

# Manar: An Arabic Game-Based Application Aimed for Teaching Cybersecurity using Image Processing

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**Abstract**—People use the Internet for various activities, including exchanging money, playing games, and shopping. However, this powerful network came at a cost: the features that provide the Internet with these capabilities are also what make it vulnerable. The need for cybersecurity tools and practices was recognized, especially for children, since they tend to be naive and can be easily tricked. Aimed at children from 6 to 12 years old, Manar is an Arabic smartphone game that seeks to build a generation who are well-informed about cybersecurity issues. It teaches them about notable cybersecurity topics such as social engineering and cryptography, it also has a very appealing theme to attract children to play the game. The theme being “pirates and islands”, each level will be represented as an island and a moving pirate ship will navigate between the levels. The application introduces the technology of image processing in a unique way, allowing children to move around and look for objects, which makes the game as interactive as possible to attract children’s attention.

**Keywords**—Cybersecurity; image processing; social engineering; cryptography

## I. INTRODUCTION

As the Internet is increasingly becoming part of people’s lives, users must be wary of the risks. Cybersecurity awareness is essential. Internet users are at constant risk of hacking, phishing, sniffing and many other threats. Many children spend an unhealthy amount of time on the Internet, using it to study and complete homework or to play online games and browse social media. Such activities may lead to unwanted exposure to risk and potential harm.

This project proposes a smartphone game directed at children which is intended to help them become more informed about cybersecurity. The application consists of various levels that focus on different cybersecurity concepts. In each level, the player learns a new concept of cybersecurity that helps them to be more careful and safer. It is hoped that they will develop a responsible attitude towards communicating in cyberspace.

Furthermore, cybersecurity and the information technology field in general became a primary interest and concern in Saudi Arabia’s Vision 2030 plan, as evidenced, for example, by the establishment of a national cybersecurity authority. Hence, the game will contribute to the goals and objectives of the Vision 2030 plan through raising awareness among young people who are not currently interested in or aware of these topics. It is hoped that through the game, awareness can be raised in a way that intrigues the children. The number of

Internet users has increased significantly, which increases the risk of hacking and other harmful activities. This increased risk raises the need for cybersecurity to protect users, especially children because they lack enough knowledge to be safe online.

This paper is structured as follows. Section II illustrates the literature review that discusses related studies and applications. The definition of the problem, the proposed solution, and the project objectives are outlined in Section III. Section IV presents the application development process used in the project. Section V discusses the limitations and future work, and Section VI concludes the paper.

## II. LITERATURE REVIEW

This section describes the differences between Manar application and similar systems. First, the features of existing systems are described. Manar application is then compared with those systems. Next, how the application’s features overcome the limitations of similar systems will be explained in more details.

### A. Related Studies

The number of Internet users has increased significantly, which increases the risk of hacking and other harmful activities. This increased risk raises the need for cybersecurity to protect users, especially children because they lack enough knowledge to be safe online.

**Cyber security** is defined as "technologies and processes constructed to protect computers, computer hardware, software, networks and data from unauthorized access, vulnerabilities supplied through the Internet by cybercriminals, terrorist groups and hackers" [1].

**Image processing** is "a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it" [2].

Risks and concerns about Internet use range from situations where innocent children are victimized by others, to situations where children have engaged in actions that are risky, irresponsible, harmful, or even illegal. The following are some key risks and concerns [3]:

1) *Cyberbullying* is bullying that takes place over digital devices like cell phones, computers, and tablets. Cyberbullying can occur through SMS, Text, and apps, or online in social media, forums, or gaming where people can

view, participate in, or share content. Cyberbullying includes sending, posting, or sharing negative, harmful, false, or mean content about someone else. It can include sharing personal or private information about someone else causing embarrassment or humiliation. Some cyberbullying crosses the line into unlawful or criminal behavior [4].

2) *Hacking* is the process of attempting to gain or successfully gaining, unauthorized access to computer resources. Computer hacking is the practice of modifying computer hardware and software to accomplish a goal outside of the creator's original purpose [5].

3) *Online gaming* describes any video game that offers online interactions with other players [6].

These risks and concerns can be effectively addressed through education and parental supervision.

The most common issues children face online [7]:

1) *Cyberbullying*: 1 in 5 repeatedly cyberbullied teens contemplate suicide.

2) *Sexual Solicitation and Exposure to Sexual Content*: A recent study found that one in five youth experienced unwanted sexual solicitation online.

