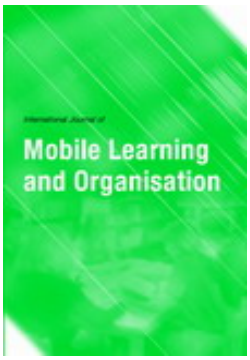


International Journal of Mobile Learning and Organisation

ISSN online: 1746-7268 - ISSN print: 1746-725X
https://www.inderscience.com/ijmlo

Smartphone apps for child sexual abuse education: gaps and design considerations

Sadia Tasnuva Pritha, Rahnuma Tasnim, Muhammad Ashad Kabir, Sumaiya Amin, Anik Das

DOI: 10.1504/IJMLO.2023.10049097

Article History:

Received:	23 December 2021
Accepted:	29 March 2022
Published online:	01 December 2023

Smartphone apps for child sexual abuse education: gaps and design considerations

Sadia Tasnuva Pritha and Rahnuma Tasnim

Department of Computer Science and Engineering,
Chittagong University of Engineering and Technology,
Chattogram 4349, Bangladesh
Email: u1604122@student.cuet.ac.bd
Email: u1604103@student.cuet.ac.bd

Muhammad Ashad Kabir*

School of Computing, Mathematics and Engineering,
Charles Sturt University,
Bathurst, NSW 2795, Australia
Email: akabir@csu.edu.au
*Corresponding author

Sumaiya Amin and Anik Das

Department of Computer Science,
St. Francis Xaiver University,
Antigonish, NS B2G 2W5, Canada
Email: x2020gae@stfx.ca
Email: x2021gmg@stfx.ca

Abstract: The objectives of this study are understanding the requirements of a child sexual abuse (CSA) education app, identifying the limitations of existing apps, and providing guidelines for better app design. An electronic search across three major app stores was conducted and the selected apps were rated by a devised app rating scale. Our rating scale evaluates essential features, functionalities, and software quality characteristics that are necessary for CSA education apps, and determined their effectiveness for potential use as CSA education programs for children. User comments from the app stores are collected and analysed to understand their expectations and views. After analysing the feasibility of the reviewed apps, CSA app design considerations are proposed that highlight game-based teaching approaches. The evaluation results show that most of the reviewed apps are not suitable for being used as CSA education programs. Moreover, all the apps need to be improved in terms of their software qualities and CSA-specific features to be considered as potential CSA education programs. This study provides the necessary knowledge to developers and individuals regarding the essential features and software quality characteristics for designing and developing CSA education apps.

Keywords: child sexual abuse; CSA; mobile learning; sexual abuse education; smartphone; mobile apps; design considerations; app rating scale.

Reference to this paper should be made as follows: Pritha, S.T., Tasnim, R., Kabir, M.A., Amin, S. and Das, A. (2024) 'Smartphone apps for child sexual abuse education: gaps and design considerations', *Int. J. Mobile Learning and Organisation*, Vol. 18, No. 1, pp.101–134.

Biographical notes: Sadia Tasnuva Pritha is pursuing her Bachelor in Computer Science and Engineering at the Chittagong University of Engineering and Technology. Her research interests include game-based learning, mobile learning, mobile apps and human computer interaction.

Rahnuma Tasnim is pursuing her Bachelor in Computer Science and Engineering at the Chittagong University of Engineering and Technology. Her research interests include game-based learning, mobile learning, mobile apps and human computer interaction.

Muhammad Ashad Kabir received his PhD in Mobile Software Engineering from the Swinburne University of Technology, Melbourne. He is a Senior Lecturer in Computer Science and deputy leader of Data Mining Research Group at the Charles Sturt University, Australia. His research interests include machine learning, smartphone apps, mobile learning, health informatics, software engineering and human-centred computing. He has published over 85 peer-reviewed articles. He has over 15 years of research experience in several universities across the globe including Nanyang Technological University (Singapore), Deakin University (Australia), Swinburne University of Technology (Australia), University of Nantes (France), and Pusan National University (South Korea). He has also been invited to visit the University of Toronto (Canada), York University (Canada), University of Maryland (USA), Texas A&M University – Kingsville (USA), Auckland University of Technology (New Zealand), Chandigarh University (India), Universitas Amikom Yogyakarta (Indonesia) and King Abdul-Aziz University (Saudi Arabia) as a guest speaker/keynote speaker/visiting scholar.

Sumaiya Amin completed her Bachelor in Computer Science and Engineering from the Chittagong University of Engineering and Technology. She is currently pursuing her Master's in Computer Science at the St. Francis Xaiver University, Canada. Her research interests include smartphone apps, game-based learning, and health informatics.

Anik Das completed his Bachelor in Computer Science and Engineering from the Chittagong University of Engineering and Technology. He is currently pursuing his Master's in Computer Science at the St. Francis Xaiver University, Canada. His research interests include smartphone apps, game-based learning, machine learning and health informatics.

1 Introduction

Child sexual abuse (CSA) is a dire public health issue that has adverse effects on the victims, their families, and society (Singh et al., 2014). CSA, as defined by the World Health Organization (WHO), is the engagement of a child in sexual activity that he or she cannot completely understand, is incompetent to provide informed approval to, or

for which the child is not developmentally fit and cannot give consent, or that breaks the laws or taboos of society (Csorba et al., 2004). CSA includes engaging in sexual activities with a child (whether by demanding or compelling), indecent exposure, child grooming, and also using a child to produce child pornography. This heinous crime is one of the most hidden and unreported forms of violence that affect children's lives worldwide (Goldman and Padayachi, 2000).

CSA has become prevalent everywhere, to the extent that it cannot be ignored anymore. In recent years, the frequency of sexual abuse targeting children has been growing unwaveringly (World Health Organization, 2020). Worldwide, one in every ten children is sexually exploited before their 18th birthday (Darkness to Light, n.d.). That means about one in seven girls and one in 25 boys will face sexual abuse before they turn eighteen. However, barely one-third of CSA occurrences are identified, and even less are reported (Singh et al., 2014). People who experience sexual abuse in childhood suffer throughout their entire life (Cho et al., 2015). They face the risk of serious mental disorders, suicide, drug misuse, eating disorders, health problems, and displaying violent behaviour. Therefore, teaching both children and adults CSA education has become indispensable. When adults are properly educated regarding the horrors of CSA, they will be more inclined to teach their children how to prevent abuse. There is no substitute for developing effective CSA educational programs that can teach children in school settings and via mobile applications.

Various prevention programs have been adopted universally to combat the sexual exploitation of children. Despite having these CSA education programs and laws for protecting children, the horrors of CSA keep growing (Sanderson, 2004). Every day around the world thousands of children are added to this list of being traumatised forever or losing their lives (Daray et al., 2016). It is evident from the statistics that laws alone cannot keep children out of the perpetrators' grasp (Cullen et al., 2020). Most of the prevention programs require children to have regular face-to-face contact with the teachers. The sexual abuse prevention programs available now show variable efficacies due to inconsistencies in the curriculum and duration of the programs (Hébert et al., 2001). Also, they are out of reach for most children who are on the lower end of the economic scale (Holloway and Pulido, 2018). Even though parents and caregivers play a major role in protecting children, school-based programs hardly ever include parents (Rudolph et al., 2018). Therefore, the obligation exists to design programs that efficiently teach both children and adults about CSA and its prevention.

Recently, several apps (e.g., Orbit Rescue, Elements of Child Sexual Abuse, Game on POSCO, Stop the Groomer, and Helpio) have been developed for making CSA education available to all children. Reporting sexual abuse, providing medical information, legal help, and teaching children the rules of safety are common features of CSA education apps. Some of these apps (e.g., iSafe English, Game on POSCO, and Orbit Rescue) use game-based learning, serious games, and others (e.g., KidzLive, Stop the Groomer, and The Ceceyara App) use standard informational learning. The good thing is, few of them solely focus on teaching parents and caregivers such as 'Bal Suraksha' (Mobile Seva, 2021). CSA education apps also provide professional training for social workers and child care professionals such as 'Elements of Child Sexual Abuse' (Academy for Professional Excellence, 2020). However, it is disputable if these apps are trustworthy as sexual abuse prevention education method (Hébert et al., 2001). Even though many apps claim to teach prevention, they should be rigorously evaluated before labelling them as reliable. To the best of our knowledge, no studies have

reviewed or evaluated the currently available CSA apps to determine their effectiveness in educating children about sexual abuse prevention.

For an app to be competent in teaching children, it needs to have some key features such as appropriate content for the target age group, including adults, focusing on developing a wholesome self-concept of players, making the learning environment appealing and relatable for all players, and evaluating children's knowledge (Stieler-Hunt et al., 2014). Furthermore, the apps need to have basic software quality characteristics to be user-friendly and helpful (Noei et al., 2017). So, it remains a question whether they are useful in educating children and parents about CSA.

In this paper, a systematic analysis of the CSA education-related apps has been carried out. A keyword-based search of over 3.5 million apps from three major app stores (i.e., Google Play Store, Apple App Store, and Microsoft Store) was conducted to find the apps related to CSA education: 191 apps were found from the electronic search and 14 apps that matched our study criteria were selected for review. Then existing app rating scales were modified to devise one that will be suitable for qualitative and quantitative analysis of our finally selected apps. The internal consistency of the modified rating system shows that this rating scale has high internal consistency. And the score of the inter-rater and intra-rater reliability among the raters justified the reliability of the study. This study was motivated by the accelerated increase of CSA education apps in the app stores, and growing interest among parents about their efficacy (*cf.* Malamsha et al., 2021; Kang et al., 2020; Moon et al., 2017; Broekman et al., 2018). In particular, this research has made the following four major contributions:

- We have systematically reviewed the existing CSA education apps available in the three major mobile app stores (i.e., Google Play Store, Apple App Store, and Microsoft Store).
- We have adopted and extended the existing mobile app rating scales for devising an app rating scale specifically suited for evaluating CSA education apps.
- We have evaluated the selected apps using our CSA education app rating scale and highlighted their design limitations.
- Our study provides developers with design guidelines they need to consider while creating an effective CSA education app. Moreover, individuals can also gain valuable information regarding the important features a CSA education app must have.

The rest of this paper is organised as follows. The app search and selection process and the proposed CSA app rating scale are described in Section 2. In Section 3, the results found by analysing the apps, the inter-rater and intra-rater consistency, and the internal reliability of our rating scale are presented. Design limitations of existing apps and future design considerations for developers and individuals are discussed in Section 4. Finally, Section 5 concludes the paper.

2 Methodology

In this section, the methodology for reviewing the CSA-related apps is discussed. The search and selection process of the CSA-related apps is explained along with the

modifications that were done for developing the scale that was used for rating CSA education apps. Also, different sub-scales of the modified rating scale are discussed in detail.

2.1 App search procedure

This research includes the apps found in the three mobile app stores: Apple App Store, Google Play Store, and Microsoft Store, which are the most popular mobile application stores presently. The search was conducted between January and February 2021. A keyword-based search process was employed in the Apple App Store, Google Play Store, and Microsoft Store following similar approaches used in previous studies (Rivera et al., 2016). The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines were also followed (Tricco et al., 2018). Following PRISMA guidelines ensures transparency and clarity of reporting and permits other researchers to replicate the search process. Examining these three stores guaranteed that both Android and iOS apps would be included in the study. The keywords were chosen carefully by analysing the names of some popular CSA related apps, so that if the same set of keywords are used at the same time point and from the same location, the search will produce the same result (Stawarz et al., 2015). The keywords that were used were: 'child sexual abuse' (CSA), 'sexual abuse prevention', 'sexual abuse', 'sexual offence', 'abuse prevention', 'child abuse'.

