Investigating the Use of Email Application in Illiterate and Semi-Illiterate Population

Sadeeq Jan[1], Imran Maqsood[2], Salman Ahmed[3, *], Zahid Wadud[3] and Iftikhar Ahmad[4]

Abstract: The use of electronic communication has been significantly increased over the last few decades. Email is one of the most well-known means of electronic communication. Traditional email applications are widely used by a large population; however, illiterate and semi-illiterate people face challenges in using them. A major population of Pakistan is illiterate that has little or no practice of computer usage. In this paper, we investigate the challenges of using email applications by illiterate and semi-illiterate people. In addition, we also propose a solution by developing an application tailored to the needs of illiterate/semi-illiterate people. Research shows that illiterate people are good at learning the designs that convey information with pictures instead of text-only, and focus more on one object/action at a time. Our proposed solution is based on designing user interfaces that consist of icons and vocal/audio instructions instead of text. Further, we use background voice/audio which is more helpful than flooding a picture with a lot of information. We tested our application using a large number of users with various skill levels (from no computer knowledge to experts). Our results of the usability tests indicate that the application can be used by illiterate people without any training or third-party's help.

Keywords: Illiterate, semi-illiterate, email usability, user interfaces.

1 Introduction

Illiterate people are perceived as ignorant to advanced technology in modern society. Conservative estimates of illiteracy suggest that there are over one billion illiterate people in the world [Plauche, Nallasamy, Pal et al. (2006)]. This population can act as a valuable human resource when equipped with computer literacy. There is a need to investigate how computing applications can be made accessible and user-friendly for the illiterate users. This poses a significant design challenge, as the share abundance of text in

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[1] National Center for Cyber Security-UETP, Department of CS&IT, University of Engineering & Technology, Peshawar, Pakistan.

[2] Department of Computer Software Engineering, University of Engineering & Technology, Mardan, Pakistan.

[3] Department of Computer Systems Engineering, University of Engineering & Technology, Peshawar, Pakistan.

* Corresponding Author: Salman Ahmed. Email: sahmed@uetpeshawar.edu.pk.

standard interfaces suggests that significant retooling of the interface or completely new interaction styles would be required to ensure usability by illiterate populations.

Previous work in designing user interfaces for illiterate and semiliterate populations focuses on broad principles, recommending features such as the use of graphical icons, minimal use of text, voice annotation, easy navigability and the use of numbers for people who may be illiterate but not innumerate [Medhi, Sagar and Toyama (2006)]. These principles have been applied to applications in the areas of job search [Akan, Farrell, Zerull et al. (2006); Mahmood, Shahzadi and Tariq (2014); Knoche and Huang (2012)], healthcare [Bose and Dipin, (2012); Medhi, Sagar and Toyama (2006)], map navigation [Mahmood, Shahzadi and Tariq (2014)] and microfinance [Ávila and Gudwin (2009); Deo, Nichols, Cunningham et al. (2004)], but has not yet been significantly applied to computer-mediated communication. The majority of communication applications targeted towards illiterate users are in the area of agriculture and dedicated to query-based communications between an illiterate person and a literate agricultural expert [Findlater, Balakrishnan and Toyama (2009); Huenerfauth (2002)]. To the best of our knowledge, there are only a few applications developed for asynchronous computer-mediated communication, dedicated to illiterate users like "feasible video mail application", however, they have limitations, e.g., users required help throughout which they were able to get mostly from the onscreen audio assistant, which indicates that such systems will probably not require a human expert attendant beyond the initial demonstration. This work includes a limited deployment of a working system to determine if the community will use it over an extended period in the field. In particular, the most common asynchronous communication tool, email, which had a profound impact on the lives of the world's literate population, is essentially inaccessible to illiterate people.

In this paper, our ultimate aim is to create a communication experience built on standard email protocols. We design a textless user-friendly Interface for email application which can be used by new illiterate persons to create their profiles, login and send/receive audio messages. Further, we also maintain data of illiterate users based on their profession, which can be used to find jobs for them**.**

2 Related work

Statistics, extrapolations, and counting by the Radicati Group[3] estimated the number of email accounts worldwide at 3.7 billion in 2017 and expected to increase to 4.2 billion by 2022. Similarly, the number of emails sent per day in 2018 averaged a staggering 281 billion and is expected to grow up to 333 billion by the year 2022. On the other hand, around 160 billion emails are processed each year by the U.S. Postal Service. The widespread use of e-mail is due to several advantages including speed [Aries (2019)], free availability, immediate response generation. E-mail is targeted and proactive. It provides better accessibility and allows us to foster long lasting relationships compared to traditional postal service. When an illiterate person uses this service on a computer, he may face two problems: (a) he has to authenticate himself (by using an email address