3) *Maintaining Privacy*: The report estimates that by the age of 13, parents have posted roughly 1300 photos and videos of their children online. According to the UK report, Barclays has forecast that by 2030 "sharenting" will account for 2/3 of identity fraud, costing hundreds of millions of dollars a year. With just a name, date of birth, and address (easy enough to find in a geotagged birthday party photo on Facebook, for example), bad actors can store this information until a person turns 18 and then begin opening accounts [8].

4) *The Generational (or Communication) Gap*: Children tend to view their lives online and offline as one and the same, whereas adults tend to view them as separate spheres. Having spent the majority of their life interacting with technology, children have an inherent advantage when it comes to navigating the Internet. The only way parents and educators can close this generational disparity is to open clear communication channels with students.

"On 15 November 2013 the online video-sharing website YouTube was searched for various cyber-safety related videos. On searching the word 'e-Safety', 141 million possibilities were identified. A search for the phrase 'e-Safety for children' produced 11 million videos and the phrase 'e-Safety for children cartoon' indicated that more than 1.8 million possible cartoon videos exist" [3]. See Table I. This shows that the best way to teach children about cybersecurity is by using cartoons as much as possible.

TABLE I. YOUTUBE SEARCHES (15 NOVEMBER 2013)

	Safety	For children	Cartoons
e-	141 m	11 m	1.8 m
Cyber	2.1 m	305 k	285 k
Internet	19 m	2 m	244 k

Recently there have been some initiatives and campaigns concerning cybersecurity in Saudi Arabia for children [9]. One example is the campaign Safe Online, it was published in 2016 by the Communications and Information Technology Commission in cooperation with the Ministry of Education. The campaign's goal was to raise children's awareness of the proper use of the Internet in a fun and educational way. They targeted children and their guardians in the cities of Riyadh, Jeddah, and Dammam to teach them about cybersecurity courses.

NEW YORK, 15 April 2020 [10] – Millions of children are at increased risk of harm as their lives move increasingly online during lockdown in the COVID-19 pandemic, UNICEF and partners said today.

"The coronavirus pandemic has led to an unprecedented rise in screen time," said Global Partnership to End Violence Executive Director Dr. Howard Taylor. "School closures and strict containment measures mean more and more families are relying on technology and digital solutions to keep children learning, entertained and connected to the outside world, but not all children have the necessary knowledge, skills and resources to keep themselves safe online."

#### B. Related Applications

- *CYBER-FIVE*: CYBER-FIVE [11] is a web-based game provided by ABCya.com that aims to teach children five rules of cybersecurity by showing them a short animation of a dialogue between two friends, Hippo and Hedgehog. Hedgehog breaks the five security rules one by one, and Hippo advises him to avoid each mistake. The game provides animation with audio for the two friends, quizzes and tests.
- *Talented & Gifted Games*: Talented & Gifted Games [12] is an Android and iOS application developed by Kids Academy that teaches that teaches children many courses like math and English. Each course consists of an educational video, game and quiz. All the courses are divided into grades: preschool (ages 2–4), kindergarten (ages 4–5), 1st grade (ages 5–7), 2nd grade (Ages 6–8), and 3rd grade (ages 9–10). The application features include augmented reality and educational videos provided by specialists.
- *Play safe! Be safe Fire safety game*: Fire safety game [13] Created in 1994, play safe! be safe! is a web-based game by the BIC corporation aimed at teaching children fire safety. It supports only the English language. The game teaches the children different things in safety like fire safety and n safe and unsafe objects to play with and so on.
- *MentalUP game*: MentalUPgame [14] measures children's performance and development with a regular report so they can discover their strengths and weaknesses and they can track their improvement over time. It provides advice after each set is terminated by the games. Also, it improves child skills like creative thinking and problem-solving.

- *Khan Academy Kids*: Khan Academy Kids [15] is an educational app dedicated to children from the ages of 2 to 6. It supports only the English language, and it operates on Apple's iOS and Google's Android. The app's main goal is to teach children about science, reading, writing, problem-solving skills and social-emotional learning in a fun and interactive way with original content. It provides multiple levels of different activities, such as drawing, matching and storytelling.
- *TripLens*: TripLens [16] is an Android and iOS application developed by Kita Bilgi to improve the user's travel experience even if they speak the local language very well. For instance, the user may not remember translating an object in that foreign language, and it is a wonderful assistant for text translations.
- *Make it*: Make it [17] is an Android and iOS application developed by Learn Land that allows teachers to make fun and interactive quizzes or games with a wide assortment of templates available. Teachers can customize the games or quizzes to suit their students' needs. The application makes it easy to add images, sounds and other educational resources to the game or quiz. Finally, students learn by doing they can make their own game at home or at school.