The investigators performed the searching, screening, and final inclusion process collaboratively. All three app stores were searched using the same enlisted keywords to minimise differences and ensure consistency. Three investigators independently performed the exact search applying the same keywords several times and assembled the final inclusion list of CSA education apps. Each investigator maintained a separate list of apps for each app store they searched. They used the inclusion and exclusion criteria (discussed in Subsection 2.3) for screening the apps. Each investigator used their smartphone for conducting this search and selection process. The separate lists kept by the investigators were merged to produce the final app list to be reviewed and analysed for this study. Conflicts between the lists were mutually resolved through discussion among all investigators.

2.2 Raters

The three raters chosen to analyse of the CSA-related apps were two final-year Bachelor of Computer Science students with two years of mobile app development experience, a final-year Bachelor student with extensive user interface design experience. Also, two computer science graduates with two years of experience in human-computer interaction and mobile application development research rated one app (Orbit Rescue) for calculating internal consistency.

The raters separately rated all the apps from the final app list produced by the investigators. Their responses were recorded in a response form (Google Forms) and respective rater response data was extracted from the spreadsheet attached to the form.

2.3 App selection process

The complete process of app searching, screening, and selection is depicted in the PRISMA diagram in Figure 1.

Table 1 List of CSA education mobile apps included in quantitative and qualitative analysis

App name	*Country of origin*	*Language*	*Platform*
Orbit Rescue (University of Sunshine Coast, 2017)	Australia	English	Android and iOS
Elements of Child Sexual Abuse (Academy for Professional Excellence, 2020)	USA	English	Android
Bal Suraksha (Mobile Seva, 2021)	India	English	Android
Shishuk jouno hoirani theke bachate koronio (Boishakhi Apps, 2020)	Bangladesh	Bangla	Android
Stewards of Children (Ericsson AB, 2016)	USA	English	Android and iOS
Game on POCSO (West Bengal Commission for the Protection of Child Rights, 2018)	India	English	Android
Stop the Groomer (Sakumura et al., 2018)	USA	English	Android and iOS
ChildAbuseInfo (New Jersey Children's Alliance, Inc., 2020)	USA	English	Android and iOS
iSafe English (Chaitra Creations, 2020)	India	English	Android and iOS
Feel Safe (Family Planning Queensland, 2017)	Australia	English	Android and iOS
Helpio (Amoora, 2020)	Nigeria	English	Android and iOS
Child Abuse Prevention (Mage Media and Entertainment Service, 2019)	Vietnam	English and Vietnamese	iOS
KidzLive (Singapore Children's Society, 2020)	Singapore	English	iOS
The Ceceyara App (The Cece Yara Child Advocacy Centre, 2020)	Nigeria	English	iOS

The keyword-based search strategy employed on three different app stores during the search process attained 191 apps. After this, the apps were selected based on their app store description. This step served as a primary screening stage. For example, if the app description suggested that it included CSA-related information, it was included in the study. For further curation, the following inclusion criteria considered:

1 apps that teach children CSA prevention

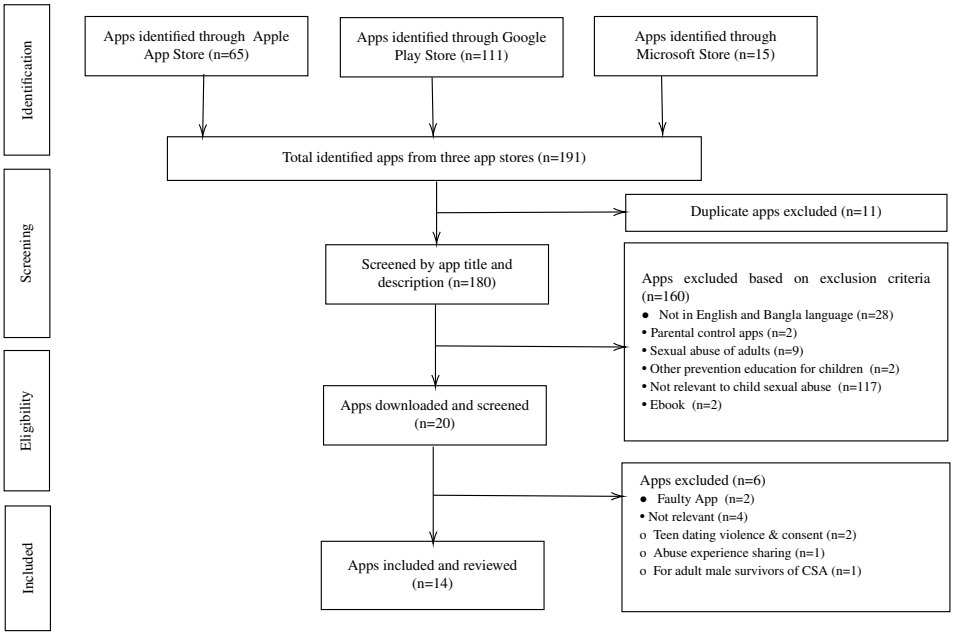
2 apps that teach parents about CSA

3 apps that provide professional training for adults on how to prevent CSA

4 apps that provide legal and medical help to CSA victims.

These inclusion standards were determined to the select apps so that the included apps would satisfy our study criteria.

Figure 1 PRISMA diagram of the method



In this phase, 11 apps were excluded because they had identical apps from the same developer or publisher in multiple app stores (a duplicated app), and therefore were excluded from one platform. Before exclusion, these apps were examined on respective platforms (Android, iOS, and Windows) to check whether they have identical features. The remaining 180 apps were screened by app title and description. From the primary screened of the apps, 160 were excluded for one or several of the following reasons:

1 apps whose language was not English or Bangla as these are the languages the authors are accustomed to

2 apps designed for sexual abuse prevention of adults

3 parental control apps for tracking children's online activity

4 apps that teach children other safety practices (e.g., fire safety, road-crossing safety, etc.) rather than sexual abuse and were selected because of misleading descriptions

5 apps that were categorised as 'e-books'.

For secondary screening, the remaining 20 apps were downloaded on the raters' smartphone device and fully assessed by the three raters individually. The apps that did not satisfy the predefined inclusion/exclusion criteria, were excluded. At this stage, six

apps were excluded because either they were faulty or had content that is not the focus of this study (e.g., experience sharing, adult male survivors of CSA, etc.). Finally, the 14 apps selected in this study are evaluated. The details of the 14 apps (name, developer, country of origin, language, intended platforms) are presented in Table 1. All 14 apps were from the Google Play Store and Apple App Store. There is no CSA-related app reviewed from the Microsoft Store. Most of the apps are from the USA and India. From 14 apps only one app (Shishuk jouno hoirani theke bachate koronio) is from Bangladesh and in the Bangla language. The 'Child Abuse Prevention' app was available in two languages: English and Vietnamese.

2.4 App metadata

Generic information about the apps is extracted from respective app stores under the app metadata category. App metadata incorporates information such as the app name, developer information, store URL, platform, number of downloads, star rating, and country of origin. As this information is excluded from the evaluation, it does not affect the rating scale. Three investigators collected the app metadata from each app store via a Google Form and the data were automatically stored on a Google Sheet. Also, these data were cross-checked after the extraction by all the investigators.

Table 2 Category-wise app name and target age group

Category	*App name*	*Target age group*
CSA education using games	Orbit Rescue	Children under age 12
	Game on POCSO English Version Online	General
	Stop the Groomer	Children (under 12) and adolescents (13–17)
	iSafe English	Children (under 12)
	Feel Safe	Adolescents (13–17)
	Child Abuse Prevention	Children (under 12)
Information guide for children	Helpio	General, above age 12
	The Ceceyara App	General
CSA prevention training for child care officials	Elements of CSA	Adults (child care professionals)
	ChildAbuseInfo	Adults (child care professionals)
Information guide for parents, teachers, and caregivers	Bal Suraksha	Adults (parents and caregivers)
	Shishuk jouno hoirani theke bachate koronio	Adults (parents and caregivers)
	Stewards of Children	Adults (parents and caregivers)
	Helpio	General (parents and caregivers)
	KidzLive	Adults (parents and caregivers)
	The Ceceyara App	General (parents and caregivers)

2.5 App classification

After analysing the apps, we have categorised them into the following subcategories (see Table 2):

1 CSA education using games

2 information guide for children

3 professional training for CSA for child care officials

4 information guide for parents, teachers, and caregivers.

CSA education through games apps incorporates either game-based learning or gamification to engage children and make them aware of the risks. Some apps also teach prevention rules via serious games. Research shows that the most effective way of teaching children is via game or game-based environments (Stieler-Hunt et al., 2014; Moon et al., 2017). The second category apps provide a CSA prevention information guide using information portrayed in charts or tables or text. The apps in the third category are targeted towards adults and provide online professional training for child care officials. Category four includes the apps that guide parents, teachers, and caregivers to protect their children and handle difficult situations. CSA education apps must provide suitable content for the target age groups (e.g., adolescents, young people, and adults). The target age group for each of the apps has been listed in Table 2.

2.6 CSA apps rating scale

We hypothesised that for properly evaluating an app's efficiency in teaching CSA and spreading awareness among the users, the app should include specific features and fulfil certain criteria. As there are many CSA apps on the app stores, a standardised rating scale would help evaluate the viability of these apps. An extensive review of existing mobile app rating scales was conducted to learn significant criteria and standards for evaluating the usefulness of mobile apps. After analysing the existing app rating scales (Faux et al., 2016; Poon and Friesen, 2015; Friesen et al., 2013; Vos-Draper, 2013; Kabir et al., 2021), we concluded that each of them is suited for distinct categories of apps. We focused on essential software quality attributes such as aesthetics, usability, functionality, and performance and efficiency, after analysing research on software quality evaluation.

Guidelines for assessing the usability of CSA education apps have not been set by any previous research. As this is a very sensitive and extremely important issue, we wanted to make sure that the app rating scale we developed was suitable for assessing this category of apps. For this, we took insight from the existing rating scales such as the mobile app rating scale (MARS) (Stoyanov et al., 2015), the end-user version of the MARS (uMARS) (Stoyanov et al., 2016), and the app rating scale for foot measurement apps (FootMARS) (Kabir et al., 2021). We modified these to suit the evaluation requirements for CSA education apps. We adopted distinctive categorical regions from the FootMARS rating scale (Kabir et al., 2021) and introduced an extended variant of the mobile app rating scale for rating CSA education apps. This rating scale includes modifications that we hypothesised to be more important for a CSA education app. It considers specific items that were discovered during the analysis of the selected CSA education apps and previous research on the effectiveness of CSA education programs.

The fundamental domains that are crucial for assessing CSA education apps can be summarised as aesthetics, general features, performance and efficiency, usability, CSA

education-specific functionality, transparency, subjective quality, and the app's perceived impacts on the user.

The app metadata and app classification category collect descriptive information about the app. These sub-scale items were omitted from quantitative measurement. The app quality assessment is centred around the domains aesthetics, general features, performance and efficiency, usability, functionality, transparency, subjective quality, and the app's perceived impacts.

We prepared a questionnaire containing 71 questions for the app quality assessment based on all app quality domains. Fifty-one of these questions were based on a five-point Likert scale. The questions that used the Likert scale to obtain the user's level of agreement or disagreement were all positively scored. The most agreement score was five and the most disagreement score was one. There were some binary scale questions. However, these questions were later converted into a Likert scale for efficient calculation. For situations where a question might not be suitable for all apps, the option 'not applicable' was included. Also, in some cases all the information could not be accessed regarding an app. The option 'not accessible' was provided for such cases. The options 'not applicable' and 'not accessible' were disregarded during the final calculation for app evaluations. The overall score of this rating scale is achieved by adding the mean of individual app quality domains.