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[3] https://www.radicati.com

consisting of numbers, letters and/or special characters); (b) he has to know the method of typing the email, adding recipient's address and then sending it. Many HCI experts have been working on both of these aspects. The results of these works produced certain feasible techniques for self-identification of illiterates. One of the pioneer works in this regard is that of Alvin H. Sacks and Richard Steele who developed the Lingraphica system [Goetze and Strothotte (2001)]. The building block of this system is a database of word-concepts connected with icons to enable communication for people with Aphasia. Patients can select the icons and drag them together on storyboards. Lingraphica automatically translates these sentence-like constructions into text and spoken words.

Another prominent related work is the mnemonics technique [Katre (2004)]. With this technique, illiterates can be identified by having a unique sequence of pictures stored as a password. Further investigating the related HCI literature, we found out several attempts to solve the said problem in email application usage. Among these, animation driven interfaces and voice driven interfaces were innovative pieces of work [Bose and Dipin (2012)]. The authors have also worked on interfaces that used a hybrid of the two types.

Literature reveals that illiterate users prefer seeing people (probably through video calling/mailing) when communicating over a computer system [Medhi, Prasad and Toyama (2007)]. They find it easier compared to typing. Furthermore, frequent page updates lead to frustrations of such users. This issue has been addressed by researchers through the use of slow animations [Medhi, Prasad and Toyama (2007)]. Also, it has been observed that illiterate users prefer high picture quality and the position of photos on a web page is also important for them [Medhi, Prasad and Toyama (2007); Deo, Nichols, Cunningham et al. (2004)].

Illiterate users remember digits and numerals by their specific shape and constant position [Katre (2004)]. Moreover, they prefer precise instructions instead of long vocal explanations having extra detail [Prasad, Medhi and Toyama (2008)]. Generally, voice annotation enhances the speed of comprehension, but audio-visual information can be confusing for the target population [Prasad, Medhi and Toyama (2008)]. The overall result is that illiterate users fail to better understand information [Medhi, Prasad and Toyama (2007)]. Speech-based User Interfaces (UIs) are more preferable than display-based UI solutions and are also more accessible than text-based UI solutions [Barnard, Schalkwyk, Heerden et al. (2010); Plauche, Nallasamy, Pal et al. (2006)]. Speech technologies such as Automatic Speech Recognition (ASR) has been used to give such solutions in interfacing [Plauche, Nallasamy, Pal et al. (2006); Deo, Nichols, Cunningham et al. (2004)].

Illiterate users appreciated visual interfacing and speech-based instructions reviewed research work on visual interfacing as well. In this work, we conclude that graphical touch-ups make the interface professional and appealing. Also, enhancement of the audio components improves the quality and ease of usage of a UI [Akan, Farrell, Zerull et al. (2006)].

Literature reveals that technology has been used to facilitate illiterate users, however, there is still room for improvement. Requirements for such users needs to be properly investigated to design effective solutions. Once the area of interest of the concerned user is clear, a suitable interaction style can be chosen for information presented to him/her [Mahmood, Shahzadi and Tariq (2014)]. Text-free designs are strongly preferred over

standard text-based interfaces by the concerned community of users. The work by Medhi et al. [Medhi, Sagar and Toyama (2006)] shows that text-free UIs are potentially able to bring even complex computer functions within the reach of users who are unable to read. As illiterates do not understand the text in an interface, they have their means of finding the required information. An example of this is their use of a mobile phone when they need to make a call: they memorize the sequence to call on a specific number, go to the menu, select familiar icons, scroll to some exact instance and finally dial the desired number [Knoche and Huang (2012)].

