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Investigating Android Apps that Educate Children about Online Privacy and Security

Do any current mobile apps help children learn about online privacy and security? This question drove a recent study conducted by the SPE4K team. Over the last six years, our team has examined existing resources to teach children about privacy and security and has developed curriculum and other resources to help children, teachers, and families become more confident in using social and mobile media and sharing data online.

In particular, we have been motivated by children's increasing use of smartphones, tablets, and other electronic devices to access various educational and gaming applications, often from very young ages and with varying levels of oversight by their parents [1, 2–5]. The pandemic exacerbated this trend further, as many children spent 2020 in virtual classrooms on Zoom or Google Meet for school, and then spent more time on devices outside of school as their parents struggled to balance working from home and childcare [11].

Given these factors, we argue that as children become primary users of mobile devices and the internet, it is critical for them to be able to identify and address online privacy and security risks themselves [6, 7, 8]. Evaluating the landscape of mobile applications available for helping children learn about online privacy and security can inform design of future educational apps.

So back to our question: are there any apps already trying to teach younger children about these topics? The short answer is no: From our analysis of 5,073 Android apps, we found that there were 333 widely used apps related to children's safety, while no apps were specifically designed for *educating* children about online privacy and security.

We provide details on how we analyzed these apps below, but the main takeaway from this and from our prior work is that talking about privacy and security with children is largely framed in terms of safety from perceived online threats rather than developing good habits related to disclosing and protecting data online. In our prior work, parents have said that this is a topic for when their kids "get older," even while their kids regularly use apps, create online accounts, and are targeted by advertisers.

What We Did: Analysis of 5000+ Android Apps

In order to identify and analyze the set of widely used mobile applications for teaching children about online privacy and security, we followed a four-pronged approach outlined in the diagram above. This included data collection from the Google Play Store, natural language processing (NLP), Latent-Dirichlet Allocation (LDA) topic modeling, and qualitative analysis of app descriptions. We scraped app metadata from the Play store using a combination of the query terms shown in the table below. For instance, the phrase "teach kids about security" was created by pulling the first element from the first set of keywords, the second element from the second set of keywords, and the third element from the third set of keywords. We then applied a series of preprocessing steps to tokenize the app description for each app in our data set. We also used the Natural Language Toolkit (NLTK) to stem and lemmatize the terms in our corpus.
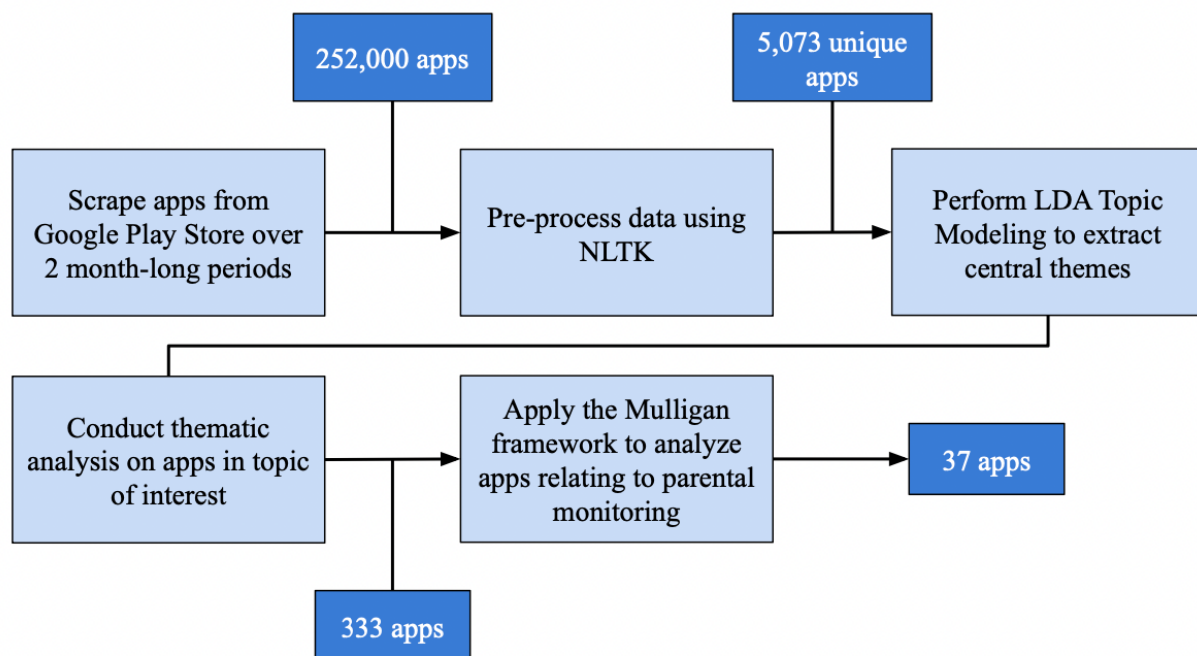
Data analysis pipeline for each phase of the study including data collection, NLP, topic modeling, and qualitative analysis

Query terms used to scrape data from the Google Play store for the app analysis.

