Identifying a Secure E-Examination User Interface for Testing Illiterate Drivers

Dr. Ejeh Patrrick Ogholuwarami[1] Clement A. Keyamo[2] Obiageli Modupe Attoh[3] Ogechi Peace Edun[3]

Department of Computer Science, Dennis Osadebay University, Anwai, Asaba[1]
Department of Cyber Security, Dennis Osadebay University[2,3]
Patrick.ejeh@dou.edu.ng[1] Clement.keyamo@dou.edu.ng[2] Attoh.obiageli@@dou.edu.ng[3]
Ogechi.edun@dou.edu.ng[3]

Abstract

In Nigeria, illiterate and other educationally challenged persons are permitted to obtain Driving Licenses but are not exempted from the required Competency Tests. Standard Oral Tests are being replaced by Online Computer Based Test (CBT). This creates a challenge for the illiterate and educationally challenged persons since the replacing CBT systems are wholly designed for the literate examinee. Designing an Online Examination Platform with the capacity to attend to illiterate and other educationally challenged persons requires an in-depth study. Two challenges are paramount: first is identifying a suitable authentication scheme(s) for the online system that can guarantee the integrity of the tests; second is building an interface that is friendly to the users, thus accommodating their challenges. Based on the aforesaid challenges, the overall aim of this research paper was to determine an appropriate authentication scheme and requisite interface that can solve the identified challenges. To accomplish this, relevant data was gathered from the review of related works. The findings show that video/image/picture annotated with audio formats were the most viable for designing User -Interface for the illiterate and that the use of numbers as passwords was acceptable to functionally illiterate persons. It was then recommended that a prototype User Interface and associated Authentication System for online CBT-based competency testing of Drivers be designed and implemented based on the data gathered from this paper.

Keywords: E-Exam, User Interface Design, Authentication Schemes, Graphical Passwords

1. Introduction

Nnamdi (2011) defined Road Traffic Administration as an act to regulate, and control vehicular traffic on highways and the licensing of such vehicles and persons in charge of same as well as other related matters.
Keyamo (2014), reports that Road Traffic in Nigeria dates back to the colonial era and that the first traffic edict enacted was the Road Traffic Ordinance of Lagos Colony and Southern Nigeria.
Presently, three agencies of government are observed to be in charge of administering Road Traffic in Nigeria: the Federal Road Safety Commission (FRSC), the Motor Licensing Office (MLO) of the Board of Internal Revenue (BIR), and the Vehicle Inspection Department (VID) of the Directorate Transport (DT) of the various states and the Federal Capital Authority (FCT). These three agencies are said to work in tandem in a tripartite arrangement.

By this arrangement, the FRSC is mandated to produce plate numbers for vehicles and plastic licenses for drivers after due approval by the other two organizations.

The responsibility of the MLO is fundamentally revenue collection in the sector and validation of collected revenue while the VID is responsible for the inspection of Motor Vehicles for issuance of Road Worthiness Certificates, Testing of Drivers for the issuance of Driver Licenses, Inspection of Vehicles involved in accidents, among other functions.

In discharging their responsibilities as highlighted by the National Road Traffic Act (2012), and the Delta State Road Traffic law (2006), the organizations are reported to have embraced the use of Information and Communication Technology (ICT), achieving some levels of success in the process. Keyamo (2014), reports that the Delta State Government successfully automated some aspects of Road Traffic management in the State, using Public Private Partnership (PPP) schemes. The aspects automated are reported to only address issues relating to financial transactions. That is, the systems were essentially transaction processing systems. Other relevant areas, such as Testing and Certification of Drivers were overlooked.

The overlooked areas are wholly manual processes with inherent challenges. Keyamo (2014) & Ikechukwu (2012) itemized some of the challenges associated with some of these manual systems in Delta State and Nigeria including the existence of a lack of manual storage space for the high volume of generated documents meant for safekeeping and retrieval by states' Central Motor Registry (CMR), a division of the DT responsible for the storage of Road Traffic data and information, amongst other duties; fraud and manipulation of data; improper and inaccurate records of persons and records of vehicles; inefficiency, amongst other challenges.