Existing literature on graphical innovations in UIs is focused to give visual aid to an illiterate user. The most important technique of displaying graphical reading aids has been described by Goetze et al. [Goetze and Strothotte (2001)]. The authors have dynamically shown pictograms by moving the pen over, or pointing on the word inside of the web browser that gives an aid for the interactive communication to illiterates [Goetze and Strothotte (2001)]. Furthermore, the concept of modularity has also been observed in which the computer-based task of an illiterate user is divided into several discrete steps that they go through when using the UI. The same methodology can also be used in information gathering based UIs that consist of questionnaires and surveys. Such a UI must be based on an interactive design so that questions are asked in a systematic manner [Al-Alaoui, Ohannessian and Choueiter et al. (2008)]. Researchers working in this domain have emphasized on avoiding abrupt questioning on one screen. They rather prefer that an illiterate user should be gradually indulged in a UI and questions should be ordered in a step-by-step method [Al-Alaoui, Ohannessian and Choueiter et al. (2008)]. Interactive dialog boxes are a befitting solution in this regard [Fitzgerald and Firby (2002)]. These provide a simple UI where task execution is done actively, and the user is able to focus on a single screen. Research has shown that in this way, an illiterate user better understands the question and its importance [Fitzgerald and Firby (2002)].

We developed an application that consists of an email environment. It displays a multitude of pages to its illiterate users for their profile building. We focused on simplifying/minimizing information in the pictures or vocal instructions. The problem is addressed by creating a self-identification interface and an email application interface for illiterates. These interfaces consist of icons as well as vocal/Audio instructions instead of text. Existing research shows that illiterate people are good at learning the design if it uses pictures having limited information, and focus more on one object or action at a time. Further, background voice/Audio is more helpful than flooding a picture with a lot of information. For this purpose, we focus on the usability of the design according to Human Computer Interaction perspective. Furthermore, the developed application can be used by illiterate people without any training or third-party's help.

3 Requirement gathering/data collection

This work aims to provide an emailing solution for illiterate users. As per the ethics of requirements engineering, the first step on this expedition was to consider the needs and psychology of the concerned users. This was significant also because we needed to know their patterns of remembering information such as user name and password.

For the data collection concerning user requirements, we conducted a set of interviews with several illiterate users. The prime objective of these question/answer sessions was to get answers to the following questions:

1. How do illiterate users use mobile phones?
2. How do they write text messages?
3. How do they dial a phone number and make a call?

Because of these sessions, we observed that these users have got their own tricks of remembering phone numbers and using mobiles. For example, they remember the icon combination and find their way to the phonebook. Afterward, since they remember the first two or three letters of the concerned person's name, they reach the name and make the call. Apart from this, they also know how to open the simple lock of the phone. In short, these users can remember icons and numbers by their shapes, which they can use to follow a conventional procedure and thus reach a number to dial. The literature on HCI also reveals this fact as stated by Ismaeel et al. [Avila and Gudwin (2009)]. They claim that illiterate users prefer icons compared to text.

In the quest of requirements gathering from the target users, we met one hundred illiterates; some of them were functional illiterates while some had primary level education. This simplifies the task ahead since most of them could understand digits that they needed to dial.

As discussed in the earlier section, literature is saturated with reviews on the need of simplified UIs for illiterate people. However, to the best of our knowledge, no emailing system for illiterate has yet been practically proposed, there exist few applications for asynchronous computer-mediated communication dedicated to illiterate users like feasible video mail application with limitations that we aim to address in this work This emphasizes the need of a system that provides profile building for illiterates for self-identification and easy emailing.

4 Proposed solution

To address the issue discussed above, we propose an email application system for illiterates so that they can be uniquely identified by profile building. As suggested by Avila et al. [Avila and Gudwin (2009); Deo, Nichols, Cunningham et al. (2004); Findlater, Balakrishnan and Toyama (2009); Toyama, Sagar and Medhi (2009); Huenerfauth (2002)], the UI of this application is designed to reduce the amount of text as much as possible. As an alternative, vocal help is used to guide the users. Besides, the interface design is self-explanatory and user friendly so that illiterate users feel comfortable when using it. Similarly, the application uses voice messages in place of text-based messages as used in traditional email applications. Consequently, the application UI is based solely upon voice-based interaction. Nevertheless, the UI design is flexible enough so that text-based interfacing can later be included as future work. We have initially avoided this practice to follow the simple HCI rule, i.e., "Simple is better". An additional reason was that the concerned user community can understand only Pushto and Hindko, and the state-of-the-art in such applications exists for the universally

accepted English language only. Therefore, a separate interface would be needed for these conversions, which can then be embedded within our proposed application.

