Designing Privacy Education Interfaces for Families in Informal Learning Settings: Interaction Design Goals

NIKITA SONI, University of Illinois Chicago, USA

YAXING YAO, University of Maryland Baltimore County, USA

Family group discussions are shown to be effective in enhancing children's critical thinking and decision-making around privacy and cybersecurity. However, existing digital educational interfaces are primarily designed to teach facts and roles, less to facilitate a collaborative discussion or meaning-making about privacy and cybersecurity concepts among family groups. One promising direction is to design such experiences leveraging public informal learning spaces (e.g., museums, libraries) as they offer a valuable platform to interactively engage multi-generational family groups to discuss privacy and cybersecurity concepts. In this workshop paper, we propose a research agenda that leverages public informal learning infrastructures as a platform for engaging families in group discussion and critical thinking about privacy and cybersecurity concepts. Drawing upon their complementary expertise in privacy education and museum learning technology for families, the authors identify four key interaction design goals for building effective privacy education experiences for multi-generational family groups. These experiences aim to facilitate a meaningful discussion around designing interactive privacy and security education interface for families in open-ended informal learning spaces. The "Privacy Interventions and Education (PIE)" workshop at CHI is an ideal setting to share and discuss our evolving understanding at the intersection of privacy education and informal learning technology design.

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

Additional Key Words and Phrases: privacy education, families, informal learning, education technology

1 INTRODUCTION

Prior work has emphasized the importance of collaborative meaning-making in engaging children to actively think and discuss privacy-related concepts [6]. Unlike passively consuming a prescribed list of privacy-related recommendations, collaborative meaning-making allows children to apply abstract privacy and cybersecurity concepts to real-world scenarios while reflecting on each other's experiences as a group from multiple perspectives. In the literature and the practice, various education materials (e.g., recommended best practices [1, 2]) have been developed to teach children and their families about privacy and cybersecurity knowledge and rules. However, these materials are not always designed for facilitating active collaborative meaning-making within family groups, which we deem to be critical in promoting privacy-related decision-making skills. Instead of relying on families to discuss the learning content on their own, we believe that an educational interface should be *intentionally designed* to effectively facilitate group discussion.

One promising direction is to facilitate privacy education through open-ended informal learning environments, by leveraging family learning opportunities that exist beyond traditional or "formal" school settings. Family groups often visit informal learning settings (e.g., museums) as social groups [5]. These learning settings have been shown to be an effective platform in instantiating meaningful discussions among families [5, 7, 15]. Museums often situate technology-enabled interactive educational interfaces, allowing family groups to actively interact and engage with the

learning content. Such interactive interfaces have been shown to be effective in supporting learning abstract science and mathematics concepts [7, 11, 15]. In this workshop paper, **we aim to discuss interaction design goals and research opportunities in leveraging interactive exhibits in informal learning spaces for the purpose of privacy and cybersecurity education.** We draw on our prior research in designing collaborative meaning-making educational interfaces for families to highlight four key interaction design goals and challenges towards effective privacy education interfaces for informal learning settings.

2 INTERACTION DESIGN GOALS

Based on our team's background in privacy literacy and experience in designing collaborative meaning-making interfaces for children and family groups in informal learning settings such as museums, we reflect on our experiences to discuss four key interaction design goals (G1-G4) that must be considered when designing interactive privacy education interfaces for families, particularly in open-ended learning environments.

2.1 G1: Accommodating for Children's Developmental Needs

When designing privacy and cybersecurity educational interfaces for family groups, it is important to support ways in which both children and adults naturally interact with technology. This will allow learners of all ages to explore and engage with the learning content at hand rather than figuring out how to operate the interface. Our previous research has shown differences in children's and adults' gesture interaction patterns with touchscreen education technology [13]. Children were more often seen performing non-standard and inventive touchscreen gestures (i.e. beyond legacy tap and swipe gestures) when interacting with touchscreen interfaces as compared to adults [3, 12–14]. For example, in our prior work, one child proposed drawing a spiral gesture on a multi-touch spherical display to rewind or undo an action [14]. This inventiveness could be attributed to children's still-developing cognitive abilities, their exploratory nature, and natural curiosity [9]. Furthermore, we also found children's physical gesture patterns to be different as compared to adults. For example, children often used more fingers when performing touchscreen gestures (e.g., zooming in with all five fingers to shrink an object) as compared to adults (e.g., zooming in with two fingers to shrink an object) [12–14].