Solutions have been proffered that resolve these challenges in the still manual aspect of Road Traffic Management in Nigeria. As an instance, Keyamo (2014), implemented a prototype system that automates the Delta State CMR, fusing it with Social Media using simple links, in a bid to resolve the aforementioned challenges in the Delta State Clime. However, many areas in the subsector are still unattended. In some cases where attempts have been made to replace manual systems with computerized ones, it has been directly observed that the replacing systems are functionally inadequate to meet the full needs of the challenged areas.

One such area, the Testing, and Certification of Drivers for issuance of Driving Licenses is the focus of this study. In the manual process for the issuance of a driving license, a Driver, after undergoing generalized training in a registered Driving School, is issued a General Certificate of Driver Education (GCDE), with which he applies for a Driving License. To obtain the License, the applicant must pass a Competency Test administered by a Vehicle Inspection Officer. This test is presently an oral examination coupled with a practical Driving Test.

Recently, the Federal Government, in collaboration with the Nigerian State Governments, introduced Computer Based Test (CBT) for Drivers at the Driving School end of the process. These CBT systems are wholly designed for literate examinees. This Creates a Challenge for The Illiterate and Educational Challenged Persons since they cannot use such systems. Illiterate and other educationally challenged persons are permitted to obtain Driving Licenses In Nigeria but are not exempted from the required competency tests (National Road Traffic Act & Delta State Road Traffic law, 2006).

Rahman & Fukuda (2015), identified the different kinds of illiterate persons that may suffer drawbacks in the use of online systems including the computer illiterate, media illiterate, visual illiterate, language illiterate, migrant illiterate, and so on. Some individuals may be efficient in their local languages but may have a challenge in others. From the above, it can be deduced that most individuals fall into a kind of illiteracy at one point or another. Again, illiteracy varies from highly skilled to functionally illiterate persons under every specific

condition. In Nigeria, by direct observation, a large number of professional drivers fall into one category of illiteracy or the other. Many are functionally illiterate and have challenges using most technology, including computer-based technology.

How can these persons, then, be integrated into the present CBT system implemented for assessing Drivers at the Driving School end, without further compounding the effect of their educational limitations and denying them their rights to obtain Driving Licenses? This is a question that requires an immediate answer. One solution is to design an Online Examination Platform with the capacity to attend to illiterate and other educationally challenged persons. To achieve this, Two challenges are paramount: first is identifying a suitable authentication scheme(s) for the online system that can guarantee the integrity of the tests; second is building an interface that is friendly to the users, thus accommodating their challenges.

How do we develop such systems for the functionally illiterate? Prasad et al., (2008) report that the emphasis of research in the area of designing User interfaces for the illiterate is on contextual design methods since illiterate users are much different from normal target users. This implies that in designing User Interface for the illiterate, the specific target groups must be considered. For instance, if the target groups are Rural Farmers or Vehicle Drivers, then these groups must be part of the data-gathering processes preceding the User Interface design. Rahman & Fukuda (2015) were able to develop such an interface that allows functionally illiterate persons to learn and use a system without any help from another person.

In the case of selecting a suitable authentication scheme for the aforesaid system, Stajano et al, (2012), have recommended that usability and deplorability must be key issues in selecting and implementing security schemes. That is, as with the design of User Interfaces, contextual issues play important role in selecting authentication schemes since such schemes must be usable by target groups.

Therefore, based on the aforesaid challenges and accompanying discussions, the overall aim of this research paper is to determine an appropriate authentication scheme and requisite interface that can be implemented on an online CBT system that can solve the identified challenges. To accomplish this task, relevant data is to be gathered from the review of related works. The gathered data is expected to be sufficient in assisting system developers in making informed choices in selecting a suitable authentication scheme, and designing an appropriate User Interface that can enable functionally illiterate Drivers to undertake a competency online test.

The rest of this paper is structured in the following way: section 2 covers user interface design for illiterate persons, section 3 deals with implementing authentication schemes for functionally illiterate person, section 4 summarizes the work, and section 5 gives some recommendations based on the findings made.