2.6.1 Aesthetics

The mobile application market is extensive at present. The internet is overrun with thousands of similar categories of apps with comparable purposes and outcomes. But the question is what makes an app better than others. A blend of innovative ideas, compact engineering, and intelligent design is the answer (Speckyboy, 2015). But there is something else that plays an indispensable role in ascertaining an app's success, which is the visual appeal of the app. A Precise layout and organised user interface elements in an app can draw the line between an app's success and downfall in today's competitive world. This quality is crucial in CSA education apps. One of the main aspects of determining the aesthetics quality of an application is that it is visually appealing to users. As the main target users of the CSA education apps would be children, the apps need to be intriguing to the children. Furthermore, the layout and organisation of the user interface have to be clean, precise, and child-friendly. If any of these characteristics is missing, then the apps will not achieve their goal. The raters considered three factors to measure the aesthetic quality of an app:

1 the layout consistency and readability of the apps
2 content resolution
3 the visual appeal of the app.

2.6.2 General features

For educating children about CSA efficiently, the apps must contain specific features such as addressing grooming, having age and gender-specific knowledge, having information for parents, etc. Apart from these, the apps must have some other general features such as social sharing and data exporting features. These features enable the

users to store what they have learned for future reference and share the knowledge with others. The authentication feature removes the user's dependencies on a particular mobile device for using the app. This feature is enabled by storing data with an individual user's credentials on the cloud with additional security features. A study found that content customisation options and more visual information in apps improve its user value (Stieler-Hunt et al., 2014). The on-board tutorial shows how to use the app properly, which is an important feature, especially for apps that are developed for children. Regular notification from a learning app may increase the usage frequency of that app, resulting in better learning outcomes (Hamari et al., 2016). Some apps provide premium subscription packages which may provide a better user experience, so, this feature was also included in the rating scale. The absence of these qualities was counted as low points while rating the apps.

2.6.3 Performance and efficiency

One of the factors that contribute most to an app's functionality is its performance rate and how efficiently it can run on the user's device. However, the features evaluated for determining performance scores may vary on different devices. The same app may perform differently across different mobile devices, due to CPU performance, total memory usage, total battery life impact, the level of device heating, etc. The raters used the data found from App settings (Android) or auxiliary software (iOS) at 15-minute intervals for tracking the battery usage of the apps. An ideal app must have the ability to work efficiently on all of devices. The apps should be lightweight and work fast since children have minimal patience compared to adults. Also, the apps that provide online courses and reporting, require greater processing power than the others. Raters thus tracked the following points for evaluating the performance efficiency of the apps:

1 how much time the app takes for responding
2 whether the features and components work accurately
3 whether the app crashes frequently
4 how much memory storage the app takes
5 whether there were any noticeable changes in device temperature during usage.

2.6.4 Usability

One of the most important steps of app development is usability. It performs a key role in shaping users' experiences and can be defined as the property that evaluates how easily a system interface can be used. Previous works involving human-computer interaction (HCI) and user-centred design show that non-intuitive gestures and poor organisation of app elements are the usability defects that drive users to abandon some mobile apps and search for better alternatives (Torous et al., 2018). Usability testing of an app is crucial in deciding whether the app has an adequate quality to draw the attention of its target user groups. For an app to be successful, it must be intuitive, and the user should be able to gain some level of familiarity with the interface quickly. Navigation and ease-of-use features come into play to ensure this. Higher ease of use increases the probability that an app will remain installed on a user's phone. The

usability of an app in real life fluctuates considerably compared to that in laboratory settings, due to the diversity of user behaviour and the user experience (Kekäläinen et al., 2005). This implies that the usability testing of an app is a crucial part of app development. By analysing previous app rating systems (Stoyanov et al., 2015, 2016), we evaluate an app's usability as 'good' if it provides the following qualities:

1 the app can be operated with ease
2 the app can be navigated without any interruption
3 the gestural designs and screen links (e.g., buttons, arrows, navigation panels, etc.) work uniformly across the whole app
4 the app presents an interactive experience.

These requirements were examined by the raters when rating the usability criteria of an app.

2.6.5 CSA education-specific functionality

The availability of certain features is one of the fundamentals for the apps that are created for expanding awareness and prevention education about CSA. However, having more properties does not imply that the app will be capable of achieve its target goal. CSA is a terrible and extremely sensitive issue, hence any application concerning this issue will only be beneficial when it can engage the children's interest and efficiently train them in safety rules. Also, the app must be able to spread knowledge and awareness among parents and caregivers on how to protect their children (Walsh and Brandon, 2012).

Apps about CSA can be divided into two categories: the first includes the apps that target children's education and the second is apps for parents and caregivers. Apps created for children also vary in factors regarding the approach followed for teaching children. Some apps utilise game environments or components as a method of education. Other apps use information and quizzes for teaching prevention rules. Several CSA education apps provide professional training for social workers and child care professionals. There are also apps for spreading awareness among parents about the dangers of CSA. Few apps have provided education for both adults and children. The common features of CSA education apps were identified by reviewing the existing apps.

Therefore, after considering the important guidelines for CSA education apps, we developed the app-specific functionality rating for CSA education apps. A major part of CSA education is teaching children prevention rules to help them stay safe from abuse (Kang et al., 2020). It is also important to educate parents and children regarding the risk of grooming techniques used by perpetrators to abuse children (Bennett and Donohue, 2020). Research about the efficacy of CSA education points to the fact that teaching methods such as game-based learning, gamification or serious games work better in teaching children prevention education (Stieler-Hunt et al., 2014). And evaluating children's knowledge after the lessons is necessary to identify the effectiveness of such apps. Research also shows the importance of providing age and gender-specific CSA education to children (Hébert et al., 2001; Scholes et al., 2012). Parents play a crucial role in protecting children from abuse. Hence, their involvement in the teaching process

is also necessary (Walsh and Brandon, 2012). It is also important for apps to provide information regarding help centres for medical and legal aid to sexually abused children. Hence, we included these two points in our CSA education-specific sub-scale.

To be considered useful in preventing CSA, an app must include the following features:

1 prevention education for children
2 addresses the risk of grooming
3 uses game-based learning, serious games or gamification
4 evaluates children's knowledge
5 provides age-specific education
6 provides gender-specific education
7 facilitates parent involvement
8 provides guidance to seek legal help
9 provides medical or counselling help
10 applicable for physically or mentally challenged children
11 provides abuse reporting facility.

2.6.6 Transparency

Privacy is an increasing concern in the digitally connected world. Mobile apps require user's social and personal information for proper functioning. However, the ability of consumers to make informed choices regarding their privacy is difficult at present in the mobile application marketplace. Businesses that capitalise on these personalised services make this choice even harder. Often, apps trade user's private data without awareness of the individuals (Chang et al., 2020). App users fall into these traps due to insufficient knowledge regarding mobile application privacy policies. Users must be conscious while consenting to their private data being accessed by apps. They should make a habit of properly reading the privacy guidelines before clicking the 'accept' button in any circumstance.

Data protection and regulation rules must be followed strictly by the apps. Furthermore, they should explicitly explain how and why they are collecting users' data. In the case of CSA education apps, the privacy guidelines should be followed strictly. Evaluation of transparency is a significant part of the app rating. With the proper and clear information, a user can make an informed decision before downloading the app by ascertaining the app's authenticity. The following points were considered to assess the transparency criteria of the selected apps:

1 whether a common alert is provided to take users consent before obtaining their personal information, location information, and/or private data
2 evaluating the accuracy of the information given on the app store description
3 determining the authenticity of the publisher or developer and the app source

4 whether the app is feasible to achieve the desired goals as claimed by the developer.

2.6.7 Subjective quality

The subjective quality of an app is based on the perspective of a user of the app. This quality can be measured by the user's app ratings and comments about the app. Much lot of information regarding the performance of an app can be found from the reviews in the app store as users often comment about their user experience in detail. Both the flaws and the unique features of an app can be discovered from user reviews. These comments can be helpful during the app review phase. So, subjective quality analysis can be a useful criterion for app evaluation. In this study, a similar approach was used for the subjective quality section. The app raters evaluated subjective quality by answering questions about the degree of satisfaction of use, potential frequency of use in the future, overall app rating, and how likely they were to pay for the apps.

2.6.8 Perceived impact of app on users

The success of an app can be determined by the impact it has on its users. Continuous discoveries in the branches of computer science and mobile apps have assisted thousands of users in finding useful and sometimes life-saving information, including many apps that are designed to provide different prevention education (e.g., sexual abuse prevention, drug abuse prevention) to users (Tait et al., 2018; Jones et al., 2020). In apps for prevention education, the main goal is to increase awareness about crime or addiction and provide necessary information about preventing this problem. Additionally, such apps may also provide intervention methods and guidance to decrease the user's negligence towards the specific problem and increase help-seeking behaviours targeting solutions to the problem. However, according to Milne-Ives et al. (2020), most health-oriented and prevention education apps yield little to no evidence of effectiveness in user outcomes and behavioural changes.

To determine the usefulness of CSA education apps, these apps must be evaluated according to their effectiveness in changing users' attitude towards CSA education and spreading awareness about CSA (Milne-Ives et al., 2020). App store comments and ratings can be used for evaluating the perceived impact an app has on its users. From the user reviews, we can get an idea about the effect the app has had on its users. The impact of an app on its users cannot be directly quantified. Therefore, the apps were rated on the following aspects to assess how much they made an impact on users:

1 whether the app contained information for raising awareness regarding CSA

2 how informative the app is considering CSA education and dangers of CSA

3 whether the information or learnings of the app will improve users' attitudes about the necessity of CSA education

4 whether the app will induce further help-seeking behaviour among users.

3 The results

In this section, an overall assessment of the reviewed 14 apps is presented. Also, a comparison between the app store rating and our rating is given. The app-specific criteria are discussed in detail. Lastly, we analyse the app store user comments to understand the good and bad aspects of existing CSA-related apps.

3.1 Internal consistency of modified rating scale

Cronbach's alpha is the most popular means of calculating internal consistency. It denotes how well a test measures, and how consistent the scale items are (Cronbach, 1951). This method has been used for calculating the internal consistencies of the sub-scales of our modified rating scale: aesthetics, performance and efficiency, usability, transparency, subjective quality, and perceived impacts on users (see Table 3). One of the CSA education apps 'Orbit Rescue' was selected for determining internal consistency. Additionally, the internal consistency of the full modified rating scale was estimated. Cronbach's alpha reliability coefficient usually ranges between 0 and 1. The closer Cronbach's alpha coefficient is to 1.0, the higher the internal consistency of the scale (Cronbach, 1951). Generally, a coefficient value greater than 0.75 is considered acceptable. However, a coefficient value greater than 0.5 is also accepted if the internal consistency is calculated for limited items. For five independent raters, the internal consistency of all sub-scale items was moderate to high. The overall internal consistency of the modified rating scale was high at alpha = 0.93, which is considered excellent (Gliem and Gliem, 2003). The sub-scale alphas were also in the range of good-excellent as can be seen in Table 3. The alpha values indicate that all the items in our modified rating scale had a high level of internal consistency. For getting positive values of Cronbach's alpha, we made sure that all questions of the scale were coded in the same way. No positively and negatively worded questions were mixed. Reverse coding was done for the negatively worded questions.