The application consists of an email environment. It displays a multitude of pages to its illiterate users for their profile building. The first page displays two buttons in red and green colors as shown in Fig. 1. Along with these, the user is also given a vocal instruction in Pushto and Hindko explaining the purpose of these buttons in the background, i.e., the user is asked to select the green button for Pushto and the red one for Hindko. Subsequently, all instructions are given in the language that is selected. The next page shows options for choosing gender as shown in Fig. 2 followed by another page to choose profession. Such data can also be used for finding jobs for these masses. Professionally sketched Images were used in the application as shown in Fig. 3. Likewise, on the next page, the window prompts the user for sign-in options: it shows a red cross mark and a green tick mark. Vocal instruction in the background confirms if the user has an account or not. Also, it instructs the user to click the green tick box for "Yes" and the Red Cross sign in case of "No". This step is shown in Fig. 4.

The users were able to repeat the background vocal messages as many times as they want. Furthermore, the questions asked by each user are saved as part of their profiles. When the user clicks on the green tick box, this confirms that he/she already has an account with the application. Therefore, he/she is asked to select his/her user name by viewing his profile picture, thus avoiding text and focusing on photos. After the selection of the profile picture (i.e., the username), the user is asked to select a specific sequence of pictures that he has previously stored as his password. Upon completion of this sequence, it is compared with the original one stored in the database. Success in this results in the user being logged in; otherwise, he is asked to re-enter the correct sequence.
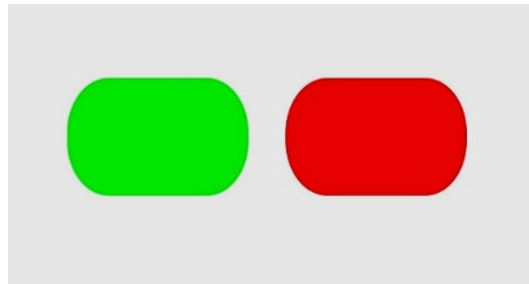

Figure 1: Language selection

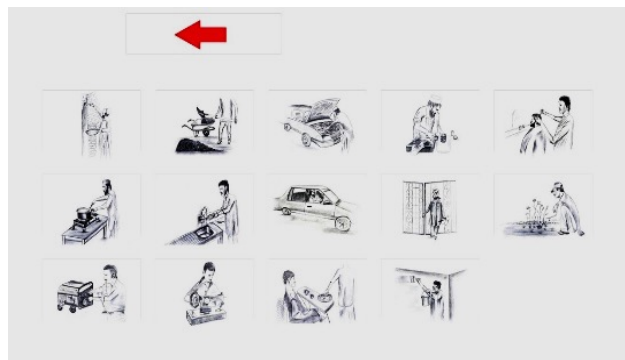**Figure 2:** Gender selection

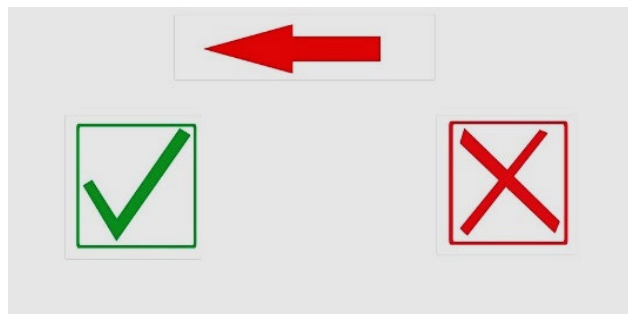**Figure 3:** Profession selection

Figure 4: Sign up/sign in

If the user does not have his account with the application, he is supposed to select the red cross box after which he is directed to the page, where he can capture his picture via webcam and guided through vocal instruction. This picture would later be used as his username. For this, a camera icon is given which is accompanied by a Green colored tick mark to confirm the picture and a Red cross to cancel it and take another picture. Fig. 5 illustrates this in the form of a screenshot. After this step, he is asked to enter his password by selecting four photos from a given album as shown in Fig. 6. Following this step, the user is ready to enter the email inbox.

As far as e-mail composition-the principal part is concerned, the subject field has multiple options. These include recording an email by clicking its dedicated icon (a hand holding a pen) and listening messages (Red color for unread messages and green for read messages). Fig. 7 shows these options pictorially.

The email recording works in a way that the user is asked to first select a photo of the recipient (again focusing on photo for ease, rather than text-based email ID of recipient), as shown in Fig. 8. After this, he can record his message for which he has to click on the microphone icon. When done, he can stop recording by clicking on the stop icon. The user can listen his recorded message by clicking on a speaker icon. Finally, he can send the email by clicking on the lock icon. This is demonstrated in Fig. 9.