Next, we used Latent Dirichlet Allocation (LDA) topic modeling using the Gensim library [9] to extract relevant topics to our dataset. For our model, we considered each document to be made up of an app description and the corpus to be the collection of all app descriptions in our data set. The output from the model consisted of five topics with the ten terms that had the highest probability of appearing in similar contexts across app descriptions. These were then assigned topic names by the researchers, as shown in the table below. Of the 5,073 unique apps, 333 apps were deemed relevant based on the results of LDA topic modeling based on the following criteria:

1. The app must have had the topic of interest being associated with it as the highest probability.

2. The relevance score of the app to the topic "Mobile Safety" from Table 2 must be greater than 99%.

Miscellaneous	Mobile Safety	Computer Systems	Student Resources	Toddler Education
"para"+"babybus"+ "islam"+"stock"+ "daniel"+"invest"+ "panda"+"tamil"+ "pbskid"+"polic"	"devic"+"student"+ "secur"+"parent"+ "protect"+"phone"+ "school"+"teacher"+ "mobil"+"lock"	"comput"+"exam"+ "cours"+"program"+ "question"+"test"+ "network"+"secur"+ "studi"+"basic"	"math"+"school"+ "teacher"+"stori"+ "child"+"game"+ "grade"+"parent"+ "student"+"read"	"kid"+"game"+ "word"+"anim"+ "letter"+"alphabet"+ "color"+"toddler"+ "number"+"children"

Topics and associated terms output by the Gensim topic model.

The topic "Mobile Safety" was chosen as the topic of interest because it contained the root terms **student**, **parent**, and **teacher**, as well as **protect**, **secur**, and **devic**. We then proceeded to conduct a qualitative analysis by reading and coding each app description. To do so, we generated a code book of app categories and had two researchers independently code each app description accordingly. Disagreements were discussed, and the researchers reached an inter-rater reliability score of 90.1% and Cohen's kappa of 88.4%, indicating near perfect agreement. The table below summarizes each app's primary functionality based on these codes.

Category	Description	% (N=333)
Classroom Communication	Portal for teachers, students, and parents to communicate about classroom activities.	6.9
College Resource	Allows students to access resources and information about college, including the application, financing, and actual experience.	5.7
Corporate Management	Tool for companies to operate effectively.	3.9
Educational App for Kids	Teaches kids a variety of subjects, ranging from math to reading and writing. Typically a supplement for their school education.	0.3
Family and Parenting Resource	Provides resources on parenting techniques and best practices.	1.5
Financial Services	Apps made by companies in the financial services industry to facilitate easy transactions.	1.2
Home Security	Home security system for monitoring the inside and outside areas of one's house.	4.8
Miscellaneous	Unrelated to teaching, children, privacy, or security.	**12.3**
Parental Control and Monitoring	Allows parents to monitor their children's activity by having access to logs, blocking specific sites, and setting time limits.	**11.1**
Personal Device Security	Secures passwords and other private information and allows one to control the information moving in and out of their personal device.	**30.3**
Physical Safety	App to track the locations of loved ones, call emergency and medical services if needed, and SOS.	6.6
Private Messaging and Secure Browsing	Allows user to communicate with others privately and browse sites securely.	1.8
Productivity Resource	Helps users be more productive in the form of notebooks, planners, and stickers for school and work.	2.1
Social Media	Communication tool for people to share content and interact online.	0.3
Teaching Resource	Allows teachers to track attendance and grades.	5.7
VPN and Secure Network	Provides a secure connection via VPN for users, shields against malware, and provides security to personal devices.	5.1

Code book for analyzing the app descriptions of 333 mobile safety apps in our app analysis and the percentage of apps labelled with each code (top 3 in bold).

Feature	Description	% (N= 37)
Content Blocker	Blocks inappropriate apps and websites.	21.6
Screen Time Restriction	Limits how much time children can use their devices.	2.7
Location Tracking	Tracking and restriction of user's physical location.	27.0
Parental Monitoring	Allows parents to see which apps and websites their children are accessing.	21.6
Parental Control	Allows parents to actively restrict which sites and apps their children are using.	27.0

Code book used to categorize 37 parental monitoring app features based on app description in our app analysis.

To further analyze these apps, we used a qualitative framework proposed by Mulligan et al. [10] to code the specific dimensions of children's privacy and security addressed by each app as described in the app description. In an effort to describe the function and value of privacy, this analytical tool separates privacy concerns into five meta-dimensions: theory, protection, harm, provision and scope. We focus on the dimensions of protection and harm an app is addressing including who the subject of protection is for each app, what they are being protected from by the app, and who they are being protected against by the app. We recorded how the app description could be used to respond to each of the questions listed in the table below in our study.