2 User Interface Design for Illiterate Persons

Rahman & Fukuda (2015) identified and categorized approaches used by researchers to develop User interfaces for systems meant for the functionally illiterate. The use of text and numbers, the use of graphics with limited text, and the use of graphics, text, and audio, are the categories identified. The limitations of some of the mentioned categories were also stated. In the case of the use of numbers instead of texts, it was claimed by Rahman & Fukuda (2015) that numbers were more relevant in mobile

phone interface design where large multimedia files may not be available. For speech recognition usage in interface design, it was observed that it was difficult to train the system to work efficiently with an increasingly large number of persons. That is, the system became increasingly less efficient as the number of users increased.

Furthermore, Rahman and Fukuda (2015), recommended the following useful tips for developing a user interface for functionally challenged illiterates:

i. Reduce the extent of hierarchical navigations. The target users may have a challenge navigating extensive menus;

ii. Avoid new concepts as much as possible by maintaining natural and familiar flows in navigating menus;

iii. Use graphics for item selection instead of text;

iv. Use colored highlights like blinking buttons to attract users to important items they need to interact with;

v. Use audio annotations in cases where clarity is required for selecting menus and;

vi. Use short audio messages to describe the purpose of each page and/or menu, each time a page is opened or loaded.

Prasad et al., (2008) explored the possibility of emails being made available to the functionally illiterate. To achieve this, an Interface structured to allow illiterate people to interface with computers to 'read' their mail was designed. The research, which closely correlates with the work of Rahman and Fukuda (2015) findings, considered several formats for the interface design, including, text, audio, video, and graphics, and used iterative usage and design sessions to refine the design.

From the research, Prasad et al., (2008) realized that the use of graphical imagery is not only preferred to text but that the nature of the graphics used can make a huge difference. Also, hand-drawn images annotated with voice messages seemed to be the preferred choice of the target groups used in their research. Also, it was discovered that the use of numbers was acceptable by the target groups over text (which was claimed should not be used). Furthermore, Prasad et al., (2008) insisted that the designed User Interface for the illiterates should have easily accessible voice feedback and help throughout the Interface as it allows for better autonomous usage of the designed interface. It was then concluded that video-audio formats were the most viable for designing User- Interface for the illiterate.

Jan et al,(2019), however, did not base their research on any developed system, but rather systematically reviewed works carried out by researchers of Human-Computer Interaction for Development(HC14D) and extracted design recommendations for User Interfaces for functionally illiterate persons, from the review.

Their review covered four contextual areas: Health; Agriculture; E-commerce and; Education. They report that designers of User Interface for the functionally illiterate are challenged in two major areas; first, a lack of education by their target users, and second; the inability of the potential users to use text. In summarizing their work, they state that people have a preference for voice instructions, less text, and clear photos or pictograms. They conclude that, in designing User Interfaces, the illiterate, semi-illiterate, and literate should be treated separately. Finally, in close agreement with Prasad et al., (2008), & Rahman & Fukuda (2015), they recommend video, audio, audio clips, speech technology, and touch screen for functionally illiterate individuals, while for semi-non-literate, they recommend multimodal interfaces (voice, pictures or diagrams and text) should be used in designing User Interface. Table 1 summarizes User Interface generalized design recommendations based on their work.

Table1. User Interface generalized design recommendation for educational use, (Jan et al., 2019

Interface	Recommendation
Voice, text multimodal	Effective for semi-non illiterate users
Text, free form, ink, audio video, audio	Video was the most viable for non illiterate
Audio clips, textual labels	Audio clips are effective for target population
Video and touch screen kiosk	Illiterate users
Icons, text free	Icons are effective for non-literate users

3 Implementing Authentication Schemes for Functionally Illiterate Persons

Concerning the implementation of authentication schemes for the functionally illiterate, the work of Stajano et al, (2012), who evaluated two decades of proposals to replace text passwords, is of interest. The work reports that replacing passwords as the preferred choice for authenticating users was difficult because none of the proposed alternatives came close to providing the benefits inherent in the password system of authentication. Many schemes may offer better security features, but in return, turn out to be more expensive or difficult to implement. Furthermore, the study claims that many of these proposals fail because the researchers did not consider a wide range of real-world limitations.

