Parent and Educator Concerns on the Pedagogical Use of AI-Equipped Social Robots

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Social robots equipped with conversational artificial intelligence are becoming increasingly common in educational settings. However, the long-term consequences of such uses remain relatively unknown due to their novelty. To ensure children's safe use of social robots, and proper adoption of the technology, it is crucial to scrutinize potential concerns regarding their usage. This exploration will provide insights to inform the design and development of this technology. Thus, this study investigated parents' and educators' perceptions of social robot use by children in the home and school settings. Our main objectives are to; 1) explore whether *the types and/or levels of concern* are tied to the role that individuals take (i.e., parents vs. educators); 2) explore if the levels of concern vary based on the gender and age of the potential child user; and 3) compile a catalogue of parents' and educators' concerns, both from the literature and those that are overlooked, surrounding children's use of SRs for learning. To address those inquiries, a cross-national online survey study was conducted with parents and educator participants (N = 396). Overall, participants indicated high levels of concern but recognized the potential in responsibly applying such technology for educational purposes.

CCS Concepts: • **Computer systems organization → External interfaces for robotics**; • **Security and privacy → Social aspects of security and privacy**; • **Applied computing → Computer-assisted instruction**; • **Human-centered computing → Interaction paradigms**.

Additional Key Words and Phrases: Safe AI, Social Robots, Conversational Agents, Education, Childcare, Survey Study, Parents, Educators, Concerns, Pedagogy

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1 INTRODUCTION

Social Robots (or SRs) come in a variety of form factors and with varying levels of autonomy, from teleoperated and "Wizard of Oz" interfaces, to leveraging fully responsive conversational artificial intelligence (AI). With the recent advances in conversational AI, it is essential to examine the potential benefits and concerns of creating SRs that fit the role of embodied conversational agents (CAs). Autonomous SRs have the potential to become ubiquitous, as they can interact with humans independently, adapting and responding to various conversations in a variety of contexts. This makes them well-suited as companions or helpers in diverse areas such as child care [49], education [71], elder care [11], healthcare [21], and entertainment [60]. However, SRs that interact using large language models (LLMs) or other black box AI methods do not have the safeguards of teleoperation [26]; there is no human controlling what the robot says, so their implementation requires greater care.

In this paper, we explore conversational AI-driven SRs, with a specific emphasis on their pedagogical applications in both home and classroom environments. These sensitive contexts play a crucial role in children's learning and early socialization [1], so responsible applications to pedagogical approaches are vital in nurturing children's healthy emotional development [70]. The focus on these environments is also due to the strengths that SRs exhibit for implementing constructivist pedagogical techniques. All the benefits that they can bring to the classroom are just as valuable in the home; when the child is working on homework, they can still participate in active learning with the social robot as a peer [65]. Furthermore, the commonly employed pedagogical approach of social constructivism posits that learning best occurs when interacting with others. This is an advantage for social robots as they can be used to guide more active and socially enriching learning activities with less educator intervention regardless of location [25]. Consequently, developers have concentrated on these educational contexts to design SRs that not only enhance children's education but also ensure their safety during child-robot interaction (CRI) [20, 32, 42]. The potential advantages of integrating SRs into classrooms include assisting children's learning [13] and fostering healthy social bonds and empathy [41]. Furthermore, integrating social robots into the home has also proven more successful than traditional methods of at-home learning [33]. Therefore, we focus on both environments to account for the potential ubiquity of SRs, ensuring our findings are relevant to more potential use cases outside of controlled classroom environments.

However, the physically embodied nature of these SRs contributes to their perceived trustworthiness [83] which can then lead to children forming strong parasocial bonds with SRs, emphasizing the need to consider the developmental consequences of how children interact with them [89]. Furthermore, long-term use of SRs involves ample opportunities for children to disclose sensitive information, which if not processed privately or stored securely, could be used irresponsibly by developers or maliciously by external actors [83].

Prior surveys have investigated public attitudes towards using SRs from myriad perspectives. The Special Eurobarometer 382 [24] looked at broad opinions on robotics in general, offering a large sample of attitudes yet only lightly touching upon their potential in childcare and education. Some surveys look at the importance of privacy and trust when using SRs [57, 58]. However, The most important stakeholders in safeguarding the development of children are parents and educators, as they are not only authorities in a child's education, but also in their primary and secondary socialization [1]. Therefore, Kennedy et al. [44] hone in teachers' attitudes towards SRs in pedagogy, focusing on long-term attitudes, utility expectations, and perceived obstacles. On the other hand, parent perspectives in relation to child-robot interaction (CRI) in education are largely overlooked, generating a gap in research involving both groups' shared and divergent concerns for children using SRs [76], there is a particular lack of surveys that focus on giving parents and educators the same questions and scenarios in broader areas of concern. Parents and educators can take different approaches when it comes to their teaching philosophies and priorities, with parents preferring to guide children and prescribe their actions, and educators preferring to allow children's agency to guide their learning [28]. Both of these approaches should be considered when gathering concerns, as the priorities and hence concerns of each group will differ [77]. Limiting an investigation

to only one group may yield insights that only apply to the classroom rather than in the home or vice-versa. Furthermore, parent-educator goal alignment and collaboration is beneficial to a child's development [70], so considering the views of both simultaneously allows for a holistic approach to social robot development that can adapt to both stakeholders' needs.

This paper aims to expand upon the methods and findings of prior research by conducting a survey study that covers multiple areas of concern regarding SRs in education from the perspective of both parents and educators (i.e., teachers and school administrators). The survey considers a child's age and gender as factors to control for their effect in the judgement of the participants. Prior research has shown that both parents and educators change their behaviour and perspectives towards a child depending on their gender [28]. The age of the child is also a factor in these judgements. Parents give older children more freedoms when interacting with technology [6], and educators adapt their curricula and approaches for different age groups. This unique approach of controlling for a participant's imagined age and gender for a child grounds their responses to better understand what biases are affecting responses. In addition, methodically controlling for the child's age and gender provides demographic-specific insights that must be considered for novel educational technologies. Further, the comparison of parent and educator concerns helps to refine how SRs are integrated into educational environments, enabling the development of SRs that support collaborative educational goals while also considering the dynamics at home, thereby facilitating the adoption of SRs into children's education without the need to pick between the environments. Combining these details with a large sample size, we aim to elucidate new concerns to consider for SR implementation.

Our research objectives when conducting the investigation are the following :

(1) To explore whether *the types and/or levels of concern* are tied to the role that individuals take (i.e., parents vs. educators)
(2) To explore if the levels of concern vary based on the gender and age of the potential child user
(3) To compile a catalogue of parents' and educators' concerns, from the literature as well as those that are overlooked, surrounding children's use of SRs for pedagogical purposes.

To conduct a comprehensive analysis, we structured our examination around distinct dimensions that emerged throughout our literature review and discussions. We then conducted a survey built in Qualtrics and distributed using Prolific, which allowed us to administer the questionnaire across numerous countries. We surveyed a total of 396 participants, with an emphasis on quantitative data collection but with an open-ended question for additional qualitative insights. With the initial literature review and the analysis of the results, we determined 10 primary areas of concern with multiple dimensions (See Fig. 1). Our ten identified areas of concern represent the most commonly apparent perspectives in both literature and in the responses of the participants, and we find that the age of the child, gender of the child, and the role of the participant interacted to vary the levels of concern and priorities between the responses.

2 BACKGROUND AND RELATED WORK

For our investigation, we review prior related works on SRs and child-robot interaction. We also look at related works involving the use of conversational agents in pedagogy. Since the SRs within our scope are those that integrate conversational AI, many of the concerns relating to CAs overlap with or are amplified by SRs.

2.1 Prior collection of Parent and Educator Perspectives

The corpus of prior research that involves the sentiments of parents and educators sparsely considers them simultaneously. Investigations tend to separate the roles of parents and educators when covering concerns over pedagogical SRs. Research on parents has yielded insights on their expectations for SRs as learning tools and storytellers [54, 81]. Parents, while recognizing the potential social and academic value of SRs, still harbor

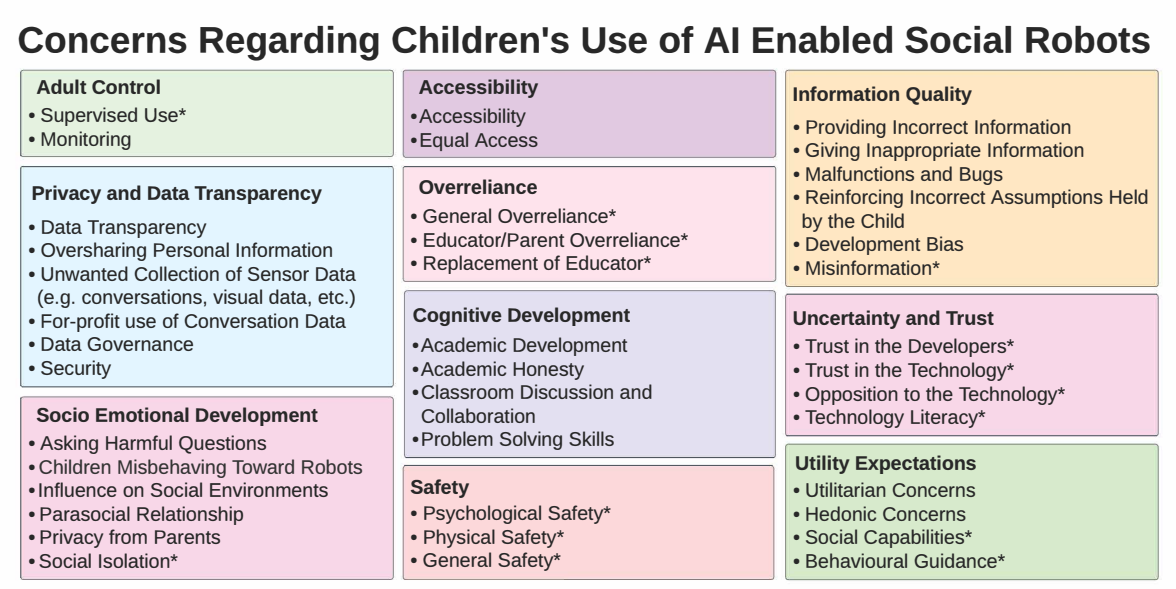

Fig. 1. Ten areas of concern around the use of SRs by children, extracted from the literature as well as participants' responses.

concerns about inappropriate content, privacy, and potential impacts on their child's social growth [48, 49]. Furthermore, they express a desire to monitor their child's interactions with these agents to mitigate risks [29, 37].

In the educational sphere, educators exhibit enthusiasm regarding potential benefits, such as productivity boosts, customized aid, and companionship. However, educator reservations linger about privacy and the risk of student isolation [44], as well as potential misuse [39]. The degree to which users ascribe human-like qualities to these agents, or anthropomorphism, plays a crucial role in shaping trust and interaction patterns [40, 50, 63].