Table 3 Internal consistency of the sub-scales

CSA app rating sub-scale	*Cronbach's alpha (α)*	*Internal consistency*
Aesthetics	0.92	Excellent ($0.9 \leq \alpha$)
Performance	0.94	Excellent ($0.9 \leq \alpha$)
Usability	0.81	Good ($0.8 \leq \alpha < 0.9$)
Transparency	0.84	Good ($0.8 \leq \alpha < 0.9$)
Subjective quality	0.70	Acceptable ($0.7 \leq \alpha < 0.8$)
Perceived impact	0.93	Excellent ($0.9 \leq \alpha$)

3.2 Inter-rater and intra-rater reliability of the modified rating scale

The evaluation of inter-rater reliability provides a way of quantifying the level of agreement between two or more raters who make independent ratings about the features of a set of subjects (Sawa and Morikawa, 2007). The significance of inter-rater reliability depicts the degree to which the data collected in the study consists of correct descriptions of the variables measured. When several raters judge a scale, inter-rater

reliability is significant to evaluate if their rating is correlated. To determine the appropriate method for calculating inter-rater reliability two things should be considered. First, it is required to know if all items included in a study have been rated by several raters, or if only a single subset is rated by multiple raters. Second, it must be determined if the same set of raters will rate the items or whether separate items are rated by separate subsets of raters. In our study, all apps were rated by the same three raters. We used the intra-class correlations (ICC) method to assess inter-rater reliability. Intra-class correlation (ICC) is one of the most popular statistics for evaluating inter-rater reliability if a study includes two or more raters (Hallgren, 2012). We have used the ICC two-way mixed model, since the use of this model is preferred when each rater assesses each app, and the raters are fixed but not randomly chosen (Koo and Li, 2016). Depending on the 95% confidence interim of the ICC estimation, values smaller than 0.5, within 0.5 and 0.75, within 0.75 and 0.9, and higher than 0.90 are suggestive of poor, moderate, good, and excellent reliability, sequentially (Koo and Li, 2016). Independent ratings on the overall scale for our final fourteen CSA education apps exhibited a high level of inter-rater reliability. Our calculated inter-rater agreement is 2-way mixed ICC = 0.97, 95% CI 0.97–0.98, which can be considered as a great level of rater reliability or agreement (Hallgren, 2012).

Intra-rater reliability is estimated to measure the validity of a test. This is a kind of reliability estimation in which the same evaluation is performed by the same rater on more than one occasion. These different ratings are then compared, generally using correlation. Again, we have used the ICC method for analysing the intra-rater reliability of our three raters. Three raters rated the final fourteen apps twice in the interval of four weeks. After completion of both ratings, consistency between two ratings of the same rater was calculated to see if their rating is reliable. This was done for all three raters – rater one showed high reliability between her two ratings (2-way mixed ICC = 0.97, 95% CI 0.97–0.98), rater two and three also presented excellent intra-rater reliability of (2-way mixed ICC = 0.96, 95% CI 0.96–0.97) and (2-way mixed ICC = 0.98, 95% CI 0.98–0.99).

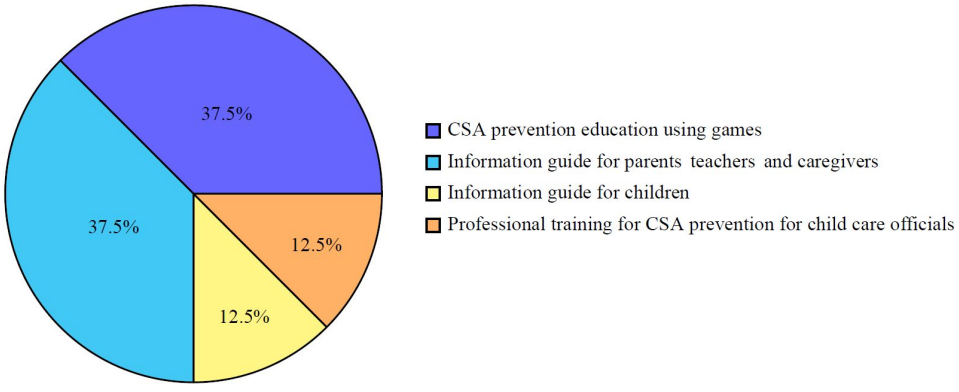
3.3 Categorical distribution of CSA education apps

The categorical distribution of all reviewed apps is shown in Figure 2. It shows that both the ‘CSA prevention education using games’ and ‘information guide for parents, teachers, and caregivers’ categories hold 37.5% of the total 14 apps. Also, 12.5% apps are placed in both the ‘information guide for children’ and ‘professional training for CSA prevention for child care professionals’ categories. Among the fourteen apps, two fall in both the ‘information guide for children’ and ‘information guides for parents, teachers, and caregivers’ categories (‘Helpio’ and ‘The Cece Yara App’).

It is evident from Figure 2 and Table 2 that most of our final fourteen apps belong to ‘CSA prevention education using games’ and ‘information guide for parents, teachers, and caregivers’ categories. Research shows that game-based learning or learning via serious games or using gamification components in teaching prevention programs are more efficient than traditional rote learning (Stieler-Hunt et al., 2014). Games help keep children engaged and make the learning process enjoyable (Behnamnia et al., 2020). CSA education using games can help children to learn the safety rules more effectively (Jones et al., 2020). Children can learn about the dangers of CSA while playing the game and also get to know how to prevent CSA. Apps in this category use different

methods for engaging children such as animated videos where cartoon characters explain the safety rules, mini-games that teach how to overcome difficult situations or interactive evaluation of the knowledge gained from a lesson.

Figure 2 Categorical distribution of apps (see online version for colours)



The other category with the most apps is the 'information guides for parents, teachers, and caregivers'. These apps spread awareness about CSA and educate parents on how they can protect their children. Parents play a crucial role in protecting children from abuse. Hence, apps in this category are highly significant. Moreover, parents can also learn how to handle disclosure about abuse and how to treat abusers.

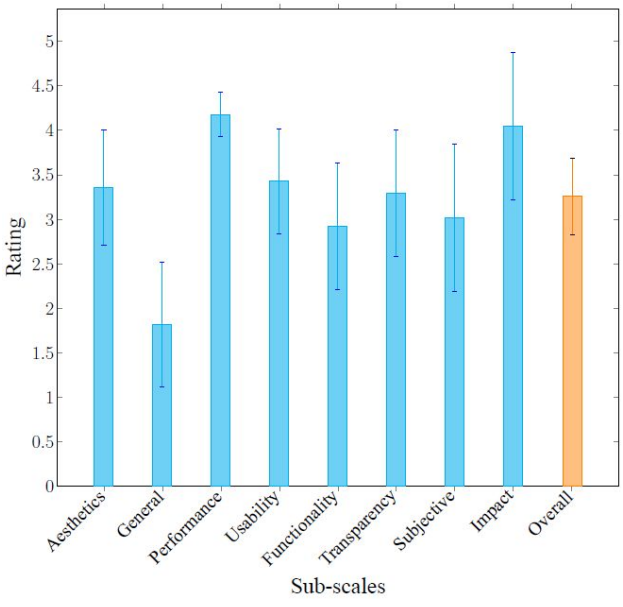
3.4 Evaluation scores

We calculated the mean and standard deviation of the sub-scale ratings for each app in Table 4. The scores the apps received in different sub-scales were used to calculate the app's overall mean and standard deviation. From the table, we can see the app that scored the lowest was named 'Shishuk jouno hoyrani theke bachate koronio'. The overall mean score for this app is 2.29, which shows that it is not of great quality and is not effective for spreading prevention information. The reason for this low score is also visible on the table. This app scored low in all the rating sub-scales and as a result, had an overall low score. It belongs to the category 'information guide for parents, teachers, and caregivers'. On the other hand, the highest mean score is 3.92. The app 'Orbit Rescue' received this score. This app scored more than average in all the rating sub-scales.

The results in the table show that the domains aesthetics, performance and efficiency, and usability have higher scores in contrast to other domains. The general range of aesthetics, performance and efficiency, and usability stands between 2.50 to 4.50, 3.86 to 4.57, and 2.75 to 4.75, respectively. Among the domains mentioned above, general app features and application-specific functionality domains received the lowest mean rating (1.82 and 2.92, respectively, out of 5). In contrast, the most highly rated domains were app performance and efficiency and perceived impact of apps on users, which received scores of 4.18 and 4.05 out of 5. Other domains that scored more than 3 out of 5 were aesthetics (3.36/5), usability (3.43/5), transparency (3.29/5), and subjective

quality (3.02/5). Domain-specific rating scores and the overall app rating are calculated from the data in Table 4 and have been depicted in Figure 3. We computed the overall app rating (mean score) from the individual mean scores of each app. The overall app rating is 3.26 out of 5.

Figure 3 Sub-scale specific ratings and overall rating (see online version for colours)



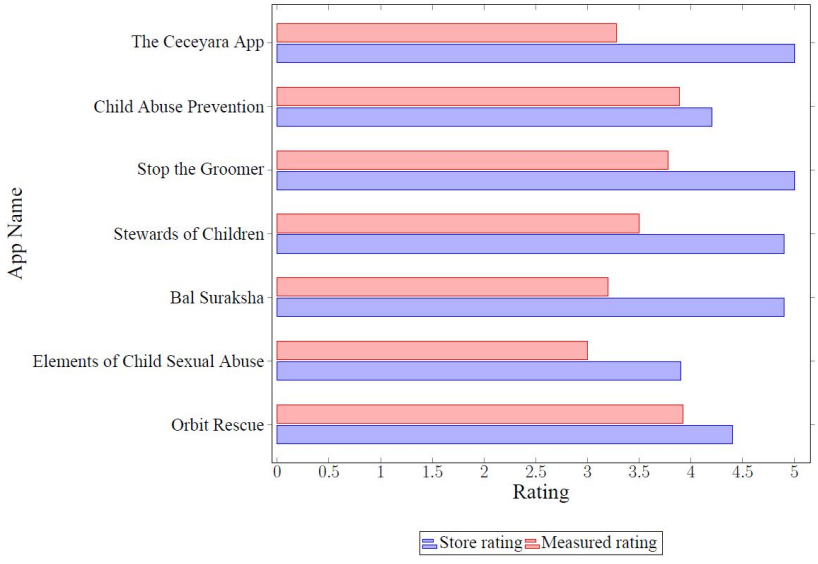
3.5 Comparison of store rating and rating scale measured ratings

A comparison between the 14 selected apps' store ratings and the score received from our rating scale is shown in Figure 4. Seven of the 14 apps had no rating in the app stores (i.e., Shishuk jouno hoirani theke bachate koronio, Game on POCSO English Version Online, ChildAbuseInfo, iSafe English, Feel Safe, Helpio, and KidzLive). Therefore, we excluded them from this comparison. We calculated the standard deviation of the total app store ratings and our rating scale score. The difference between the two standard deviation scores for the reviewed apps was 0.08. This deviation is reasonable, considering that the score in our rating scale is an aggregated mean of various domains necessary for specifying the quality and criteria of CSA education apps. Two of the 14 apps (e.g., Stop the Groomer and The Ceceyara App), which had a five-star rating in the app store, did not get the full score on our modified rating scale and received 3.78 and 3.28, respectively, out of 5. The app that scored the highest rating on our scale was called 'Orbit Rescue'. This app received 3.92 on our rating scale and 4.40 in the app store. The app that had the second-highest rating according to our scale is 'Child Abuse Prevention'. This app had a 4.2 rating in the app store and 3.89 on our rating scale. Overall, the measured rating scores for each app are less than the app store rating value. A possible reason for this difference is that we have determined rating scores by calculating the mean of all sub-scale values.