### C. Discussion

Early childhood education about cybersecurity results in increased social awareness. Children become more aware of how to protect themselves and their information on the Internet. The Manar application will raise awareness about cybersecurity in a way that is superior to traditional methods of education. Additionally, as the game uses the Arabic language, it will contribute to Arabic content in the IT field and promote the value of the Arabic language among children. Moreover, Manar will contribute to the goals and objectives of the country's Vision 2030 [18].

The systems introduced above helped us understand the available features in children games to consider missing features and improve existing features to provide an interactive and interesting game. As mentioned in Table II games have many features, but they also have many limitations. Some of the most common limitations are that they do not support mobile devices, they do not support Arabic language, they do not use a reward system, they do not support image processing, and they do not teach cybersecurity. In contrast, Manar application provides all these features, among others.

### III. PROBLEM DEFINITION

Smart devices and technology in general have become a significant part of people's lives, and they are easily accessible to all generations. However, it is well-known that the cyber world is in many ways potentially harmful to adults and even more so for children, who may be incautious in regard to online activity.

This raises concerns about children's use of the Internet, as they are exposed to computers, smartphones, and tablets at an

early age, often using them without supervision and with direct connection to complete strangers. This situation may lead to various threats, such as exposure to inappropriate content, cyberbullying, and online scams.

Manar is our proposed solution. It's an application, a smartphone game that teaches children about cybersecurity in a fun and interactive way. The theme will be "pirates and islands", which will add flamboyance to the application.

The game will be divided into different levels, each level representing a new island. The game will also include a reward system, and the child must pass each level to collect rewards. These rewards will add an element of excitement and motivation to the game.

To add an interactive element, the game will include image-processing technology, specifically image recognition. At the beginning of each level, a hint will be given of what the level is going to be about, and the child will be asked a question which they must respond to with a photograph of an object.

The application will be developed for Android OS through Android Studio using the Java programming language.

The main goals of the project are to raise awareness of cybersecurity among children, using a fun, interactive game that lets children move around and protects them from potential threats of the cyber world. From these goals are derived the following objectives:

- Teaching children about various cybersecurity concepts, such as hacking, protection, and social engineering.
- Designing a vivid interface with fun characters and themes.
- Applying the concepts illustrated and taught in the game by asking different types of questions.
- Using the reward system to motivate the players.
- Increasing children's physical activity by adding image-processing (image recognition) technology, which allows them to move around their environment looking for certain objects.

### IV. APPLICATION DEVELOPMENT

This section outlines the process by which we developed the application, beginning with the information gathering strategies used in the analysis phase then continuing with an overview of the system design, user interfaces, system implementation and lastly system Implementation and testing.

#### A. Information Gathering

The first method of information gathering in conducting interviews. A meeting was held with Hanan AlShehri, a coordinator at the Cybersecurity for Kids initiative. The meeting was held on the 25th of September 2020, with all team members present. The purpose of the meeting was to learn how to provide interactive games dedicated to children, since this initiative is already providing activities to children in the cybersecurity field. Also, the project team interviewed

three children from ages 11 to 12, it was conducted on the 30th of September. The interviews were useful, as these children were in the target demographic of the application.

The second method was conducting an online questionnaire, it received 624 responses and targeted parents in Saudi Arabia. The results of the survey indicated that 55.9% of children spend more than four hours on their devices and 9.1% of them spend one hour. Another observation was that 44.6% of children sometimes talk to unknown people on social media or online games and 39.9% of them never talk to unknown people. Some children are aware, but the majority still lack perception. The respondents were also asked “Are you keen to add anti-virus programs to your child’s device?”, to which 67.3% answered “I do not care about downloading antivirus software” and 32.7% answered “I download antivirus software for my child’s devices”. Another question was “Does your child connect to public Wi-Fi networks (such as restaurants and hotels)?”, to which 46% answered “Sometimes” and 30.1% answered “Never”. Also, it showed that 47.4% of children do not have different passwords chosen for each account, and only 16% do. Another question was “Do you think your children need to significantly increase their level of awareness about cybersecurity?” to which 87.7% agreed and 2.7% disagreed. Another question was “Do you support an educational application. Finally, the respondents were asked for suggestions and features to include in the Manar application. They responded that they wanted the application to avoid difficult terms, to use other non-educational characteristics to attract children, and to not advertise it as a purely educational program because most children are averse to anything that benefits them. The respondents commented that the attractive appearance of the application attracts children, and they hoped that the

application would reach the widest range of children through dissemination by the Ministry of Education. Designed to teach children the principles of cybersecurity in fun ways?”, to which 92.3% answered “Yes” and 2.9% answered “No”.