These prior works offer very valuable insight into the perspectives of both parents and educators. However, they very often consider them separately. Parents and educators have been found to have different priorities when educating pre-school aged children: Fuertes et al. find that parents are "more spontaneous, favoring imitative actions" while educators are group-oriented and "challenged the children to think about their decisions and ideas" [28]. They also identify that both parents and educators change their perspectives and teaching strategies depending on the gender of the child, with girls being allowed more cooperative work whereas boys were often given leader or follower roles in the same activities [28]. This finding suggests that perspectives on pedagogical approaches also depend on the gender of the child, making the need to control for the gender of a child more apparent when surveying these stakeholders.

Overall, the differences in priorities and teaching approaches are important to identifying the two sides of pedagogy between the home and the classroom. Parent-educator goal alignment is important to child well-being and learning outcomes [70], so both perspectives must be considered within the same investigation to offer a better understanding of where the main concerns lie between these two stakeholders.

2.2 Use of Robot on Child Development

Research on child-robot interactions and children's engagement with CAs offers vital insights into the developmental impacts SRs can have. Xu et al. find that children can differentiate between living beings and AI,

yet they frequently perceive conversational AI entities as social agents [90]. Interestingly, even when children understand how CAs operate, they often form strong parasocial bonds, exhibiting heightened trust [84, 85]. Furthermore, younger children are more prone to anthropomorphizing CAs in general while recognizing their inanimate nature [36]. Kory-Westlund et al. find that the physical appearance of a robot leads to children rating them higher in animacy and human likeness than a computer interface [46]. In educational environments, SRs have been observed to guide students toward positive social behaviours, such as reputation management and empathy [42, 68]. Notably, allowing children to tutor SRs also enhances their learning experiences alongside their social development [13, 55]. Across various settings, children have demonstrated their capacity to forge meaningful social connections with robots, accepting them as peers [15, 22, 41, 89].

In educational environments, SRs have been observed to guide students toward positive social behaviours, such as reputation management and empathy [42, 68]. Notably, allowing children to tutor SRs also enhances their learning experiences alongside their social development [13, 55]. Across various settings, children have demonstrated their capacity to forge meaningful social connections with robots, accepting them as peers [15, 22, 41, 89]. However, these interactions demand care. While SRs can promote better social conformity among younger children, there's potential for misuse or erroneous influence [87]. Prolonged technology exposure can potentially negatively impact a child's social and emotional growth [38], with some children even showing aggressive behaviors toward robots in unstructured public settings [10]. Prior research from Naggita et al. suggests that parents are likely to step in to discipline robot abuse. However, they found that the perceived animism of a robot does not affect how parents discipline such behaviour against them [66]. Considering how children anthropomorphize SRs, better understanding just how concerned parents and educators are of children's overall behaviour towards them will highlight how tangible they believe child-robot bonds really can be. Such bonds play a pivotal role in shaping the social-emotional characteristics of children, impacting their emotional intelligence, behavior, and social perception [62]. Cognitively, the integration of CAs in educational scenarios shows a variety of outcomes [8, 47]. SRs have demonstrated the potential to impact education by enhancing content delivery, student engagement, and collaborative learning, thereby improving retention [14, 42, 45, 71]. Furthermore, SRs have been successful in fostering subject-specific interests and improving learning outcomes [64, 73]. However, Technical issues, unmet expectations [39, 86], and even excessive social behaviors [43] can disrupt learning and cognitive development.

Both domestic and academic environments play a critical role in shaping children's social-emotional and cognitive development [5, 61]. Education in the home is just as important as education in the classroom, with homework being crucial for academic performance and development [64]. In these contexts, parents and educators are essential advocates for children's development. Parents particularly value adaptability in SRs to the spontaneity of children in their learning environments [81]. However, potential issues identified in the literature, such as technical glitches and disruptive social behaviors, can hinder this adaptability and consequently affect expected learning outcomes. Recognizing the importance of understanding long-term implications, existing research emphasizes the potential for child development alongside robots, but uncertainties persist [41, 45, 46].

Given the concerns that are apparent in prior research, our investigation continues this line of questioning and aims to determine which factors are most important for parents and educators depending on the child they are considering, in order to create a foundation for adapting robot development to different developmental contexts.

2.3 Information Integrity and Safety

While the developmental outcomes of child interactions with SRs are vital, they are not the sole concerns. The reliability and truthfulness of information dispensed by AI within SRs and CAs is another prime consideration [4]. Fallibility can sometimes serve as a pedagogical tool; when children recognize and correct inaccuracies in the CA, they experience an enriched learning dynamic [55]. However, younger children may have more difficulties

catching these inaccuracies, and may lead to poor learning outcomes, so the target age of a child must be taken into consideration for developing these kinds of learning techniques. Conversational AI, particularly those using LLMs are prone to hallucinations, this kind of incorrect information is unpredictable, fictitious or incomprehensible [2]. Due to the impressionable nature of children [87], it is crucial to ensure that these AI systems deliver accurate and unbiased information to bolster healthy development.

Safety issues also arise when AIs deliver incorrect information, posing risks as children might inadvertently heed unsafe advice [23]. Beyond grave risks, the general fidelity of information from CAs remains paramount. Given their inability to critically evaluate content, CAs can unintentionally relay unsuitable or offensive material [75]. Dinan et al. [23] spotlight two key issues: the inadvertent production of contextually offensive content and the "yea-sayer effect", where a CA might sustain inappropriate dialogues merely to keep the conversation going. Addressing these challenges requires a targeted approach to training robots. Emphasis should be placed on curating age-appropriate content, with some scholars advocating for child-specific corpora [7] or even open-source, collaboratively-verified training material [53]. Ensuring moderated content across the board tends to enhance the user experience with these AI systems [56].

In the context of the study, we incorporate questions relating to the quality of the information a SR may give so that we may determine which of these factors is of the biggest concern to a child's education.

2.4 Privacy Considerations

The type of information that a SR receives from children is just as consequential as the information it imparts to them. The integrity of interactions between children and these robots is of paramount importance, given the significant implications for child safety and well-being. Notably, SRs have shown a heightened propensity to obtain more consensual information compared to CAs [50, 83]. Existing research underscores the necessity for transparency and trustworthiness in the storage and handling of conversation data, ensuring meaningful and safe robot interactions [59, 72, 82]. This is particularly poignant considering parents' expectations of full transparency about the data their children share with such devices [37]. However, parental oversight can be a privacy conundrum; older children might perceive excessive monitoring as an invasion of privacy, highlighting the importance of establishing mutual trust [35, 67]. Younger children (<13 years of age), on the other hand, have been found to be more positive towards parental monitoring with technology [67].

Further investigations have spotlighted the inherent vulnerability children may experience when communicating with CAs, particularly when unsupervised [7, 51]. Younger children, who often exhibit lesser concerns about privacy [30], are at greater risk. As such, protective measures have been suggested to prevent robots from inadvertently sharing a child's data [80]. Navigating the collection of children's data poses a plethora of legal and ethical challenges. Much of the existing legal framework remains unprepared for the intricacies of AI, both virtual and embodied, especially concerning child data protection [17, 18, 67]. This landscape raises a host of legal dilemmas regarding data collection and retention, extending beyond just the realm of children [57, 79]. A consensus emerging among scholars suggests that a focus on robust data governance policies, retaining only essential data, can strike the balance—protecting privacy and fostering trust in SRs [15, 58, 72].

With these privacy considerations in mind, we survey parents and educators to determine if certain aspects of data privacy hold more priority for each group, and if they differ depending on the child in question.

3 METHODOLOGY

To extend our knowledge regarding the types and levels of concern parents and educators have regarding childrens' use of social robots, we designed and ran a survey aiming at answering the following research questions:

- **RQ1:** How are the types and/or levels of concerns influenced by the role individuals take (i.e., parents vs. educators)?

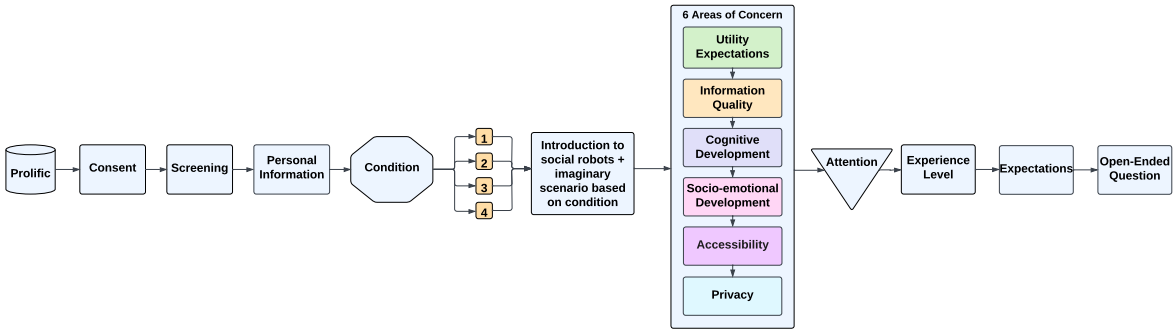

Fig. 2. Participants who identified themselves as parent or educator were recruited via Prolific. All the participants had identical content and survey flow except that parents were asked questions about a child's use of an SR in the *home* context, while educators were asked about a student in the context of a *classroom*. Participants from both camps were randomly and equally distributed to one of four conditions for their imaginary user: 1) a 7-year-old girl, 2) a 16-year-old girl, 3) a 7-year-old boy, and 4) a 16-year-old boy.

- **RQ2:** How do the levels of concern vary based on the gender and age of the potential child user?
- **RQ3:** Do parents and educators have other concerns that are overlooked in the literature?

3.1 Survey Design

3.1.1 Survey Development. To capture previously identified constructs pertinent to people's concerns about children's use of SRs, an extensive literature search was conducted. Using keywords such as "Privacy," "Data Transparency," and "Utility," 64 papers were identified. Next, two researchers discussed these papers and constructed a mind map illustrating the concepts of concern about children's use of SRs. Consequently, six overarching foundational constructs or areas of concern, namely 1) *Privacy and Data Transparency;* 2) *Perceived Utility;* 3) *Accessibility*; 4) *Cognitive Development;* 5) *Socio-emotional Development;* and 6) *Information Quality*, were identified and specific concerns were grouped within those six areas (See Fig. 11 in Appendix A). We then began generating survey questions based on these six constructs. Naturally, when a paper included question items, we examined them to see if they could be adapted for our study. For privacy and data transparency, we adopted and adjusted the works of Lutz et al. [57, 58] (e.g., "Overall, I find it risky to have a social robot for Alex as it could collect their personal data." with a 7-point Likert scale, 1; Strongly Disagree, to 7; Strongly Agree). To generate question items relating to utility expectations and cognitive development in the context of academics, we referenced Kennedy et al. [44] (e.g., "I think social robots could be …useful for children in a classroom" and "I am worried that the use of social robots in schools could have a negative influence on Alex's cognitive development", both using a 7-point Likert scale, 1; Not al all, to 7; Extremely). Lastly, for other categories, new questions were generated. Originally, we generated 129 questions. We then conducted three rounds of pilot studies whereby participants (who are HCI researchers) provided detailed feedback. After analyzing the feedback and responses closely for redundancy/overlaps, the final survey contained 42 items (See A.1 in Appendix A for the survey).