Question	Code	Description	% (N = 37)
Who is the app protecting?	Children	Individuals less than age 13	86.5
	Teens	Individual between age 13 and 17	10.8
	Adults	Individuals aged 18 and above	0.0
	Everyone	No age restriction	21.6
What is the app protecting from?	Inappropriate Content	Content targeted towards an 18+ audience	86.5
	Overuse of electronic devices	Limits the amount screen time by setting number of hours or time frame over which device is accessible	45.9
	Physical danger	Content which can cause physical harm	73.0
	Parent-specific content	Content for parents only (especially on shared devices). Can be for parents' jobs or personal lives.	13.5
	Cyberbullying	Threatening or intimidating communication 13	21.6
	Inappropriate communication	Texting, sexting, calling, or social media interactions between individuals which is not deemed appropriate by parent or guardian	43.2
Who or what is the app protecting against?	Bad actors and malware	Threat actors or cybersecurity adversaries who attack devices using malicious software	10.8
	Other children or teens	Other individuals younger than the age of 18	32.4
	Child's inability to manage screen time	Child's perceived inability to define limits on device usage	43.2
	Individuals sharing inappropriate content	Inappropriate communication through texting, calling, or social media	73.0

Code book used to label 37 parental monitoring apps using the Mulligan et al. framework. The table also shows the percentage of apps labelled with each code in our app analysis [10].

From our analysis of 5,073 Android apps, we found that resources relating to online privacy and security for children are scarce and **no popular apps exist** that focus on educating children about these topics. Rather, most focus on mobile safety more generally. We found that apps that focus on digital safety for children are designed for *parents* to manage their child's access to digital technologies. Such proactive and reactive parental tools increase children's online privacy and security but rely greatly on technology to identify and mitigate potential harm. This keeps children from learning how to manage their digital habits independently and serves as a barrier to their ability to self-regulate. The limited agency children are afforded by these types of designs could be detrimental to their ability to safely use their devices in an increasingly digitized world.

App developers should consider incorporating educational components into existing applications for children to provide them with skills around online privacy and security instead of simply restricting their abilities to access specific content. Our findings suggest that there is a large product gap in available resources for helping children learn about online privacy and security, which can be mitigated by adding further scaffolding around app privacy or security related screens for increased education. Additional study findings and limitations (such as the data collection platform) can be found here.

References:

[1] Pew Internet Research Center. Many turn to youtube for children's content, news, how-to lessons. 2018. https://www.pewresearch.org/internet/2018/11/07/many-turn-to-youtube-for-childrens-content-news-how-to-lessons/

[2] Common Sense Media. Media Use by Tweens and Teens. 2015. https://www.commonsensemedia.org/research/the-common-sense-census-media-use-by-tweens-and-teens-2019

[3] Common Sense Media. Media Use by Kids Age Zero to Eight. 2017. https://www.commonsensemedia.org/research/the-common-sense-census-media-use-by-kids-age-zero-to-eight-2017

[4] Common Sense Media. The Common Sense Census: Media Use by Kids Age Zero to Eight. 2020. https://www.commonsensemedia.org/research/the-common-sense-census-media-use-by-kids-age-zero-to-eight-2020

[5] Patrícia Dias, Rita Brito, Wannes Ribbens, Linda Daniela, Zanda Rubene, Michael Dreier, Monica Gemo, Rosanna Di Gioia, and Stéphane Chaudron. The role of parents in the engagement of young children with digital technologies: Exploring tensions between rights of access and protection, from 'gatekeepers' to 'scaffolders'. Global Studies of

[7] Juan Pablo Hourcade, Alissa N. Antle, Lisa Anthony, Jerry Alan Fails, Ole Sejer Iversen, Elisa Rubegni, Mikael Skov, Petr Slovak, Greg Walsh, and Anja Zeising. Child-computer interaction, ubiquitous technologies, and big data. Interactions, 25(6):78–81, oct 2018.

[8] Gila Cohen Zilka. Awareness of esafety and potential online dangers among children and teenagers. Journal of Information Technology Education: Research, 16:319–338, 2017.

[9] Bhagyashree Vyankatrao Barde and Anant Madhavrao Bainwad. An overview of topic modeling methods and tools. In 2017 International Conference on Intelligent Computing and Control Systems (ICICCS), pages 745–750, 2017.

[10] Deirdre Mulligan, Colin Koopman, and Nick Doty. Privacy is an essentially contested concept: a multi-dimensional analytic for mapping privacy: Table 1. Philosophical Transactions of The Royal Society A Mathematical Physical and Engineering Sciences, 374:20160118, 12 2016.

[11] Pierpaolo Limone and Giusi Antonia Toto. Psychological and emotional e̶̶ ̶̶ology on children in covid-19 pandemic. Brain Sciences, 11(9), 2021.