According to Stajeno et al, (2012), designers of authentication schemes tend to focus more on security, but less on usability and deployment issues. This is a very important point. After all, what use is a very secure system that is not implementable or usable?

It suffices that, to be useful, every system must be usable by the target group, therefore usability must be a key issue in selecting and implementing security schemes. Thus, one may claim that contextual issues play important role in designing authentication schemes since such schemes must be usable by target groups.

Ologundudu & Sakpere (2021), who defined authentication as determining who gains access to certain systems or resources, and carried out a usability study on textual and graphical passwords, agree with the above views of Stajeno et al, (2012). Though the research work of Ologundudu & Sakpere (2021), is not specifically targeted at the design of systems for the functional illiterates, their findings present useful data relevant to the present study.

According to Ologundudu & Sakpere (2021), Novel password schemes(text-based) have the advantage of usability but are susceptible to attack using brute force, shoulder surfing, and dictionary attacks, amongst others. Memorability issues also limit novel password schemes as authentication schemes since users tend to use the same passwords across several platforms. Memorability implies the capacity for a user to easily remember his chosen password. This would influence the usability of a system. That is, if the system creates memorability issues, then the system becomes increasingly difficult to use. This is a very important consideration when building systems meant for illiterates as they have challenges in this regard. These limitations to novel pass word schemes are said to have spawned the design and implementation of alternative password schemes.

Ologundudu & Sakpere (2021), then highlight the benefits of graphical passwords as an alternative to novel text-based passwords. A graphical password scheme involves the user selecting a series of images or points of an image in a particular order. Users can recall images, faces, and places for longer periods than texts and figures, according to Ologundudu & Sakpere (2021), and this makes the graphical password more secure and more effective in

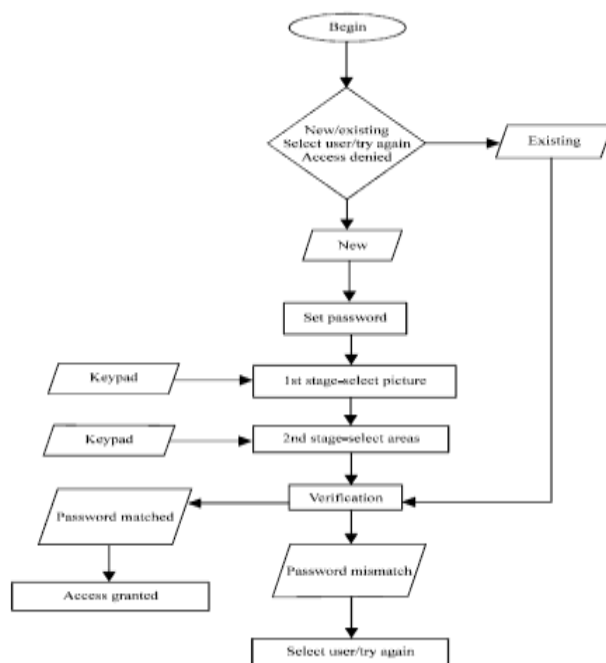terms of memorability. Figure 1 depicts a generic algorithm for a graphical password scheme.

Figure 1: generic graphical authentication scheme (Siva et.al., 2014)

With the diversity of tools available for authenticating Users and knowing that the use of one over another is determined by contextual issues, there is a need to have a system that can be used to determine the comparative usability of a planned tool seeing how important this is. How does one select a suitable scheme that can satisfy usability and memorability requirements in comparison to a set of alternatives?

Stajeno et al, (2012), proposed a standard benchmark and framework for rating such schemes. It is claimed that the benchmark allows schemes to be rated using a common spectrum of defined 25 properties. Such a scheme can be useful to a designer in selecting a suitable authentication scheme from a set of alternatives. For instance, in selecting a security scheme for illiterate persons from a set of alternatives, a designer may consider this framework as an effective tool for that purpose.