3.1.2 Survey Flow and Variants. After completing the consent form, participants answered the screening (i.e., the experience of working in education or having at least one child) and demographic questions (e.g., age, gender): Here, participants were given a brief introduction to SRs, including their use cases in pedagogy and at home (See Fig. 3). To control participants' potential expectations about SRs' functionality, we presented images of SRs that are non-zoomorphic. This was to reduce participants' potential bias for SRs' functions. Once participants

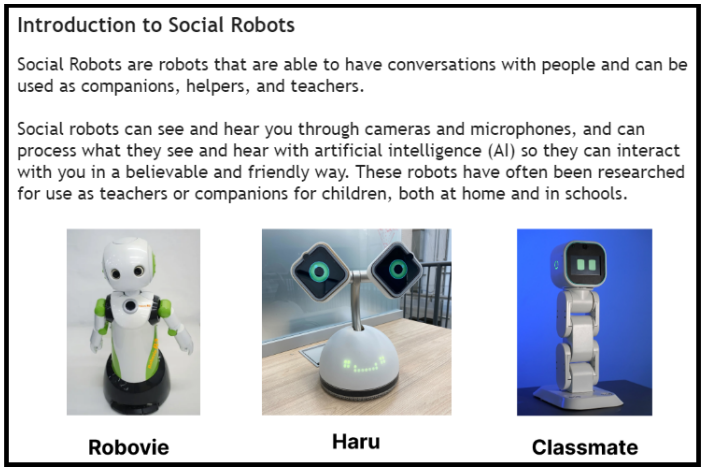

Fig. 3. Three example images of SRs used for research: Haru from the Honda Research Institute (Middle) [32], Robovie R3 from Vstone (Left) [42], and Classmate from Protom (Right) [19, 20]. For experimental purposes, we narrowed down the form factors and chose to include only robots that are non-zoomorphic to reduce participants' potential bias for SRs' functions. Further, to keep the participants' imaginations about the functionalities of SRs unrestricted, we chose to include images of SRs (i.e., instead of videos).

completed these sections, they moved to the actual survey. To effectively capture participants' concerns about children's use of SRs, some situational questions needed to be modified to align with the survey condition (i.e., Educator vs. Parent; RQ2 & 3). For instance, the *location* placeholder in "...social robots could be useful for children in a [*location*]" was substituted with classroom or home based on the condition. Further, to control for the age and gender of the child of concern in a participant's mind, we created four imaginary children named Alex in the survey (differing in age: young vs. older; and gender: girl vs. boy). Participants from both groups were randomly distributed to one of four conditions and were instructed to answer the survey questions envisioning this specific child using a social robot; RQ2. [1]

3.1.3 Survey Main Body. The main body of questions was composed of six blocks, covering the areas of concerns previous studies had identified. Each block began with a brief preamble to inform participants what the block was about and remind them about their role (i.e., Parent vs. Educator), as well as the age and gender of the child to consider (e.g., "This section asks questions regarding the usefulness and aesthetics of a social robot. Please remember to imagine yourself as the parent of Alex, the 16-year-old boy.") [2] The purpose of these six blocks was to gain deeper insights about *concerns outlined in the literature*. Specifically, we explore how the types and levels of concerns could vary based on the role of the participant as well as the gender and age of the child envisioned to be interacting with the social robot (RQs 1 & 2). Next, participants' experience level with SRs, AI chatbots, and voice assistants was assessed (e.g., "How experienced are you with social robots?" with a 7-point Likert Scale ranging from 1; Not Experienced at all, to 7; Extremely Experienced). The following block included questions to capture participants' general expectations of the robot and its interactions with the child (e.g., if the child would

[1]This approach was selected to reduce the potential influence of extraneous factors. For example, if a participant has five children and imagined the youngest daughter for one question and the oldest son for another question, then the participant's response could be influenced by the child's age and gender. Thus, we developed four imaginary children to control these factors.
[2]Two relatively technical terms (*Social-emotional development* and *cognitive development*) were briefly defined at the beginning of their respective blocks to ensure all the participants comprehended the meanings in a comparable manner.

interact respectfully with the robot, the need to teach the child about the robot's capabilities and limitations). Finally, an open-ended question ("Do you have any additional concerns regarding social robots being used by children? Is there any concern you think to be of upmost importance?") asked them to express any additional or important concerns about children's use of SRs. This question aimed at collecting qualitative insights, as well as *concerns that were not covered in the existing literature* (RQ3). The participant was then redirected to the Prolific website for remuneration (See Fig. 2 for an overview of the survey flow).

3.2 Study Administration

Our survey was created using Qualtrics and published on Prolific for online participant recruitment. The study received ethics approval from the REB at the local university, and the researchers are all certified under the TCPS 2: CORE for Ethical Conduct for Research Involving Humans. We recruited participants who: 1) spoke fluent English; 2) were above 18; 3) were parents (for the parents' survey) or worked/or had worked in the education field (e.g., a teacher, school administrator) for the educators' survey. The first requirement for participants was added to account for the survey only being distributed in English with no translations. In compliance with the study ethics agreement and Prolific payment terms, all participants received a £2.50 honorarium following their participation (with a 15 minute expected completion time, this is £10.00/hr, which is above the minimum wage requirements of the province where ethics approval occurred).

4 RESULTS

4.1 Participants

In total, 398 participants were recruited for the survey, and 36 nationalities were recognized (See Fig. 12 in Appendix A). Two people failed to correctly answer the attention check ("For this question, please select the colour 'green'. This is an attention check"). This left us with 396 participants (N = 396; F = 199, M = 194, Non-binary = 1, Not listed = 1 Prefer Not To Say = 1), and their ages ranged between 19 and 77 (M = 38.14; SD = 11.49). The analyses were conducted using IBM SPSS Statistics (Version 29). Participants in the *parent* condition (n = 197) reported their children's age as follows (the mean age of the oldest child = 10.10, SD = 5.72; n = 188; children's age ranged between 0 and 18 or older) [3]. Those participants in the *educator* condition, n = 199, reported that they either taught or managed 0 to 5 years-old age group (13.6%); 6 to 10 (31.2 %); 11 to 14 (39.2 %); 15 to 18 (41.7 %); and/or 19+ (33.2 %). Participants were roughly equally distributed to eight conditions, and the study took between design; Role (Parents vs. Educators) x Imagined Child's Gender (Girl vs. Boy) x Age (7 years old vs. 16 years old) as seen in Table 1 in Appendix A. On average, participants spent 13.52 minutes on the survey (SD = 8.10 mins). Three items explored participants' prior experience using SRs, AI, and voice assistants (M = 4.07, SD = 1.37); Cronbach's α was .73 and thus, the index was created for the exploration. No role effect was found: Participants' experience using SRs was roughly equal across both roles. The majority of our participants had either post-secondary education (35.9 %) or postgraduate education (52.3 %). Throughout the analyses, all the assumptions were first tested and suitable analyses were selected. Further, Bonferroni adjustment was applied whenever appropriate.

4.2 General Expectations

A question ("Alex should be taught to understand the limitations and capabilities of the social robot" with a 7-point Likert Scale with a higher number indicating stronger agreement) explored participants' opinions about how children should be prepared before they start using SRs. An ANOVA confirmed the levels of parents' and educators' expectations did not vary significantly, F (1, 387) = 1.54, p = .22, η^2 = .004. The relatively high grand mean (M = 6.39, SD = .91) indicated that *both parents and educators perceived the necessity for children to have some*

[3]Nine did not answer

level of preparation before using a SR. Another question asked about the participants' trust in the confidentiality of conversation data between children and a SR ("If the robot manufacturer were to say that conversation data would not leave the robot, I would believe them" with a 7-point Likert Scale, a higher number indicating stronger agreement). Again, no significant role effect was found, F (1, 386) = .32, p = .57, η^2= .001, (M = 3.46, SD = 1.69) the grand mean is lower than the midpoint potentially reflecting *parents' and teachers' general distrust towards data security.* We further examined participants' anticipation of children's aggressive behaviours towards SRs ("I think Alex could interact with a social robot respectfully without verbal or physical abuse" with a 7-point Likert, a higher number indicating stronger agreement). A significant role effect was found with a small to medium effect; F (1, 388) = 7.89, p = .005, η^2 = .020 (See [16]). *Compared to educators (M = 5.12, SD = 1.28), parents had more relaxed views of their children's behaviours toward SRs (M = 5.50, SD = 1.37).* This difference could reflect children's context-specific aggressive behaviours (e.g., acting roughly when being in a group): This differential effect indicates the importance of covering both parents' and educators' concerns in the development of SRs (RQ1). We further conducted ANOVAs to explore any interaction effects between the role (Educators vs. Parents) x gender of the imagined child (Girl vs. Boy) x age of the child (7 vs. 16) on these three questions. Only one marginal interaction effect was found between the gender and the age of the imaginary child F(1, 381) = 3.13, p = .078, with a negligible effect, η_p^2 = .008. Only when participants imagined a girl, the age of the child made a marginal difference. Specifically, *participants who imagined a younger girl (7 years old) felt a higher need for preparation compared to those who imagined an older girl (16 years old)* (RQ2). No other effects were found (See Fig. 4): Child users' gender and age need to be explored carefully to understand parents' and educators' concerns towards children's use of SRs.

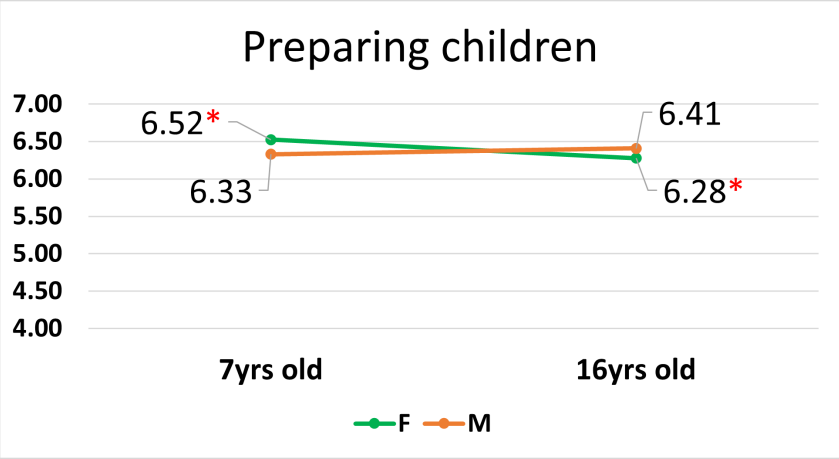

Fig. 4. Perceived need to prepare children before using social robots. Participants who imagined a younger girl felt a higher need for preparation compared to those who imagined an older girl.