As privacy and cybersecurity concepts can be complicated and abstract [8], **it is important to design education interfaces that account for children's cognitive and physical needs, unique interaction styles, and their natural exploratory nature** in learning to ensure their active engagement.

2.2 G2: Supporting Flexible Group Collaboration Patterns

Educational interfaces designed for open-ended informal learning settings should be intentionally designed to support family groups' natural collaboration behaviors and patterns [15]. Our prior work with museum learning large touchscreen display interfaces showed that family groups employed a range of collaboration styles when collectively learning and discussing science content [15]. On occasions, we observed groups collaborating closely, engaging in discussions about their activities and what they were discovering while interacting with the interface. However, at other times, groups worked more independently, with children and adults exploring the content on their own before regrouping to discuss it. We also saw some instances where parents played the role of facilitator or guide, instructing children on what to do and explaining the learning content.

As such, when designing privacy and cybersecurity educational interfaces for family groups in informal learning settings, **it is important to support both independent exploration and close group collaboration behaviors**.

This will provide autonomy in learning for each group member as well as opportunities for all group members to follow their natural behaviors in informal learning settings rather than adjusting their learning habits purposely.

2.3 G3: Providing Discussion Starter Prompts

Informal learning settings such as museums and public libraries provide an open-ended, participatory learning environment, allowing family groups to interact and learn using digital interfaces at their own pace, often without a guide or a formal teacher. Similar to our prior work that focuses on group-based settings (e.g., participatory design [15, 17, 18]), it is important to provide appropriate and effective discussion starters for families to encourage meaningful conversations [4, 15]. These starter prompts can also encourage all group members to participate in discussions and interactively engage with the learning content [4, 15]. In our prior work, we saw that parents tended to repeat the provided task prompts or questions to children to further guide groups' exploration of the educational prototype and facilitate group meaning-making [10, 15].

The abstract nature of privacy and cybersecurity concepts makes it even more difficult for families to have an instant desire for further engagement. As such, **embedding conversation starter prompts or questions** can be critical to support the groups' learning process, and to **provide an entry point for family groups to deeply engage with the privacy and cybersecurity content**.

2.4 G4: Exploring Interfaces that Support Bodily Experiences to Enhance Privacy Learning

According to the theory of Embodied Cognition in the learning sciences [16], the acquisition of knowledge is not limited to mental processes alone. Instead, it is influenced by a range of bodily experiences, including interactions with tangible educational tools using direct manipulative gestures, as well as conversations with others. Prior work in computer-supported collaborative learning (CSCL) has demonstrated that educational interfaces that provide learners with the ability to manipulate learning content through physical bodily interactions, such as touchscreen gestures, can be highly effective in supporting learning about abstract STEM concepts. This is because when learners physically manipulate learning content in an embodied way [16], it can help to solidify their mental representations of the material, resulting in a deeper understanding and more effective transfer of knowledge to new situations and contexts.

Drawing from prior literature in learning sciences and computer-supported collaborative learning, and acknowledging the contextual nature of privacy literacy, it may be **valuable to investigate the potential benefits of interfaces that enable learners to interact with natural input modalities such as touch, speech, or whole-body input, in enhancing privacy education outcomes**.

3 CONCLUSION

In this position paper, we discuss a promising research opportunity that leverages informal learning settings for privacy and cybersecurity education. We draw insights from our prior work and discuss four design considerations when designing interactive exhibits to facilitate family-based discussion around privacy and cybersecurity concepts in informal learning settings.

REFERENCES

[1] 2023. Privacy & Security: How can I Keep my Private Data Safe and Secure? https://www.commonsense.org/education/digital-citizenship/topic/privacy-and-security

[2] 2023. Resources for Engaging Parents and Families. https://www.commonsense.org/education/toolkit/family-engagement-resources

[3] Lisa Anthony, Kathryn A. Stofer, Annie Luc, and Jacob O. Wobbrock. 2016. Gestures by Children and Adults on Touch Tables and Touch Walls in a Public Science Center. In *Proceedings of the International Conference on Interaction Design and Children (IDC'16)*. 344–355.

[4] Clara Cahill, Alex Kuhn, Shannon Schmoll, Alex Pompe, and Chris Quintana. 2010. Zydeco: Using Mobile and Web Technologies to Support Seamless Inquiry between Museum and School Contexts. In *Proceedings of the International Conference on Interaction Design and Children (IDC'10)*. 174–177.