Stajeno et al, (2012), later demonstrated the effectiveness of their proposal by testing 35 password alternative schemes and comparing them with the legacy password scheme. Their findings are quite interesting. One clear result of their work was that no security scheme was perfect. Password (that is, legacy or text-based pass word) remained dominant over other schemes, though some schemes may have advantages over them in some areas. For example, in terms of security, most schemes did better than a password, but for deplorability, (and in several cases, usability) password was king.

One important result of this work that may be useful in the planned design of an Interface and Authentication System for Drivers is that a kind of password scheme for illiterates may always be useful. Can passwords for illiterate persons be made practically feasible, knowing that most of such schemes are textual? We have seen from Ologundudu & Sakpere (2021) that in generalized systems, graphical passwords are not only good but may be preferable to

legacy password schemes. What about the targeted functionally illiterate persons? Are graphical password schemes feasible in this context?

Prasad et al, (2008) did some work on the use of pictorial password schemes for authenticating illiterate persons. The research recorded several challenges associated with implementing pictorial password schemes including including: the inability of users to recall a set of images in the ordered sequence, amongst others. To solve this challenge, they introduced numerals as passwords. That is, for User- Interface design, no textual inputs were required. Users' pictures were used as login ID, while a sequence of numerals was considered for passwords. So for functionally challenged persons, numerals may be more feasible over graphics as an alternative to legacy passwords, the reason being that it is easier for the illiterate to recall a series of numbers than it was to recall a series of images. Though the two are feasible, it may be easier to design a more usable system with numerals than with images. This is subject to further investigation as the issue of context, again, determines what and what not to implement (Stajano et al, 2012 & Prasad et al, 2008).

4. Findings

The following findings were made from the reviewed literature that may be useful in the design of a suitable User Interface and Authentication System for an online CBT system for the Competency Test of illiterate Drivers in Nigeria:

i. in designing User Interface, the illiterate, semi-illiterate, and literates should be treated separately;

ii. the use of graphical imagery is not only preferred to text but the nature of the graphics used can make a huge difference;

iii. Hand-drawn images annotated with voice messages are preferred by the functionally illiterate in User-Interfaces;

iv. video- audio formats were the most viable for designing User- Interface for the illiterate;

v. replacing passwords as a preferred choice for authenticating users was difficult because none of the proposed alternatives came close to providing the benefits inherent in a password system of authentication;

vi. The use of numbers for passwords was acceptable to illiterate persons as a means of authentication in online systems;

vii. Usability, memorability, and deplorability are key issues in selecting and implementing security schemes for challenged persons;

viii. The Stajeno et al, (2012), proposed benchmark and framework for rating authentication schemes can be useful to a designer in selecting a suitable authentication scheme from a set of alternatives.

4. Summary

This paper focuses on identifying a suitable Authentication Scheme and associated User Interface that can be used in the design of an online CBT system for testing illiterate drivers in Nigeria for issuing Driving Licenses. The Nigerian government by her road traffic Acts and Laws recognizes the right of the functionally illiterate to obtain Driving Licenses. The recent trend of replacing the oral competency test administered to applicants practically limits the prospects of illiterate persons since they cannot use such systems with designs that are mainly for the print literates. To accommodate the challenged persons, therefore, there is a need to develop a system that is accessible to them.

Related works were reviewed to identify important pointers to solve the present challenge. Among others, it was realized that functionally challenged persons preferred voice annotated

images or pictures or videos as tools for User Interface design and accept pictures, numerals, hand drawn images over text for authentication purposes.

5.0 Recommendations

It is recommended that a prototype User Interface and associated authentication system be designed and implemented based on the data gathered from this paper. Also, the proposed prototype should be tested iteratively using real life subjects selected from illiterate drivers in the Nigerian clime to gather more research data that can further improve what has been done in developing User Interfaces in this area generally and in building a CBT systems that can be used specifically in the Driver Licensing Sector in Nigeria.

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