4.3 Perceived Usefulness of Social Robots

Participants' general perception about how useful SRs could be for children's learning was assessed by three items ("e.g., I think social robots could be .... useful for children in a classroom" using a 7-point Likert scale, 1; Not at all, to 7; Extremely). Since Cronbach's α was sufficiently high (= .77), the aggregate of these items was used for the analysis (M = 4.64, SD = 1.21). An ANOVA did not yield any significant effects. *Both parents and educators felt that the use of SRs could be useful (i.e., higher than the midpoint) regardless of the gender and the age of the child.*

4.4 Quality of Information Provided by Social Robots

Five items assessed participants' concerns about the quality of the information SRs could provide (e.g., "I am concerned about social robots giving inaccurate responses to Alex's questions", with a scale ranging from 1; Strongly Disagree, to 7; Strongly agree). With sufficiently high Cronbach's alpha (α = .76), an aggregate was used to conduct an ANOVA with three factors; Role x Gender x Age. Since a significant three-way interaction was found, F (7, 388) = 4.61, p = .03, η_p^2 = .012, we split the data by role to identify where the interaction is located. While the child's gender and age had a marginal two-way interaction only for parents, F (3, 197) = 3.56, p = .06, with a small to moderate effect, η_p^2 = .018, no simple main effects were found.

4.5 Concerns about Cognitive Development

Four items assessed participants' concerns about the influences of using SRs on children's cognitive development (e.g., "I am worried that Alex might not learn how to solve problems if she/he relies on a social robot" with a scale ranging from 1; Strongly Disagree, to 7; Strongly agree). The Cronbach's α was .86 and thus, the aggregate was used for further analysis. An ANOVA yielded a 3-way interaction (i.e., Role, Gender, Age), F (1, 388) = 5.65, p = .018. We then split the data by the age of the imaginary child (7 vs. 16). A significant two-way interaction between the gender of the imaginary child and the role of the participants emerged only for those who imagined a 7-year old child, F (1, 197) = 10.024, p = .002. Further pairwise comparisons yielded only for parents, the imaginary child's gender mattered, F (1. 197) = 9.16, p = .003, η_p^2 = .044. 5 (see Fig. 5). *Specifically, parents who imagined a 7-year-old boy indicated higher concerns about the impact of using SRs on his cognitive development than those who imagined a 7-year-old girl* (RQ 1 & 2).

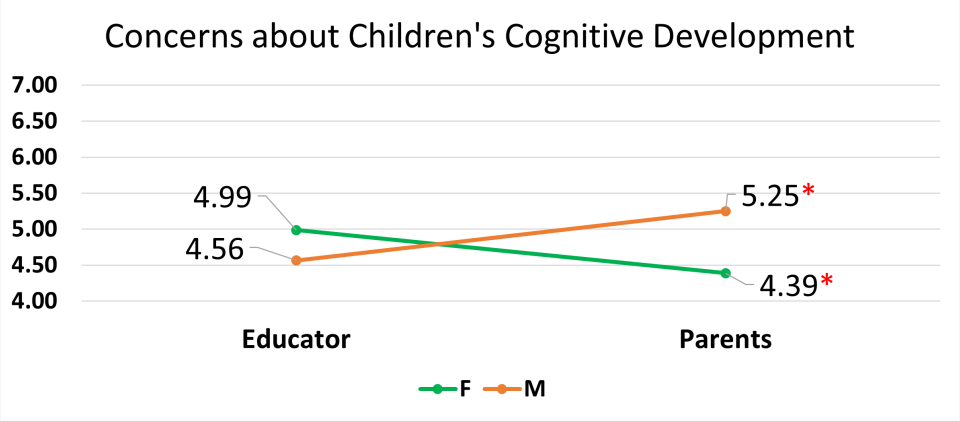

Fig. 5. Concerns about children's cognitive development when imagining a 7-year-old child (i.e., conditions 1 & 3). Parents are more concerned about younger boys.

4.6 Socio-Emotional Developmental Concerns

Five items assessed participants' concerns about the use of SRs on children's socio-emotional development (e.g., "I would be comfortable with the idea of a social robot fostering Alex's social-emotional development" with a 7-point scale, a higher number indicating stronger agreement). [4] The aggregate of the five items was used as an index (Cronbach's α =.73). A univariate ANOVA yielded a 3-way interaction (i.e., Role, Gender of the child, Age

[4]Note some items were reverse-coded so higher numbers indicate higher levels of concern.

of the child), F (1, 388) = 5.69, p = .018, η_p^2 = 014. A subsequent ANOVA was conducted by splitting the data based on the child's age. A two-way interaction effect was found only for participants who imagined a 7-year-old child, F (1, 197) = 5.24, p = .023, η_p^2 = .026. For socio-emotional development, the interaction effect was driven by the simple main effect of gender *only for educators* F(1, 197) = 4.14, p = .043, η_p^2 = .021 (RQ 1 & 2; See Fig. 6).

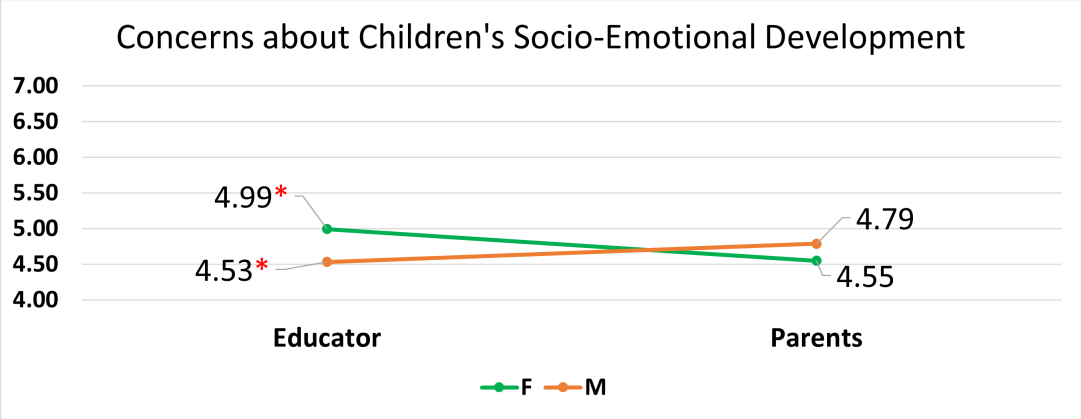

Fig. 6. Concerns about children's socio-emotional development from the perspective of participants who imagined a 7-year-old child (i.e., conditions 1 & 3). Educators are more concerned about younger girls.

4.7 Privacy Concerns

Three items explored participants' data privacy-related concerns (e.g., "Overall, I find it risky to have a social robot for Alex as it could collect his/her personal data (e.g., passwords, health conditions, family affairs, personal conversations, etc.)" with a 7-point scale, a higher number indicating higher levels of concern. The aggregate of the three items was used for privacy concern (M = 5.73, SD = 1.17, Cronbach's α = .73). No main effects nor interaction effects were found. Based on the descriptive statistics, we learned that participants have relatively higher levels of concern about data privacy. We further analyzed location-specific levels of privacy concerns ("Please rate how comfortable you would be to have a social robot in these parts of your home" with a 7-point scale with *lower numbers indicating higher concerns*). Six common locations in a house were explored (1: Bedroom, 2: Living room, 3: Kitchen, 4: Dining room, 5: Bathroom, 6:Basement). After reverse coding process, we explored the general pattern of location-specific privacy concerns. A subsequent unianova was conducted by splitting on the imaginary child's age. Participants were highly concerned when they considered using a SR in the bedrooms (M = 5.97; SD = 1.41), and bathrooms (M = 6.35, SD = 1.25). While the mean for the basement (M = 4.05, SD = 1.95) was around the midpoint, the Living room, Kitchen, and Dining room did not yield higher levels of concern (See Fig. 7). *This set of results indicates individuals' privacy concerns associated with the use of SRs are potentially location-specific.* We further conducted a MANOVA with role, Gender of Alex, and Age of Alex as factors, and the six locations as dependent variables. The main effect of role (Parents vs. Educators) was the only significant factor. Pairwise comparisons revealed that the *participants who have worked or currently work as educators have higher levels of concern in every location*, as shown in Figure 7 (RQ 1). No other effects were found. Next, we asked about participants' comfort levels in terms of the duration of data storage in a SR ("How long would you be comfortable having a child's conversations stored in an external cloud?"). *The majority of participants were uncomfortable about storing any data in SRs* (See Fig. 8). Finally, we assessed participants' conditional willingness to store data ("I would be more willing to use a social robot if I knew what legal protections our data has" with a

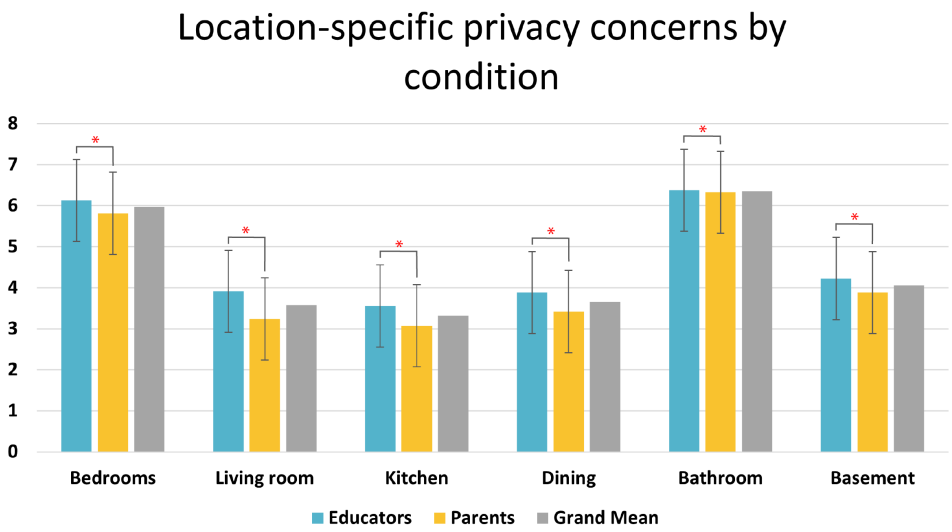

Fig. 7. Mean of privacy concern level per condition based on the location of the robot. Overall, participants in all conditions showed a high level of concern regarding the robot's use in bedrooms and bathrooms. In all locations, educators were significantly more concerned than parents.

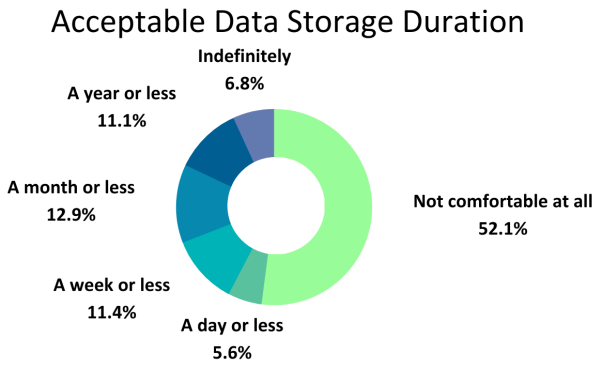

Fig. 8. The duration at which participants would be comfortable having the child's data stored in the cloud.