[5] Kevin Crowley, Palmyre Pierroux, and Karen Knutson. 2014. *Informal Learning in Museums.* Cambridge University Press, 461–478.

[6] Priya C. Kumar and Virginia L. Byrne. 2022. The 5Ds of Privacy Literacy: A Framework for Privacy Education. *Information and Learning Sciences (ILS'22)* 123, 7/8, 445–461.

[7] Joyce Ma, Lisa Sindorf, Isaac Liao, and Jennifer Frazier. 2015. Using a Tangible versus a Multi-touch Graphical User Interface to Support Data Exploration at a Museum Exhibit. In *Proceedings of the International Conference on Tangible, Embedded, and Embodied Interaction (TEI'15)*. 33–40.

[8] Maggie Oates, Yama Ahmadullah, Abigail Marsh, Chelse Swoopes, Shikun Zhang, Rebecca Balebako, and Lorrie Faith Cranor. 2018. Turtles, Locks, and Bathrooms: Understanding Mental Models of Privacy through Illustration. *In Proceedings on Privacy Enhancing Technologies (PETS'18)* 2018, 4, 5–32.

[9] Madeline Pelz, Amanda Yung, and Celeste Kidd. 2015. Quantifying Curiosity and Exploratory Play on Touchscreen Tablets. In *Proceedings of the Workshop on Digital Assessment and Promotion of Children's Curiosity.*

[10] Carrie Schuman, Kathryn A Stofer, Lisa Anthony, Hannah Neff, Peter Chang, Nikita Soni, Alice Darrow, Annie Luc, Amanda Morales, Jeremy Alexandre, and Brittani Kirkland. 2020. Ocean Data Visualization on a Touchtable Demonstrates Group Content Learning, Science Practices Use, and Potential Embodied Cognition. *Research in Science Education* (2020), 1–13.

[11] Peter Sommerauer and Oliver Müller. 2014. Augmented Reality in Informal Learning Environments: A Field Experiment in a Mathematics Exhibition. *Computers & Education* 79, 59–68.

[12] Nikita Soni, Sayli Bapat, Schuyler Gleaves, Alice Darrow, Carrie Schuman, Hannah Neff, Peter Chang, Kathryn A Stofer, and Lisa Anthony. 2019. Towards Understanding Interactions with Multi-touch Spherical Displays. In *Extended Abstracts of the Conference on Human Factors in Computing Systems (CHIEA'19)*. 1–6.

[13] Nikita Soni, Schuyler Gleaves, Hannah Neff, Sarah Morrison-Smith, Shaghayegh Esmaeili, Ian Mayne, Sayli Bapat, Carrie Schuman, Kathryn A Stofer, and Lisa Anthony. 2019. Do User-defined Gestures for Flatscreens Generalize to Interactive Spherical Displays for Adults and Children?. In *Proceedings of the International Symposium on Pervasive Displays (PerDis'19)*. 1–7.

[14] Nikita Soni, Schuyler Gleaves, Hannah Neff, Sarah Morrison-Smith, Shaghayegh Esmaeili, Ian Mayne, Sayli Bapat, Carrie Schuman, Kathryn A Stofer, and Lisa Anthony. 2020. Adults' and Children's Mental Models for Gestural Interactions with Interactive Spherical Displays. In *Proceedings of the Conference on Human Factors in Computing Systems (CHI'20)*. 1–12.

[15] Nikita Soni, Ailish Tierney, Katarina Jurczyk, Schuyler Gleaves, Elisabeth Schreiber, Kathryn A Stofer, and Lisa Anthony. 2021. Collaboration around Multi-touch Spherical Displays: A Field Study at a Science Museum. *Proceedings of the ACM on Human-Computer Interaction* 5, CSCW2 (2021), 1–34.

[16] Margaret Wilson. 2002. Six Views of Embodied Cognition. *Psychonomic Bulletin & Review* 9 (2002), 625–636.

[17] Yaxing Yao, Justin Reed Basdeo, Smirity Kaushik, and Yang Wang. 2019. Defending my Castle: A Co-design Study of Privacy Mechanisms for Smart Homes. In *Proceedings of the Conference on Human Factors in Computing Systems (CHI'19)*. 1–12.

[18] Yaxing Yao, Justin Reed Basdeo, Oriana Rosata Mcdonough, and Yang Wang. 2019. Privacy Perceptions and Designs of Bystanders in Smart Homes. *Proceedings of the ACM on Human-Computer Interaction* 3, CSCW, 1–24.