Table 4 Evaluation scores for CSA education apps

App name	*Aesthetics*	*General*	*Performance*	*Usability*	*Functionality*	*Transparency*	*Subjective*	*Impact*	*Mean (st. dev.)*
Orbit Rescue	4.25	3.00	4.00	3.75	3.57	4.25	3.67	4.83	3.92 (0.55)
Elements of Child Sexual Abuse	3.50	1.50	4.57	3.75	1.29	3.25	2.67	3.50	3.00 (1.13)
Bal Suraksha	3.25	1.50	4.43	3.25	2.71	3.25	3.00	4.17	3.20 (0.90)
Shishuk Jouno Hoirani Theke Bachate Koronio	2.75	1.00	4.57	3.50	1.86	1.50	1.33	1.83	2.29 (1.22)
Stewards of Children	2.50	2.00	4.29	2.75	3.29	4.50	4.00	4.67	3.50 (1.01)
Game on POCSO English Version Online	4.00	1.50	4.14	3.50	2.71	3.50	3.33	4.33	3.38 (0.92)
Stop the Groomer	4.25	1.50	4.29	4.75	3.29	3.50	3.67	5.00	3.78 (1.10)
ChildAbuseInfo	3.00	1.50	4.00	2.75	3.29	3.50	2.33	4.83	3.15 (1.02)
iSafe English	2.75	2.50	3.86	2.75	3.29	3.00	2.00	3.33	2.94 (0.57)
Feel Safe	2.75	2.00	4.00	3.00	3.00	2.75	3.67	4.17	3.17 (0.73)
Helpio	3.00	2.50	4.43	3.25	3.00	2.75	2.33	3.67	3.12 (0.68)
Child Abuse Prevention	4.50	3.00	4.14	4.25	3.00	3.25	4.33	4.67	3.89 (0.69)
KidzLive	3.25	1.00	4.00	3.00	2.43	3.75	3.00	3.67	3.01 (0.96)
The Ceceyara App	3.25	1.00	3.86	3.75	4.14	3.25	3.00	4.00	3.28 (1.01)

Figure 4 Comparison between app store rating and measured rating (see online version for colours)



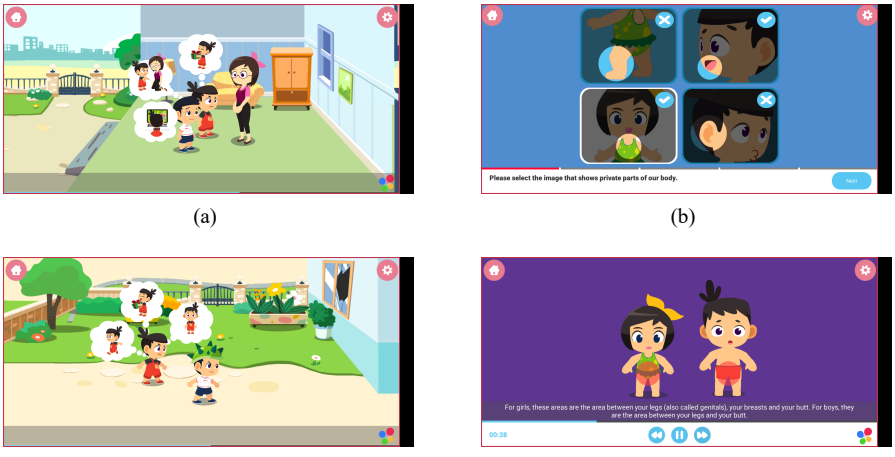
3.6 *Assessment of CSA education-specific functionalities in apps*

For evaluating CSA education apps, some essential functionalities for a CSA education app were defined. The use of game-based components, including information about grooming, gender, and age-specific prevention techniques, providing knowledge for adults, presenting legal and medical help are some of the key points for measuring the effectiveness of a CSA education app. Our rating scale evaluated the apps based on 11 measurement criteria. These CSA education-specific functionalities and the percentage of apps that have these features are shown in Table 5. Figures 5 and 6 show some apps' screenshots of CSA education-specific functionalities.

Table 5 Assessment of CSA education-specific functionalities in apps

Functionality measurement criteria	*Google Play (n = 8) n (%)*	*Apple Store (n = 6) n (%)*	*Total apps (N = 14) N (%)*
Uses game/game-based components/gamification	3 (37.50)	4 (66.67)	7 (50.00)
Teaches about grooming	2 (25.00)	3 (50.00)	5 (35.71)
Teaches children using information	1 (12.50)	1 (16.67)	2 (14.29)
Gender specific teaching	1 (12.50)	2 (33.33)	3 (21.43)
Age specific teaching	2 (25.00)	0 (0)	2 (14.29)
Evaluates children's knowledge	3 (37.50)	4 (66.67)	7 (50.00)
Parent's involvement	6 (75.00)	5 (83.33)	11 (78.57)
Provides medical aid	3 (37.50)	2 (33.33)	5 (35.71)
Provides legal info	4 (50.00)	5 (83.33)	9 (64.29)
Provides reporting system	2 (25.00)	4 (66.67)	6 (42.86)
Considers physically/mentally challenged children	1 (12.50)	1 (16.67)	2 (14.29)

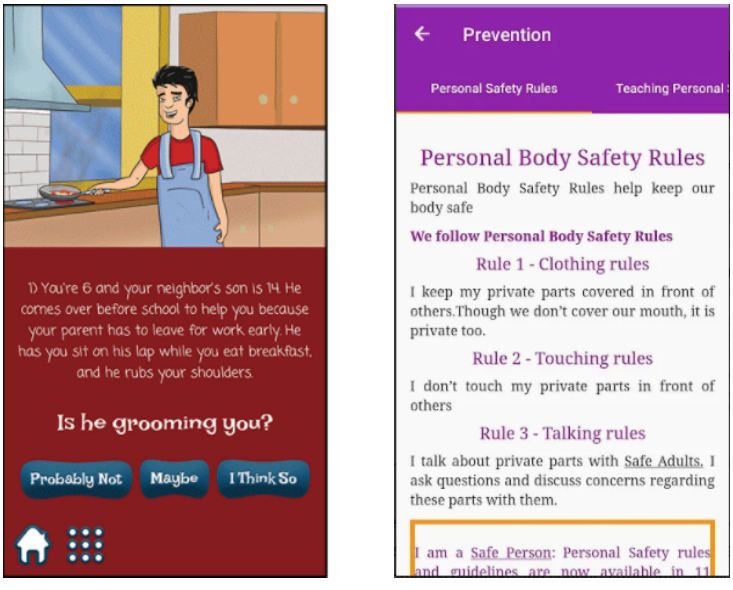
Figure 5 Screenshots of 'Child Abuse Prevention' app showing their CSA education-specific functionalities, (a) parent's involvement in learning (b) evaluates children's knowledge (c) use of game in learning (d) provides gender-specific teaching (see online version for colours)



(a) (b)

(c) (d)

Figure 6 Screenshots of apps showing their CSA education-specific functionalities, (a) 'Stop the Groomer' app: teaches grooming and evaluates children's knowledge (b) 'Bal Suraksha' app: teaches children using information (see online version for colours)



(a) (b)

Table 5 shows that the 'parent's involvement' feature is found in 78.57% (11 out of 14) of the apps. Figure 5(a) shows a screenshot of parent's involvement feature of 'Child

Abuse Prevention' app. The next feature that most apps have is legal information for users 64.29% (9 out of 14) of apps include this feature. It is important to evaluate how well children have received the teaching to assess the effectiveness of a prevention program. 50% of the apps (7 out of 14) evaluate children's knowledge regarding CSA and CSA prevention immediately after a lesson. Figure 5(b) shows a screenshot of 'Child Abuse Prevention' app evaluating children's knowledge. Serious games or gamification were used as a teaching method by 50% of the apps. Figure 5(c) shows a screenshot of 'Child Abuse Prevention' app that uses game in learning. Having a reporting system for users to report abuse and provide medical aid in case of abuse is also a significant feature that CSA education apps must include. Among the 14 apps, 42.86% (6 out of 14) apps have a reporting system, and 35.71% (5 out of 14) of apps provide medical aid-related information.

Five apps (35.71%) used charts, graphs, and tables to provide prevention information. Only for of 14 apps (Orbit, Stop the groomer [see Figure 6(a)], iSafe English, and Helpio) provide knowledge about grooming techniques, which is an essential aspect of CSA education. Other criteria where the reviewed apps lacked were providing age and gender-specific knowledge and special education for disabled children. Only two apps (14.29%) mention in their store description that they can help physically or mentally challenged children. Also, 3 apps (21.43%) had gender-specific information [see Figure 5(d)] and 2 apps (14.29%) had age-specific information for children. It is evident from these statistics that gender-specific and age-specific teaching are rare in reviewed apps. Six of the apps targeted a general age group with no age requirements (42.86%). These apps were for the use of parents, caregivers, and childcare professionals. Among all the apps, 4 (28.57%) are targeted at children under age 12. Two apps (14.29%) deal with adolescent users (aged between 13 to 17) – they are 'Stop the Groomer' and 'Feel Safe'. The app 'Stop the Groomer' targeted both children and adolescents.

Overall, among 14 apps, one app (The Cece Yara App) had seven features from 11 desired features. Three apps (Stop the Groomer, iSafe, and Helpio) included six features: 57.14% of apps (9 out of 14) have less than half these features. 'Elements of Child Sexual Abuse' app had no features and 'Shishuk jouno hoirani theke bachate koranio' app had only one feature.

Most of our reviewed apps are missing several criteria and most do not provide CSA lessons systematically, which is required for learning efficiently. Children's knowledge regarding prevention should be tested multiple times during the learning (Stieler-Hunt et al., 2014). Also, any app for CSA and its prevention needs to have a trusted adult involvement. Moreover, it must include all of the required measurement features for effectively in rendering prevention education against CSA. In our study, apps that targeted parents and caregivers provide a small amount of information regarding how they can protect children from abuse, how to deal with cases of abuse, where to seek medical or counseling help, etc. Finally, during the app evaluation, no app was found that focused specifically on children with disabilities.

3.7 Analysis of user reviews from app store

The most common way to know whether an app provides all the claimed features is to scrutinise the app store comments left by users of the apps (Guzman et al., 2018). Nowadays, all major app stores allow users to critique their hosted apps. These user

comments often provide detailed information about the features of the apps, which gives general users a clear insight about the apps' performance. These comments point out the shortcomings of these apps as well. Many users rely on users' reviews before downloading an app. As a consequence, developers and publishers aim to receive good and positive reviews, since these reviews act as quality indicators of apps (Vasa et al., 2012).

Considering the importance of user comment analysis, we collected users' feedback for the apps from the respective app stores while collecting metadata. We divided the user comments into two categories based on the users' rating for the apps: if the rating is four stars or more the comment is considered 'good', otherwise the comment is considered 'bad'. We discovered that most of the apps do not have a sufficient number of feedback comments from users because the number of downloads for the respective apps was generally low. Two apps (14.29%) were downloaded only 10+ times and two apps (14.29%) were downloaded 100+ times. Three out of 14 apps (21.4%) have been downloaded 1,000+ times. And only one app (Elements of Child Sexual Abuse) has been downloaded more than 5,000 times. The Apple Store does not provide access to the number of downloads for iOS apps (6 out of 14). Moreover, the number of informative reviews was very low as users rarely give detailed reasons for their rating and sometimes they write irrelevant comments (Vasa et al., 2012). Our study discovered that 35.7% of the apps (5 out of 14) had no comments and 21.4% (3 out of 14) had extremely short comments to support the ratings.

To gain a better insight from the users' comments, we used a word-cloud to visualising the comments. In Figure 7, the positive and negative comments are portrayed. Figure 7(a) illustrates the words derived from positive comments of the users. The most used words are 'app', 'love', 'kids', 'great', 'game'. From these words, we can say that users preferred the apps that use a game for teaching children about prevention education. Figure 7(b) represents the negative comments of the users. The most visible words in this word-cloud are 'private', 'picture', 'parts', 'image'. The number of negative comments was low. Therefore, getting an insight from the word cloud is difficult. However, the most common words indicate one app has some technical difficulties in a lesson where the game freezes when users select the private parts. Some apps had received specific complaints in their negative comments for their performance issues such as 'features not working properly', 'app freezing continuously', 'all lessons not being available in the free version'. It was perceived from the negative comments that the structural flow of technical aspects was confusing and difficult in some apps, making it difficult for the user to follow.

Only one of the reviewed apps, 'Stop the Groomer', has detailed informative reviews from users. Users referred to this app as both engaging and informative for children. This app focuses on teaching children about the grooming techniques that perpetrators use. It includes game-based components where children learn how to stay safe by playing simple games and can implement their knowledge in real-life scenarios. This app has a five-star rating based on the reviews of several users. Good feedback with no negative comments was found in the app 'Bal Suraksha', which also scored high ratings in the app store. This app belongs to the category of information guide for parents, teachers, and caregivers. Targeted users for this app are parents and it provides information about teaching children safety rules, answering children's questions about sexual abuse, dealing with disclosure of abuse, etc. According to users, this app helps spread awareness among adults about CSA education. Another app where user

comments were positive and consistent with app store ratings is 'Stewards of Children'. This app is targeted towards the adults in a child's life. It provides training regarding CSA to parents and caregivers. Parents can also evaluate their knowledge using this app. Even though this app mostly has good reviews, the app's rating was low according to our app rating scale.