7-point scale with a higher number indicating higher levels of willingness). A MANOVA yielded one three-way interaction effect. Further pairwise comparisons identified the role effect: Significant differences in levels of willingness between educators and parents emerged only when participants envisioned a 7-year-old girl (RQ 1 & 2). *Once again, parents exhibited a more relaxed attitude,* indicating higher levels of willingness compared to their counterparts.

4.8 Qualitative Analysis

An open-ended question was asked: "Do you have any additional concerns regarding social robots being used by children? Is there any concern you think to be of upmost importance?" to explore any other concerns that

our survey might have not touched upon (e.g., something unexplored in the literature) (RQ 3). After the first round of coding with the six identified areas (Privacy and Data Transparency, Perceived Utility, Accessibility, Cognitive Development, Socio-emotional Development, and Information Quality), four additional constructs emerged (Safety, Adult Control, Uncertainty and Trust, and overreliance). [5] Thus, we conducted another round of coding to examine if those four constructs should be considered as areas of concerns.

For this round of coding, when a response expressed more than one concept, the response was categorized into multiple dimensions (e.g., "...it may provide them with misinformation, ... the social robot can record the child and anyone can easily get access to such personal and private matters..., the social robot can track the child live location... kidnapping and robbery"). The three coders discussed until an agreement was achieved.

Out of 396 participants, 201 participants (or 50.8%) spontaneously described their concerns. Chi-square analyses revealed that in the educator condition, more people (n = 140; 69.7%) left concerns, X^2 (1, n = 199) = 32.97, p < .001, while, in the parent condition, fewer people left such concerns (n = 61 or 30.3%), X^2 (1, n = 197) = 28.55, p < .001, possibly reflecting educators' higher awareness of potential issues associated with SRs in children's learning environment. Overall, the majority of reported concerns (f = 217) fell under three concepts: Privacy and Data Transparency concerns had the highest frequency (f = 100), followed by Socio-Emotional Development (f = 74), and Uncertainty and Trust (f = 43). As it can be seen in Fig. 9, the four additional constructs (i.e., Safety, Adult Control, Uncertainty and Trust, and overreliance) were observed sufficiently frequently to be recognized as areas of concerns.

4.8.1 Parents vs. Educators. We explored the difference between Parents' and Educators' response frequency for the ten areas using Chi-square tests. [6] Here, we focus on reporting significant results. For Utility Expectations, Socio Emotional Development, Cognitive Development, and Uncertainty & Trust, more concerns were reported in the educator condition than in the parent condition (*ps < .005)*, See Fig. 9. As seen in Figure 9, in 31 dimensions out of the 42 dimensions we identified, participants in the educator condition expressed more concerns than their counterparts. We speculate this could be because educators need to oversee numerous children at once while parents often oversee fewer children. Hence, educators, being more attuned to potential risks in children's environments, may have higher levels of awareness that surpass that of parents. Interestingly, in two dimensions, the reported frequency of parents' concerns exceeded the educators' concerns (Monitoring and Security), however. We conducted Chi-square tests to explore the differences. Although the differences were not significant, the reversed trend in monitoring (e.g., "The filters provided on the social robot would need to be closely monitored to make sure it's suitable") in particular, is thought-provoking. We contemplate this might be reflecting parents' desire for close control in their children's use of SRs. Interestingly, for supervised use (e.g., "I think most of the child's usage should be supervised by a parent or educator") the frequencies were equal across the conditions. An investigation of possible differential outcomes between monitoring and supervision is needed. Finally, although we successfully recruited participants from 36 countries to enhance the generalizability of our findings, our study was limited in conducting detailed country-based analyses due to the challenge of controlling sample sizes across each country (Please see Fig. 12, 13, 14. for summarized country-based data).

5 DISCUSSION

There were three major objectives in this paper:*1) to explore whether the types and/or levels of concern are tied to the role that individuals take (i.e., parents vs. educators); 2) to explore if the levels of concern vary based on the gender and age of the potential child; and 3) to compile a catalogue of parents' and educators' concerns, from the literature as well as those that are overlooked, surrounding children's use of SRs for pedagogical purposes;*

[5]Note these constructs were touched on briefly, which were not considered as independent areas of concerns or foundational constructs even though we had found these factors in the literature.

[6]Note due to the multiple number of comparisons (i.e., 10), we adjusted the alpha to .005.

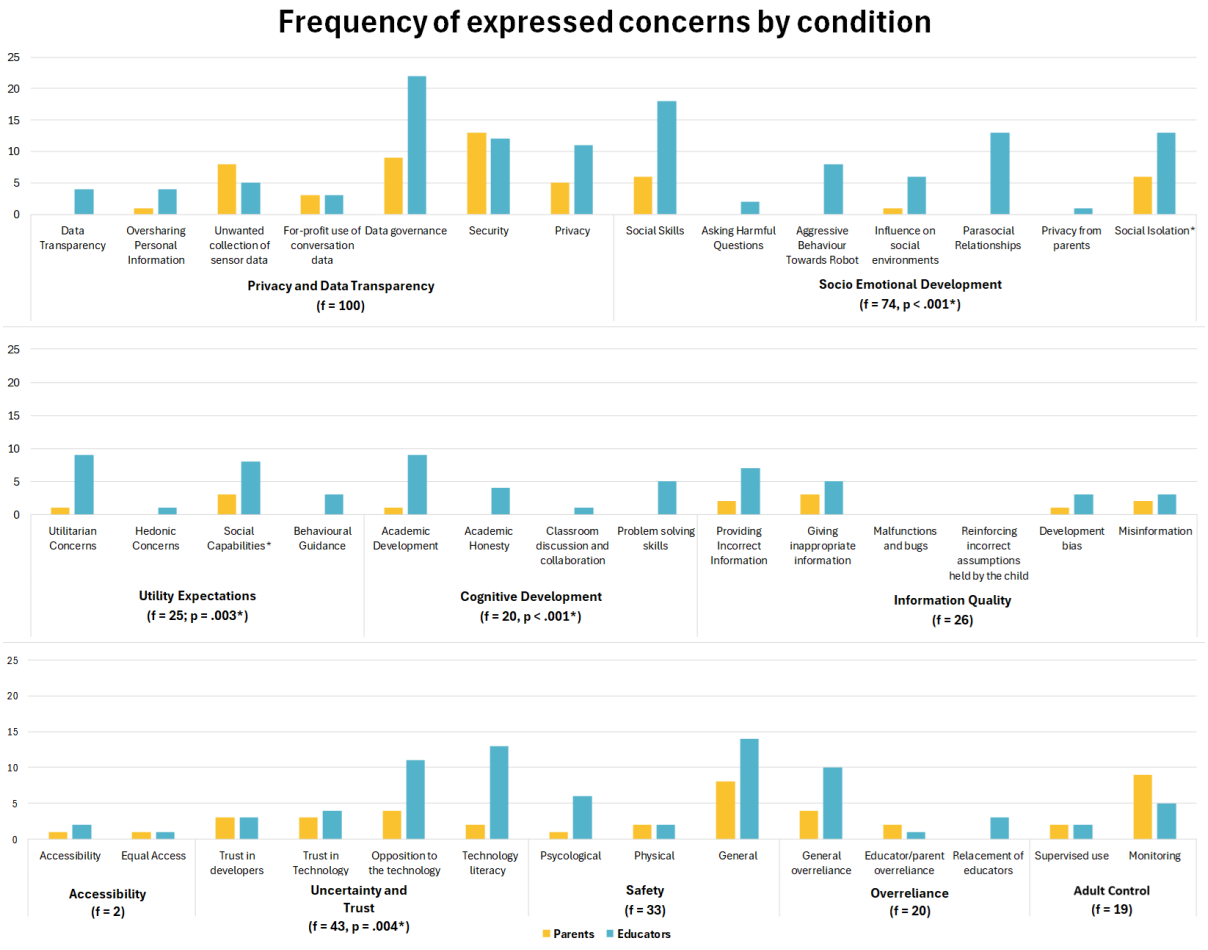

Fig. 9. Frequency of identified concerns by role: The effect of role (parents vs. educators) was examined using Chi-square for all ten categories using $p = .005$ as a cutoff. Although educators generally expressed more concerns, the pattern was reversed for monitoring where five educators expressed the need for monitoring while nine parents expressed their desire for monitoring. While this difference was non-significant, the pattern is worth noting.

By focusing on the home and classroom environments, we explored adults' concerns surrounding children's interaction with SRs. Given that parents and educators are the primary adults involved with children in these settings, it is reasonable to assume that they will play a key role in the decision-making process about children's use of SRs. While previous research has pinpointed specific concern areas for parents (e.g., privacy and social development [48]) as well as educators (e.g., isolation and misuse [39, 44]) there is no way to report disagreement or consensus on those findings with ideal parity as none of the conducted studies examined both parties. Accordingly, our research aimed at gaining insights into their concerns.

5.1 Objective 1

Results indicate that, in general, both parents and educators find it necessary for children (regardless of their age and gender) to be educated about the robots' capabilities and limitations before they interact with them, while both parties indicated their distrust towards the security of the conversation data recorded on the robots. However, educators exhibited overall *stricter/more protective* views toward children's use of SRs than parents did. We speculate this could be attributed to the fact that through their work environment, educators are made to be more aware of professional protocols (e.g., picture consent, clinical consent, etc.) when protecting children. Additionally, educators often have a higher number of children to supervise, compared to parents. In such situations, stricter approaches might be perceived as necessary, and we believe these distinct experiences might have led educators to choose more conservative options than those in the parents' condition did. In sum, our findings suggest that the levels and the types of concerns that individuals have about children's use of SRs are closely tied to the roles they take.

5.2 Objective 2

On cognitive development, we found significant effect of role and gender for participants who imagined a 7-year-old child; parents answering with a 7-year-old boy in mind reported higher levels of concern than those parents who imagined a girl. This effect could be explained by parents' gender schema [9]: Through their gender schema, participants might have imagined boys' stronger interest in technologies such as robots. Such underlying perceived gender differences could have led some parents to feel that boys will be preoccupied with the SR and thus, their cognitive development might be hindered: Understanding parents' gender specific attitude might shed some light on this effect.

As for the concerns associated with children's socio-emotional development, a significant role effect was again observed in the data of participants who imagined a 7-year-old child; Educators were more concerned about girls. Educators see children in social settings while parents usually see them in a private setting (i.e., home). Thus, teachers might be more attuned to children's social behaviours. Additionally, male's friendships are often described as side-by-side while female relationships are described as face-to-face (see [88] for the classic gender comparison), implying men enjoy shared activities while women enjoy communication itself. Thus, socio-emotional-related concerns could have been perceived as having greater consequences for females whose friendships require sophisticated social skills. Altogether, to understand potential risks of SRs in children's learning content, the gender and age of the child user need to be considered.