The conclusion is that all information gathered from this section will be taken into consideration when developing Manar. Manar will help parents to protect their children from threats that they may face on the Internet. It will teach children about various cybersecurity concepts using a vivid interface to make learning fun. All the information gathered and presented in this section will be helpful for system analysis.

### B. System Design

Manar application is designed as a smartphone game that teaches children about cybersecurity in a fun and interactive way. The application targets Saudi children, both boys and girls, in the age range 6–12 years. It will support only the Arabic language, and it will be directed to schools and children’s institutes.

As the game targets children, the design and look of it is very important. The theme is “pirates and islands”, which will add flamboyance to the application and a parrot character designed to guide the child throughout the application. The game will be divided into different levels, each level representing a new island. The game will also include a reward system, and the child must pass each level to collect rewards. These rewards will add an element of excitement and motivation to the game. To add an interactive element, the game will include image-processing technology, specifically image recognition. At the beginning of each level, a hint will be given of what the level is going to be about, and the child will be asked a question which they must respond to with a photograph of an object.

TABLE II. COMPARISON BETWEEN SIMILAR SYSTEMS AND MANAR

Application features	Make it	CYBER-FIVE	TripLens	Talented & gifted	Fire safety game	MentalUP	Khan Academy Kids	Manar
Mobile Application	✓	✗	✓	✓	✗	✓	✓	✓
Support Arabic language	partially	✗	✗	✗	✗	✗	✗	✓
Support image processing	✗	✗	✓	✓	✗	✗	✗	✓
Teach cybersecurity	✗	✓	✗	✗	✗	✗	✗	✓
Provide certification at the end / Applied the reward system	✗	✗	✗	✓	✗	✗	✓	✓
User has more than one Account	✗	✗	✗	✗	✗	✓	✓	✓
Provide quiz	✓	✓	✗	✓	✓	✓	✓	✓
Has multiple levels	✓	✗	✗	✗	✓	✓	✓	✓

Manar application uses a hybrid architecture [19] that consists of an MVP (model-view-presenter) pattern for the client side and a client-server model for the whole system. The MVP pattern was chosen because of its ability to facilitate automated unit testing and improve the separation of concerns in presentation logic. The Presenter contains the user-interface business logic for the View. All invocations from the View are delegated directly to the Presenter. The Presenter is also decoupled directly from the View and communicates with it through an interface, as shown in Fig. 1.

The client-server architecture was chosen because of the system's requirement to acquire information from an external source acting as a server, namely, the IBM image-recognition API. In the client-server model, any process can act as server or client. It is not the type, size, or computing power of the machine that makes it a server; it is its ability to serve requests that makes a machine a server. For the Manar application, a repository architecture was not chosen because the application does not have large volumes of data. A peer-to-peer architecture was not chosen because the application does not have multiple clients with equal capabilities and responsibilities.

### C. User Interfaces

This part presents a sample of screen shots in Manar application to illustrate the user interface design (Fig. 2 to 9).

### D. System Implementation

Manar used the Android Studio environment to program the application by using the Java programming language. Furthermore, to execute and test Manar application, the team used Android mobile and virtual devices provided by Android Studio. Moreover, Adobe illustrator and Photoshop applications were used to design the pictures and instructions included in the application. For Manar's database, we chose Firebase because it is the most suitable since it is a real-time and cloud database dealing with cloud and real-time data. We used the database to save the user's information, lessons and quizzes questions. Finally, we used the IBM Watson API to Recognition image by extract images and detect for specific content.

In the beginning, the application starts to run with the start window then a registration window that contains the user registration with the name and characters (boy and girl). Next, a map window showing a series of locked islands that the child must unlock to reach the last island is displayed. Each island represents a level in the application and introduces one of the cybersecurity concepts, to unlock the island the child must solve a puzzle by photographing a specific object and the IBM Watson API recognize and detect the image. The island (level) contains lessons, then interactive quiz after the lessons that measures the child's understanding. A "Hint" option will be provided with each question to assist the child if needed after three wrong attempts. The application is applying a reward strategy to motivate children. Once the child finishes the quiz, the total score will be given that represented by coins which will be added to his/her treasure. After that the child will be able to move to the next island. The child's progress will be shown throughout each level. The child will visit five islands that provide five cybersecurity concepts: Password

level, Social engineering level, Viruses level, Cyber Bully level and Encryption level. Finally, when the child finishes all the levels successfully if the child collects 100 coins, he/she will encrypt his/her name as a prize for him. Regardless of the number of coins, the child will receive a certificate, the certificate will contain the child's name and total score and can be saved or shared through different social applications.