Figure 7 Word cloud of, (a) good (b) bad comments (see online version for colours)

(a) (b)

The app that has the maximum number of positive reviews is 'Orbit Rescue'. But the comments are not very informative. This app uses a serious game for educating children about CSA prevention and is targeted at children between the age of 8 to 10 years. Users suggest this app is an excellent app for teaching safety rules to children. However, it also contains a few negative comments that imply this app might have some technical difficulty. The ratings of our modified scale were consistent with user review and app store ratings. Our rating was also consistent with user reviews for the app 'Child Abuse Prevention'. This app uses a serious game approach and has quite a few app store reviews, containing both positive and negative comments. It includes 26 stories that teach children aged 3 to 10 years about prevention rules to stay safe from abuse. One of the negative aspects highlighted in the comments is that this app should be made free for wider accessibility.

We have found an interesting observation between the app store rating and user comments. For starters, 'The Cece Yara App' has a five-star rating in the app store. However, it does not have any user comments. The comment size was low for 'Elements of Child Sexual Abuse' and mostly irrelevant, but the app store rating was high. Also, the apps 'Helpio', 'Feel Safe' and 'Game on POCSO English Version Online' have user reviews, but no star rating in the store. The apps 'Kidzlive', 'iSafe', 'ChildAbuseInfo', and 'Shishuk jouno hoyrani theke bachate koroniyo' had no user comments.

From the analysis of the CSA education apps' user reviews, it can be argued that user comments do not always represent the actual status of the apps. Also, there is a difference between users' comments found in the app store for an app and the rating of our modified scale. One of the reasons for this is the variation of the apps' performance and functionality characteristics observed in different devices, as most of the apps we have reviewed performed differently on different devices. This implies that the bulk of the apps currently available in app stores have built-in and device-to-device functioning issues. Hence, they require proper optimisation on various devices. Another potential reason for the variance between ratings and user reviews is that general users

hardly focus on perceived impacts, transparency, and technical functionality of the apps. Therefore, the user comments on the app store are not reliable in determining the apps' overall software quality characteristics.

4 Findings and discussion

4.1 Limitations of reviewed apps

4.1.1 Feasibility of reviewed apps as CSA prevention programs

Although there are plenty of apps that claim to provide CSA prevention information, most of them lack the key features (such as using game-based learning or serious games to teach children, involve parents in the education process, providing age and gender-specific education, etc.) that were deemed necessary by our study. Furthermore, delivering appropriate content to the target age group, creating content that will interest and encourage children and caregivers to learn, and evaluating the children's rate of learning are some of the characteristics that are indispensable for an app to work effectively as a CSA prevention program (Kenny and Wurtele, 2012). While apps may be targeted at different users, such as younger children, adolescents, or adults, their main goal is spreading awareness of the horrors of CSA. For an app to achieve the goal of being successful as a CSA prevention program, it must have both the software quality characteristics and the specific features required for spreading knowledge about CSA. Therefore, apps that cannot fulfil the measurement criteria determined by this study for rendering proper and precise CSA education are deemed unsuitable for being used as CSA prevention programs.

By analysing the existing literature (Jones et al., 2020; Moon et al., 2017; Othman et al., 2015), a CSA education-specific functionality sub-scale was devised that inquires about the most important features of a CSA education app such as parents' involvement in education, using scenarios that children can relate to, including education about grooming, etc. Studies show that parent's involvement in the CSA education programs is crucial (Rudolph et al., 2018). Also, parents themselves need to know all the crucial information about CSA and its prevention methods. Without the proper knowledge, they will not be able to protect their children or deal with post-abuse situations. Moreover, young children require their parents' help to better understand what they are learning. Among the apps we have reviewed, only one app (The Cece Yara App) had achieved 7 out of 11 features. Six apps had five or more features, and seven apps had less than five features. Among them, one app has fulfilled only one feature. Also, there was an app that did not satisfy any CSA education-specific features that were required. The app with the maximum number of features, did not score very well in our overall rating. The reason for this inconsistency is that it has received a low score in other sub-scales of the rating scale like, aesthetics, general app features, transparency, and subjective quality. A similar variance between software quality characteristics and CSA education-specific features was seen among the apps 'Stop the Groomer', 'Helpio' and 'iSafe'. They also had more than average features but failed to meet the quality standard and thus, scored low in overall ratings. Another reason for this is the lack of more features and the features available being poorly optimised. On the flip side, the app 'Orbit Rescue' scored the highest rating in our modified rating scale. This is because this app provides all the necessary CSA education features along with required software quality characteristics.

Another app, 'Child Abuse Prevention', scored second-highest because it also possesses both the software qualities and necessary features.

From the apps we reviewed, none fulfilled all of the crucial points necessary for rendering effective CSA education. For example, children with either physical or mental disabilities are more dependent on adults for their care. Hence, they stand a higher risk of being abused (Sanderson, 2004), but only two (The Cece Yara App and Orbit Rescue) of the 14 apps have mentioned disabled children. And these two provided no information on how disabled children can protect themselves or how their caregivers can keep them out of harm's way. One app included a character with a wheelchair as the main player (Orbit Rescue). And the other app (The Cece Yara App) only informed adults about the increased risk of abuse for disabled children; it offered no information on how they can be protected. CSA education apps must be equally appealing and relatable to all of the target audience including children of all gender identities (Scholes et al., 2012). However, the existing apps mainly focus on scenarios where female children are abused. In our study, we found that only three apps (iSafe, Child Abuse Prevention, and Feel Safe) feature gender-specific abuse scenarios. This absence of knowledge regarding the situations where male children face the risk of abuse leaves them confused about which situations are dangerous for them and how to overcome those situations.

Another important feature that the present apps fail to provide is proper age-specific CSA education. Small children have less attention spans than older children. Also, younger children need special care and often require parental supervision for understanding what they are learning (Hébert et al., 2001). Therefore, apps targeted towards them need to have easily understandable content and a simple user interface. However, the simplistic content in the apps created for younger children will not be able to engage older children. Hence, the inclusion of age-specific content is indispensable. Only the app 'Feel Safe' provided age-specific scenarios of CSA and taught children how to prevent or deal with those situations. To protect themselves children need to recognise the various tactics that abusers apply to manipulate and exploit children (Scholes et al., 2012; Smallbone and Wortley, 2001; Wurtele, 2014). Unfortunately, only five of the 14 apps discussed how to be safe from grooming tactics. And only two of them, 'Stop the Groomer' and 'Orbit Rescue', include proper preventative knowledge for children. Also, the app 'Child Abuse Info' provides such information for child care professionals.

Transparency is an extremely important part of any mobile app. Without proper credibility, no app can be considered trustworthy (Corral et al., 2014). The questions we inquired about in our transparency sub-scale included user consent, the accuracy of the store description, the legitimacy of the source, and the feasibility of achieving the stated goals. Three out of 14 apps scored 3.5 and above out of 5 in the transparency sub-scale. These apps tried to fulfil the goals that they promised in their app store description. But only one app, 'Orbit Rescue', had published literature to support the fulfilment of their goal, which is to assess the effectiveness of a game-based approach to teach CSA education to children aged 8–10 years (Scholes et al., 2014). Ten of the 14 apps had related websites that provided more information. Three apps (Bal Suraksha, Child Abuse Info, and Game on POSCO) were part of government projects and thus had high legitimacy. Some apps were not explicit about the consent taken from the user. Moreover, some apps did not even have information about their privacy policy regarding users' personal information on their support websites or inside the app privacy policy

page, which raises a question about the authenticity of their intention of keeping user data private.

The most amazing part of having apps that teach about CSA is that children can learn by themselves from any location. However, for individual use of these apps as CSA prevention programs, they need to have all the necessary features and information. When child abuse prevention programs are integrated into school systems, their efficiency increases (Sánchez and Favero, 2019). In a school, setting children are taught about CSA using lessons across an extended period. These smaller lessons repeated for a longer period help children learn better. When children get to revise what they learned at school using the apps at home, their understanding of the matters will improve. Therefore, CSA education apps should be designed so that the apps can be used both at home and in a classroom setting. These apps should provide information about CSA and its prevention in an organised way that can be learned at home and also at school. Apps should also arrange their lectures in small lessons as children can develop key learnings progressively if lessons are provided in small portions and for a continued time period (Stieler-Hunt et al., 2014). Only the app 'Orbit Rescue' presents CSA education in a lesson-wise manner that could be used for both home and school-based education. It was tested as part of the school curriculum in classroom settings and it evaluated the improvement of children's knowledge regarding CSA after using the app (Jones et al., 2020). Other apps that had prevention education divided into lessons were 'Child Abuse Prevention', 'Stop the Groomer' and 'Stewards of Children'. The 'Stewards of Children' app is intended for parents or caregivers. Among these three apps, the app 'Child Abuse Prevention' has detailed lesson-wise content that can be implemented in school. But we found no evidence of it being tested at school.

Overall, it is clear that most of the apps present in app stores are not suitable for being used as CSA education programs. While a few can teach children and parents individually, only one app could be deemed suitable for a school-based education program. These apps need to be improved both in terms of their software qualities and CSA-specific features to be considered as potential CSA education programs.

4.1.2 Potential of reviewed apps to induce behaviour changes about CSA education

Without evaluating the impact of the apps on the target audience in real-life settings, it cannot be determined whether these apps will induce behaviour change. After analysing the apps, we found that only one app has information regarding the impact of the app on children after using it. However, from our ratings acquired from the perceived impact sub-scale, it can be assumed that a few apps have the potential for bringing behavioural changes regarding the importance of prevention education for fighting CSA. Our modified rating scale has measured several factors for analysing the feasibility of these apps in achieving the perceived impact we wanted. Behaviour change towards CSA requires increasing awareness among users about the depth of the problem and spreading accurate knowledge concerning prevention (McKibbin and Humphreys, 2020). These apps ideally should help to change both the attitude and intention of a user regarding CSA education. Furthermore, by using the apps users should be encouraged to seek help in cases of CSA. The apps (5/14) that did not meet these measurement criteria were deemed unsuitable for inducing awareness and help-seeking behaviour regarding CSA education. However, our study showed that 8 out of 14 apps scored more than 4 in the perceived impact on users sub-scale, implying that these apps can induce behaviour

changes of the users. Five of these apps are intended for children's use. Among these only one app (Orbit Rescue) evaluated the impact of their app on children (Jones et al., 2020). The researchers behind this app conducted a randomised control trial in school settings and evaluated children's knowledge before and after using the application. They found that children who completed the serious game for CSA education had increased knowledge and the serious game approach was effective for rendering CSA education. However, they did not analyse behaviour change among the students. Hence, the actual behaviour change impact cannot be determined. Such statistics suggest that while the commercial market has grown with an increasing number of CSA-related apps, ensuring their potentiality regarding inducing behaviour change requires properly administered research including children and adults.

4.2 CSA app design considerations

4.2.1 Game-based approaches

After analysing 14 apps on CSA education, all of our ratings pointed to one conclusion: the most effective approach for teaching children sexual abuse prevention is game-based approaches such as gamification, game-based learning, and serious games. Gamification is an unconventional umbrella term used to express the use of game elements in a non-gaming practice to improve user experience and engagement (Pereira et al., 2014). Game-based learning involves the process and practice of learning using games (Plass et al., 2015). Whereas, serious games are custom-built games with a specific learning objective (Scholes et al., 2014). Research indicates that systems built using gamification, game-based learning, or serious games are a more attractive, appealing, and useful educational method for introducing prevention education to children (Desmet et al., 2015; Haruna et al., 2018; Scholes et al., 2014). Through these kinds of systems, children can gain awareness about the need to protecting their bodies, learn how to recognise potential danger factors in their environment, and ask trusted adults for help when in danger. More importantly, these methods help to form a link between home, social forces, and school (Shan, 2019). A recent study shows that these game-based approaches help children learn about prevention against this sensitive issue while ensuring they do not get traumatised (Stieler-Hunt et al., 2014).