5.3 Objective 3

We incorporated an open-ended question to capture any concerns that may not have been addressed in the literature we reviewed or represented by the question items we generated based on the review; Our qualitative analysis indeed yielded additional insights into the survey responses. While we had initially identified six areas of concern based on the literature review, our qualitative data coding yielded four additional areas of concern, namely *Adult Control*, *Overreliance*, *Safety*, and *Uncertainty and Trust*. Each of these new areas yielded interesting ideas to consider.

Starting with adult control, we observed a clear distinction in the responses between the themes of supervision (presence of an adult during CRI) and monitoring (desire for tools to surveil CRI and moderate interactions). Although the desire for supervision was comparable across parents and educators, parents expressed a greater desire for monitoring CRI than educators did[7]. This could be attributed to the differences in educational approaches, with parents usually preferring to guide and prescribe actions due to their affective approach to education as opposed to educators' group oriented approach [28]. Additionally, the inclusion-of-other-in-self principle proposed

[7]While the effect was not significant, the trend was recognized.

within the context of self-expansion theory might explain this difference for monitoring (i.e., more direct control over children's use of SRs) [34]. That is, since parents could see their children as a part of themselves, their desire for direct control in children's use of SRs might be simply higher. Interestingly, one participant exhibited concern about the act of monitoring CRI at home, stating that "this level of intrusion does not seem like a healthy relationship between parents and children and could potentially have negative consequences" and "If the child is not comfortable sharing something with real people, there is already a deeper problem." This sentiment is in line with the idea of the importance of mutual trust between child and parent [35]. While only one participant expressed such concern, *overparenting* could cause psychological distress in children and impact their psychological well-being [31]. A future longitudinal investigation on at-home SR use and safety measures focusing on children's privacy concerns while considering the need for parental monitoring could be fruitful.

Overreliance on SRs emerged as a concern among parents and educators, encompassing worries about laziness caused by the robot to preventing children from being innovative and independent thinkers. They also expressed concerns regarding overreliance on the robot by the adults themselves, worrying that parents would use them as an alternative to spending time with their children or that the SRs would be made the primary educators of children rather than tools. This raises issues similar to those in the ongoing debate over child screen time and its developmental impact [12]. These concerns are presently an important discussion among researchers [69, 74] and are pertinent given the potential roles SRs might play in child development, such as digital babysitters. For SR designers, these concerns mean that ethical implementation of SRs to prevent overreliance would need to include a clear delineation of what the robot's role is meant to be for parents or educators. Furthermore, the implementation of gamifications, habit forming features, or aids that could make educational work trivial must be heavily scrutinized to prevent putting a child's development at risk.

Furthermore, two new dimensions emerged under Safety: physical safety and psychological safety. Parents and educators were similarly concerned about the physical safety of a child with a SR, particularly with their moving parts. Psychological safety was a more prominent concern among educators, who were particularly worried about vulnerable children such as those with autism or children experiencing mental health difficulties. A prior work by Lemaignan et al. investigates children with autism, and their findings of a requirement for careful SR integration align with these participants' concerns [52]. One educator even stated a concern that a child could experience psychological trauma ("The emotional reliance/friendship with them and trauma if they break or stop working.") While a longitudinal study with child participants and actual SRs is valuable, academics must first have an in depth discussion with the relevant caretakers to make sure each child's psychological needs are considered.

We found that a significant number of educators were opposed to adding this technology to children's education, citing concerns about children's social development ("Children are already struggling enough because the prevalent use of technology has made it hard for them to interact appropriately with other humans. I don't think that social robots would be a good thing for children at all"), as well as being opposed to more technology in the classrooms in general ("I would be strongly opposed to social robots being used in schools. We already have enough technology. What we are finding in recent years is that students actually need more time away from screens in order to succeed - they need to play with real toys, have real conversations, and go outside more often"). These sentiments generally address the broader use of technology in classrooms rather than solely focusing on specific SRs. They do not necessarily indicate a resistance to technology but may reflect a common concern about the alignment between newly developed pedagogical technologies and teachers' educational approaches [3, 27]. To address these issues, it is important to ensure SRs are designed to adapt to teaching styles rather than imposing a one-size-fits-all approach. A lack of a learning plan when incorporating such technology can create friction for both students and educators, but more knowledge about the technologies can ease adoption in the classroom [27]. Consequently, educators found technology literacy of particular importance, with it being their fourth most prominent dimension. For developers, creating accessible tools, documentation, and guides for parents and educators, regardless of their technology experience, would enhance SR integration in learning

environments and allow these stakeholders to make the most out of the devices. This approach also helps prepare children to interact responsibly with SRs while teaching them about how technologies such as AI work [78].

All of the final concerns compiled and their dimensions allowed us to fully compare the perspectives of both parents and educators (See Fig. 9), and we were able to define all of these dimensions for future investigation (See Appendix B). Altogether, the identified role effects and role specific interaction effects (role x age x gender) underscore the importance of incorporating multiple perspectives in designing SRs for children, while taking into account the age and gender of those children. Furthermore, to mitigate any risk of potential psychological trauma for child users, further exploration with relevant adults may be needed before undertaking any longitudinal in the wild studies with younger children. Preparing both children and adults through education about SRs is essential.

6 LIMITATIONS AND FUTURE WORK

Although our goal was to present findings that encompass the concerns of educators and parents from diverse ethnic and cultural backgrounds, the limited sample size and the absence of specific cultural representation, such as China and India, lowers the generalizability of our results. Also, our hugely unbalanced country-based sample sizes (See Fig. 12) did not allow us to conduct statistical analyses based on countries: A future study with controlled country-based sample sizes (i.e., quota sampling) would be crucial in exploring such aspects. Further, while we limited our imaginary children's gender to only boys and girls, inclusion of other gender categories in future studies will be important, since some of our results revealed gender effects. The breadth of the areas of concern found in this investigation provide an ample foundation for a variety of future endeavors. Currently, we plan on conducting a future study that focuses on privacy, adult control, and technology literacy by having parents and educators evaluate a tool which shows conversations between a child and a social robot through data visualizations. The goal of such a study is to allow non-expert users to peer into the black box of AI and and have a better understanding and control over how their data is used, why it is used, and how it affects children. Such a study is only one example of how these findings can be used to inform new research and implementation, as all of the areas of concern warrant investigation. It is important to note however that our findings show that while longitudinal use of a SR is likely to yield more fruitful results, such a study needs to be conducted with exceptional care and consideration to the developmental and psychological safety of children.

7 CONCLUSION

This paper focused on child users and aimed at gathering and measuring the concerns of parents and educators around children's use of SRs. Our findings underscore the need for a transparent, trust-centric approach in AI-empowered human-robot interaction, advocating for a future where all users and their interactions are both knowledgeable and safeguarded. Altogether, our findings point toward the importance of designers of SRs to consider how the ages and genders of children affect how the devices will be approached, especially when integrating them with parents' and educators' perspectives in mind. Further, by understanding the concerns that we identified, designers could effectively mitigate potential risks associated with children's SR use. We urge SR designers to carefully consider all the areas of concerns we have identified, as they could play a key role in ensuring the safety of SRs for children.

Finally, our results showed that despite higher levels of apprehension, both parents and educators have positive attitudes toward the usefulness and the potential utility of such technology in pedagogy. We would like to note this resembles the historical adoption of cars by society despite their potential risks. We emphasize that thorough and comprehensive research needs to be conducted in a timely manner to prevent potential harm to child users.

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A DESCRIPTIVES

A.1 Survey Question Items and Raw Qualtrics Files

Below is the Qualtrics template for the parent variant of the survey sent to participants, the educator survey contains the same questions with minor variations. For a more detailed look or for reproduction of the survey, the Qualtrics exports and PDFs for both variants can be found in the following repository:
https://osf.io/s6jv7/?view_only=8845020aec00452a9df5dd3c4de9959e

Parent Variant - Responsible AI: Understanding Users' Concerns

Start of Block: Intro

Introduction **Introduction to Social Robots**
Social Robots are robots that are able to have conversations with people and can be used as companions, helpers, and teachers.
Social robots can see and hear you through cameras and microphones, and can process what they see and hear with artificial intelligence (AI) so they can interact with you in a believable and friendly way. These robots have often been researched for use as teachers or companions for children, both at home and in schools.

Robovie

Haru

Classmate

For taking this survey, we would like you to imagine the following.

There is a **${e://Field/age}-year-old ${e://Field/gender}** named Alex. Please imagine that you are ${e://Field/pos-pronoun} parent: Thus, whenever a question involves Alex, please answer them as if ${e://Field/pronoun} is your ${e://Field/role}.

Please note this survey focuses on Alex's use of Social Robots (Robots with AI) as well as how you feel about Social Robots.

End of Block: Intro

Start of Block: Technology Acceptance

Acceptance Intro
This section asks questions regarding the usefulness and aesthetics of a social robot.

Please remember to imagine yourself as the parent of Alex, the **${e://Field/age}-year-old ${e://Field/gender}**.

TA1 : **For the following statement, please fill in the blank to best match your opinion.**
(1 Not at all – 7 Extremely)

I think social robots could be _____ useful for children at home.

Importance Intro
Please rate how important the following qualities would be for a social robot to have.
(1 Not at all Important – 7 Extremely Important)

TA2: **The robot provides help to children in the home environment.**

TA3: **The robot assists parents with duties involving children.**

TA4: **The robot is fun to use and interact with.**

TA5: **The robot is aesthetically pleasing.**

TA6: **Please rate your agreement with the following statement.**
(1 Strongly Disagree – 7 Strongly Agree)

The appearance of a social robot would influence my decision to let Alex use it.

End of Block: Technology Acceptance

Start of Block: Information Quality

Info Q Intro
This section focuses on the quality of the information the social robot replies with.

Please remember to imagine yourself as the parent of Alex, the **${e://Field/age}-year-old ${e://Field/gender}**.

Please rate your agreement with the following statements.
(1 Strongly Disagree – 7 Strongly Agree)

IQ1: **I am concerned about social robots giving inaccurate responses to Alex's questions.**

IQ2: **It is important for parents and educators to monitor the information provided by social robots.**

IQ3: **I am concerned that the information provided by the social robot to Alex could be influenced by common stereotypes and biases.**

IQ4: **I am concerned the robot will not correct Alex when ${e://Field/pronoun} is wrong.**

IQ5: **A robot might assist Alex in performing dangerous activities by providing information without discerning if it is harmful or not.**

End of Block: Information Quality

Start of Block: Cognitive Development

Cognitive Intro
This section is about social robots' potential influence on children's cognitive development.

Cognitive Development is how children develop the ability to think, reason, and solve problems.

