCP)	APC1	Adults (teachers/parents) can guide students with ASD in safe digital practices.
	APC2	Adults can identify potential digital risks faced by students with ASD.
	APC3	Adults actively monitor students' digital learning activities.
	APC4	Adults are able to respond effectively to digital safety issues.
Home–School Collaboration (HSC)	HSC1	Schools communicate with parents about students' digital safety issues.
	HSC2	Schools provide guidance to families on supporting digital safety.
	HSC3	Schools value parents' opinions regarding digital safety.
	HSC4	Schools and families work together to ensure students' digital safety.
Protection Effectiveness in Digital Education (PECP)	PECP1	Students with ASD are safe during digital learning at school.
	PECP2	Digital safety issues are handled promptly by the school.
	PECP3	The school provides a secure digital learning environment.
	PECP4	I trust the school's digital protection measures.

Note. All items were measured using a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. Source: authors' own work. FMHS, family-mediated home support; TSCP, teacher safeguarding competence; ASD, autism spectrum disorder.

Appendix C. Measurement Model Assessment

Table 8. Indicator reliability and collinearity diagnostics.

Construct	Indicator	Loading	CI low	CI high	*p*-value (Sig.)	Weight	VIF
Adult Protection Capacity (APC)	APC1	0.844	0.784	0.884	***	0.277	2.166
	APC2	0.867	0.8	0.905	***	0.312	2.271
	APC3	0.82	0.757	0.862	***	0.299	1.839
	APC4	0.839	0.776	0.88	***	0.299	1.995
ASD-related digital vulnerability (ASDV)	ASDV1	0.84	0.785	0.874	***	0.327	1.914
	ASDV2	0.781	0.686	0.846	***	0.247	1.866
	ASDV3	0.871	0.813	0.906	***	0.324	2.332
	ASDV4	0.815	0.732	0.865	***	0.307	1.873
Home–School Collaboration (HSC)	HSC1	0.804	0.741	0.848	***	0.321	1.681
	HSC2	0.851	0.791	0.892	***	0.31	2.079
	HSC3	0.83	0.768	0.87	***	0.297	1.918
	HSC4	0.811	0.727	0.866	***	0.286	1.863
Perceived Digital Risk (PDR)	PDR1	0.821	0.762	0.866	***	0.249	2.051
	PDR2	0.889	0.857	0.918	***	0.329	2.521
	PDR3	0.857	0.804	0.893	***	0.342	2.051
	PDR4	0.8	0.718	0.855	***	0.262	1.821
Protection Effectiveness in Digital Education (PECP)	PECP1	0.887	0.844	0.917	***	0.264	2.837
	PECP2	0.911	0.882	0.935	***	0.262	3.518
	PECP3	0.896	0.863	0.92	***	0.283	2.935
	PECP4	0.925	0.902	0.943	***	0.297	3.783
School Safeguarding Systems (SSG)	SSG1	0.878	0.843	0.907	***	0.304	2.442
	SSG2	0.859	0.81	0.893	***	0.28	2.31
	SSG3	0.836	0.785	0.877	***	0.282	2.03
	SSG4	0.873	0.827	0.904	***	0.293	2.448

Note. ***$p < 0.001$. All loadings exceed 0.70, indicating satisfactory indicator reliability. VIF values are below the threshold of 5, suggesting no multicollinearity issues. Source: authors' own work. CI, confidence interval; VIF, variance inflation factors.

Table 9. Discriminant validity (HTMT results).

Construct 1	Construct 2	HTMT	95% CI	CI < 1	Assessment
ASDV	SSG	0.131	[0.062, 0.242]	Yes	Discriminant
ASDV	APC	0.065	[0.041, 0.069]	Yes	Discriminant
ASDV	HSC	0.127	[0.061, 0.188]	Yes	Discriminant
ASDV	PDR	0.532	[0.386, 0.649]	Yes	Discriminant
ASDV	PECP	0.184	[0.076, 0.339]	Yes	Discriminant
SSG	APC	0.553	[0.424, 0.666]	Yes	Discriminant
SSG	HSC	0.602	[0.465, 0.701]	Yes	Discriminant
SSG	PDR	0.104	[0.055, 0.137]	Yes	Discriminant
SSG	PECP	0.628	[0.517, 0.719]	Yes	Discriminant
APC	HSC	0.307	[0.168, 0.451]	Yes	Discriminant
APC	PDR	0.069	[0.043, 0.073]	Yes	Discriminant
APC	PECP	0.532	[0.400, 0.651]	Yes	Discriminant
HSC	PDR	0.077	[0.047, 0.087]	Yes	Discriminant
HSC	PECP	0.637	[0.527, 0.726]	Yes	Discriminant
PDR	PECP	0.249	[0.103, 0.406]	Yes	Discriminant

Note. All HTMT values are below the conservative threshold of 0.85, and all confidence intervals exclude 1, confirming adequate discriminant validity (Henseler et al., 2015). Source: authors' own work. HTMT, heterotrait–monotrait; ASDV, ASD-related digital vulnerability; SSG, school safeguarding systems; APC, adult protection capacity; HSC, home–school collaboration; PDR, perceived digital risk; PECP, protection effectiveness in digital education.

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