For the other way round; i.e., if the user wants to listen to received emails, he can do so by a set of simple steps. In a similar fashion, as discussed for email sending, the user selects the received email by clicking on the sender's photo. Afterwards, he selects the speaker icon and listens to the audio message, which he can delete after listening. These steps are shown in Fig. 10.
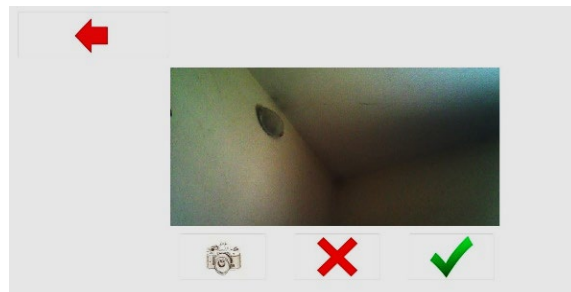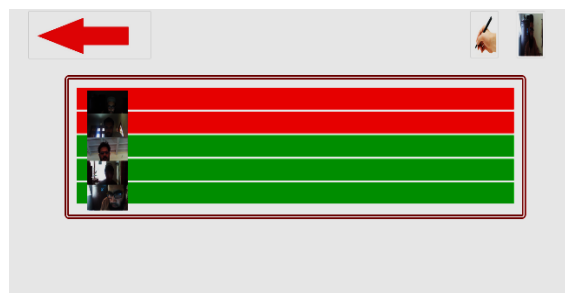
Figure 5: Picture capture

Figure 6: Password selection
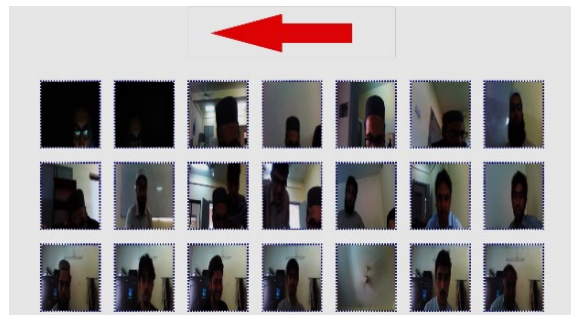
Figure 7: Email page

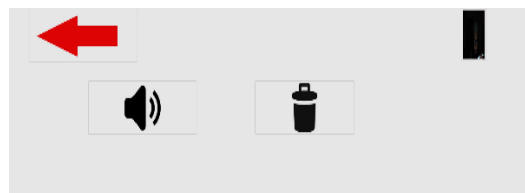**Figure 8:** Select Receiver's Picture

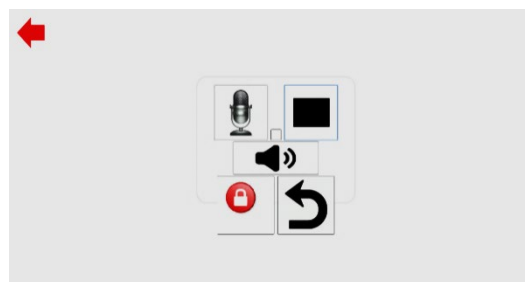**Figure 9:** Email recording page

Figure 10: Email listening page

It is customary to mention here that we have deliberately included the back button in each of the screens so that the user may easily navigate back and may listen to vocals repeatedly.

5 Usability tests

This section summarizes our evaluation and analysis of the final application by testing it on various users. We tested the application on 180 people with an equal ratio of illiterates and literates, i.e., 90/90. To better understand and categorize the findings of these tests, we have summarized them in Tab. 1. It includes various entities like the interaction ability of each user, education, and age. The table highlights the time taken by each user to use the application, as well as the problems faced during this time.

This was done with the aim that the user could focus on each step without any haste and we may infer correct approximations about the UI. The evaluations were largely based on the following research questions:

1. What mistakes do the users make while using the UI of the application?
2. Which part of the UI they use without any hesitation and audio help?
3. How many times on average do they repeat the vocal instructions?
4. Which part of the UI is unused by the majority of users?

The prime objective behind these evaluations was to find out the way an illiterate user uses this application without any training. Moreover, we aimed to approximate the level of computer/email understanding gained by an average illiterate user after using this application. Additional research questions that were addressed in these evaluations include:

1. Does the user understand this email application by himself without third-party help?
2. Does he/she remember the password?
3. Does he/she understand the purpose of a password and email?