Please remember to imagine yourself as the parent of Alex, the **${e://Field/age}-year-old ${e://Field/gender}**.

Please rate your agreement with the following statements.
(1 Strongly Disagree – 7 Strongly Agree)

CD1: **I am worried that the use of social robots in schools could have a negative influence on Alex's cognitive development.**

CD2: **I am worried that the use of social robots at home could have a negative influence on Alex's cognitive development.**

CD3: **I am concerned that Alex could use the robot to cheat on ${e://Field/pos-pronoun} assignments.**

CD4: **I am worried that Alex might not learn how to solve problems if ${e://Field/pronoun} relies on a social robot.**

End of Block: Cognitive Development

Start of Block: Socio-emotional Development

Social-Emo Intro
This section focuses on social robots' potential influence on children's social-emotional development.
Social-emotional development is how children develop the ability to understand, express, and manage their emotions as well as to form meaningful connections with other people.

Please remember to imagine yourself as the parent of Alex, the **${e://Field/age}-year-old ${e://Field/gender}**.

Please select the most appropriate response for the following questions.

SE1: **I would be comfortable with the idea of a social robot fostering Alex's social-emotional development.**
(1 Strongly Disagree – 7 Strongly Agree)

Attention
For this question, please select the colour 'green'. This is an attention check.

Based on the text you read above, what colour were you asked to enter?
(red, yellow, blue, green, purple, magenta, cyan)

SE2: **I think that a social robot would _____ Alex's development of the social skills needed to make friends with other children.**
(1 Negatively Influence – 7 Positively Influence)

SE3: **I am comfortable with Alex developing a friendship with the robot.**
(1 Strongly Disagree – 7 Strongly Agree)

SE4:**I think using a social robot at home will negatively influence what Alex believes is acceptable to do or say in front of another person.**
(1 Strongly Disagree – 7 Strongly Agree)

SE5: **I think it is important for parents to be aware of their children having sensitive conversations with a robot.**
(1 Strongly Disagree – 7 Strongly Agree)

SE6: **Until what age is it appropriate for parents to be notified when a child has a sensitive conversation with a robot?**
Please select 18 if you want to choose an age that is 18 or older.

(Slider: 0-18)

End of Block: Socio-emotional Development

Start of Block: Accessibility

Accessibility Intro
Next, please tell us about your thoughts regarding the accessibility of a social robot.

Please rate your agreement with the following statements.
(1 Strongly Disagree – 7 Strongly Agree)

A1: **I think integrating a social robot into the home would be easy.**

A2: **I think it is important that social robots provide accessibility features for children (e.g., features for impaired hearing, eyesight, etc.).**

End of Block: Accessibility

Start of Block: Privacy

Privacy Intro
This section focuses on the collection and storage of the data that a social robot would collect.
These data are what the robot sees and hears with its cameras and microphones.

Please remember to imagine yourself as the parent of Alex, the **${e://Field/age}-year-old ${e://Field/gender}**.

Please rate your agreement with the following statements.
(1 Strongly Disagree – 7 Strongly Agree)

P1: **Parents and teachers should know what type of data are collected by a social robot before it is used by any child.**

P2: **Overall, I find it risky to have a social robot for Alex as it could collect ${e://Field/pos-pronoun} personal data. (e.g., passwords, health conditions, family affairs, personal conversations, etc.)**
P3: **I would be worried that the robot is hearing Alex's private conversations even when ${e://Field/pronoun} thinks it is not in use.**

P4: **Please rate how comfortable you would be to have a social robot in these parts of your home.**
(1 Extremely Uncomfortable – 7 Extremely Comfortable)

Bedrooms (1), Living room (2), Kitchen (3),
Dining room (4), Bathroom (5), Basement (6)

P5: **Who do you think should be able to access the data collected by social robots? Please click all that apply.**
("Children", "Parents", "Educators", "The developers of the robot", "The government of the country where the robot is used", "Other")

P6: **How long would you be comfortable having a child's conversations stored internally in the robot?**
(“Not Comfortable at all”, “ A day or less”, “A week or less”, “A month or less”, “A year or less”, “Indefinitely”, “Other timeframe, please describe“)

P7: **How long would you be comfortable having a child's conversations stored in an external cloud?**
(“Not Comfortable at all”, “ A day or less”, “A week or less”, “A month or less”, “A year or less”, “Indefinitely”, “Other timeframe, please describe“)

Please rate your agreement with the following statements.
(1 Strongly Disagree – 7 Strongly Agree)

P8:**I would be more willing to use a social robot if I knew what legal protections our data has.**

P9: **I think it would be important to be notified when Alex's conversations with the robot are stolen.**

P10: **I would be concerned about Alex's data being used for commercial purposes.**

End of Block: Privacy

Start of Block: Experience Level

Experience Level **This section asks about your experience with social robots and related technologies.**

For the following questions, please input what you think your experience level is.
(1 Not Experienced at all – 7 Extremely Experience)

EL1: **How experienced are you with social robots?**

EL2: **How experienced are you with artificial intelligence chatbots? (e.g., ChatGPT)**

EL3: **How experienced are you with Voice Assistants? (e.g., Amazon Alexa, Siri, Google Home)**

End of Block: Experience Level

Start of Block: Expectations

Expectations Intro **In this final section, we are asking about your overall expectations for children using social robots.**

Please remember to imagine yourself as the parent of Alex, the **${e://Field/age}-year-old ${e://Field/gender}**.

EX1: **How helpful do you feel a social robot could be for children to better learn and understand the following subjects?**
(1 Extremely Hindering – 7 Extremely Helpful)

Maths (1), Science (2), Computing (3),
Languages (4), Arts (5), Social Studies (6)

Please rate your agreement with the following statements.
(1 Strongly Disagree – 7 Strongly Agree)

EX2: **If I were to get a social robot, I would be more concerned than other parents about the cost of buying and maintaining it.**

EX3: **I think Alex could interact with a social robot respectfully (without verbal or physical abuse).**

EX4: **Alex should be taught to understand the limitations and capabilities of the social robot.**

EX5: **If the robot manufacturer were to say that conversation data would not leave the robot, I would believe them.**

EX6: **For the following statement, please fill in the blank to best match your opinion.**
(1 Extremely Unsafe – 7 Extremely Safe)

Overall, I think Social Robots are _____ for Alex's use.

EX7: **Do you have any additional concerns regarding social robots being used by children? Is there any concern you think to be of upmost importance?**
(Text Input)

End of Block: Expectations

End of Survey **Thank you for taking part in this study. Please click the proceed button below to be redirected to Prolific and register your submission.**

A.2 Original Mind Map used to discuss and generate concern dimensions

Fig. 10. The first half of the map of concerns generated from literature and discussion, highlighting the areas of Cognitive Development, Technology Acceptance, and Socio-Emotional Development. It includes their dimensions, discussion questions, and statements relating to them.

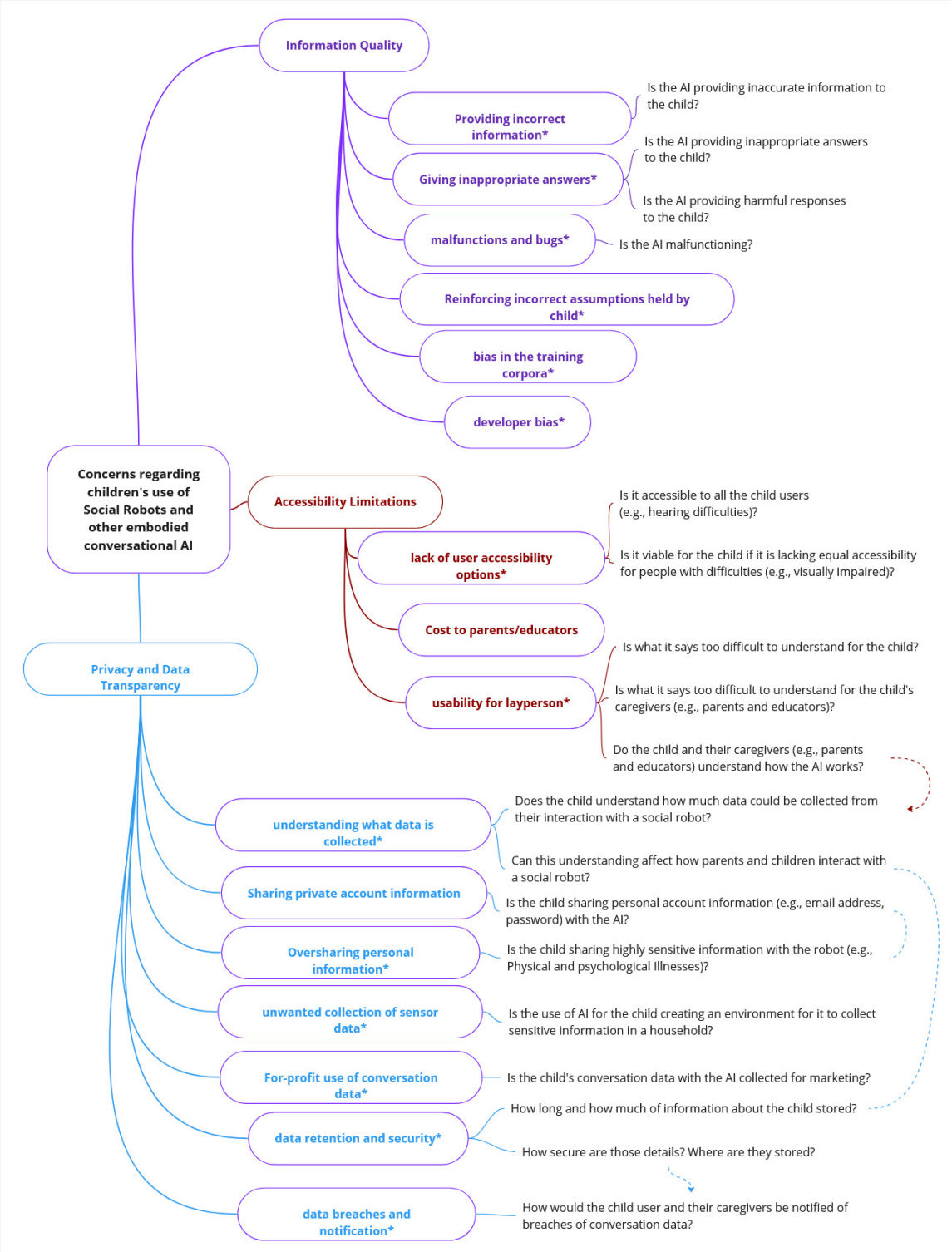

Fig. 11. This is the other half of the map of concerns generated, highlighting the areas of Information Quality, Accessibility Limitations, and Privacy and Data Transparency. Also including their dimensions, discussion questions, and statements relating to them.