The popularity of the apps that used games or game-based components is evident from the usage frequency of apps found by our raters. Eight apps had an average usage frequency of more than 10 times over 12 months. Five of these apps (Orbit Rescue, Game on POSCO, Stop the Groomer, Child Abuse Prevention, and Feel Safe) were intended for children and all of them provided prevention education using either game-based components for teaching children or serious games focused on CSA prevention. Two of these apps (Orbit Rescue and Child Abuse Prevention) had a usage frequency of 10 to 50. One of these apps used the serious game method while the other had a game-based learning approach. We should mention that these two apps also scored the highest rating according to our scale. Moreover, the scores from the perceived impact sub-scale also suggest that apps that utilise the approach of teaching children via game-based components or games have more potential for inducing behaviour change regarding CSA education. Five of the 8 apps with more than 4 in this sub-scale rating were the same apps that used such approaches. The usage statistics and calculated ratings of such apps reflect the analysis of the user reviews from app stores, suggesting

that the game-based learning, gamification, and serious games approaches are the most efficient and preferred methods for educating children in CSA prevention.

4.2.2 Design guidelines

This study shows that the existing CSA education apps available in the app stores are not fully suitable for rendering prevention education about CSA. They need further improvement in both software qualities (i.e., performance, aesthetics, usability) and CSA-specific features. Therefore, future development must consider the limitations found in the existing apps pointed out in our study. Developers can test their apps using our rating scale to evaluate an app's effectiveness. The CSA education rating scale devised in our study will also be helpful to developers for deciding the most important features necessary for a CSA education app.

Following the reviews and ratings of the existing CSA education apps and evaluating the recent research on effective methods for rendering prevention education, we believe that developers should consider some additional points before designing an app for this purpose. Children tend to learn better when they find the learning constituents relatable to their life (Hamari et al., 2016). Therefore, the apps' contents must include real-life scenarios. Game-based apps are better for educating children about sensitive issues like sexual abuse (Schoech et al., 2013). Hence, developers should focus on game-based learning, gamification or serious game approaches for creating CSA education apps. Furthermore, user customisation features should be increased so that children can easily get into the characters in the apps. The typical quiz-based learning apps often fail to engage children while teaching (Egenfeldt-Nielsen, 2013; Kirriemuir and McFarlane, 2004). Therefore, designers should consider ways where children can learn through playing and observing. If quiz methods are required for evaluation, children should be given the scope for fixing their mistakes in a way that goes beyond rote learning (Stieler-Hunt et al., 2014). Research shows that children who possess healthy self-esteem are more likely to accept the message delivered in CSA prevention education programs (Sanderson, 2004). So developers should focus on creating apps that will promote behavioural change and help build a positive self-concept in children. The inclusion of parents or caregivers in the same program as children is essential for teaching younger children (Kang et al., 2020). This also helps children to choose their trusted adults and build healthy communication with them. Thus the apps must include information for both the children and parents. Also, the apps must promote the necessary knowledge for the trusted adults, so that they can act appropriately when an abusive incident is disclosed. When adults understand the dangers of CSA and are properly educated in prevention education, they will be more eager to educate their children using CSA education apps.

5 Conclusions and future work

In this study, we have systematically reviewed CSA education apps available in the app stores. For selecting apps that meet our study criteria we formulated specific keywords and inclusion criteria. From the initial 191 apps, we selected 14 apps for review. For analysing the selected apps, we devised an app rating scale by modifying the existing rating scales keeping in mind the specific needs of evaluating CSA education

apps. The verdict drawn from the use of our rating scale on the selected CSA apps and the analysis of the results showed that most apps in app stores do not meet satisfactory features required to teach children about CSA and its prevention. The flaws observed in this review show that important features are needed and the software quality of these apps needs to be improved. The results also indicate that children prefer apps that use game-based learning approaches for teaching CSA education. This study also provides the necessary knowledge to developers and individuals regarding software quality characteristics and CSA education. Furthermore, it points at the possible directions of advancing research and development in CSA education apps. Moreover, individuals can gain insights from this study about what features a CSA education app must have to be truly useful. With the help of this study, developers will be able to design apps that will help individuals to properly address CSA and become more aware of the importance of learning about CSA education.

A child expert's opinion from a child expert can help improve the rating scale for CSA education apps and provide a comprehensive CSA education structure for children. Therefore, future research will include a specialist's perspective on this topic for a more credible research outcome. Another future recommendation for this study would be to evaluate these apps with both children and adults in real-life settings. The feedback from respective users can enhance the possibility of including more features. Also, from such a study, the effectiveness of these apps for providing CSA education would become clear. Our study included only those CSA apps available in English and Bangla languages since these are the languages that authors are familiar with. As a consequence, even though we reviewed an enormous number of CSA apps, we may have missed some apps because of our language barrier. Another factor that needs to be noted is that some apps may exist that could not be accessed due to regional restrictions. Also, since no prior research has been done on searching and reviewing the CSA education apps, the search methods used in our review were modelled on those conducted in other research area (Milne-Ives et al., 2020; Rivera et al., 2016). Thus, another research direction would be expanding the study regardless of search criteria, language variations, and regional restrictions of the app stores.

References

Academy for Professional Excellence (2020) *Elements of Child Sexual Abuse* [online] https://play.google.com/store/apps/details?id=com.andromo.dev88207.app127483 (accessed 21 December 2020).

Amoora, S. (2020) *Helpio* [online] https://play.google.com/store/apps/details?id=com.shamrockinnovations.helpio&hl=en_AU&gl=US (accessed 16 March 2022).

Behnamnia, N., Kamsin, A., Ismail, M.A.B. and Hayati, A. (2020) 'The effective components of creativity in digital game-based learning among young children: a case study', *Children and Youth Services Review*, Vol. 116, p.105227.

Bennett, N. and Donohue, W.O. (2020) 'Identifying grooming of children for sexual abuse: gender effects and increased false positives from internet information', *International Journal of Psychology and Psychological Therapy*, Vol. 20, No. 2, pp.133–145.

Boishakhi Apps (2020) *Shishuk Jouno Joirani Theke Bachate Koronio* [online] https://play.google.com/store/apps/details?id=com.boishakhiapps.SisukeJounoHoirani (accessed 16 March 2022).

Broekman, F.L., Piotrowski, J.T., Beentjes, H.W.J. and Valkenburg, P.M. (2018) 'App features that fulfill parents' needs in apps for children', *Mobile Media & Communication*, Vol. 6, No. 3, pp.367–389.

Chaitra Creations (2020) *iSafe* [online] https://www.isafewesafe.com/ (accessed 16 March 2022).

Chang, K.C., Zaeem, R.N. and Barber, K.S. (2020) 'Is your phone you? how privacy policies of mobile apps allow the use of your personally identifiable information', *2020 Second IEEE International Conference on Trust, Privacy and Security in Intelligent Systems and Applications (TPS-ISA)*, IEEE Computer Society, pp.256–262.

Cho, Y-R., Kim, J-E. and Park, K-M. (2015) 'Differences in the characteristics of sexual abuse victimization between low- and high-grade elementary school children and correlations among the characteristics', *Journal of Korean Academy of Community Health Nursing*, Vol. 26, No. 2, pp.119–127.

Corral, L., Sillitti, A. and Succi, G. (2014) 'Defining relevant software quality characteristics from publishing policies of mobile app stores', in Awan, I., Younas, M., Franch, X. and Quer, C.E. (Eds.): *Mobile Web Information Systems*, Vol. 8640, pp.205–217. Springer, Cham.

Cronbach, L.J. (1951) 'Coefficient alpha and the internal structure of tests', *Psychometrika*, Vol. 16, No. 3, pp.297–334.

Csorba, R., Póka, R., Székely, P., Borsos, A., Balla, L. and Oláh, É. (2004) 'Child sexual abuse', *Orvosi hetilap*, Vol. 145, No. 5, pp.223–227.

Cullen, O., Zug Ernst, K., Dawes, N., Binford, W. and Dimitropoulos, G. (2020) ''Our laws have not caught up with the technology': understanding challenges and facilitators in investigating and prosecuting child sexual abuse materials in the United States', *Laws*, Vol. 9, No. 4, pp.1–19.

Daray, F.M., Rojas, S.M., Bridges, A.J., Badour, C.L., Grendas, L., Rodante, D., Puppo, S. and Rebok, F. (2016) 'The independent effects of child sexual abuse and impulsivity on lifetime suicide attempts among female patients', *Child Abuse & Neglect*, Vol. 58, pp.91–98.

Darkness to Light (n.d.) [online] https://www.d2l.org/the-issue/statistics/ (accessed 13 January 2021).

Desmet, A., Shegog, R., van Ryckeghem, D., Crombez, G. and De Bourdeaudhuij, I. (2015) 'A systematic review and meta-analysis of interventions for sexual health promotion involving serious digital games', *Games Health Journal*, Vol. 4, No. 2, pp.78–90.

Egenfeldt-Nielsen, S. (2013) *Beyond Edutainment: Exploring the Educational Potential of Computer Games*, Lulu.com, Købmagergade 11A, 4. floor 1150, Copenhagen.

Ericsson AB (2016) *Stewards of Children Prevention Toolkit* [online] https://apps.apple.com/us/app/stewards-of-children-prevention-toolkit/id1143010931 (accessed 16 March 2022).

Family Planning Queensland (2017) *Feel Safe* [online] https://apps.apple.com/us/app/feel-safe-personal-safety/id1318607014 (accessed 16 March 2022).

Faux, F., Bastide, R., Souf, N. and Zgheib, R. (2016) 'Smartphone-based collaborative system for wounds tracking', *eTELEMED 2016*, pp.104–109, Open Archive TOULOUSE Archive Ouverte (OATAO).

Friesen, M.R., Hamel, C. and McLeod, R.D. (2013) 'A mHealth application for chronic wound care: findings of a user trial', *International Journal of Environmental Research and Public Health*, Vol. 10, No. 11, pp.6199–6214.

Gliem, J.A. and Gliem, R.R. (2003) 'Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales', *2003 Midwest Research to Practice Conference in Adult, Continuing, and Community Education*, pp.82–88.

Goldman, J.D. and Padayachi, U.K. (2000) 'Some methodological problems in estimating incidence and prevalence in child sexual abuse research', *The Journal of Sex Research*, Vol. 37, No. 4, pp.305–314.

Guzman, E., Oliveira, L., Steiner, Y., Wagner, L.C. and Glinz, M. (2018) 'User feedback in the app store: a cross-cultural study', *2018 IEEE/ACM 40th International Conference on Software Engineering: Software Engineering in Society (ICSE-SEIS)*, pp.13–22.

Hallgren, K.A. (2012) 'Computing inter-rater reliability for observational data: an overview and tutorial', *Tutorials in Quantitative Methods for Psychology*, Vol. 8, No. 1, pp.23–34.

Hamari, J., Shernoff, D.J., Rowe, E., Coller, B., Asbell-Clarke, J. and Edwards, T. (2016) 'Challenging games help students learn: an empirical study on engagement, flow and immersion in game-based learning', *Computers in Human Behavior*, Vol. 54, pp.170–179.

Haruna, H., Hu, X., Chu, S.K.W., Mellecker, R.R., Gabriel, G. and Ndekao, P.S. (2018) 'Improving sexual health education programs for adolescent students through game-based learning and gamification', *International Journal of Environmental Research and Public Health*, Vol. 15, No. 9, p.26.