Tab.1 further reports these evaluations. As already mentioned, there were a variety of users that took part in the testing phase. These users have been categorized into three types based on their computing skills (Good, Fair, Nill).

Subjects' Computer Literacy:

●**Good:** Users in this category had used computer/mobile applications earlier and had the basic knowledge of using emails.

●**Fair:** Users in this group knew little about computer usage. They could open files (e.g. playing a song stored on the hard disk) so their activity was offline.

●**Nil:** These users have zero literacy about computer usage.

Table 1: Excerpt from Results of different users for the Email application

Subject Name	Age	Education	Computer Interactivity	Mobile Interactivity (Smartphone)	Time (minutes)
User 1	23	Nil	Nil	Good	4
User 2	24	Nil	Nil	Nil	7.2
User 3	17	10th class	Good	Good	5.8
User 4	35	Nil	Nil	Nil	7.3
User 5	17	5th class	Nil	Good	6.8
User 6	28	10th class	Nil	Nil	7.9
User 7	40	10th class	Nil	Nil	8.8
User 8	19	Nil	Nil	Nil	7.1
User 9	38	10th class	Good	Good	8.2
User 10	21	Nil	Nil	Nil	7.4

6 Results

We tested our application on 180 people having knowledge of Pashto and Hindko languages. Half of them were illiterates while half were literates. Literates used the application by themselves while the illiterate users were directed about the steps of using the application for the first time. Listed below are some prominent deductions that we made:

Throughout the testing phase, we analyzed that the design was usable. Not even a single subject found it difficult to use. Especially the illiterate users were satisfied by using the application. After using the interface, these users commented that the application is 'interesting' and 'easy'. This helped them overcome the hesitation they had for computer usage, specifically for the touchpad of laptops. We analyzed that by following instructions, they tend to remember the very first or the very last instructions and act accordingly.

As we have used sketches as well as pictures in our application, we observed that the illiterate people were good at remembering pictures with no background and colored content, e.g., tomato or chair etc. Hence, such pictures were used for passwords. We found out that they can remember any picture or sketch that doesn't have background information and focus on the object/action in the sketch/picture.

Using repeated background vocals as instructions have been proved helpful. The illiterates used to listen to every instruction and learned by following them. These instructions worked out for them because we kept them as precise as possible. Apart from this, the UI used less number of icons on each page so that the users may find it easy to identify what they are supposed to do. In this way, the instructions can be easily divided into multiple pages and the task becomes simpler for an illiterate user. Like in the UI under discussion, one instruction is repeatedly prompted for until the user correctly completes it. The user can proceed and see the next step/page in the process only after following the previous instruction.

We used black and white sketches, colored boxes, colored pictures, and colored signs throughout the UI of this application. To this aim, the color combinations for blind people were given special emphasis. We used less options on a single page so that they can select from a maximum of three icons. With all these measures taken, the UI design turned out to be usable enough for illiterates; as verified by the usability tests.

We observed a certain time variance of using our application by the literates and illiterates users. On the average, the illiterate users did their task (sign up and sending email) in almost 7.5 minutes; while the literates did the same in 5 minutes. We also found out that once the illiterates create their account, and are asked to log-in again; they don't even hear the instructions but repeat the steps learnt previously. This was the main success of the application that it is easy to learn as well as memorable. These users not only remembered their choices but also summoned up the photos for their username and passwords.

7 Conclusion and future work

In this paper, we developed an email application specifically for illiterate and semi-illiterate people. The application design is based on the idea of using pictures and voice for user interfaces instead of text. For evaluating our developed application, we gave it to different types of users based on their education/skills level. The results were collected from a total of 180 people which demonstrate that using precise voice instructions, less icons, simple/clear photos help the illiterate people in using email applications. Such design principles yield an effective UI that is usable as well as memorable for the mentioned community of users.

As a future endeavor, we intend to increase the scalability of this application so that more user groups can use it. Currently, the application addresses the challenges faced by a unique group of users i.e., the illiterates. In future, additional features can be added, e.g., for the farmers to get information about the weather and their crops. They can share such information with other farmers.

Additionally, we aim to resolve the design issues that we faced during this work to make it compatible with all platforms including mobile devices. Further, the current application design focuses on two services; namely, login and email for illiterates. The results for both services show affirmative accomplishments; however, we intend to improve them by increasing the security of the system.

As a secondary upgradation, we plan to include more languages for emails to make the application usable in other regions of the world. Also, another feature of adding voice-to-text conversions and vice versa can be added in the application.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

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