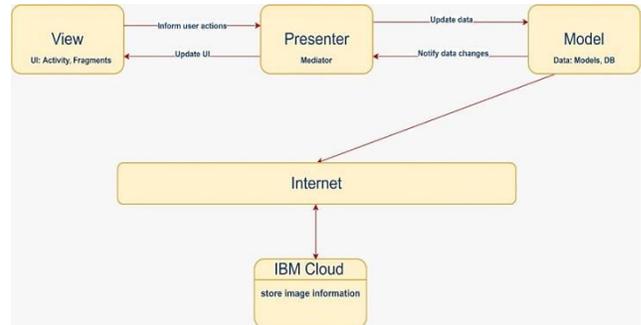


Fig. 1. Manar's Hybrid Architecture (Combines MVP and Client-Server Architectures).

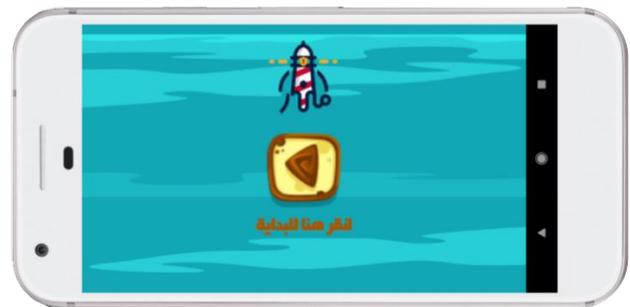


Fig. 2. Beginning Page, the First UI Seen by the user.



Fig. 3. Registration Page, the user has to Choose a Name and a Profile Picture.



Fig. 4. Welcome Page, a Nice Welcoming to the user.



Fig. 5. Choose Account Page, Appears when the user wants to Switch Accounts.



Fig. 9. Child's Certificate, the end Reward of completing all the Levels.



Fig. 6. Map Page, Appears when the user completes a Level and uses it to go to the Next.



Fig. 7. Level Unlock Question, the user is presented with a Puzzle that is solved by taking a Picture of the Answer.



Fig. 8. Match Question, an Example of a Type of Question that the user could Face.

### E. System Evaluation and Testing

To assure that the system performs all requirements, meet the objective and to uncover errors there must a testing method preformed. Manar application applied several test strategies such as unit testing, integration testing, user acceptance testing, and performance testing.

User Acceptance Testing (UAT) [20] is a type of testing performed by the end user or the client to verify/accept the software system before moving the software application to the production environment. The Test has been conducted on five Arab children, their ages, ranges from 6 to 12 years old. The users' feedback, sectioned according to task, are illustrated in Table III.

TABLE III. USER ACCEPTANCE TESTING

Username	Tamim Almalki			
Task	Number of Errors	Time Needed min: sec: msec	User Feedback	Completion status
Enter Name	0	00:15:25	I want to enter my name in English	Pass
Take Picture	0	00:13:02	Wow	Pass
View Level	0	59:05:10	-	Pass
View Lessons	0	34:07:39	New information	Pass
Solve Quiz	0	20:00:05	This is funny	Pass
View Hint	0	00:05:75	Oh, I understand	Pass
Display Result sheet	0	00:07:22		Pass
View Certificate	0	00:09:22	Its colors are beautiful	Pass
Save Certificate	0	00:10:59		Pass
Share Certificate	0	00:13:55	Great	Pass

## V. LIMITATIONS AND FUTURE WORK

One of the limitations of Manar application is that it will only be available for Android devices. Also, Manar is only available in Arabic, which limits the number of users that it can reach.

## VI. CONCLUSION

In this project, the Manar smartphone game was developed to teach children about cybersecurity in a fun and interactive way.

The theme is “pirates and islands”, which are added to the application. The game divides into different levels, each level representing a new island. The game also includes a reward system, and the child must pass each level to collect rewards. These rewards will add an element of excitement and motivation to the game. To add an interactive element, the game includes image-processing technology, specifically image recognition. At the beginning of each level, a hint will be given of what the level is going to be about, and the child will be asked a question which they must respond to with a photograph of an object. Finally, the number of Internet users has increased significantly, which increases the risk of hacking and other harmful activities. This increased risk raises the need for cybersecurity to protect users, especially children because they lack enough knowledge to be safe online. We hope that the Manar application reaches all children to spread awareness of cybersecurity among them

## VII. FUTURE WORK

Support iOS device is one of the planned features for the application and to extend the scope of the application and reach more users the intention is to support more languages. Also, because the field of cybersecurity is wide-ranging, more lessons, levels and quizzes will be added to introduce more information and concepts. Moreover, another planned addition to the application is a live scoreboard, which would keep the scores for each player and motivate players to compete against one another.

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