Hébert, M., Lavoie, F., Piché, C. and Poitras, M. (2001) 'Proximate effects of a child sexual abuse prevention program in elementary school children', *Child Abuse & Neglect*, Vol. 25, pp.505–522.

Holloway, J.L. and Pulido, M.L. (2018) 'Sexual abuse prevention concept knowledge: low income children are learning but still lagging', *Journal of Child Sexual Abuse*, Vol. 27, No. 6, pp.642–662.

Jones, C., Scholes, L., Rolfe, B. and Stieler-Hunt, C. (2020) 'A serious-game for child sexual abuse prevention: an evaluation of orbit', *Child Abuse and Neglect*, Vol. 107.

Kabir, M.A., Rahman, S.S., Islam, M.M., Ahmed, S. and Laird, C. (2021) 'Mobile apps for foot measurement in pedorthic practice: scoping review', *JMIR Mhealth Uhealth*, Vol. 9, No. 3, p.e24202.

Kang, S.R., Kim, S.J. and Kang, K.A. (2020) 'Effects of child sexual abuse prevention education program using hybrid application (CSAPE-H) on fifth-grade students in South Korea', *Journal of School Nursing*, pp.1–12.

Kekäläinen, A., Kaikkonen, A., Kankainen, A., Cankar, M. and Kallio, T. (2005) 'Usability testing of mobile applications: a comparison between laboratory and field testing', *Journal of Usability Studies*, Vol. 1, No. 1, pp.4–16.

Kenny, M.C. and Wurtele, S.K. (2012) 'Preventing childhood sexual abuse: an ecological approach', *Journal of Child Sexual Abuse*, October 2013, Vol. 21, No. 4, pp.361–367.

Kirriemuir, J. and McFarlane, A. (2004) *Literature Review in Games and Learning*, Nesta Futurelab, Bristol.

Koo, T.K. and Li, M.Y. (2016) 'A guideline of selecting and reporting intraclass correlation coefficients for reliability research', *Journal of Chiropractic Medicine*, Vol. 15, No. 2, pp.155–163.

Mage Media and Entertainment Service (2019) *Child Abuse Prevention* [online] https://apps.apple.com/us/app/child-abuse-prevention/id1459859413 (accessed 16 March 2022).

Malamsha, M.P., Sauli, E. and Luhanga, E.T. (2021) 'Development and validation of a mobile game for culturally sensitive child sexual abuse prevention education in Tanzania: mixed methods study', *JMIR Serious Games*, Vol. 9, No. 4, p.e30350.

McKibbin, G. and Humphreys, C. (2020) 'Future directions in child sexual abuse prevention: an Australian perspective', *Child Abuse and Neglect*, December 2019, Vol. 105, p.104422.

Milne-Ives, M., LamMEng, C., de Cock, C., van Velthoven, M.H. and Ma, E.M. (2020) 'Mobile apps for health behavior change in physical activity, diet, drug and alcohol use, and mental health: systematic review', *JMIR mHealth uHealth*, Vol. 8, No. 3, Article No. e17046, 16pp.

Mobile Seva (2021) *Bal Suraksha* [online] https://play.google.com/store/apps/details?id=com.cdac.safe_spaces_children_English (accessed 28 January 2021).

Moon, K.J., Park, K.M. and Sung, Y. (2017) 'Sexual abuse prevention mobile application (SAP_MobAPP) for primary school children in Korea', *Journal of Child Sexual Abuse*, Vol. 26, No. 5, pp.573–589.

New Jersey Children's Alliance, Inc. (2020) *ChildAbuseInfo* [online] https://apps.apple.com/us/app/childabuseinfo/id1507193525 (accessed 16 March 2022).

Noei, E., Syer, M.D., Zou, Y., Hassan, A.E. and Keivanloo, I. (2017) 'A study of the relation of mobile device attributes with the user-perceived quality of Android apps', *Empirical Software Engineering*, Vol. 22, No. 6, pp.3088–3116.

Othman, A., Wan Yahaya, W.A.J. and Muniandy, B. (2015) 'Integration of persuasive multimedia in designing learning application for child sexual abuse', *Jurnal Teknologi*, Vol. 77, No. 29, pp.97–101.

Pereira, P., Duarte, E., Rebelo, F. and Noriega, P. (2014) 'A review of gamification for health-related contexts', in Marcus, A. (Ed.): *Design, User Experience, and Usability. User Experience Design for Diverse Interaction Platforms and Environments*, Vol. 8518 of *Lecture Notes in Computer Science*, pp.742–753, Springer, Cham.

Plass, J.L., Homer, B.D. and Kinzer, C.K. (2015) 'Foundations of game-based learning', *Educational Psychologist*, Vol. 50, No. 4, pp.258–283.

Poon, T.W.K. and Friesen, M.R. (2015) 'Algorithms for size and color detection of smartphone images of chronic wounds for healthcare applications', *IEEE Access*, Vol. 3, pp.1799–1808.

Rivera, J., McPherson, A., Hamilton, J., Birken, C., Coons, M., Iyer, S., Agarwal, A., Lalloo, C. and Stinson, J. (2016) 'Mobile apps for weight management: a scoping review', *JMIR mHealth and uHealth*, Vol. 4, No. 3, p.e87.

Rudolph, J., Zimmer-Gembeck, M.J., Shanley, D.C. and Hawkins, R. (2018) 'Child sexual abuse prevention opportunities: parenting, programs, and the reduction of risk', *Child Maltreatment*, Vol. 23, No. 1, pp.96–106.

Sakumura, D., Steiner, M., Stone, C. and Zafirovski, D. (2018) *Stop the Groomer* [online] https://stopthegroomer.com/ (accessed 16 March 2022).

Sanderson, J. (2004) *Child-Focused Sexual Abuse Prevention Programs How Effective are They in Preventing Child Abuse?*, Crime and Misconduct Commission, Brisbane, Qld.

Sawa, J. and Morikawa, T. (2007) 'Inter-rater reliability for multiple raters in clinical trials of ordinal scale', *Drug Information Journal*, Vol. 41, No. 5, pp.595–605.

Schoech, D., Boyas, J.F., Black, B.M. and Elias, N. (2013) 'Gamification for behavior change: lessons from developing a social, multiuser, web-tablet based prevention game for youths', *Journal of Technology in Human Services*, August, Vol. 31, No. 3, pp.197–217.

Scholes, L., Jones, C., Stieler-Hunt, C. and Rolfe, B. (2014) 'Serious games for learning: games-based child sexual abuse prevention in schools', *International Journal of Inclusive Education*, Vol. 18, No. 9, pp.934–956.

Scholes, L., Jones, C., Stieler-hunt, C., Rolfe, B. and Pozzebon, K. (2012) 'The teachers' role in child sexual abuse prevention programs: implications for teacher education', *Australian Journal of Teacher Education*, Vol. 37, No. 11, 29pp.

Shan, Y. (2019) *Protect Me: An Interactive Mobile Educational Tool for Children to Help and Prevent Sexual Abuse*, Master's thesis, Rochester Institute of Technology.

Singapore Children's Society (2020) *Kidzlive* [online] https://play.google.com/store/apps/details?id=com.sgchildrensociety.kidzlive&hl=en_AU&gl=US (accessed 16 March 2022).

Singh, M., Parsekar, S. and Nair, S. (2014) 'An epidemiological overview of child sexual abuse', *Journal of Family Medicine and Primary Care*, Vol. 3, No. 4, pp.430–435.

Smallbone, S. and Wortley, R. (2001) 'Child sexual abuse in Queensland: Offender characteristics and modus operandi', *Trends and Issues in Crime and Criminal Justice*, January, Vol. 193, 6pp.

Sánchez, A. and Favero, M. (2019) 'Effectiveness of programs for the prevention of child sexual abuse: a comprehensive review of evaluation studies', *European Psychologist*, Vol. 25, No. 1, pp.1–15.

Speckyboy (2015) *The Aesthetics of a Successful Mobile App: Lessons from Three Top Grossing Apps* [online] https://speckyboy.com/the-aesthetics-of-a-successful-mobile-app-lessons-from-three-top-grossing-apps/ (accessed 25 December 2020).

Stawarz, K., Cox, A.L. and Blandford, A. (2015) 'Beyond self-tracking and reminders: designing smartphone apps that support habit formation', *Conference on Human Factors in Computing Systems – Proceedings*, pp.2653–2662.

Stieler-Hunt, C., Jones, C.M., Rolfe, B. and Pozzebon, K. (2014) 'Examining key design decisions involved in developing a serious game for child sexual abuse prevention', *Frontiers in Psychology*, Vol. 5, Article No. 73, pp.1–10.

Stoyanov, S.R., Hides, L., Kavanagh, D.J. and Wilson, H. (2016) 'Development and validation of the user version of the mobile application rating scale (uMARS)', *JMIR mHealth uHealth*, Vol. 4, No. 2, pp.1–5.

Stoyanov, S.R., Hides, L., Kavanagh, D.J., Zelenko, O., Tjondronegoro, D. and Mani, M. (2015) 'Mobile app rating scale: a new tool for assessing the quality of health mobile apps', *JMIR mHealth uHealth*, Vol. 3, No. 1, p.e27.

Tait, R.J., Kirkman, J.J.L. and Schaub, M.P. (2018) 'A participatory health promotion mobile app addressing alcohol use problems (The Daybreak Program): protocol for a randomized controlled trial', *JMIR Research Protocols*, June, Vol. 7, No. 5, Article No. e148, 11pp.

The Cece Yara Child Advocacy Centre (2020) *The Ceceyara App* [online] https://play.google.com/store/apps/details?id=com.Mindkraft.TheCeceyaraApp (accessed 16 March 2022).

Torous, J., Nicholas, J., Larsen, M.E., Firth, J. and Christensen, H. (2018) 'Clinical review of user engagement with mental health smartphone apps: evidence, theory and improvements', *Evidence Based Mental Health*, Vol. 21, No. 3, pp.116–119.

Tricco, A., Lillie, E., Zarin, W., O'Brien, K., Colquhoun, H., Levac, D., Moher, D., Peters, M., Horsley, T., Weeks, L., Hempel, S., Akl, E., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M., Garritty, C. and Straus, S. (2018) 'PRISMA extension for scoping reviews (PRISMA-SCR): checklist and explanation', *Annals of Internal Medicine*, Vol. 169, No. 7, pp.467–473.

University of Sunshine Coast (2017) *Orbit Rescue* [online] http://orbit.org.au/play/ (accessed 16 March 2022).

Vasa, R., Hoon, L., Mouzakis, K. and Noguchi, A. (2012) 'A preliminary analysis of mobile app user reviews', *Proceedings of the 24th Australian Computer-Human Interaction Conference, OzCHI 2012, OzCHI '12*, Association for Computing Machinery, NY, USA, pp.241–244.

Vos-Draper, T. (2013) 'Poster 29 wireless seat interface pressure mapping on a smartphone: feasibility study in users with SCI', *Archives of Physical Medicine and Rehabilitation*, Vol. 94, No. 10, pp.e21–e22.

Walsh, K. and Brandon, L. (2012) 'Their children's first educators: parents' views about child sexual abuse prevention education', *Journal of Child and Family Studies*, Vol. 21, No. 5, pp.734–746.

West Bengal Commission for the Protection of Child Rights (2018) *Game on POCSO* [online] https://m.apkpure.com/game-on-pocso-english-version-online/air.POCSOenglishonline (accessed 16 March 2022).

World Health Organization (2020) *Global Status Report on Preventing Violence against Children*, World Health Organization, Geneva.

Wurtele, S.K. (2014) 'Preventing sexual abuse of children in the twenty-first century: preparing for challenges and opportunities', *Journal of Child Sexual Abuse*, May, Vol. 18, No. 1, pp.1–18.