A.3 Number of Participants per Condition

Condition	Gender					Total
	Man	Woman	Non-binary	Not listed	Prefer not to say	
Educator: 7 yrs girl	23	26	0	0	1	50
Educator: 7 yrs boy	28	23	0	0	0	51
Educator: 16 yrs girl	20	27	0	0	0	48
Educator: 16 yrs boy	25	25	0	0	0	50
Parent: 7 yrs girl	25	24	0	0	0	49
Parent: 7 yrs boy	28	23	0	0	0	51
Parent: 16 yrs girl	22	25	0	0	0	47
Parent: 16 yrs boy	23	26	0	1	0	50
Total	194	199	1	1	1	396

Table 1. Number of participants per condition

A.4 Number of Participants per Country

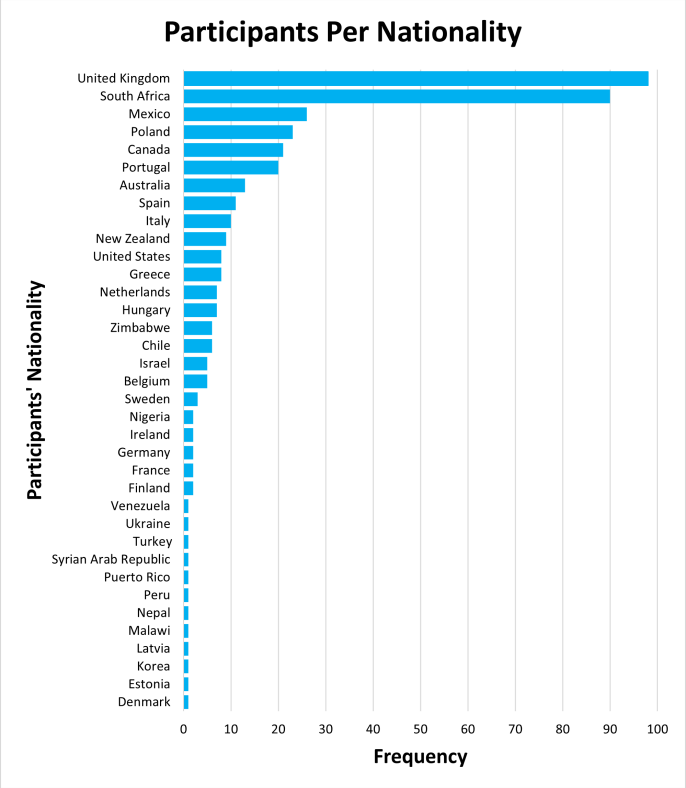

Fig. 12. 398 participants of 36 different nationalities participated in the survey.

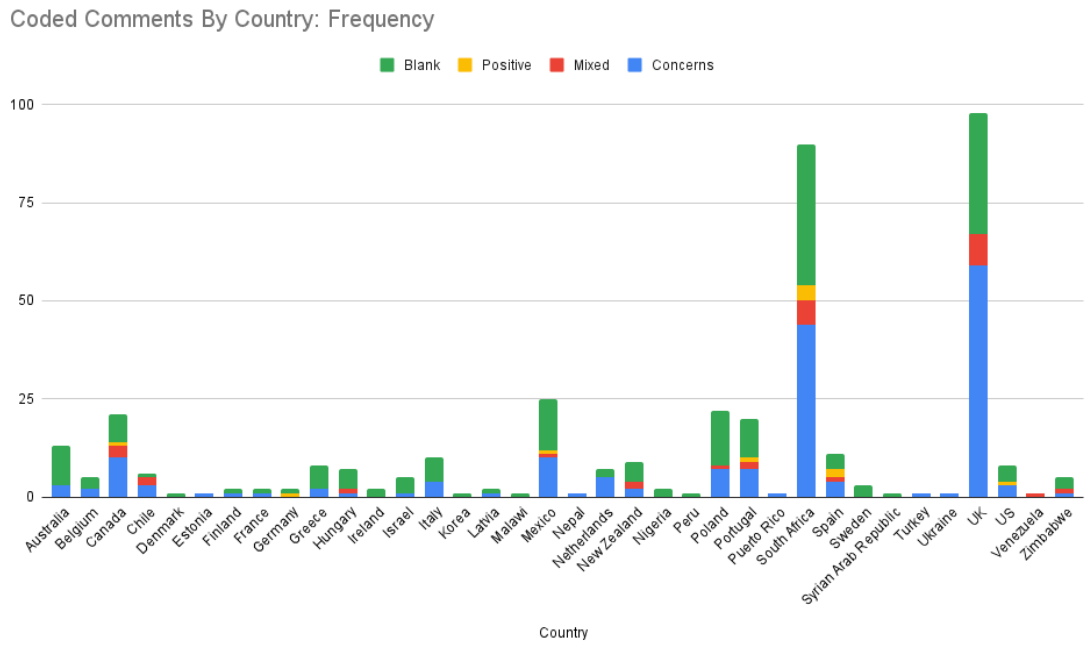

Fig. 13. Frequency of qualitative response type for each country

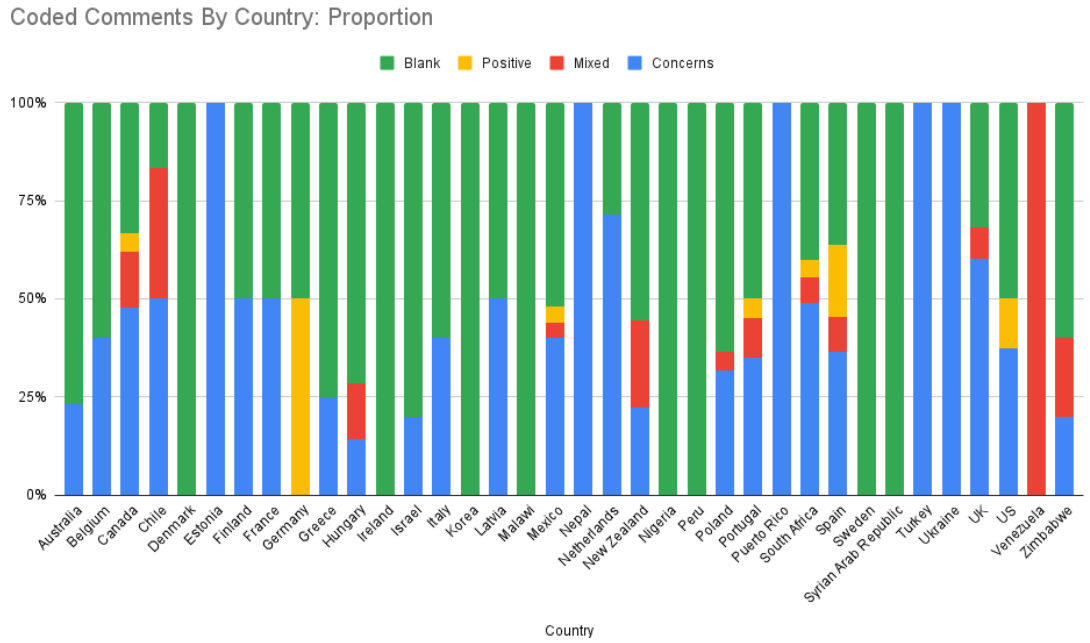

Fig. 14. Proportion of qualitative response type for each country

B LIST OF TEN AREA OF CONCERN AND THEIR CONSTITUENT DIMENSIONS

Area of Concern	Dimensions	Description
Utility Expectations	Utilitarian Concerns	The utility of the robot in pedagogical applications.
	Hedonic Concerns	The robot's appearance and user experience.
	Social Capabilities	The robot's ability to be social.
	Behavioural Guidance	The robot's ability to guide a child when they show undesirable behaviour.
Privacy & Data Transparency	Data Transparency	The user has access to their collected data, how it is collected, and can control who has access to it.
	Oversharing Personal Information	The child willingly disclosing personal or sensitive information to the social robot in conversation.
	Unwanted Collection of Sensor Data	The robot seeing or hearing things it is not meant to while it is not in use.
	For-Profit Use of Sensor Data	The child data collected by the robot being used for advertising or sold.
	Data Governance	Concerning the rules, regulations, and protections regarding the collection and retention of personal data needed for the social robot to function.
	Security	Concerns surrounding child data being stolen by external malicious actors without the knowledge of the developers.
Cognitive Development	Academic Development	Children's learning outcomes being affected by the robot.
	Academic Honesty	Children's intentional use of the robot to cheat on assignments.
	Classroom discussion and Collaboration	The use of the robot affecting how students collaborate in the classroom.
	Problem solving skills	Children's problem solving and critical thinking skills being affected by the robot.
Accessibility	Accessibility	The possibility for the robot to be used by children of diverse physical/neurological abilities.
	Equal Access	The possibility for the robot to be used by children of diverse socioeconomic backgrounds.
Overreliance	General Overreliance	A child's general overreliance on using the social robot for task completion or stimulation.
	Educator/parent Overreliance	Parent or educators' overreliance on using the robot to alleviate their own teaching and caretaking responsibilities.
	Replacement of Educator	The use of the robot as a sole educator rather than as a supplemental tool or assistant.
Socio Emotional Development	Asking Harmful Questions	The child uses the robot to ask questions that a parent or educator may deem harmful to answer.
	Misbehaviour Towards Robot	The child misuses the robot, speaks to it aggressively, or physically damages the robot.
	Influence on Social Environments	The robot causing children to discriminate against those who use or not use the robot in class.
	Parasocial Relationships	The creation of a strong bond between the robot and the child.
	Privacy From Parents	The child is able to interact with the robot alone through mutual trust and agreement with parents.
	Social Isolation	The child chooses to interact with the robot rather than with the people around them.
Information Quality	Providing Incorrect Information	The robot providing information that is incorrect or a hallucination.
	Giving Inappropriate Information	The robot giving responses not meant for the age/maturity of the child or the context of their interaction.
	Malfunctions and Bugs	The robot malfunctions and gives incomprehensible or unintended information.
	Reinforcing Incorrect Assumptions	The robot acts as a "yea-sayer" and agrees with whatever the child says to continue the flow of conversation regardless of the statement's veracity.
	Development Bias	Biases in the corpora or models used to train the social robot affecting how it responds to questions.
	Misinformation	The robot is programmed to intentionally spread misinformation or further certain narratives by the developer
Uncertainty and Trust	Trust in Developers	Trust that the developers are competent and have good intentions for the children they design the social robots for.
	Trust in Technology	Trust that the technology behind social robots is functional and ethical.
	Opposition to Technology	Total opposition to social robots and similar pedagogical agents.
	Technology Literacy	The understanding of how social robots and their AI capabilities function, their limitations, and the roles they can play.
Safety	Psychological Safety	The robot will not bring psychological harm to the child (such as affect their mental health or cause emotional anguish).
	Physical safety	The robot will not bring physical harm to the child (such as catching fingers in moving parts or breaking down in a dangerous manner).
	General Safety	The overall sentiment for the safety of the social robot for children.
Adult Control	Supervised use	The presence of an adult during child-robot interaction.
	Monitoring	The remote surveillance and moderation of child-robot interaction.